Historical Landscape Change in Remote Mountainous Parks: Management Challenges Observed Through a Repeat Photographic Lens

by

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B.A., McMaster University, 2011

A Thesis Submitted in Partial Fulfillment
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Abstract

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Remote ecosystems in Canadian Rocky Mountain parks and protected areas are being pressured by indirect impacts of human activities across the landscape. Ecological impacts can result from a variety of stressors such as climate change, fire suppression and prescription, visitor use, invasive species, and surrounding land-uses. With intensified challenges relating to logistics and moral issues inherent in remote ecosystem management (Higgs and Hobbs, 2010; Higgs and Roush, 2011), managers of these landscapes continue to struggle with questions of "what do we do here?" For ecological restoration and conservation management, historical landscape changes (predominantly following years of fire suppression and rapid climate change) are complicating decisions and our understanding of ecological processes. While intervention may become increasingly necessary for maintaining biodiversity and ecosystem services under conditions of rapid change (Hobbs *et al*., 2011), direct action may not be the most appropriate tactic, especially when lacking adequate information and foresight (Harris *et al*., 2006; Higgs and Roush, 2011).

This study investigates observable historical remote landscape change in two protected areas in the Canadian Rockies, and examines the resulting implications for management and restoration. Present conditions in Willmore Wilderness Park and Mount Robson Provincial Park were evaluated in a comparative case-study approach. The influence of factors such as jurisdiction, climate, socioeconomics and settlement history were seen to strongly shape how environmental changes impacted management efforts and decisions. Long-term landscape changes were observed through repeat photography with the Mountain Legacy Project. Through focus groups using photo-elicitation with park managers, repeat photo pairs guided discussion. I pursued this research question: "how do long-term landscape changes influence conservation and restoration objectives in remote mountain ecosystems?" This also incorporated subsidiary questions: "what are the inherent challenges in managing (and restoring) remote ecosystems?" and "how could managers of remote ecosystems best approach these issues in the face of rapid ecological change?" Significant landscape changes are observed in both parks and include glacier retreat, forest stand aging, valley infill (encroachment) and upward movement of the treeline ecotone. While ecological changes are seen as significant and as threatening to various park values and public safety, efforts to better understand these changes or address them are limited. The majority of remote ecosystem management efforts in both parks are indirect (passive), with the exception of fire management. This is largely due to capacity and resource constraints, and agency recreation mandates and visitor needs monopolizing manager focus. Suggested restoration efforts would assist climate adaptation and reduce indirect impacts without placing notable pressure on remote ecosystems. The use of repeat photography for monitoring of ecological change is a strong possibility for parks management, particularly if public engagement through citizen science was implemented to minimize dependence on management resources.

Table of Contents

Supervisory Committee ..... **ii**

Abstract ..... **iii**

Table of Contents ..... **iv**

List of Tables ..... **vi**

List of Figures ..... **vii**

Acknowledgments ..... **x**

Dedication ..... **xi**

Introduction **1**

Chapter One: Ecological Restoration and Remote Mountain Areas **3**

1.1 Historical Context of the Canadian Rocky Mountains **3**

1.1.1 History of Photo-topographic Surveying 4

1.1.2 The Rocky Mountains Today 9

1.2 Ecological Restoration **9**

1.2.1 Historical Development 10

1.2.2 Ecological Restoration Today 10

1.3 Remote Ecosystems: Remote From What? **14**

1.4 Protected Areas Management **15**

1.4.1 Historical Development of North American Parks and Protected Areas 16

1.4.2 Canadian Parks and Protected Areas Today: Challenges and Pressures 17

1.4.3 Best Practices, Assessment Frameworks, and Reflexive Steps Forward 22

1.5 Summary **24**

Chapter Two: A Tale of Two Parks **26**

2.1 Mount Robson Provincial Park **26**

2.1.1 Biogeography 28

2.1.2 Settlement History 34

2.1.3 Park Development and Management History 38

2.1.4 Current Management Aims 43

2.1.5 Local Socioeconomic Conditions 51

2.1.6 Ecological Restoration and Remote Ecosystems 53

2.1.7 Summary 55

2.2 Willmore Wilderness Park **56**

2.2.1 Biogeography 57

2.2.2 Settlement History 66

2.2.3 Park Development and Management History 69

2.2.4 Current Management Aims 70

2.2.5 Local Socioeconomic Conditions 74

2.2.6 Ecological Restoration and Remote Ecosystems 75

2.2.7 Summary 78

Chapter Three: Methods **79**

3.1 Comparative Case Studies **79**

3.2 Data Collection **80**

3.2.1 Repeat Photography ... 80
3.2.2 Photo Elicitation ... 100
3.2.3 Focus Groups ... 103
3.2.4 Individual Semi-structured Interviews ... 109
3.3 Content Reductive Analysis ... 111
3.4 Limitations ... 113

Chapter Four: Findings ... 115
4.1 Management of Remote Ecosystems ... 122
4.2 Valley Infill ... 129
4.3 Upward Movement of the Treeline Ecotone ... 134
4.4 Homogeneity of Forest Stands ... 136
4.5 Wildfire and Prescribed Burns ... 141
4.6 Philosophical Differences and Interagency Collaboration ... 146
4.7 Societal Shifts Impacting Management ... 147
4.7.1 Changing Visitor Use ... 147
4.7.2 Industrial Development and Capacity ... 149
4.7.3 Public Education ... 152
4.8 Climate Change ... 154
4.9 Chapter Summary ... 159

Chapter Five: Synthesis ... 161
5.1 The Two-Park Comparison: Across the Continental Divide ... 163
5.2 Repeat Photography and Photo Elicitation ... 164
5.3 Intervening in Remote Ecosystems ... 166
5.4 Conceptual Challenges: Managing for What? ... 167
5.5 Expanding Ecological Restoration in the Parks ... 171
5.6 Climate Change ... 177
5.7 Restoring Remote Ecosystems - Additions to the Literature ... 182
5.8 Recommendations and Future Work ... 183
5.9 Conclusions ... 188

Works Cited ... 190

Appendix A: List of Abbreviations ... 210

Appendix B: Participant Recruitment Materials ... 211

Appendix C: Human Ethics and Participant Consent Form ... 215

Appendix D: Focus Group Materials ... 218

Appendix E: Follow-up Interview Materials ... 222

Appendix F: Repeat Photography ... 225

Appendix G: General Figures ... 232

List of Tables

Table 1: WCPA Management Effectiveness Evaluation Framework 23
Table 2: Biogeoclimatic zone representation in Mount Robson Provincial Park 32
Table 3: Mount Robson Provincial Park zonations as compared to IUCN zones 48
Table 4: Elements incorporated into the BC Parks Long-term Ecological Change Monitoring Program 55
Table 5: Repeat photo pairs used 85
Table 6: Number of individual codes within final Excel spreadsheets 112
Table 7: Key Themes of Analysis 116
Table 8: Participant views of remote ecosystems and remoteness as a concept 123
Table 9: Ecological indicators for assessing ecological integrity 179
Table 10: Commitments and changes recommended 181
Table 11: Synthesis of general recommendations 183
Table 12: Potential future research 186
Table 13: Biophysical characteristics of natural subregions of Alberta……..…..…….225

List of Figures

Figure 1: Two crewmembers from Bridgland's 1914 survey of the Rocky Mountain Forest Reserve (MLP, 2014) 5
Figure 2: Grid overlay on survey photograph (Adapted from Bridgland, 1924) 6
Figure 3: Glass plate negatives over light table (Photo credit: Eric Higgs, 2004) 7
Figure 4: Conceptual model showing potential edge effects of land-use change on protected areas' functioning (Adapted from Hansen and DeFries, 2007) 18
Figure 5: Canadian Rocky Mountains World Heritage Site (Adapted from Y2Y, 2014) 20
Figure 6: Map of Mount Robson Provincial Park (adapted from BC Parks, 2011) 27
Figure 7: Mean annual temperature changes in Canada, based on climate data from 1950-2007 (Adapted from Zhang *et al*., 2011) 30
Figure 8: Biogeoclimatic zones of the Canadian Rocky Mountains Ecoregion, BC (Adapted from Nature Conservancy of Canada, 2004) 31
Figure 9: The traditional territory of the Simpcw First Nation, relative to the Robson Valley Land and Resource Management area (Adapted from Patterson, 2010) 35
Figure 10: Kinder Morgan Canada Inc. pipeline route (Adapted from Novak and Fryer, 2009) . 41
Figure 11: Mount Robson Provincial Park additions 2010 (Adapted from BC Parks, 2011) 42
Figure 12: Orthographic photo showing proposed treatment zones in Mount Robson Provincial Park, as recommended by the Forest Health Strategy, 2005 (Adapted from B.A. Blackwell and Associates, 2005) 44
Figure 13: Mount Robson Provincial Park forest seral stage distribution (Adapted from B.A. Blackwell and Associates, 2005) 45
Figure 14: Mount Robson Provincial Park fire hazard (Adapted from B.A. Blackwell and Associates, 2005) 46
Figure 15: Mount Robson Provincial Park zoning plan (Adapted from BC Parks, 2011) 47
Figure 16: Core Visitor Area Zoning Plan, Mount Robson Provincial Park Management Plan 2011 (Adapted from BC Parks, 2011) 49
Figure 17: Yellowhead Corridor West Intensive Recreation Zoning Plan, Mount Robson Provincial Park Management Plan 2011 (Adapted from BC Parks, 2011) 50
Figure 18: The Robson Valley, as organized by the Robson Valley Land and Resource Management Plan (Adapted from Robson Valley Round Table, 1999) 51
Figure 19: August 2011 flooding on the Berg Lake Trail, Mount Robson Provincial Park (Photo credit: Jenna Falk, 2011) 53
Figure 20: Location map of Willmore Wilderness Park (Adapted from AWA, n.d.). 56
Figure 21: Natural Regions and Subregions of Alberta Map (Adapted from AB SRD *et al*., 2005) 58
Figure 22: Natural Regions and Subregions of WWP (Adapted from AWA, n.d.) 59
Figure 23: Willmore Wilderness Park Hydrology (Adapted from: Graham and Quintilio, 2006)61
Figure 24: Species at Risk Cycle (Adapted from AB ESRD updated May 22, 2013) Retrieved from: http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/AlbertasSpeciesAtRiskStrategy/Default.aspx November 1, 2013 63
Figure 25: Historic and current range distributions of Woodland caribou in Alberta (Adapted from AB SRD and ACA, 2010b) 65

Figure 26: Traditional land use and current land holdings of the AWN (Adapted from AWN, n.d.) 68
Figure 27: Wildfire Distribution in WWP 1931-2006 (Adapted from Graham and Quintilio, 2006) 71
Figure 28: Fire Management Zones, WWP (Adapted from Graham and Quintilio, 2006) 72
Figure 29: Fire Risk and Suppression Capacity in WWP (Adapted from Graham and Quintilio, 2006) 73
Figure 30: WWP Prescribed burns, capping units and containment lines (Adapted from Graham and Quintilio, 2006) 76
Figure 31: Fire Progression Map of July 4-6, 2006 Jackpine Fire (Adapted from Bonnie Hood, 2006) 77
Figure 32: Location photo showing me lining up the repeat photo, Bull Creek Station, Kananaskis Country, Alberta July 2012 (Photo credit: Heike Lettrari, 2012)..... 81
Figure 33: The extended MLP field crew for the Mount Robson Provincial Park expedition before heading up the Berg Lake Trail, late August 2011. From Left to right, Stuart Higgs, Chris Gat, myself, Claire Higgs and Ellie Stephenson. (Photo credit: camera auto-timer) 88
Figure 34: Survey cairns can be extremely helpful in locating a photo station. Example of a prominent survey cairn in WWP, July 2012 (Photo credit: Heike Lettrari, 2012) 89
Figure 35: Historic image with cross-hairs is used to locate camera station and align tripod (Photo credit: Jenna Falk, 2012) 90
Figure 36: Mary Sanseverino holds down a small tree while I line up a photo (Photo credit: Heike Lettrari, 2012)..... 91
Figure 37: Large storm moving into eastern Willmore, August 2012 (Photo credit: Jenna Falk, 2012) 92
Figure 38: Jenna and Mary setting up WWP station, July 29, 2012; morning sun angles led to difficult sun angles for photography (Photo credit: Heike Lettrari, 2012) 92
Figure 39: Heike completes fieldnotes and takes environmental measurements at a photo station, July 2012 (Photo credit: Jenna Falk, 2012) 93
Figure 40: 2011 field crew at Ptarmigan Peak #1 Station, with the Robson Glacier in the background (left to right) Myself, Clare, Ellie and Stuart (Photo Credit: Chris Gat, 2011)..... 94
Figure 41: (left to right) Myself and Mary lining up a photo, while Heike records fieldnotes and takes environmental readings at Yellowhead Pass Station (Photo Credit: Eric Higgs, 2012)..... 95
Figure 42: (left to right) Mary and I lining up a photo at Moose Lake West #2 Station, with Moose Lake in the background (Photo Credit: Heike Lettrari, 2012) 96
Figure 43: Heike and I taking a snack break close to the Rock Lake station (Photo Credit: Mary Sanseverino)..... 97
Figure 44: MLP Director Eric Higgs joins us in the field in Clearwater, Alberta (left to right: the author, Mary Sanseverino, Eric Higgs, pilot Allison Smit) (Photo credit: Heike Lettrari, 2012) 98
Figure 45: (left to right) Myself and Mary trying to line up the photo through a dense forest stand (Photo Credit: Heike Lettrari, 2012) 98
Figure 46: Scenic photo taken from near Station 17, looking east along the Wildhay River Valley (Photo Credit: Jenna Falk, 2012) 99
Figure 47: Heike takes fieldnotes at Station 15 (Photo Credit: Jenna Falk, 2012) 100
Figure 48: Example of participant annotations on laminated photo pairs (Photo credit: Jenna Falk, 2012) 102
Figure 49: Lambart's Station #51; Lambart 1927 (top) and MLP 2007 (bottom) 127

Figure 50: Nidd Station 15 Panorama Pair; Nidd, 1944 (top) and MLP, 2012 (bottom) 130
Figure 51: Annotated copy of Nidd Station 15 historical capture showing participant emphasis on the similar valley bottom forest boundaries and nearby slope infill 131
Figure 52: Wheeler's 1923 Courier Mountain Station #251; Wheeler 1923 (top) and MLP 2007 (bottom) 132
Figure 53: Wheeler's 1911 Moose Lake West #1 Station, panorama; Wheeler 1911 (top), MLP 2012 (bottom) 133
Figure 54: Wheeler's Yellowhead Pass Station, looking west across Yellowhead Lake; MLP 2012 (left) and Wheeler 1911 (right) 137
Figure 55: Annotated historic capture from Wheeler's 1911 Yellowhead Pass Station 138
Figure 56: Wheeler's Yellowhead Pass Station, looking south towards Mount Fitzwilliam; Wheeler 1911 (top) and MLP 2012 (bottom) 139
Figure 57: Spider Station #247; Wheeler 1923 (top) and MLP 2007 (bottom) 140
Figure 58: Wheeler's Sheep Creek South Station #292, first section of panorama; Wheeler 1924 (top), and MLP 2011 (bottom) 144
Figure 59: Wheeler's Moose Lake West #2 Station; Wheeler 1911 (left), and MLP 2012 (right) 151
Figure 60: MRPP Moose Lake Prescribed Burn, 2004 (Safford and Dobson, n.d.) 152
Figure 61: Wheeler's 1911 Ptarmigan Peak #1 Station; MLP 2011 (top), and Wheeler 1911 (bottom) 156
Figure 62: The Robson Glacier, showing notable crevasse development (Photo Credit: Stuart Higgs, August 2011) 157
Figure 63: Wildhay River swell (left) and washed out Mountain Trail from flash storm, August 2012 in WWP (Photo Credits: Jenna Falk, 2012) 158
Figure 64: Annotated repeat photo (2007) from Wheeler's Courier Mountain Station showing participant labeling of the 2006 Jackpine fire, noting the fire whirl location and the fire as "man caused" 165
Figure 65: A man rests and contemplates while storms pass close to Clearwater, AB (Photo Credit: Jenna Falk, 2012) 176
Figure 66: Forest growth over rock gardens from Japanese internment camp workers. Educating and engaging park visitors about both the environmental and human legacies in the park could nurture a stronger relationship to place and to our history in and around protected areas (Photo Credit: Jenna Falk, 2012) 177
Figure 67: Wheeler 1924 Interprovincial Boundary Survey Map showing Sheep Creek South Station 292 at bottom right. 225
Figure 68: Wheeler's 1924 Sheep Creek South Station #292; Wheeler 1924 (top) and MLP 2011 (bottom) 226
Figure 69: Wheeler 1923 Interprovincial Boundary Survey Map; Courier Mountain Station 251 top center 227
Figure 70: Wheeler 1911 Mount Robson Map 228
Figure 71: Wheeler's 1923 Holmes North Station #245; Wheeler 1923 (top), MLP 2007 (bottom) 229
Figure 73: Nidd 1944 Station #11; Nidd 1944 (top), MLP 2012 (bottom) 230
Figure 74: Nidd 1944 Station #20; Nidd 1944 (top), MLP 2012 (bottom) 231
Figure 75: Coded themes of analysis as distilled from Excel. 233

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Dedication

For Harriet and Norm

Who gave me my appreciation of Nature,

and showed me that “the world is mud-luscious and puddle-wonderful.” -E.E. Cummings

Introduction

Human activities have altered the vast majority of the world's land surface (Ehrlich and Ehrlich, 2009; Ellis and Ramankutty, 2008; Perring and Ellis, 2013). In the Canadian Rocky Mountains, the majority of direct human impacts are limited to population centers and industrial resource extraction such as mining, oil, gas and forestry. However the weight of our activities are nonetheless felt across the landscape. Indirect effects of land use, climate change and industrial pollution have reached far beyond our backyards.

Even remote ecosystems feel these effects, in those scattered reaches of the world where severe climatic, topographic or environmental conditions exist (Higgs and Roush, 2011). These conditions make human interactions with these areas significantly more challenging, however do not necessarily mean the land is uninhabitable. Some remote areas have been protected in part to maintain ideals of undisturbed wilderness. For managers of these landscapes, logistical and moral issues inherent in remote ecosystems intensify challenges (Higgs and Hobbs, 2010; Higgs and Roush, 2011).

For ecological restoration and conservation management, questions of “what do we do here” are magnified when dealing with more remote areas. Intervening in the first place necessarily reduces the remoteness of the landscape, and there is risk of a shifting baseline for management goals away from more wild or remote ecosystems. Keeping hubris in check is critical to slow interventions lacking adequate information and foresight (Harris *et al*., 2006; Higgs and Roush, 2011).

Hobbs and colleagues (2011) argue that intervention will become increasingly necessary for maintaining biodiversity and ecosystem services under conditions of rapid change, including climate change, fire suppression and prescription, visitor use, invasive species, and land-use surrounding protected areas. These complexities and difficulties are brought to the forefront in managing protected areas in mountainous regions of western Canada.

Research Questions

In reflecting on rapid ecological change and complex socioeconomic drivers I pursued this research question: "how do long-term landscape changes influence conservation and restoration objectives in remote mountain ecosystems?" By long-term I am referring to the last 100-150 years. This also incorporated subsidiary questions: "what are the inherent challenges in managing (and restoring) remote ecosystems?” and “how should managers of remote ecosystems best approach these issues in the face of rapid ecological change?” Framed within a comparative case-study approach, this study investigates observable long-term remote landscape change in two protected areas in the Canadian Rockies. Mount Robson Provincial Park and Willmore Wilderness Park serve as a comparison for examining the resulting implications of long-term landscape change for management and restoration.

Methods

To best answer these questions, which have not to my knowledge been addressed substantially in other studies, my methods included focus groups and individual semi-structured

interviews with park managers. Discussions were structured around photo-elicitation activities, which used repeat photography photo pairs of the long-term landscape changes in their parks. Repeat photography was completed through the Mountain Legacy Project, and historic photographs were from surveys completed in the early to mid 20th century. This interpersonal form of inquiry allowed me access to a broad array of issues.

Case Study #1: Mount Robson Provincial Park

At 2,248 km^2, Mount Robson (MRPP) acts as a flagship for the provincial protected areas network, welcoming visitors to the province at Yellowhead Pass. Bisected by this busy transportation corridor, MRPP receives many visitors as they pass into British Columbia (BC). While the park's namesake peak spurred on the area's official protection, the headwaters of one of BC's most significant rivers, the Fraser, are also protected. MRPP is part of the Canadian Rocky Mountains Parks World Heritage Site, and the Rocky Mountains protected areas network, which comprises a significant complex for connectivity. In this network, MRPP joins four contiguous national parks, three provincial parks, as well as Kakwa Wildland and Willmore Wilderness Park (BC Parks, 2011).

Case Study #2: Willmore Wilderness Park

Northeast across the provincial border, Willmore (WWP) covers over 4,600 km^2 and extends from the continental divide into the upper foothills of Alberta (Graham and Quintilio, 2006). The welcome here is quite different than in MRPP. With no park-specific Visitor Center, the trailheads point you into the park at four staging areas. Two of which are via Provincial Parks, found north of Rock Lake or south of Grande Cache at Sulphur Gates. Cowlick Creek and the Berland River offer access as well (Town of Grande Cache, 2013). From there you are largely on your own. The solitude and lack of infrastructure within park boundaries has turned unsuspecting visitors on their heels. Yet, it is likely the reason why the park draws the majority of its visitors. Hunting, backpacking and backcountry horse trips are outstanding. Together with MRPP and Jasper National Park, these three parks protect the core area of a Yellowhead ecosystem extending over 68,000 km^2.

Insights Gained From Case Studies

These two parks offer unique case studies with significant contrasting characteristics. This study investigates what respectful intervention means in remote areas of the Canadian Rockies today, and how managers of these remote areas are influenced by and feel about the landscape changes occurring in their respective parks. When evaluated in conjunction, this offers insight both into the diversity of our Rocky Mountain protected areas, and how influential long-term landscape change can be for these parks under the current context of climate change and restoration goals.

What is to Come in This Thesis

The following chapters will offer a detailed discussion of this project. Chapter One brings a contextual and conceptual overview of the Canadian Rocky Mountains, ecological restoration,

remote ecosystems and protected areas management in Canada. Chapter Two is divided by park, and brings a discussion of the biogeography, settlement history, past and present management and state of ecological restoration efforts in each park. Chapter Three moves on to methodology, discussing comparative case studies as the primary method used in this study. Data collection by way of photo-elicitation in focus groups and individual semi-structured interviews follows, and is concluded by a discussion of repeat photography from its history to present-day use. Chapter Three concludes with an explanation of content reductive analysis techniques used, and the limitations throughout. The study's findings are described in chapter Four, followed by the final chapter, Five, which offers an overarching synthesis and the resulting conclusions of the study.

Chapter One: Ecological Restoration and Remote Mountain Areas

The remoteness of damage is a concept generally applied to legal claims. In general law, if the damage or loss suffered by the claimant is too remote and beyond established duty of care, the defendant is no longer liable (Harpwood, 2008). Theoretically, it keeps things fair and reasonable. Parallels exist in the Canadian Rocky Mountains. In places where the most discernable paths are those of wildlife, and tree carvings are claw scrapes or antler rubs instead of the initials of passersby, remoteness can be felt. With a lure of solitude and the subtle noise of the forest, these areas exert a sense of place both fragile and enduring. Where is the damage here, however? Often lacking direct physical links to our activities, the remote mountainous regions of the world are nonetheless changing under our influence.

The following chapter offers a discussion of the relevant literature to the study and the contextual framework for the case studies of chapter Two. Chapter One begins with a description of the Canadian Rocky Mountains and the history of photo-topographic surveying is described. Utilizing those survey photos, repeat photography as a method is discussed later in chapter Three. Chapter One then continues on to discuss ecological restoration, remote ecosystems and protected areas management in Canada.

1.1 Historical Context of the Canadian Rocky Mountains

The Rocky Mountains are iconic of Canadian wilderness. Often referred to as offering something for everyone, the Rocky Mountains region boasts world-class tourism and outdoor recreation opportunities alongside a well-established natural resource industry and diverse cultural roots.

The heart of this region is motivated by ancient geological forces, and sculpted by fire, wind and ice over geological timescales. While the romantic idea of Canada's mountainous regions as being largely untouched until recent centuries has survived to present day, the reality has been carved, cut and dug out of a different cloth (Dent, 2013). For the past 11,000 years the Canadian Rocky Mountains have been home to indigenous peoples, well before the first European settlers in the late 17th century (Cashman, 1971; Pole, 1993). Recent decades have seen increasing awareness of our long-term influence and involvement in the mountainous regions of

Canada (e.g. MacLaren, 1999; 2007). In 2002, Canada participated in the United Nations International Year of Mountains initiative, and the resultant research offered much evidence to contradict views of a pristine and wild region (Sandford, 2010).

The historical context from which the current conditions have arisen began thousands of years before. Dating back 10-12,000 years, indigenous peoples have inhabited the Rocky Mountains. The eastern slopes served as a travel route further into North America (Sandford, 2010). Archaeological evidence suggests widespread hunting in the region, and there are theories that indigenous hunting may have had a very significant impact on the populations and long-term survival of large wildlife species (Sandford, 2010).

While modern circumstances of industrial development make the impacts of hunter-gatherer cultures seem negligible, people nonetheless had a great influence over the mountain environment. Cultivating plants, hunting, and modifying ecosystems through fire led to notable changes in the mountain landscapes over time. An estimated 9 million indigenous people lived in North America by the time European explorers arrived (Sandford, 2010).

European involvement began in the 17th century with the burgeoning fur trade, guided by the Hudson's Bay Company. A thirst for exploration and economic expansion fueled interest to continue west and north into the unchartered continent. Ventures inland were hesitant and limited for many decades; indigenous peoples were not trusted and perils of the endless forest were many (Hudson's Bay Co., 1958). It took many years before trading reached the Canadian mountain west, or crossed the continental divide.[1]

Indigenous peoples provided critical support by way of guiding and traversing the rugged landscape, as well as food and shelter support in particularly difficult times (Cashman, 1971; Milton and Cheadle, 1865). Hunting and trapping in the mountain west became extensive from the 19th century on; this soon became an ill-fated collaboration of sorts between the fur traders and First Nations groups. Regional historical backgrounds of the indigenous peoples will be described in detail for each park in chapter 2. As human influence on mountain landscapes greatly predates European involvement, an overview of historic involvement provides necessary context to the current landscape changes being observed.

1.1.1 History of Photo-topographic Surveying

As discussed in chapter three, this study has employed repeat photographic methods to capture long-term landscape change. Repeat images have been taken through the Mountain Legacy Project (MLP). The history and current efforts of MLP are discussed in detail in 3.2.1.1. This section offers an overview of the historic images having been repeated for this study.

The historic images are from photo-topographic surveys of Canada's mountain west. Taken for the purpose of making topographic maps across the Canadian West, the historical survey photographs are part of what was a systematic and extensive government effort. The railway advances west brought national surveying crews early on, to document in great precision and detail the expansive lands of the Canadian west, hitherto not documented in systematic maps. This lends both to their utility and intrigue; curators, historians and researchers continue to investigate various circumstances surrounding the photographs, and the possibilities for their use are many.

[1] The earliest recorded European trek was in 1793 when Alexander MacKenzie of the North West Company traversed the Rockies to the Pacific from the upper Peace River (Hudson's Bay Co., 1958). The journey took 74 days (Cashman, 1971).

There exist vast collections of historical survey photographs for the Canadian Rocky Mountains. In company with impressive collections covering the Himalayas and other mountain belts, the Canadian inventory is the largest systematic collection of historic mountain photography in the world to this day. While some efforts began in the 1850's (e.g. by the Royal Engineers when surveying the 49th Parallel), the majority of surveys were completed from the 1880's to 1950's. The Canadian Department of the Interior's Dominion Land Survey, Topographic Survey of Canada (1888-1958) and the Geological Survey of Canada were the predominant forces behind the use of this surveying method. Surveys were also conducted for the Department of National Defense (from 1946-1956) and the Department of Mines and Minerals (from 1895-1920). Surveyors commissioned included A.O. Wheeler, R.W. Cautley, M.P. Bridgland, J.J. McArthur, H.F. Lambart, and M. Nidd.



Figure 1: Two crewmembers from Bridgland's 1914 survey of the Rocky Mountain Forest Reserve (MLP, 2014)

Arthur Wheeler was a prominent figure in photo-topographic surveying and mountain culture in Western Canada in the early 20th century. Wheeler co-founded the Alpine Club of Canada in 1906 with Mrs. Elizabeth Parker (Fraser, 1978). Wheeler completed photo-topographic surveys throughout the Rocky Mountains from the 1890's to 1920's (Fraser, 1978). While attempting countless climbs of significant risk and extent, Wheeler did not describe himself as fearless. Alternatively, he wrote of this danger as "…worth it… To feel the thrill of danger and the tingle of the keen rarified air. To see the whole world and glory of it!… I know of no more fascinating avocation than the disentangling of Nature's puzzle in the breaking up of the original terrain and the reducing of it to a readable map" (Fraser, 1978:91).

Following the creation of the Department of the Interior in 1870, the Dominion Lands Branch was given responsibility to survey and map new territory. Starting in Ontario and Quebec, traditional surveying was completed moving west to ultimately produce a nationwide collection of 1:50,000 topographic maps (White, 1897). Difficulty arose for traditional surveying techniques when encountering regions with significant changes in relief and elevation, and made traditional techniques too costly and time-consuming; the Rocky Mountains presented this issue (Bridgland, 1916).

As a reaction, photo-topographic surveying (photogrammetry) was inaugurated in 1888 by the Surveyor General for Dominion Lands, Captain E. Deville (Felmer, 1906). Furthering the earlier work (1849) of French scientist Laussedat, the technique combined trigonometric surveying with photography to gain accurate topographic perspectives from oblique photos (Larmour, 2005). These techniques allowed the quick generation of highly accurate topographic surveys of large mountainous regions. By using high elevations in the landscape as an integral component to the surveying technique, surveyors took panoramic photographs (often >360º coverage from a station) from notable peaks or ridges. From these photographs, elevations of the surrounding landscape could be back calculated by placing a grid over the resulting photographs.

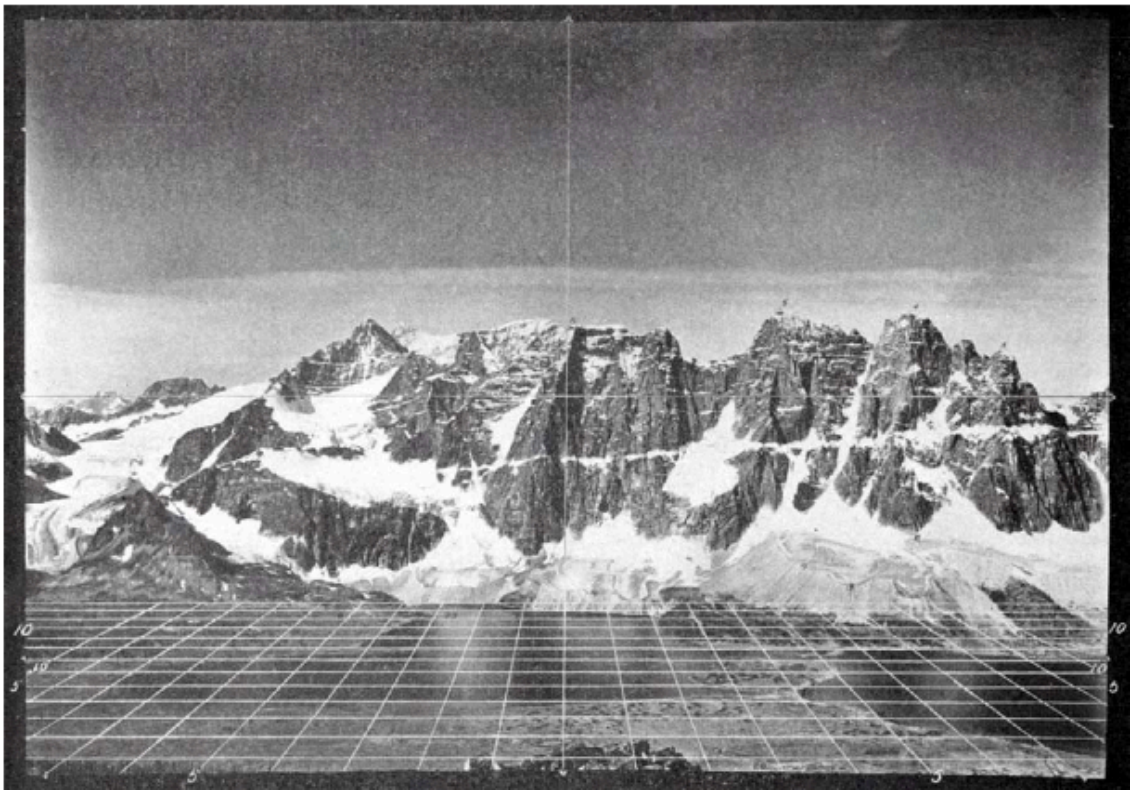

Figure 2: Grid overlay on survey photograph (Adapted from Bridgland, 1924)

Using points of known elevation in the photographs, and evaluating these on their overlaid grid, surveyors could determine to within a few meters accuracy the topography of the majority of the landscape within a given photograph using custom instruments and a perspectometer for flatter areas (Bridgland, 1916). Therefore, the necessary topographic information was available for extrapolation into regional maps at a cost, pace and scale unbeatable by traditional methods (Bridgland, 1916). Overall, photo-topographic surveying was

at least one tenth of the cost (Gordon, 2006). As a result, lands that could not be mapped through the use of traditional techniques were no longer unapproachable.

With photo-topographic surveying taking advantage of photography early in the development of the technology, photographs in these survey collections range from the 1880's to 1960's. The photographs taken from the late 1880's to late 1950's are on glass plate negatives and usually on a 4 3/4" x 6 1/2" plate from a medium format camera (Bridgland, 1916). Plates of this size have been noted with Wheeler's work during the 1913-1924 Interprovincial Boundary Survey (Fraser, 1978:101). In the advent of film photography, surveyors had slightly less burdensome camera equipment for their work, and photographs from the 1930's to 1950's were increasingly being taken on film negatives. The last glass plates were exposed in 1958; over 80 years from the technique's first experimental use.

Ordinary plates would not suffice. Orthochromatic plates allowed distant details to remain crisp, and plates with wide ranges of exposure allowed dramatic ranges in light and dark to be captured.[2] Camera, case and a dozen plates weighed in at 20 lbs.; the tripod weighed 15 lbs. (Bridgland, 1916). It remains an impressive task that the original surveyors worked with delicate and weighty glass plates for early photographic work in the challenging conditions of the Canadian mountain west.

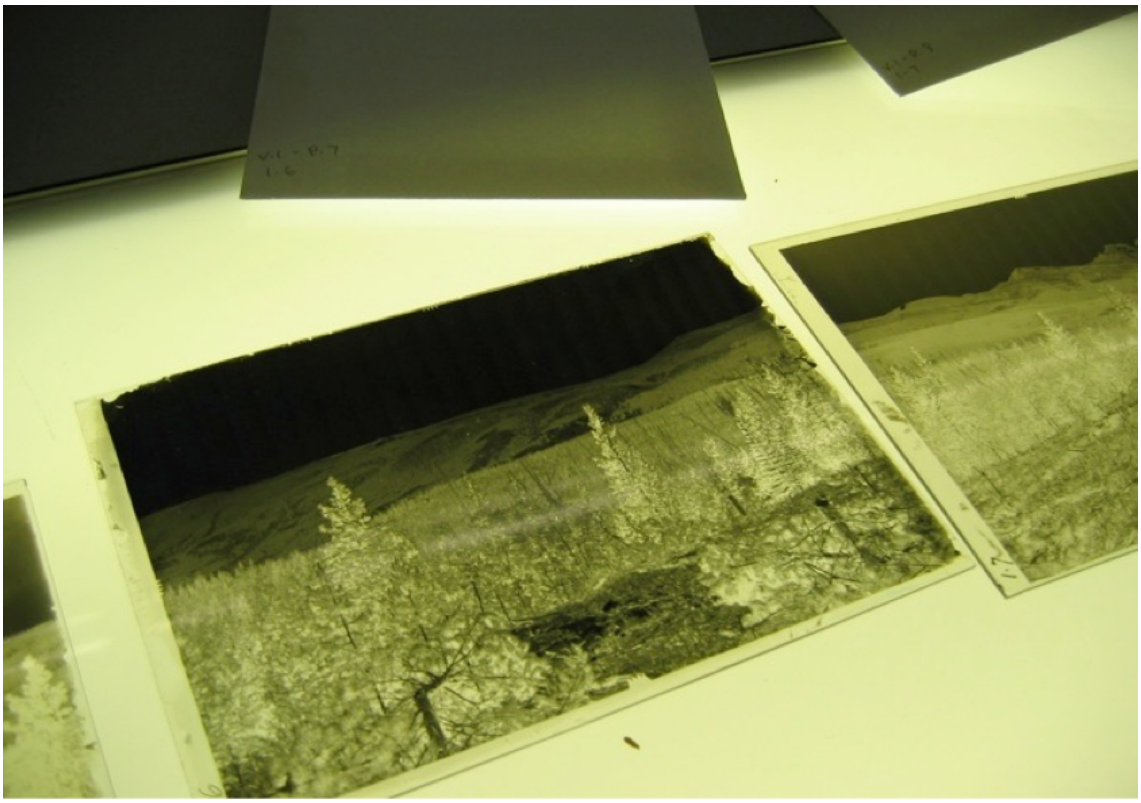

Figure 3: Glass plate negatives over light table (Photo credit: Eric Higgs, 2004)

Historical survey photographs may be available in various formats, but most predominantly as black and white prints, film negatives, and glass plate negatives. Culminating

[2] For more information on specific types of glass plate negatives used for the Canadian Surveys in the 1910's see Bridgland's "Photographic Surveying In Canada" (In: Geographical Review, Vol. 2. July 1916. pp. 19 – 26).

from many decades of work, around 70,000 plates were relocated from the Department of Mines and Technical Surveys to Public Archives Records Centre in Ottawa for alternative storage and/or disposal in the early 1970's (Library and Archives Canada, 2008). Other collections remain unknown and dispersed nationally and some went to the Public Archives of Canada (now Library and Archives of Canada) (R. Watt, personal communication, December 29, 2013). Today, these materials have in some cases witnessed a century or more of storing, and the quality and level of damage varies greatly. In some cases, only prints have be found for a given photograph, or collection. As many decades have come and gone since the plates or filmstrips were processed and stored, it has been seen that entire collections of photographs have been lost, destroyed or degraded to the point of nonuse.

While glass plate negatives are more cumbersome to handle and store, careful storage and care of the glass plates has left a reasonably small percentage of them with cracks or missing pieces over the years. The majority of damage to the plates has occurred in past decades before systematic protection and storage of the collections began. Beyond environmental conditions degrading the photographs, time itself is not a particularly devastating factor for the condition of plates. When plates are stored in an upright position, the emulsion will slowly move, following gravity's pull. Within the timescales involved in this work, this is not a significant worry yet as the emulsion degrades at a negligible rate. Nonetheless, continued efforts to digitize and scan the historic photographs is of great value, and the Mountain Legacy Project database now offers an additional subsidiary storage place for many of these photographs.

Predominantly stored in environmentally sensitive containers in storage vaults at government facilities, there continue to be collections of various extent uncovered. A critical aspect of working with historic materials is the discovery and management of collections. This project utilizes photographs from several Canadian photo-topographic surveys. The key players involved in managing those photographs are Library and Archives Canada in Ottawa, BC Archives in Victoria, as well as the Glenbow and Whyte Museums in Calgary and Banff respectively. A great acknowledgement is due here, as without this privilege of access to the historic plate collections made possible by the support of individuals at these museums and archives, work of this kind on remote ecosystems could not take place.

Library and Archives Canada (LAC) is the primary force allowing this research to continue, and the majority of historic survey photographs are ordered as digital files from LAC or BC Archives. The extensive government archives housed in specialized environmentally controlled vaults are managed by a group of extremely talented and dedicated professionals. Promoting the continued preservation of and public access to Canadian cultural heritage through documents, archives, and other materials (Library and Archives Canada, 2007), LAC is located in Ottawa, and has extensive and well-curated historical collections. Maintained and made accessible by LAC include tens of millions of publications, artworks, electronic documents, photographs, audio-visual and sound recordings and archival records. Included in their repository are well over 21.3 million photographs since the 1850's (Library and Archives Canada, 2007), including vast collections of historic photo-topographic survey photos.

Additionally, museums and archives in Alberta and British Columbia manage large numbers of photographs, with an emphasis on the history, art and culture of the Canadian Rocky Mountains and its people. The Whyte Museum in Banff offers both world-class exhibits and its own Library and Archives, which was established in 1966. Interwoven with this museum was the Alpine Club of Canada's collection until 2010 (Whyte Museum of the Canadian Rockies, 2011,

Archives and Library, para. 4) The Glenbow Museum in Calgary houses the largest non-governmental repository of historical archives, and promotes the cultural, political, economic and social history of the region (Glenbow Museum, 2013, para. 1).

1.1.2 The Rocky Mountains Today

Within our generational timescales, our interactions with the land have mostly been scratching the surface. Our settlements and travel routes gradually fill valley bottoms; we remove tree stands, mineral ores, fish and wildlife, water and fuel. Recent centuries have seen European expansion westward, technological and industrial advancements, and a rise of globalization. Our scratching fingers have been replaced. Now, our far-reaching technologies can leave persisting one-shot impressions with each stroke. While the long-term involvement of humans in mountain landscapes necessarily influences ecological and biogeophysical conditions, up until recent centuries the significance of our influence on the land was largely due to its consistency over many years.

Today, the Rocky Mountains continue to draw hundreds of thousands of tourists and thousands of new residents each year. The region supports billions of dollars of provincial tourism revenue (Government of Alberta, 2013). This patchwork is as varied over time and space as the ecosystems themselves, from valley bottoms to alpine peaks.

Increased development pressures and human presence are placing strain on Rocky Mountain communities and ecosystems. The once isolated railway towns scattered along the main mountain passes have grown in population and become more socioculturally homogenous (Sandford, 2010). The unique character of each settlement, shaped by the rivers, slopes and winters once dominant forces in mountain life, has been put to the test by tourism pressures and visitor preferences which are becomingly increasingly urban in taste. People leave the cities for the smaller mountain towns to “get away”, however these destinations are gradually reflecting those cities more and more. Visitor demands fuel development of amenities and luxuries that at one point, the mountain towns were idyllically vacant of (Sandford, 2010). Serving as a dynamic and complex regional backdrop to the cases of this study, the Rocky Mountains are inextricably linked to both the challenges being faced by parks managers and to the path forward.

1.2 Ecological Restoration

A reasonable reaction to a tangle is to slowly unknot the strands. Or, perhaps as a last resort, begin afresh. Finding even a modest equilibrium for our interactions with the natural world remains a complex challenge. Nonetheless, and often quite determinedly, there are continued efforts to restore natural systems that our activities have disturbed or altered. To many, the art and science of ecological restoration serves as a critical way of bringing balance back to our relations with the natural world, one stream bank, watershed or meadow at a time (Jordan and Lubick, 2011; Parks Canada and Canadian Parks Council, 2008; Society for Ecological Restoration International Science & Policy Working Group, 2004).

This overview of ecological restoration begins in 1.2.1 with a brief discussion of the historical development of the field of ecological restoration to what it is today. Following this in 1.2.2, the current context and challenges surrounding the field is described. This section is

divided into 1.2.2.1 - 1.2.2.3, which include; challenges for practitioners and project development, debates within the field, and lastly a brief discussion asking why do we restore.

1.2.1 Historical Development

From the late 1800's, the idea of recreating and restoring natural systems began to form. Alongside wilderness conservation pleas of naturalists like John Muir and Henry David Thoreau, George Perkins Marsh was arguably the first to explicitly call for the healing of lands damaged by human activities (Howell *et al*., 2012). In his 1867 publication *Man and Nature*, Marsh advocated for forest restoration in light of its ecological and human benefits ranging from flood protection to resource use (Marsh, 1867). Marsh observed nature as a force rather than a place, and offered that human action rather than inaction - however rational the interventions - was to blame for damaging ecosystems (Hall, 2005).

In those early decades (1870-1940) an ecocentric view gradually began to gain momentum. Land management for human utility was now in the company of restoring land to a healthy state for the benefit of natural processes. The inclusion of native plants in landscaping and gardening projects were spearheaded by a handful of individuals from Europe and North America in diverse fields from horticulture to landscape architecture and writing (Howell *et al*., 2012). Among them was a landscape architect named Frederick Law Olmsted. In 1878 Olmsted was commissioned to redesign the Boston Back Bay Fens, historically a salt marsh system that had been severely degraded by raw sewage effluent. Olmsted restored the urban marsh by engineering the system's hydrology; effluent flows were redirected, gates controlled water levels and native plants were selected for revegetation (Howell *et al*., 2012).

Six well-developed restoration projects were being undertaken in the 1930's, including the well-known example of the John T. Curtis Prairie in Madison, Wisconsin. Initiated by Norman Fassett, William Longenecker, Aldo Leopold and Ted Sperry, the prairie was among several ecosystems the professors aimed to rehabilitate for use as an outdoor laboratory for students. The tall grass prairie became the first restored ecosystem in the official sense, and ecological restoration as a practice began (Howell *et al*., 2012; Jordan and Lubick, 2011). Ideals of untouched wilderness and landscapes devoid of human influence fueled efforts in this period. While most of these ecocentric projects lost support shortly after, the 1970's brought renewed interest and commitment to this direction of land management (Jordan & Lubick, 2011). Taking form in 1988 as an international nonprofit organization, The Society for Ecological Restoration has been furthering knowledge and practice of ecological restoration as a means of improving our relationship with nature and to support the world's biodiversity (Jordan & Lubick, 2011).

1.2.2 Ecological Restoration Today

Today, the science and practice of ecological restoration has expanded and diversified and is represented around the world. Practitioners can be anyone; most often involved are private individuals, national agencies or conservation groups. Supporting and improving ecological integrity is a national goal, through restoration initiatives that are "effective, efficient and engaging" (Parks Canada and Canadian Parks Council, 2008:18).

The scale of these projects can be anything from a backyard to thousands of square kilometers of internationally coordinated initiatives. While certain ecosystem processes may necessarily extend beyond site boundaries (e.g. hydrology), it is not always possible to extend the geographic scale of restoration accordingly. Protected areas management is a critical example of this difficulty. While connectivity in nature is paramount, land use boundaries and legal delineations in otherwise ecologically integrated regions leave managers with few options to buffer their parks from surrounding activities. These edge effects will be discussed in detail in section 1.4.

The degree of site degradation is case-specific, ranging from those unfortunate sites with largely irreparable damage, to those seemingly undisturbed (Howell *et al*., 2012). Specific project aims should reflect the most suitable way to return a system's predisturbance functions and processes (Parks Canada and Canadian Parks Council, 2008). Some sites will require the removal or addition of a component(s), intensive machinery and technological aids, hydrological or topographic adjustments (Howell *et al*., 2012). Others will be less complex, technical and costly, and/or on a smaller scale. Depending on the expertise and resources available to the practitioners, goals will be set. The project aims will influence the scope - that is, what the restoration work is considering and hoping to improve - and the scope will likely influence the cost (Keenleyside *et al*., 2012). Beyond these logistical limitations, overarching aims should be to support more resilient and self-sustaining ecosystems in a way that is sensitive to the broader socioecological context they exist within (Parks Canada and Canadian Parks Council, 2008).

The interdisciplinary nature of ecological restoration allows for the joint, coordinated efforts of practitioners from various fields. Drawing from the humanities, social sciences, physical and biological sciences, and design, restoration is an approach as multifaceted as the ecosystems it aims to heal. For instance, engineering and landscape architectural roots give it spatial and logistical awareness. Geography, sociology, anthropology and philosophy give it sociopolitical, historical and moral sensitivities. Ecology and biology give a keen eye to dynamic ecosystem interactions (Howell *et al*., 2012). While transdisciplinarity offers strength and durability to projects, the collaboration between disciplines can be challenging, expensive and time consuming.

1.2.2.1 Challenges for Practitioners and Project Development

Ecological restoration has its share of challenges. At the logistics level, these include many factors such as financial, resource and time constraints. Volunteer hours can be invaluable, and flexibility to adjust plans and schedules may be minimal, particularly when coordinating larger groups. Following that, acknowledging and incorporating the various views and interests of stakeholders and collaborators is critical for success, however can be quite practically and logistically trying at times (Howell *et al*., 2012; Parks Canada and Canadian Parks Council, 2008).

Additionally, each project is unique and there are rarely "quick fixes" for damaged natural systems. It is difficult to secure long-term resources to carry projects through to completion and beyond for critical monitoring. There are few restoration projects that have long-term monitoring following completion, and subsequently little information is available regarding overall success rates and reasons behind failures (Howell *et al*., 2012).

Natural systems are very complex and constantly changing. This leaves us with varying degrees of uncertainty when attempting to restore a system (Howell *et al*., 2012). And, for every ecological component we know we do not understand, there are undoubtedly others we are completely unaware of. To approach restoration in light of this, specific snapshots of ecological conditions of the past cannot be the foremost goal to reach for all cases (Hall, 2010), and increasingly so novel ecosystems are involved (Hobbs *et al*., 2013). Alternatively, supporting the system in its transition to a more healthy state is one way to approach constant change (Jackson and Hobbs, 2009).

1.2.2.2 Debates Within the Field

Interwoven in the field of ecological restoration have been several overarching debates with particular relevance to this study. These include the role of history in restoration, and the role of technology and machinery in restoration. This study is in some ways an attempt to weave historical ecological conditions into perceptions of present day landscape change and ecological conditions in parks, in the context of managing remote ecosystems. The historic photo-topographic survey photos offer snapshots in time of what park landscapes previously looked like. Having additional information of past conditions is of benefit as park managers observe ongoing ecological changes, and refer to and improve upon management planning and goals. Ecological restoration efforts in parks can particularly benefit from historical references.

History in Restoration. The first to be discussed is the role of history in restoration. Restoration practitioners aim to return an ecosystem (or community, landscape, and so forth) to a natural state (Jordan & Lubick, 2011). This is ostensibly a simple, self-explanatory goal; if human activities have altered a given ecosystem in some negative, unnatural way (we will return to the natural/unnatural debate later), then returning the land to what previously existed is of unquestionable benefit. The term restoration itself speaks to regaining what has been lost, insinuating a benefit in this change.

In their book, Making Nature Whole (2011:4), Jordan and Lubick summarize this commitment to historical conditions as "a response to the mixture of regret, nostalgia, and curiosity some feel" towards landscapes altered by past and present non-indigenous generations. Some have argued that the only true "natural ecosystem" to restore to must be fit to the conditions preceding human involvement in the area. In the "New Worlds" (western hemisphere), this is particularly ambiguous following two distinct periods of colonization - 12,000 – 14,000 years ago via Beringia and European contact 500 years ago (Jackson and Hobbs, 2009). This leaves contention, having the former suggesting that Native American land management was still natural (Hunter, 1996). Others feel that ecological representation of historical benchmarks is sufficient (Czech, 2004), but that naturalness declines with increasing human intervention (Ridder, 2007).

This debate requires coherent answers as to what counts as natural and how we would best go about deciding that. However, what if this previous "natural" ecosystem state is beyond our historical knowledge? Closely in tow, views of naturalness excluding human use are largely incongruent for restoration goals except in outlying cases. Globally there is indigenous land use dating back far beyond our legible ecological records (Jackson and Hobbs, 2009). Both historical accuracy and our place in – or cultural separation from - the natural world, are tightly bound in

this discussion. This debate releases a reservoir of tough questions, with the potential to wash away decades of belief and ways of thinking of how and why we restore ecosystems.

The legitimacy and appropriateness of returning to historical conditions has been put into stark question in recent years (Jackson and Hobbs, 2009). When approached through timescales of centuries instead of decades, the "historical ecosystems" restorationists aim for become fleeting moments of lands that have passed through a variety of states, from grassland to forest to desert and back, all before we started worrying about what the natural state was (Jackson and Hobbs, 2009). Nonetheless, these long-term environmental dynamics lose relevancy when we are pulling invasive English Ivy from Douglas fir trunks here in BC. Some changes are direct, irrefutably human impacts; courtesy of land-use changes, globalized transport and dispersal of materials, ecosystem boundary pressures, and now climate change. In such cases, this leaves restoration to look for a pre-disturbance state - not necessarily pre-human, but before significant environmental degradation took place.

Pre-disturbance Baselines. Subsequently, the next hurdle is that of historical pre-disturbance baselines. Returning signifies backward propulsion - giving back what was lost. While winding the clock back is a noble aspiration to pre-disturbance stability for an ecosystem (Falk, 1990), this has severe difficulty in several ways. First, a growing number of ecologists and restoration practitioners would argue the impossibility of truly returning a system to a previous state. Just as tree rings are thinner in more difficult years, you cannot erase the ecological memory of hardship with its discontinuation. The past remains engrained, but things can move forward and even flourish. The second challenge is that of historic baselines becoming irrelevant under rapid change in the present and future. Under these conditions, historical baselines may no longer account for climate change, invasive species, and novel ecosystems (Jackson and Hobbs, 2009).

Therefore, challenges exist under rapid change for historical baselines in restoration. Their adaptability and applicability for present and future conditions has been questioned, and our ability to shift degraded systems towards conditions inherent in historical states is far from simple. For instance, we may aim to reintroduce species to an ecosystem to return some of the ecosystem's community dynamics and visual similarities of its pre-disturbance state. However, under shifting climatic conditions and complications of invasive or exotic species reconfiguring the ecosystem, it may become apparent that the given suite of species lacks resilience and no longer contributes to the necessary processes and functions of an ecosystem of that kind; we are faced with explicitly value-laden trade-offs.

Mechanization of Restoration. Some concern exists about the mechanization of restoration projects. Technological dominance in restoration efforts has in recent years come into question by some, who feel that industrializing the process incurs great risk. This shift in the practice of ecological restoration offers savings of time and cost, as physical scales of operation are broadened and site-specific characteristics give way to goals of ecosystem services and international standards (Higgs in Comín, 2010). Termed "technological restoration" by Higgs (2003:186), this vision of restoration offers benefit to the practice however can be greatly lacking any meaningful engagement between people and ecosystems being repaired (Higgs, 2003). In the following case studies, the mechanization of our interactions with wilderness areas becomes apparent through prescriptive fire and large-scale fire suppression efforts in WWP and MRPP.

1.2.2.3 Why do we Restore?

There can be vast differences in the fundamental reasons why we restore. This varies within a group of volunteers pulling ivy, within countries and internationally. At each scale the underlying factors may shift. At the individual level, our personal goals and objectives, views of nature and of a site will guide our feelings towards its restoration. At the national and international level, governmental support for restoration initiatives will vary and influence the structure and scope of certain efforts. However, sociocultural factors play a significant role as well in what we aim to restore, how, and why. The values and guiding principles of practitioners will impact what is perceived of as improved or restored, and what type of restoration they will undertake (Higgs in Comín, 2010; Howell *et al*., 2012). The extent of this sociocultural diversity having influence over ecological restoration has seen little discourse and few studies have explicitly focused on understanding this variation, to the extent of my knowledge. Ultimately, these cultural and social characteristics will have significant influence on restoration efforts, their sustainability and success.

Whether we restore for guilt, curiosity or feelings of responsibility, we are unavoidably going forth and seeding, weeding and planting within a structure of intentions rooted in our sociocultural norms. Perhaps this completes the circle. Notwithstanding these debates, restoration with a commitment to ecological betterment separate from human utility and interest is value-laden. However, it does not have to be crippled or immobilized by this influence, particularly through encouraging our continued reflectance on our involvement in the natural world. We get to know an ecosystem very well when restoring, and this leaves us more aware of our influence on it, throughout and long after the restoration process itself (Higgs, 2003). The powerful bond and social rejuvenation that community, or what Higgs terms, “focal” restoration efforts instill can be invaluable far beyond the restoration project itself (Higgs, 2003). This leaves great opportunity to strengthen and promote a restoration ethic, which fosters personal and social repair alongside, ecological.

1.3 Remote Ecosystems: Remote From What?

The idea of ecosystems removed from direct human influence began as a matter-of-fact concept for this thesis. Starting with the article “Restoring Remote Ecosystems” by Higgs and Roush (2011) sent my curiosities spiraling. Remoteness is to be acted on or controlled indirectly from a distance, being separated by (perceived or actual) time or distance greater than usual. These ecosystems stand apart as being independent, less influenced, and removed from our direct actions. Indirect impacts are felt even in these places. Nonetheless, their unique designation is settled only insofar as they exist apart from direct anthropogenic influences. Higgs and Roush (2011:554) offer that "remote landscapes are a product of their inherent qualities (environmental severity, distance from human impact) and the cultural values, or lack thereof (high esthetic or spiritual appeal), we attach to them."

Restoration in these ecosystems may become increasingly necessary into the future, as indirect human impacts are found even here (Higgs and Roush, 2011). Still, the idea of wilderness restoration is not without debate. While participatory focal restoration has been advocated (Higgs, 2003; 2006), others argue that even damaged wilderness areas are better left to heal themselves than experience restoration (Throop and Purdom, 2006). The differing ways in

which people view wilderness and restoration were found to be central to this disagreement (Higgs, 2006).

While my use of the concept of remote ecosystem restoration began with the intention of achieving a better idea of what managers and stewards feel is appropriate and necessary in these far reaches of our mountain parks, it soon developed other aspects that begged exploration. It became apparent that perceptions of remoteness and remote ecosystems, and the current challenges in these ecosystems within specific case studies have not been fully explored and serve as two information gaps.

Before moving on, it is necessary to acknowledge that the framework of remoteness in this study and also the intentions set within Higgs and Roush (2011; E. Higgs, personal communication, April 24, 2014) are deeply set within the context of contemporary management realities. Some places that are deemed wilderness or remote today were not necessarily such historically, before indigenous groups were forced to relocate for the creation of parks and protected areas and colonial development. In this way, remote ecosystems may not have been so separate from direct human activities and land uses in the past. The last few decades have seen a surge in research on traditional ecological knowledge (TEK) and we are now aware that there are truly few places that are "remote" with regards to traditional life ways (Turner, 2005). For the purposes of this study, however, the timeframe of consideration is that which mirrors the contemporary realities of parks, in which First Nations groups are (for now) not pursuing their traditional ways of life within park boundaries.

1.4 Protected Areas Management

Section 1.4 begins with a brief overview of protected areas management, and serves as the last of four conceptual pillars that form the literature review of this thesis. Three specific foci are taken in this background discussion on protected areas management. These include (1.4.1) the historical development of North American parks and protected areas, (1.4.2) challenges and pressures surrounding Canadian parks and protected areas, and lastly (1.4.3) a short discussion of best practices and assessment frameworks. The Canadian context of 1.4.2 is further expanded to include two sections discussing challenges beyond park borders and traditional land use within parks and protected areas. To conclude chapter One overall, 1.5 offers a summary of the four topics within this literature review - history of the Canadian Rocky Mountains, ecological restoration, remote ecosystems and protected areas management.

Protected areas are managed to protect and maintain natural and cultural resources and biodiversity in situ. The general aim is to locally remove certain pressures and threats to biodiversity through limiting certain land uses and other activities (Hamilton and McMillan, 1994; Margules and Pressey, 2000; Possingham *et al*., 2006). Flowing from this designation - which has many variations within and between countries - are conditions of the land's protection and management. Depending on the protection status of a given area, human use of and activities on the land are limited accordingly.

In Canada, there are a variety of designations that protected areas may fall under[3]. WWP, for instance, was protected to ensure its continued and sustainable use for hunting, fishing and

[3] AB Parks regulations and legislation for the different categories of protected areas can be found here:
1) http://www.albertaparks.ca/albertaparksca/management-land-use/legislation-regulations.aspx

trapping for the local community and citizens of Alberta (Province of Alberta, 2002). Not falling under the Wilderness Act, but rather the Willmore Wilderness Park Act (1959). Because of these preferences driving its protection, it is a wilderness area and, for instance, not a provincial or national park, which do not allow those activities.

In British Columbia, it has been stressed that protected areas respect treaty rights and remain indisputably free from industrial activities or for purchase (British Columbia, 1993). MRPP was established in 1912 predominantly for the protection of scenic landscapes and recreational opportunities, however conservation mandates have increased in priority since then, and efforts have been made to include local First Nations in planning (BC Parks, 2011). Nonetheless, as discussed in Chapter Two, industry has encroached upon parkland in multiple ways.

1.4.1 Historical Development of North American Parks and Protected Areas

To put these circumstances in perspective, it is helpful to understand the development of the modern protected areas system in Canada. Taking root in the mid 19th century when vast amounts of land were being designated for agriculture, livestock and urban development, the concept of national parks and protected areas began to evolve. Well-read works of Thoreau, Muir and others helped ignite new perceptions of wilderness in directions quite opposite of those previously held – the unruly, uncontrolled wild was no longer purely associated with negative connotations or feelings (McNeely, 1994; Miles, 2009; Schullery, 1997). Instead, the untrammeled wilderness of the west in particular offered the opportunity to get closer to the omniscient, providing "sublime solitude" (Congressional Record, 1896; Miles, 2009:16).

Following more widespread development from the late 19th century on, it was believed that having areas set aside with a marked removal or decrease in human influence would act to preserve wilderness and natural processes therein (Hansen and DeFries, 2007; Miles, 2009). John Muir's *Our National Parks* (1901) exemplifies this attitude. The success of these appeals to create parks was in large part due to increasing social concern over the destruction of natural lands during development and progress, and want of non-urban recreational areas (Marsh and Hodgins, 1998).

The primary sociopolitical factors driving the establishment of the first Canadian protected areas were similar to other new world countries like Australia and the United States. These included interest in revenue generation via domestic and international tourism, and the use of public parks to foster national pride and patriotism (Marsh and Hodgins, 1998). Parks were to be "improved" away from wilderness and natural resources were to be used within a conservation philosophy, rather than preservation. While this remained the case for the majority of the 20th century, recent decades have shown official legislative changes into primary mandates emphasizing ecological integrity and preservationist goals (Marsh and Hodgins, 1998; Parks Canada and Canadian Parks Council, 2008).

BC Parks regulations and legislation for the different categories of protected areas can be found here:
1) http://www.env.gov.bc.ca/bcparks/aboutBCParks/legis.html
2) http://www.env.gov.bc.ca/bcparks/aboutBCParks/prk_desig.html

1.4.2 Canadian Parks and Protected Areas Today: Challenges and Pressures

The creation of protected areas in Canada continues today, with the majority having been designated as such since the 1970's (Ervin, 2003; Phillips, 2000). Nearly 10% of Canada's land is designated protected area, and as of 2010, over 100 million hectares of terrestrial land base was protected (Lemieux *et al*., 2010). While it has been argued that many protected areas are no longer fulfilling original mandates and ecological goals (e.g. through natural process/regime alteration, diversity loss, invasive species, climate change) (Araujo *et al*., 2004; Phillips, 2000), ecological structures and systems are not necessarily the primary decision factors on the delineation of protected areas (Scott *et al*., 2001). Following shifts in societal views and concerns, difficulties have arisen for some parks and protected areas established historically, because the original creation of the park or reserve was under quite different circumstances (Hamilton and McMillan, 2004).

Pressures to use natural areas for recreation and tourism can 'sway the vote' towards preserving areas with scenic beauty or other characteristics more anthropocentrically preferred. It is no coincidence that mountains cover 30% of the world, and are represented in over 40% of protected areas (Thorsell and Hamilton, 2002). Alongside recreational preferences is resource development. In some cases (and predominantly historically) protected areas have been located where nothing else could be viable for industry or other development (Marsh and Hodgins, 1998), and boundaries have been readjusted to allow resource extraction in previously protected lands. This has, in many cases, resulted in an incomplete coverage of key habitat or areas necessary for the maintenance of a variety of natural processes, flows and regimes. Nonetheless, defining these boundaries is a subjective act, and "ecosystem boundaries are necessarily abstractions that reflect the human choice of the ecosystem property of focus and the strength of interactions used in the definition" (Hansen and DeFries, 2007:977).

1.4.2.1 Challenges Beyond Borders: Edge Effects, Climate Change and Biodiversity

Today, we understand that simply setting aside natural areas for a marked decrease in human influence is not prescriptive to preserving wilderness, natural processes and resilient ecological communities (Miles, 2009). Biodiversity is in decline globally, and protected areas are experiencing losses as well (Craigie *et al*., 2010). In many cases, official protection status draws more visitors than would otherwise come, placing additional user pressure on the land. As the recreation-conservation pendulum often leans, funding for and from visitors is usually critical for park operations.

This section will discuss several critical challenges that parks managers are faced with, that originate or operate beyond protected area boundaries. Beginning with a brief discussion of potential edge effects in 1.4.2.1.1, we will move into a description of climate-induced species migrations and biodiversity corridors in 1.4.2.1.2. Next, the challenge of integrating goals of ecological integrity and resilience into parks management is discussed. The discussion closes with a brief overview of the more recent proposal of parks and protected areas as natural solutions to climate change adaptation and mitigation.

1.4.2.1.1 Edge Effects Around Parks and Protected Areas

Along with the visitors' footprint, edge effects can exert considerable influence (Buechner, 1987). This is particularly notable when protected areas are in more highly traveled, developed regions of the country such as the most southerly reaches. Due to increased development and land-use change in neighbouring regions, protected areas are undergoing ecological change regardless of their protected status (Hansen *et al*., 2004). This is a significant challenge for management, as the majority of terrestrial reserves are sufficiently defended within their boundaries (DeFries *et al*., 2005). Through multiple ecological mechanisms operating between protected areas and the surrounding developed lands, ecosystem processes, functions and biodiversity can be impacted (Bruner *et al*., 2001; Hansen and DeFries, 2007). Large ranging species are most at risk of extirpation from reserves due to these pressures (Woodroffe and Ginsberg, 1998). Intuitive influences such as the transfer of materials and species in/out of the reserve, availability of habitat across seasons and for migrations, and greater exposure to humans will be altered through land use changes and development (see Figure 4 for conceptual model). Human presence and surrounding disturbance will influence invasive species prevalence (McKinney, 2002) and wildlife behavior (Musiani *et al*., 2010). Several groups (Hamilton and McMillan, 2004; Heller and Zavaleta, 2009; UNESCO, 1974) have proposed creating a gradient of land use intensity around reserves. However, there are barriers to implementation; negligible results exist regarding the application of this strategy.

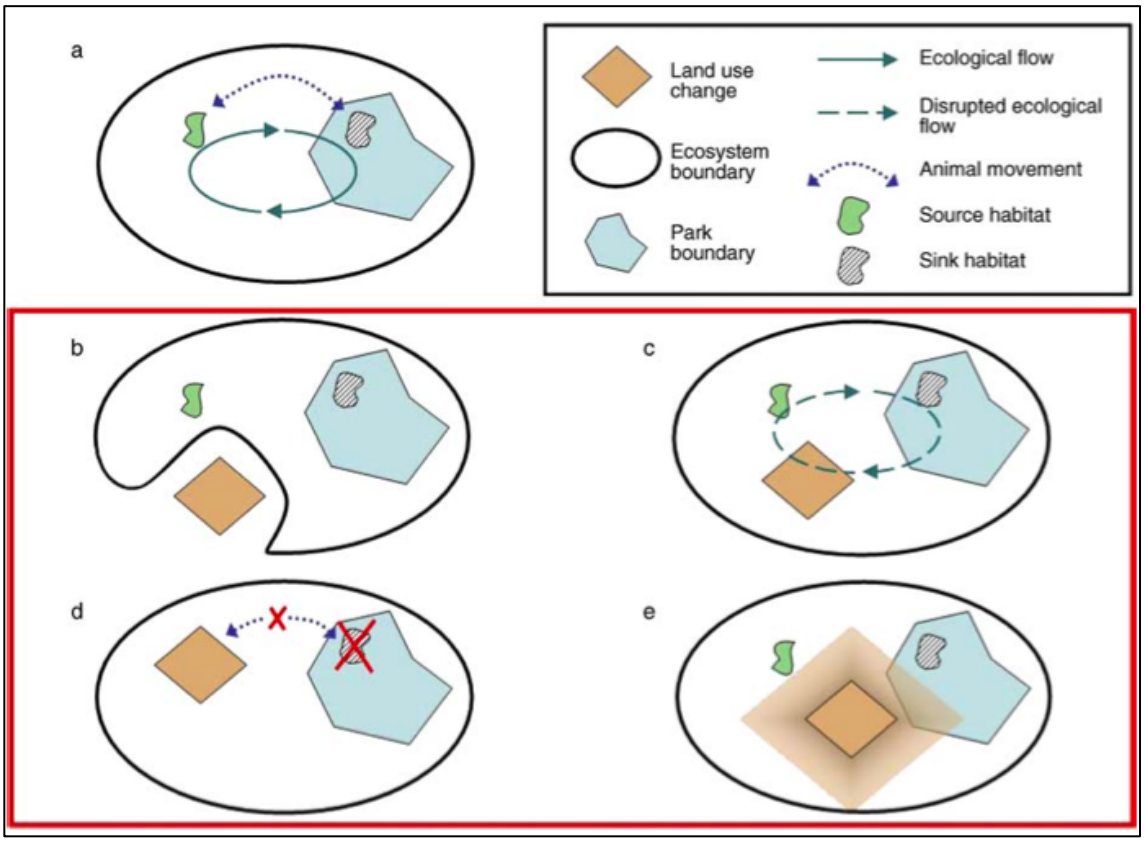

Figure 4: Conceptual model showing potential edge effects of land-use change on protected areas' functioning (Adapted from Hansen and DeFries, 2007)

1.4.2.1.2 Climate-Induced Species Migrations and Biodiversity Corridors

Accommodating the regional migration of species following climate change pressures is one that is largely unsuited to the static nature of park and protected area boundaries. Of particular concern are areas of high latitude and/or elevation, which are expected to see a considerable amount of change (Heller and Zavaleta, 2009); the mountainous regions of Canada are of specific concern here. As a possible solution, designating areas with coverage from summit to sea is optimal as this provides a range of altitudinal habitats and access to resources for ecological communities (Hamilton and McMillan, 2004). Mountain parks offer great elevational diversity, which supports these efforts greatly. Nonetheless, parks and protected areas will remain as critical refugia into the future under rapid climate change. For species experiencing range shifts, they will offer connectivity for dispersal to suitable habitat (Keenleyside *et al*., 2012).

Providing biodiversity corridors is also proactive (Heller and Zavaleta, 2009), as under climate change predictions many species and communities will lose representation in current protected areas (Araujo *et al*., 2004). However, proactive protection of new protected areas lacks pragmatism. Future climate-induced migrations will be highly variable between species, and it has been argued that dispersal barriers may reduce migration extents, leaving some species to rely on a greater climatic tolerance (Keith *et al*., 2011). Other studies offer that climatic envelopes in the future will shrink for many species (Thuiller *et al*., 2005), posing nearly guaranteed risk of extinction (Thomas *et al*., 2004).

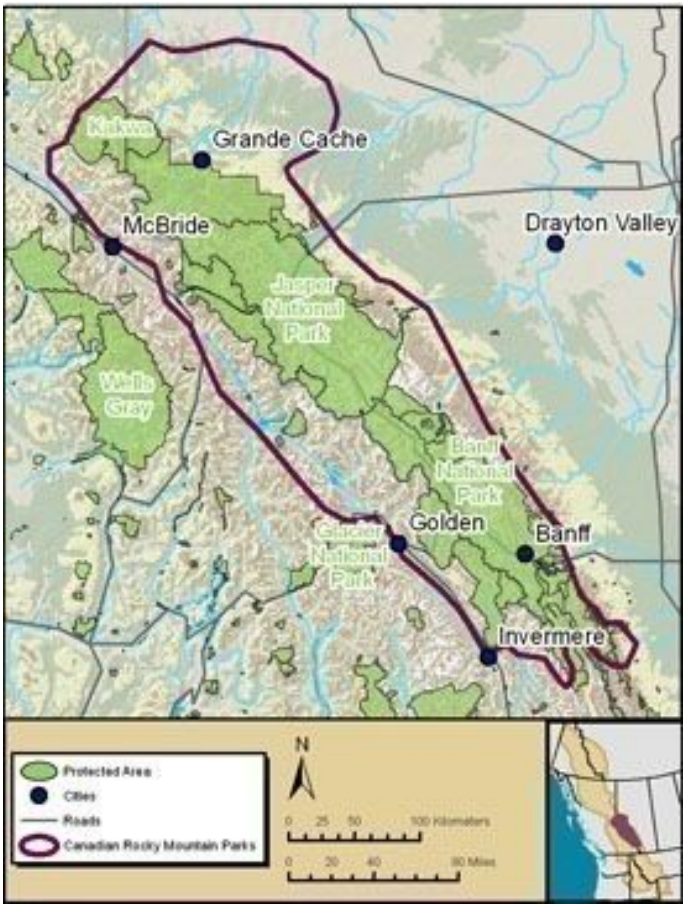

Figure 5: Canadian Rocky Mountains World Heritage Site (Adapted from Y2Y, 2014)

An internationally significant success story for Canada was the creation of the UNESCO Canadian Rocky Mountain Parks World Heritage Site, offering significant connectivity and biodiversity benefits along the continental divide (Sandford, 2010). This will be discussed in Chapter 2.1.3, however in this context it is important to recognize this system as offering a 23,000 square kilometer land base under protection from development and ecologically detrimental land uses. Beyond these delineations also lie several other protected areas sharing boundaries with one of more of the Rocky Mountain Parks, further extending the benefits from Kananaskis to Kakwa. The Site's extent and diversity helps address many of the above challenges of edge effects, connectivity, species migrations and biodiversity corridors under rapid change, if ecosystems are given the flexibility to adapt and change over time.

1.4.2.1.3 Integrating Ecological Integrity and Resilience into Parks Management

A guiding principle of Canadian park and protected areas agencies today (e.g. Parks Canada Agency, 2008a; Alberta, 2009; Environment Canada, 2009) is to manage for ecological integrity and to improve resilience. Described as an ecosystem's ability to absorb change without undergoing a serious/fundamental shift in state or character (Holling, 1973), resilience is something that we want in spades. It offers some protection and adaptability in the face of rapid climate change, natural disturbances and other pressures. Improving or restoring resilience requires parks and protected areas to be "maintaining or restoring ecosystem structure, function

and diversity and enhancing the connectivity of landscapes and seascapes" (CPCCCWG, 2013:9).

Ecological integrity is defined as "whole and complete biological systems, including species, landscape elements, and processes" (Parks Canada Agency, 2000 1:14). A protected area's integrity is "a condition that is determined to be characteristic of its natural region and likely to persist, including abiotic components and the composition and abundance of native species and biological components, rates of change and supporting processes (Canada National Parks Act, 2000:1). First expressed by Aldo Leopold (1949), ecological integrity as a management mandate became an addition (1988) to the Park's Canada Agency over 25 years ago. It has since been a struggle to embrace as a realizable, pragmatic goal given the resources, public education and science integration necessary (Mortimer and Sandilands, 2009). The Agency's lack of a 'conservation culture' also created barriers for prioritizing ecological mandates (Dearden and Dempsey, 2004).

1.4.2.1.4 Parks and Protected Areas as Natural Solutions to Climate Change

Numerous reports have argued for the importance of maintaining and improving ecological integrity and resilience in the face of climate change (Colls *et al*., 2009; CPCCCWG, 2013; Dudley *et al*., 2011). Well accepted as conditions that support ecological and social adaptation and mitigation of climate change and other stressors, integrity and resilience are being increasingly applied to parks and protected areas literature in Canada with the hopes of these areas being natural solutions to climate change (CPCCCWG, 2013; Environment Canada, 2009; 2011a). In the 2009 IUCN report "Ecosystem-based adaptation: a natural response to climate change", Colls and colleagues emphasize the importance of the effective management of protected areas to maintain ecosystem services delivery for increased resilience against climate change (Colls *et al*., 2009:1).

Through the guiding principles of "protect, connect and restore" (CPCCCWG, 2013:3), the Canadian Parks Council promotes inter-agency collaboration within and beyond the parks and protected areas network to best contribute to climate change adaption and mitigation in Canada. Maintaining habitat, connecting natural landscapes, protecting ecosystem services, collaborative restoration and community engagement are offered as ways to reach this socioecological resilience. A large emphasis is placed on the maintenance of ecosystem services, as through their continued flow communities will be better equipped to adapt to climate change (CPCCCWG, 2013:9).

1.4.2.2 Traditional Land Use in Parks and Protected Areas

Incorporating and adequately acknowledging the current ways of life of populations proximate to a protected area or park is critically important. While this has rarely been the case in the past, recently more effort has been made to involve local communities, particularly indigenous or First Nations groups, in protected areas planning (Hamilton and McMillan, 2004). The most optimal solutions ultimately allow for the preservation of ecological properties of concern while also maintaining the rightful freedoms of the people relying on the area.

If regional conservation restrictions will greatly disrupt the reliance of a community on natural resources, the development of the protected area should be critically examined (Hamilton

and McMillan, 2004). Likewise, there are a number of threatened cultural groups residing in more remote areas, often in less accessible mountainous areas; the conservation of cultural diversity and biological diversity may be opposing goals (Hamilton and McMillan, 2004). The BC Protected Areas Strategy (1993) promotes the freedom of indigenous groups to continue traditional land use as a great benefit of protected areas (British Columbia, 1993). However, constraints placed on the landscape by management (such as fire suppression) work against this optimistic proposal (Hamilton and McMillan, 2004); activities become "subject to conservation objectives" (British Columbia, 1993:5).

Offered as a method of determining which ecological communities are therefore appropriate for environmental protection status, designating separate zones within a protected area can allow for different objectives and levels of use. The aim here is for maximum benefit and sustainability for both local community development and environmental protection (Hamilton and McMillan, 2004). While theoretically sound, this approach requires consistent, long-term commitment of management to monitor and enforce, and of the community to abide by the designated zoning restrictions. When set within the circumstances of remote areas, this may become increasingly unlikely to succeed as reduced staff capacity and public involvement often accompany.

1.4.3 Best Practices, Assessment Frameworks, and Reflexive Steps Forward

Suggestions and systematic frameworks have been offered by the scientific community for the adaptive management of protected areas (e.g. Stolton and Leverington, 2006). Systematic conservation planning from Margules and Pressey (2000) acts as a guideline for creating a cost-effective network of protected areas focused on the distribution of biodiversity. Case studies exist of its success and application, showing the use of explicit and functional goals, implementation, and monitoring strategies (Margules *et al*., 2007). Learning from how past targets have been met is emphasized (Margules and Pressey, 2000). Hansen and DeFries (2007) offer that understanding the spatial range of key interactions beyond protected areas can help dictate management across the larger (effective) ecosystem. Regional conservation strategies and land-use monitoring can then be appropriately scaled. However, the successful interweaving of socioeconomic and political dimensions with ecological phenomena is generally lacking in the majority of strategies.

Table 1: WCPA Management Effectiveness Evaluation Framework

Elements of evaluation	Explanation	Criteria that are assessed	Focus of evaluation
Context	**Where are we now?** Assessment of importance, threats and policy environment	- Significance - Threats - Vulnerability - National context	Status
Planning	**Where do we want to be?** Assessment of protected area design and planning	- Protected area legislation and policy - Protected area system design - Reserve design - Management planning	Appropriateness
Inputs	**What do we need?** Assessment of resources needed to carry out management	- Resourcing of agency - Resourcing of site - Partners	Resources
Processes	**How do we go about it?** Assessment of the way in which management is conducted	- Suitability of management processes	Efficiency and appropriateness
Outputs	**What were the results?** Assessment of the implementation of management programmes and actions; delivery of products and services	- Results of management actions - Services and products	Effectiveness
Outcomes	**What did we achieve?** Assessment of the outcomes and the extent to which they achieved objectives	- Impacts: effects of management in relation to objectives	Effectiveness and appropriateness

(Adapted from Hockings *et al*., 2000)

Looking beyond these challenges and best practices, a critical examination of the success of current protected areas management is fitting. The World Commission on Protected Areas (WCPA) has offered a step-wise 6-element assessment framework for management effectiveness with which many assessment methodologies have subsequently been cross-evaluated (see Table 1 above) (Hockings, 2003; *et al*., 2006). This framework is similar to the National Inventory and Monitoring Programs of both Canada and the United States (Parks Canada Agency, 2005; 2007; U.S. National Park Service, 1992). The continual collection of (modest) ecological data and management adjustments following ecological changes are now more commonplace strategic requirements. While there has been a vast assortment of management assessment methodologies, Hockings (*et al*., 2000; 2003) has gone further. Building upon 27 other methodologies, they have offered a unifying, overarching framework for effectiveness assessments overall. This encourages the readjustment of existing frameworks, or if necessary the design of new ones for a

more comprehensive evaluation of both quantitative (monitoring) and qualitative (individual scoring) data illustrating management effectiveness (Hockings, 2003).

Following these challenges and limitations, it is important that we acknowledge why we care about these reserved natural areas. Protected areas are predominantly valued for recreational use, natural beauty, ecological, cultural or spiritual significance (McNeely, 1994), for providing refuge to species and communities (Eagles *et al*., 2000; Ervin, 2003; IUCN, 2005), and for their perceived wildness; their "wild condition a romantic fragment of the past" (Miles, 2009:3). In hopes of bringing a tangible weight to these values for decision-making, attempts have been made to translate into economic terms. Once an area is protected, efforts are usually made explicitly to incorporate them into management objectives and mandates. However, severe challenges exist both when integrating valuation methods with ecological phenomena, and when it is a necessity to balance both social and ecological needs within a protected area (Hamilton and McMillan, 2004). While to date a large assortment of methods have been developed to place value on ecosystems (or their components, properties), in many instances improper application occurs (Fischer and Kerry Turner, 2008; IUCN, 2005). Worries also exist about the danger of tangling the natural world in economics (Costanza, 2000). This brings the nature of value itself into debate. Value is subjectively attributed and added to natural features or objects, despite their unchanged existence before and after human awareness of them (Rolston III, 1994). Placing value on ecological phenomena is one of several challenges when creating and managing protected areas, and preserving natural conditions therein.

Successfully incorporating adaptive measures to manage the above difficulties is an immense undertaking, and when achieved, protected areas can serve as incredibly important safeguards for significant natural and cultural features, species and communities (Hamilton and McMillan, 2004). Certain challenges are difficult to overcome, as political boundaries limit flexibilities to adjust park coverage, urban fringes expand, and biodiversity is dynamic and stressed in many places. Despite logistics, many suggested adaptive measures are within the category of general principle and are less actionable, leaving gaps as to who should act and exactly what improvements can be made (Heller and Zavaleta, 2009).

However, it is also becoming more apparent from the literature that a lack of action generally overshadows a lack of information for informed steps forward. We, for the most part, know what is necessary to adapt protected areas to climate change, public use, boundary and edge effects, and a variety of other stressors. Next we need to construct widely applicable and feasible solutions to do so, and tailor them to local park contexts. The predominant categories of suggested actions include corridor building, policy reform to allow for proactive decisions and flexibility, and the protection of more land (Heller and Zavaleta, 2009). Moving forward with these in mind, protected area benefits have potential to increasingly overshadow associated difficulties.

1.5 Summary

In summary, Chapter One has served as a literature review for this study, structured by four distinct but interrelated subjects. Beginning in 1.1 with a discussion of the Canadian Rocky Mountains, the historical background and current context was given, within which the following case studies of chapter two are situated. The field of ecological restoration, the history of its development, current progress and challenges was next discussed in 1.2. Subsequently in 1.3 the

concept of remote ecosystems was brought in, and placed as a central concept for this study from which the primary research questions stem from. Through a focus on remote ecosystems, this study offers a fresh angle to investigate parks management and restoration goals in parks. Lastly, 1.4 discussed protected areas management. A description of the historical development of parks and protected areas in North America was followed by a snapshot of the system in Canada today, along with some notable challenges including that of edge effects, traditional land use and biodiversity loss under climate change. Closing the chapter in 1.4.3 by looking forward, select best practices and frameworks put forth to assessment management effectiveness were discussed, as well as suggestions for improvements and opportunities into the future.

Chapter Two: A Tale of Two Parks

Chapter Two serves as a detailed comparison of two Rocky Mountain protected areas as case studies - Mount Robson Provincial Park and Willmore Wilderness Park. Beginning with Mount Robson Provincial Park in west-central British Columbia, the discussion will be structured within six broad categories. These subsections include the following; biogeography, settlement history, park development and management history, current management aims, local socioeconomic conditions, and lastly ecological restoration and remote ecosystems. Summaries will follow the discussion of each case study.

2.1 Mount Robson Provincial Park

This chapter offers a detailed description of the first case study, Mount Robson Provincial Park (MRPP). Divided into six sections, relevant conditions of the park will be discussed. First, the biogeography of the park is discussed to give a brief background of the geology and ecology of the area. Next, a shift to historic conditions of local settlement is made followed by the park's development and management history. The last three sections focus on current conditions in and around the park. This includes the current management aims, socioeconomic conditions in the local area, the ecological restoration efforts taking place in the park, and an overview of management efforts in more remote landscapes.



Figure 6: Map of Mount Robson Provincial Park (adapted from BC Parks, 2011)

Resting against the provincial border in British Columbia's Omineca Region, MRPP protects 2,248 km^2 hectares of the Yellowhead ecosystem along the Rocky Mountains spine, immediately west of Jasper National Park (in Alberta) and southwest of Willmore Wilderness Park (WWP). The park, while named for and made famous by the Robson peak itself, at 3,954 meters the tallest peak in the Canadian Rockies, also serves to protect many other geological and ecological treasures including Arctomys Cave (the deepest cave in North America north of Mexico) and the Upper Fraser area (BC Parks, 2011:iii).

The headwaters of the Fraser River begin as a mere stream in Mount Robson and disperse into the Salish Sea south of Vancouver. Coming from Yellowhead Lake it quickly gains strength, and by the time the Fraser leaves the park's western boundary it is a force to be reckoned with. The lands of the Upper Fraser exemplify what some working in the park feel makes Mount Robson a "true park". There are high use areas with notable trail infrastructure and facilities for visitors. However, the vast majority of park area is managed for non-human species with the aim

of maintaining (as much as possible) conditions of wilderness, or wildlands. This combination offers something for everyone, and not far off the busy, well-graded Berg Lake Trail one can find solitude and rugged terrain. As Area Supervisor Wayne VanVelzen said simply, "don't build it and they will come" (Peters and Bakala, 2003:45).

2.1.1 Biogeography

The biogeography of MRPP is discussed in several broad categories of geology, climate, ecology, and species at risk. These same categories are discussed for WWP in 2.2.1, and relevant links will be made back to this first case study. As the parks are located close to one another, both touching the continental divide and sharing borders with Jasper National Park, there are notable similarities in their biogeography.

To begin, there are several prominent valley corridors protected in the park. MRPP protects the headwaters of the Fraser River and its tributaries the Robson and Moose rivers. The Fraser River serves as a hydrological life force to the local area and far beyond it. The river begins at Yellowhead Pass. The Pass and the Robson Valley are extremely culturally and ecologically significant. Extensively used by indigenous peoples preceding the park's establishment, the valley offered a diverse and rotating seasonal supply of wildlife, fish and other resources. While large sections of MRPP have not seen repeat photographic efforts to date by the Mountain Legacy Project, Yellowhead Pass is well documented in the repeat photographs taken in summer 2012.

Geology. The geology of the park is very diverse, with deposits ranging in age from the Proterozoic Era (2,500-545 mya) to the Ordovician period (490-443 mya) in the Paleozoic Era, when the first vertebrates were evolving. Deposits are largely shale, siltstone and calcareous (limestone and dolostone) and represent periods of inland seas, rapid erosion and deposition following sea level changes, and glaciation (Iredale, n.d.). It was not until the late Jurassic period (165-144 mya) that the Rockies began to develop. The Mount Robson peak maintains its height due to flat-lying beds, which aids in greater resistance to erosion (Iredale, n.d.). Alpine areas are characterized by exposed bedrock and colluvial deposits are common into the subalpine on steep slopes.

The extent of Mount Robson Park is considerable, and encompasses a multitude of mountain ranges and unique geological and ecological features. The Rainbow range, visible from the Yellowhead Highway, is part of the overarching Northern Continental Range, and offers a namesake display of rich ochre and yellow rock (Province of British Columbia, 2013a). The Selwyn Range and South Jasper Ranges are also represented well in the park, and the Rampart Mountains constitute the southeastern tip of the park (Province of British Columbia, 2013b).

Hydrology. The protection of the hydrological features in MRPP is one of the Park's invaluable conservation roles. There are many streams within MRPP, and a few large water bodies and wetlands. Kinney Lake and Berg Lake are found along the Berg Lake Trail, at 10.5 and 21.5 km up respectively. Berg Lake is fed by glacial outwash from the Robson Glacier. Annual spring floods accompany the alpine and subalpine zone melt. Under conditions of rapid climate change, the timing and magnitude of the floods may be affected (BC Parks, 2011).

Just west of Yellowhead Pass, the Fraser River emerges out of Yellowhead Lake, and cuts west through the park towards Moose Lake. The two latter lakes are found along the Yellowhead Highway corridor, which is discussed in 2.1.2. Both the Robson and Moose Rivers serve as tributaries to the Fraser River (BC Parks, 2011). Found alongside the Fraser River is the Moose Marsh, which is the largest wetland complex in the park, accompanied by several small pocket wetlands. Following the construction of the TMX Anchor Loop Project (discussed in 2.1.3), monitoring occurred on the neighbouring wetlands and it was found that the hydrological functioning of the wetlands had been damaged. Kinder Morgan's post-wetland monitoring program was established for continued surveillance of wetland conditions (BC Parks, 2011).

Climate. Climate in the park is typical of the central Canadian Rocky Mountains, with long winters and short dry summers. Mean annual precipitation varies from 609 mm/yr (sub-boreal spruce biogeoclimatic subzone) to 1031 mm/yr (alpine tundra). Precipitation estimates include snowfall, which has been recorded on average 9 months a year (BC Parks *et al.,* 2001). Lush forests can be found in sites of higher precipitation. Changes in the depth and temporal extent of snowpack have been observed since 1950. Data suggests that the end date of snow cover has changed and come sooner; from 1950 to 2007, there has been a loss of more than 20 days of snow cover (≥ 2 cm) (Zhang *et al*., 2011). This faster spring melt correlates well to temperature data described below. There has also been a decrease in the proportion of total precipitation falling as snow over that time period (Zhang *et al*., 2011).

Jasper, Alberta serves as the closest long-term Environment Canada weather station for both MRPP and WWP, with detailed weather data since 1926. Based on this, average annual temperature for the region is 3.5 degrees Celsius. Average temperature minimum and maximum ranges from -14.6 to 21.6 degrees Celsius (1971 - 2000), with recorded extremes of -46.5 and 36.7 degrees Celsius since 1926 (Environment Canada, 2011). Local mean temperatures of the coldest and warmest months are −11 and 15.5 degrees Celsius respectively (BC Parks *et al*., 2001). Warming trends following climate change have led to mean annual temperature increases of 1.5 to 3 degrees Celsius between 1950 and 2007 in the Rocky Mountains (Zhang *et al*., 2011). The largest increases were seen in summer and winter. Conversely, mean fall temperatures (Sept. - Nov.) were seen to decrease 0.5 to 3 degrees Celsius. All of these trends apply to WWP as well. Figure 8 below illustrates the mean annual temperature changes across Canada over this time period. Only a few weather stations in southern Ontario and in the Maritimes show a decrease in mean annual temperature over this time period.

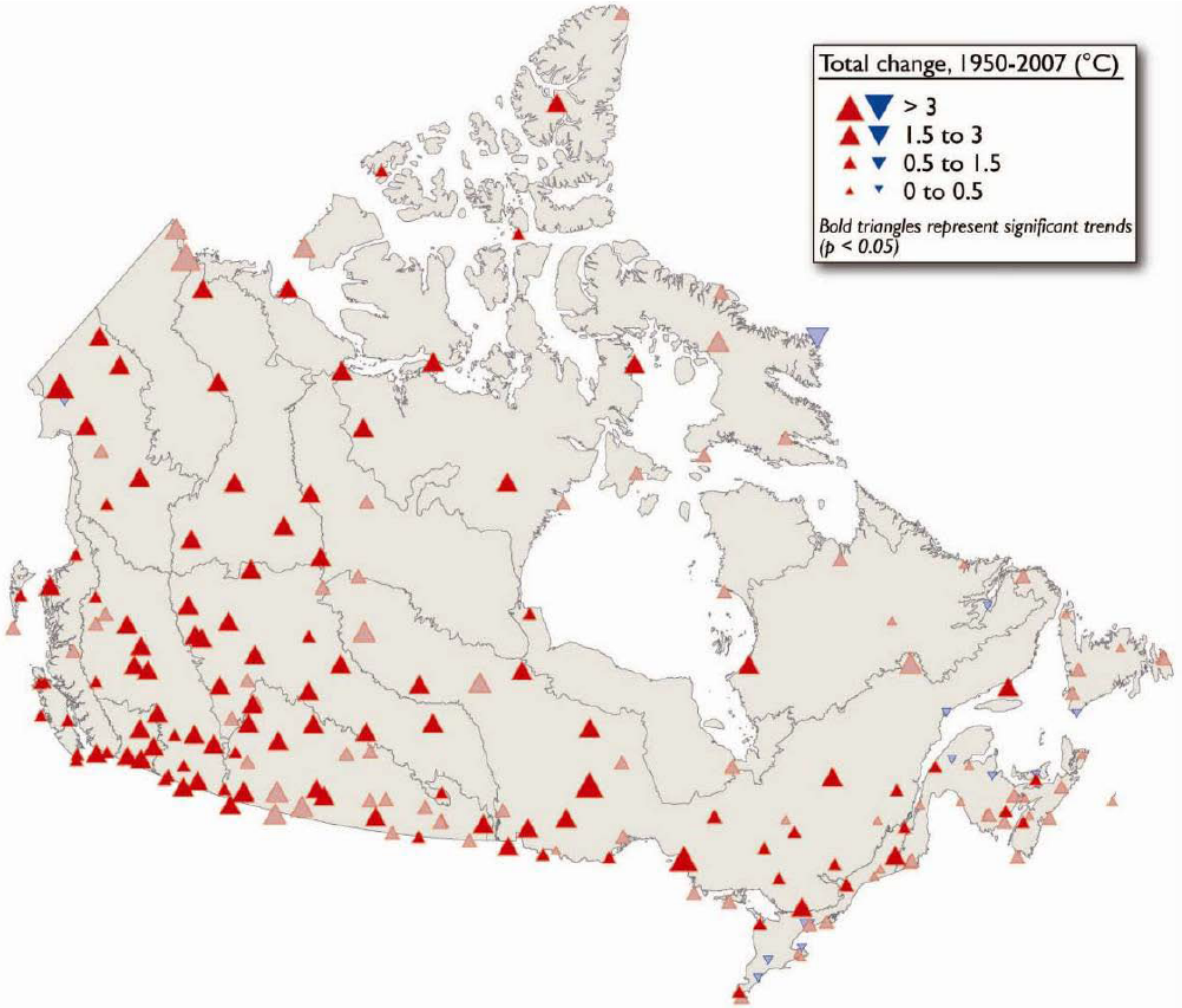

Figure 7: Mean annual temperature changes in Canada, based on climate data from 1950-2007 (Adapted from Zhang *et al*., 2011)

Ecology. In BC, the Ecoregion Classification System separates ecosystem types based on physiographic and climatic differences. From specific to broad, there are 116 ecosections within 43 ecoregions within 11 ecoprovinces, seven ecodivisions and four ecodomains (BC Parks, 2011; Demarchi, 2011). MRPP protects over 30% of the Northern Park Ranges Ecosection in BC. This serves as the primary conservation role of the park. In addition, the park protects several variants of the Engelmann Spruce Subalpine Fir (ESSF), Alpine Tundra (AT), Interior Cedar Hemlock (ICH) and Sub-boreal Spruce (SBS) biogeoclimatic zones (B.A. Blackwell and Associates, 2005; BC Parks, 2011). All BGC zones and their respective coverage in the park are displayed in Table 2 below. Biogeoclimatic (BGC) zones, while possible to organize within a given ecosection, are a separate indicator of ecosystems based on regional climate similarities. The ecosystems are categorized within a hierarchy of 14 BGC zones divided into 76 subzones and then further into variants and phases (which denote slightly different climates but similar vegetation to a subzone) (Demarchi, 2011). Figure 8 below shows the biogeoclimatic zones of the Canadian Rocky Mountains ecoregion.

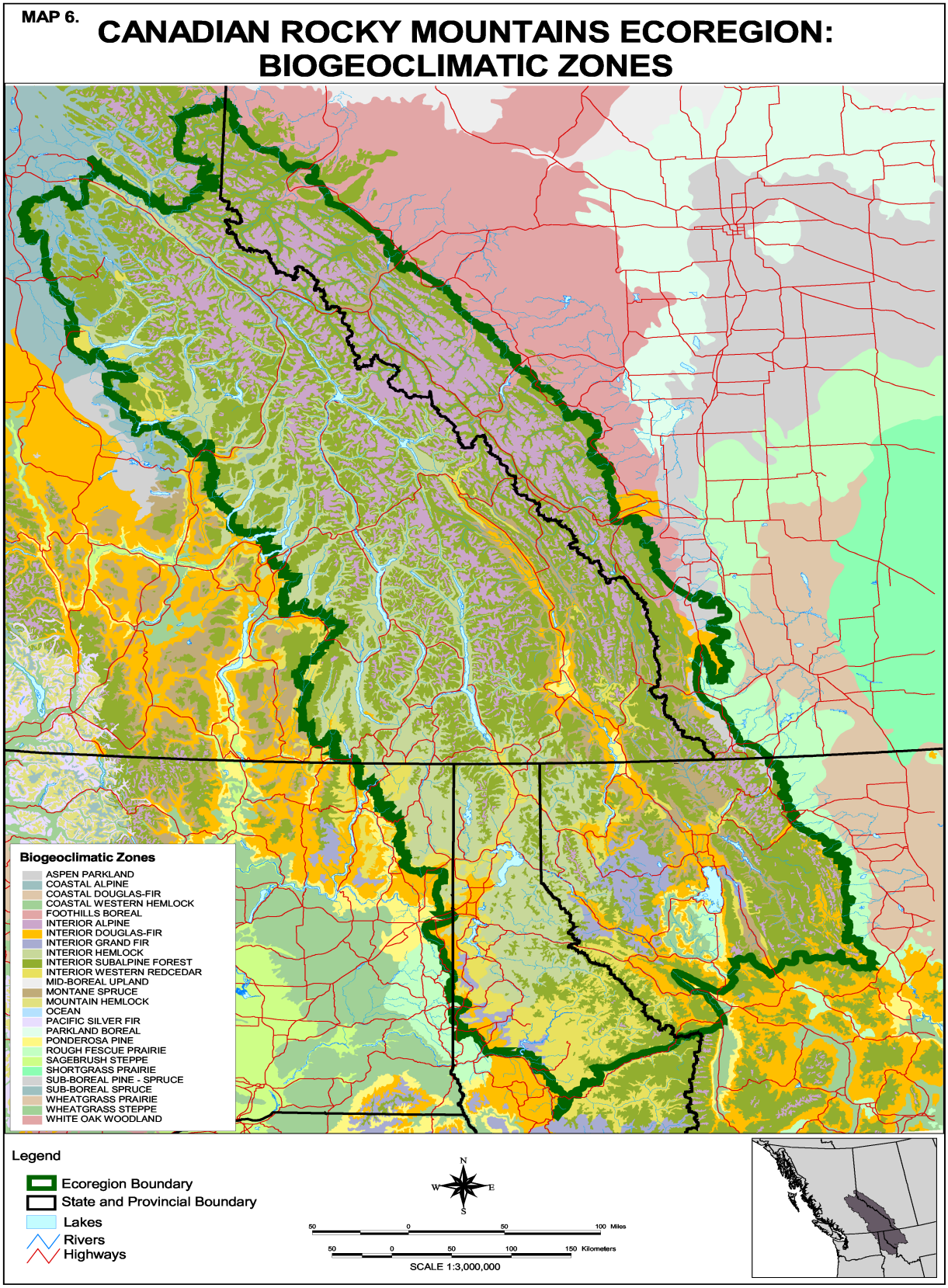

Figure 8: Biogeoclimatic zones of the Canadian Rocky Mountains Ecoregion, BC (Adapted from Nature Conservancy of Canada, 2004)

Table 2: Biogeoclimatic zone representation in Mount Robson Provincial Park

BGC Zone	Total BGC Zone area within the province (ha)	Total province-wide protected area in this BGC Zone (ha)	% of the total BGC Zone area within the province that is protected	% of province-wide protected area in this BGC Zone	Number of protected areas in this BGC Zone	Area of this BGC Zone in this Provincial PA (ha)	% of this BGC Zone in this Provincial PA	% of the province-wide protected area in this BGC Zone that is in this Provincial PA
ESSF	16,961,492	2,724,806	16.0	22.9	161	131,519	0.8	4.8
ICH	5,179,131	483,235	9.3	4.1	138	5,815	0.1	1.2
IMA	1,606,371	507,960	31.6	4.3	59	66,692	4.1	13.1
SBS	9,603,583	578,011	6.0	4.9	110	18,744	0.2	3.2
ESSFmm 1	296,348	41,253	13.9	0.3	11	36,522	12.3	88.5
ESSFmm 2	21,582	21,582	100.0	0.2	1	21,582	100	100
ESSFmmp	344,815	79,603	23.1	0.7	11	73,415	21.3	92.2
ICH mm	144,170	7,981	5.5	0.1	6	5,815	4.0	72.9
IMA un	1,160,441	345,631	29.8	2.9	51	66,696	5.7	19.3
SBS dh 1	65,151	1,644	2.5	0.0	5	752	1.1	45.7
SBS dh 2	18,609	17,992	96.7	0.1	1	17,992	96.7	100

(Adapted from BC Parks, 2011)

Tree species found within the ESSF include Lodgepole pine (*Pinus contorta*), Subalpine fir (*Abies lasiocarpa*), and Engelmann spruce (*Picea engelmannii*). Where fire disturbance has occurred, lodgepole pine is often the dominant species (BC Ministry of Forests Research Branch, 1998a). In drier areas of ESSF, species found may include Limber pine (*Pinus flexilis*) and Whitebark pine (*Pinus albicaulis*). Some of the oldest whitebark pine trees in Canada are also found in MRPP, at 800 years old (Luckman and Colenutt, 1988, as cited in BC Parks, 2011).

The ICH zone is dominated by Western red cedar (*Thuja plicata*) and Western hemlock (*Tsuga heterophylla*) but also includes Douglas fir (*Psuedotsuga Menziesii*), lodgepole pine and several over tree species (BC Ministry of Forests Research Branch, 1998b). Few deciduous trees are found in the ESSF, ICH and SBB zones. Exceptions include trembling aspen (*Populos tremuloides*) and paper birch (*Betula papyrifera*) in dry areas of the ICH and in moist to dry SBB sites (BC Ministry of Forests Research Branch, 1998b).

Beyond forest, the park is host to a variety of habitats. Over 2,200 hectares of non-forests wetlands (willow - sedge fen) are found in the park (BC Parks *et al*., 2001). Diverse subalpine communities are found above the treeline, with krummholz tree patches and stunted shrubs interspersed within open alpine meadows and alpine tundra at higher elevations. Grasses, sedges and lichens dominate the alpine zones in MRPP, which are categorized as Boreal Altai Fescue Alpine and differ in vegetation and terrain from alpine areas of the coast and interior mountains of BC (BC Ministry of Forests and Range Research Branch, 2006).

Within these varying habitats, notable diversity of flora and fauna can be found. Varying with moisture and canopy cover, understory vegetation may include a variety of species. When moist, species present may include; red-osier dogwood (*Cornus sericea*), highbush cranberry (*Viburnum trilobum*), devil's club (*Oplopanax horridos*), and numerous species of dense mosses and lichens. When dry conditions exist, species present may include thimbleberry (*Rubus*

parviflorus), twinflower (*Linnaea borealis*), bunchberry (*Cornus canadensis*) and kinnickinnick (*Arctostaphylos* genus*)* (BC Parks *et al*., 2001).

Starting in the 1940's, long-term fire suppression has led to aging forest stands increasingly at risk (B.A. Blackwell & Associates and Compass Resource Management, 2003). In 1913, the last large fires went through the main valley corridor accompanying railway construction. This left an even-aged forest over a large area. Ecologically, the presence of a large area with stand homogeneity and absence of early seral and old forest can increase vulnerability to pests, disease and catastrophic large-scale fire (B.A. Blackwell and Associates and Compass Resource Management, 2005).

Stands of homogenous Lodgepole Pine (*Pinus contorta*), now 100 years old, dominate the landscape and have been invaded by mountain pine beetle (*Dendroctonus Ponderosae)* in recent years (B.A. Blackwell and Associates and Compass Resource Management, 2005). Mountain pine beetle was first seen in the park in 1997, shortly preceded by strong acknowledgement that the aging, homogenous forests created by the railway fires were becoming increasingly susceptible. In these earlier years, the Swift Current drainage on the western boundary of MRPP experienced beetle activity, but this soon spread into the Robson Valley as far east as Yellowhead Lake, which sits nearly at the provincial border (B.A. Blackwell and Associates and Compass Resource Management, 2003). Mountain pine beetle has since moved through to Jasper National Park.

Species at Risk. Species at risk in BC are classified by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and subsequently under Canada's *Species at Risk Act* (SARA) for species of greatest concern. MRPP is located in the Fraser-Fort George Regional District, and species at risk can be organized within this region to allow for a more geographically specific understanding of which species are under pressure in and around the park. Of a total of 106 species at risk, the majority are plants; 40 vascular plants, 26 mosses are on the list. The remaining species are split fairly evening between mammals (eight), breeding birds (12) insects (nine) and fishes (seven). A total of 21 species are on the BC Red List, and 81 are on the BC Blue List (Pearson and Healey, 2012). Based on COSEWIC guidelines, the Red List designation indicates that the particular species is extirpated, endangered or threatened. The Blue List designation denotes a species that is of special concern.

COSEWIC has rated five species in this regional district as endangered, five as threatened, and nine as Special Concern. If considered threatened by COSEWIC, the species is most at risk and if limiting factors continue will likely become endangered (Pearson and Healey, 2012). If considered endangered, imminent extinction or extirpation is expected. A species is believed to be slightly less at risk when considered Special Concern (Pearson and Healey, 2012). This designation denotes a species that will likely become threatened or endangered due to known threats and biological characteristics (Pearson and Healey, 2012). Also at the national level, SARA places 14 species in the regional district under Schedule 1, which denotes a legal requirement for recovery plans to be developed and implemented for species deemed at risk by COSEWIC.

The park protects valuable habitat for wide-ranging mammal species at risk such as grizzly bear (*Ursus arctos*), wolverine (*Gulo gulo*) and woodland caribou (*Rangifer tarandus caribou*). Other species at risk include the fisher (*Martes pennanti*), bighorn sheep (*Ovis canadensis)*, short-eared owl (*Asio flammeus*), coho salmon (*Oncorhynchus kisutch*), white

sturgeon (*Acipenser transmontanus*), Canada anemone (*Anemone canadensis*), whitebark pine (*Pinus albicaulis*), Haller's apple moss (*Bartramia halleriana),* and dozens of other species (Pearson and Healey, 2012). A few species are discussed in detail below, with a focus on those which park management efforts are most involved with.

The grizzly bear (*Ursus arctos*) is blue listed in BC and is of special concern to COSEWIC (Pearson and Healey, 2012). Research suggests that habitat fragmentation and loss are the primary factors in the species' decline in western Canada, however added pressures on the populations include human-bear conflicts (hunting, poaching) and travel corridor mortalities (Pearson and Healey, 2012). BC remains the species' stronghold in Canada, with around 50% of the national bear population in the province and an estimated 13,800 individuals remaining in recent years (Gyug *et al*., 2004). Within the Robson Valley, grizzly bear habitat management efforts are focused on habitat enhancement and maintenance to promote the genetic variability and distribution of bears in the region. Nine strategies have been developed to support these goals, which encourage sensitive land use practices and road locations/access, and protection of forage species (Gyug *et al*., 2004). Restoration efforts include prescribed burns in the ESSF for berry productivity and thinning of forest stands.

In addition, the southern and northern mountain populations of woodland caribou (*Rangifer tarandus caribou*) are found in the regional district. The southern populations are red listed in BC, considered Threatened by COSEWIC and listed under SARA (Pearson and Healey, 2012). The northern populations are larger and less endangered, however increasing northern development is placing growing pressure on them. The northern populations are considered blue listed in BC, of Special Concern by COSEWIC and listed under SARA. Overall, woodland caribou populations in BC are declining primarily due to habitat loss to development, predation, and human harassment (Pearson and Healey, 2012).

The wolverine (*Gulo gulo*) is not listed in BC but is of Special Concern to COSEWIC. In Willmore Wilderness Park (WWP), the wolverine is of high conservation priority to management, as population densities in the region are among the highest in the province of Alberta (Fisher *et al*., 2013). Primary pressures on populations are similar to those of grizzly bears, with habitat loss/fragmentation, and travel corridors as major factors. Other pressures include backcountry recreational activities, trapping and poisoned baits set by human hunters for wolves (Pearson and Healey, 2012). While protected from harm under the provincial *Wildlife Act*, legal harvest for pelts is permitted in most regions of BC (Weir, 2004).

2.1.2 Settlement History

The human history in and around Mount Robson dates back thousands of years. For centuries, indigenous peoples used the valleys following seasonal cycles of hunting and fishing, and the patterns of salmon, deer, elk, bear and other species. Travelling over large regions was common to follow resources and trade (or fight) with other groups. Small numbers of "Shuswap Indians" lived in the Mount Robson and Jasper areas in the early 1800's (Glen *et al*., 2008). They are now known as the Simpcw First Nation, and are a divison of the Secwepemc or Shuswap. Their traditional territory is shown in figure 10 below, and their current population is 640 (Province of British Columbia Labour and Citizen Services, 2013c). The Lhtako Dene Nation (Red Bluff Indian Band) and the Lheidli T'enneh Nation also had traditional territories in the area, but are not longer living in there. Present populations of these communities today are 148

and 320 respectively (Province of British Columbia Labour and Citizen Services, 2013a; 2013b). BC Parks states that they are consulted during park planning (BC Parks, 2011). The Texqakallt First Nation represents the earliest known inhabitants of the Fraser River's upper reaches, in present-day Mount Robson Provincial Park. The great peak was called "Yuh-hai-has-kun' (the mountain of the spiral road) because of the peak's distinct layered appearance (BC Parks, 2013).

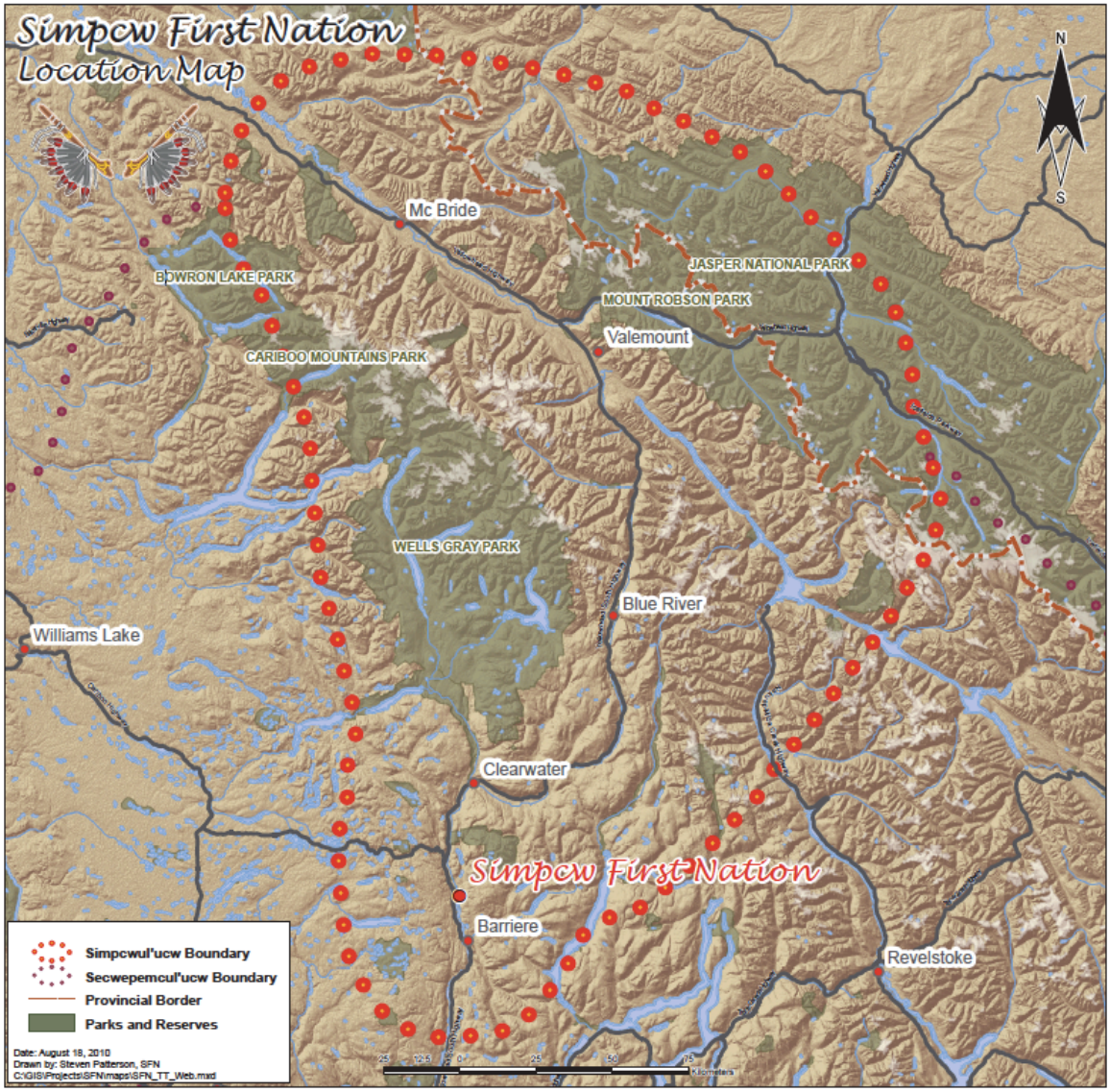

Figure 9: The traditional territory of the Simpcw First Nation, relative to the Robson Valley Land and Resource Management area (Adapted from Patterson, 2010)

While many First Nations in Canada have signed treaties, those communities once local to the Mount Robson area have largely abstained from these agreements so far. The Simpcw First Nation is part of the Shuswap Nation Tribal Council which is not involved in the BC treaty process (Province of British Columbia Labour and Citizen Services, 2013c). The Lheidli T'enneh Nation has yet to agree on and finalize a treaty settlement, as the most recent Final Agreement initialed by chief negotiators (August 2006) was not ratified by the community (March 2007) (Province of British Columbia Labour and Citizen Services, 2013b). The Lhatko

Dene Nation is part of the Carrier Chilcotin Tribal Council and is not involved in the BC treaty process, however did sign two forestry agreements in 2006 (Province of British Columbia Labour and Citizen Services, 2013a)

European involvement in the Robson Valley began in the 18th century. While Alexander MacKenzie had crossed to the Pacific from the Peace River in 1793 (Hudson's Bay Co., 1958), only sporadic fur trading activities were taking place in the Mount Robson region for nearly a century after due to the treacherous terrain. While the majority of early 19th century travel and trade used Athabasca Pass, this use dissolved within a few decades (MacGregor, 1974). An Iroquois man called Tete Jaune or Yellow Head crossed at another pass further north in 1823 and left his fur cache nearby. Subsequent fur traders soon began using the pass following his lead. Yellowhead Pass and the local community of Tete Jaune Cache remain as his namesakes (MacGregor, 1974).

In the early 1860's, European interest in the Yellowhead Pass grew following news of the Caribou Gold Rush in BC. The Pass was traversed by the Overlanders[4] in 1862 (Wade, 1981), followed shortly thereafter by Milton and Cheadle[5], who entered British Columbia through what is now the eastern highway-accessible entrance to Mount Robson Park (Milton and Cheadle, 1865). Upon seeing Mount Robson's majestic peak for the first time, they wrote that "on every side the snowy heads of mighty hills crowded round, whilst, immediately behind us, a giant among giants, and immeasurably supreme, rose Robson's Peak" (Milton and Cheadle, 1865).

From the late 1800's, the railway survey era was alive and slowly making tracks into the Canadian west. Yellowhead Pass experienced large-scale rail construction in 1910 when the CNoR came through from Edmonton to Vancouver (Regehr, 1972). The already present Canadian Pacific Railway (CPR) line, constructed in the 1880's (Pole, 1993), meant an inconvenient and expensive route along the Fraser and Thompson Rivers - in most cases literally building across the river from the established line; severe damage was done to Fraser salmon runs. Wisdom in hindsight resulted in one line being torn up following the amalgamation of several rail companies in the coming decades (MacGregor, 1974). Today, two rail lines cross into BC at Yellowhead Pass and follow the Fraser River west through MRPP. The CPR line remains active. This route remains a critical transportation route today, connecting British Columbia to the rest of Canada.

Between 1885 and 1905, 2 million people came to the Rocky Mountains region by train, populating numerous railway towns (Cashman, 1971). While many have grown and sustained their populations over time, there were also boom and bust towns, which often dissolved shortly after the railway's completion (Pole, 1993). Several examples can be found in MRPP itself. The town sites of Summit City, Moose City, Lucerne and Red Pass were once located right off the railway, and were settled in the wake of its 1913-1915 construction (B.A. Blackwell & Associates and Compass Resource Management, 2003). In situ evidence of these communities has all but disappeared under forest regeneration. However, if you take even a few steps off the

[4] The Overlanders were the first Canadian party to head to the Caribou, the travelers were a large group comprised of many small parties from Ontario, Manitoba and New York. Of their starting party of 150, several dozen perished before making the Fraser's headwaters. Along with compounding struggles of terrain, starvation and exhaustion upon reaching this region, the Fraser River's tumultuous rapids claimed a number of travelers (Wade, 1981).

[5] In the early 1860's, Milton and Cheadle were tasked by the British Crown with finding a route across British territory to the pacific via a northern Rocky Mountain passage. These efforts were fueled by interest in the Caribou gold regions, northern highway establishment for improved communications with Asia, and expanding colonization in the prairies and further west. Leaving Liverpool by boat on June 19th, 1862, the journey took several years. The pair's expedition began in Quebec, dipped below the Great Lakes into the United States, then proceeded towards the mountains through the prairies of Saskatchewan and Alberta (Milton and Cheadle, 1865).

Yellowhead Highway in the right place, you will stumble upon a rich and complicated historical settlement record amongst the trees. There are old roadbeds nearly invisible now, and rusted milk cans, engine parts and jars scattered in what used to be a residential area. Small community cemeteries still maintained by current generations exist in several locations in the park as reminders of these settlements, giving clues to historic epidemics and family lineages.

In addition to these voluntary settlements, Japanese gardens from internment camps[6] can be seen beneath forest stands near the Yellowhead Highway. Hundreds of men lived in the Valemount - Mount Robson area (B. Wilkinson, personal communication, April 2, 2013). The above descriptions are various snapshots of human activities among thousands, offering a more vivid picture of what the land has seen come and go, and to emphasize the changes that occurred in the early to mid 1900's.

Along with ensuring a link for BC to the eastern provinces, mountain tourism was a major incentive for the railway's construction. National promotion was encouraging travel west by rail to see the "shining mountains", as first described by Anthony Henday (Pole, 1993). Early climbing and mountain culture became vibrant in and around the Robson Valley, and played a primary role in its designation as a provincial park. The area's daunting peaks, diversity and scenery seemed a perfect fit for world-class expeditions and adventure. A.O. Wheeler and his topographic survey team came in 1911 to map the area. From that expedition, great interest was ignited in the area, and he soon became a strong promoter for the park's creation (discussed in the next section).

Following the Great Depression in the 1930's and its gradual resolution, consistent population growth occurred in the Canadian west, and communities were becoming more urban (Cashman, 1971). In the late 1940's, various communities collectively pushed for highway construction through Yellowhead Pass (MacGregor, 1974). However, the Trans-Canada Highway #1 was instead put through Kicking Horse Pass; the Yellowhead route was seen as more expensive with less utility. Subsequently completed by 1970, the Yellowhead Highway now serves as the northern counterpart of Highway #1, splitting west from Winnipeg and extending through Prince George (MacGregor, 1974). The highway is a notable factor in the park, cutting through the central reaches of the park not far from Mount Robson itself. This route offers an assortment of challenges for park managers; including wildlife crossing mortalities, hydrological impacts on neighbouring wetlands, invasive species, automobile pollution and pressures on ecological connectivity. Running alongside the highway includes twinned gas pipelines, a fibre-optics communications line and the railway (BC Parks, 2011).

However, the highway brings in people, lots of people, which keeps the whole thing running. In this way, Mount Robson acts as a gateway to BC and a flagship park for the BC Parks provincial protected areas system. Offering diverse recreational opportunities for visitors and considerable facilities along the Berg Lake trail in particular, the park is well arranged for a wide array of visitors - from weekend campers, curious travellers just passing through, or those looking for a backcountry trip set well away from busy trails.

In conclusion, the settlement in and around MRPP began with indigenous groups thousands of years ago. Using the land for hunting, trapping and fishing, small groups travelled

[6] Beginning in January 1942, nearly 20,000 Japanese Canadian aliens from the western reaches of British Columbia were forced to abandon their homes, have their families divided between work camps and move into the interior or further east (Ward, 1982). World War II had set in motion dramatic widespread actions fueled by nearly 70 years of racial tensions in the province, which was home to 95% of Japanese-Canadians at the time (Sunahara, 1981). Men aged 18-45 were considered threats and sent to various work camps near Jasper, Alberta (Miki and Kobayashi, 1991).

over large areas following seasonal cycles of plants and animals, and to trade with neighbouring groups. By the 18th century, European exploration and expansion into western Canada increased. With the combined energies of the fur trade and railway construction over the coming centuries, a stronger connection from the eastern provinces was forged and more settlers moved west. Mountain tourism became a new draw, and in time Yellowhead Pass became the northern counterpart to the Trans-Canada Highway connection into BC. By 1913, MRPP was designated a provincial park, and in time would become a flagship park at the northern gateway into the province. The history of MRPP's establishment is discussed in detail in the coming section, 2.1.3.

2.1.3 Park Development and Management History

Established on March 1, 1913, MRPP's centennial was celebrated in the year this thesis is being written. Its establishment was largely due to the efforts of the surveyor A.O. Wheeler and colleagues (BC Parks, 2011). After experiencing the park and surrounding area early on while completing the Mount Robson 1911 Survey, they actively advocated for its protection and park status. The spectacular views and recreational opportunities available in the area were the main push behind its park designation.

Following a 1911 expedition involving Conrad Kain, A.O. Wheeler and Reverend Kinney, Whitehorn Mountain was summited and Arctomys Cave was discovered, which is the deepest known cave system north of Mexico. Mount Robson itself is the highest peak in the Canadian Rockies at 3,954 meters. After a few failed attempts to climb it in the early 1900's, largely due to logistics and weather challenges, a 1913 Alpine Club of Canada Berg Lake camp expedition led to the first recorded ascent (BC Parks, 2011).

In the same year, Wheeler also advocated for a trail to be put through to Berg Lake, which was used for this same expedition. This involved in part, a highly engineered 4 km graded slope constructed up to Emperor Falls from the Kinney Lake flats. This allowed visitors to overcome the significant headwall through a long but only moderately steep ascent, and was deemed necessary for allowing greater access to the remainder of the trail to Berg Lake. It was completed in the early years of the park. The Berg Lake trail continues to be a major component of the park's visitor experience, hosting over 35,000 annual day-use visitors (Peters and Bakala, 2003).

MRPP is managed by BC Parks and is currently categorized provincially as a Class A Park. This designation instills a dedication to "[preserve the park's] natural environments for the inspiration, use and enjoyment of the public" (BC Parks, 2013:1). While this status also provides the park with extra protection against use permits pertaining to land use and natural resources, development activities within the park have nonetheless gone forth in recent years. In order for these activities to take place, the park must be "named and described in Section D of the *Protected Areas of British Columbia Act"* (BC Parks, 2013:4). Management within the park operates within expectations set by the *Park Act,* the *Park, Conservancy and Recreation Area Regulation*, and relevant procedures and policies of the Ministry of Environment (BC Parks, 2011).

The International Union for Conservation of Nature (IUCN) designation best applied to MRPP is the Protected Areas Category II, National Parks. This category denotes a protected area that protects ecosystems and their functioning while also allowing sustainable levels of human use via recreational tourism and supporting the local economy (UNEP, 2014). Conservation

goals are balanced with visitor use and subsequent facilities (e.g. campgrounds, visitor centers, trails, alpine huts).

In 1984 the Canadian Rocky Mountain Parks (UNESCO) World Heritage Site was granted its designation. This included Banff, Kootenay, Jasper, and Yoho National Parks. In 1990, Mount Assiniboine, Mount Robson and Hamber Provincial Parks were subsequently inscribed as part of the Heritage Site. The Rocky Mountain Parks offer universal value in both the representation of natural phenomena and beauty, 12 iconic and/or IUCN red-listed species, the Burgess Shale fossil deposits, and on-going ecological and biological processes (Parks Canada Agency, 2004). The dramatic and rugged peaks throughout the parks, alongside the Burgess Shale fossil site, were influential in the decision to designate the area.

Known to some as the Magnificent Seven, this contiguous group of four national and three provincial parks is of international significance and protected 23,000 square kilometers of the Canadian Rocky Mountains (Sandford, 2010). The parks themselves protect over 900 archaeological sites, 23 significant mountain passes, 667 notable peaks, 384 glaciers, 295 lakes and 44 rivers. Living within those landscapes are an incredible diversity of plant, bird and mammal species and 13 large carnivores (Sandford, 2010). This includes species which are extremely culturally salient and represent the region, such as the grizzly bear, bighorn sheep, and mountain goat.

MRPP has a particularly well-developed and extensive management planning history, particularly in comparison to other protected areas. Contrastingly, due to various complexities, Willmore Wilderness Park continues to await an inaugural management plan. A brief review of MRPP's planning documents is necessary to fully depict the decision-making aims and strategies that have lead to the present management system, to be discussed in the next section.

The MRPP Management Plan has to date seen two major installments and updates. These took place in 1992 and 2011. The initial Management Plan in 1992 was prepared by BC Parks Prince George District. Since then, a third party on contract has spearheaded each update, from prescribed burns to Mountain Pine Beetle and biodiversity. B.A. Blackwell and Associates Ltd. led the 2011 Management Plan, the 2003 Prescribed Fire Evaluation, the 2005 Forest Health Strategy, as well as the 2001 Ecosystem Management Plan. The Fire Management Plan and the Moose River prescribed burn plan were both completed in 2000 (B.A. Blackwell and Associates *et al*., 2001).

In 1992, the MRPP Master Plan served as a detailed account of what the park represented culturally and what it supported ecologically. Defining the park's role nearly 80 years after official legal designation required the incorporation of present goals and concerns - both local and those of the BC Parks agency - along with the ideals that largely led to the development of the park. The plan offers several key adjustments, including explicit zoning (80% or 176,000 hectares zoned 'wilderness'), helicopter use permits, and recommendations for specific management plans (Berg Lake Trail, travel corridor vegetation and wildlife, wildlife overall, forests). The Master Plan also highlighted the Swiftcurrent watershed as an area of concern (BC Parks, 1992). The Swiftcurrent Creek area is at the far western boundary of MRPP, north of Tete Jaune Cache and close to the Yellowhead Highway route.

Alongside the 1992 Master Plan and subsequent documents, the Robson Valley and MRPP have been jointly managed under a series of legislation for resource management and conscientious development of crown land. These include the Forest Practices Code of BC Act, and ongoing updates to natural resource use through Timber Supply Reviews and Analyses

(1994 – 2005, multiple updates). Additionally, the 1991 revision document Striking the Balance: BC Parks Policy described the protected area policy and zoning adjustments made to the parks system in BC in relation to public-accountability and the provincial land use strategy (BC Parks, 1991).

Until a park expansion in 1973 (BC Parks, 2011), no changes to extent or geographic coverage had been made since the park establishment in 1913. A Swiftcurrent River addition came in 2000 after being recommended for addition by the 1999 Robson Valley Land and Resource Management Plan (LRMP) (Omineca Region Environmental Stewardship Division, 2005). While the mid section of the Swiftcurrent Creek was already within park boundaries, the recommended area (6,038 hectares) protected most of the remaining watershed (Robson Valley Round Table, 1999). The area offers backcountry recreation opportunities and improves the ecosection representation of ecosystems.[7] In 2004, 14 hectares of the 5,956-hectare addition were removed from the park and established as Mount Robson Protected Area due to water line construction (Omineca Region Environmental Stewardship Division, 2005; BC Parks, 2011).

The Robson Valley LRMP offered broad guidance on land use management and planning from mining to recreation. A total of 1.4 million hectares lying within the Robson Valley Forest District were addressed, and classified into 23 Resource Management Zones (RMZs) comprised of 5 different categories. While Mount Robson and Mount Terry Fox Provincial Parks are not included in the Timber Supply Area (TSA), the LRMP nonetheless incorporates their presence into planning aims. There is a notable emphasis on resource development, with 31.4% of the plan area under guidance for these "intensive development" activities (Robson Valley Round Table, 1999). Mount Robson Provincial Park falls within the 20.4% block of the plan area as Protected Areas; 4.9% of which is newly under this designation.

Today, there are 3 protected areas managed under the Mount Robson Park Management Plan: Mount Robson Park, Mount Robson Protected Area, and Mount Robson Corridor Protected Area. Legislative changes have made this dissection possible. Largely for purposes of industrial development, loopholes and legislative adjustments have been made in recent years to the park's boundaries. Adjustments have been made temporarily to allow for development projects such as water lines, pipelines and other activities that would not be allowable under the Class A Park restrictions.

As a prominent inter-provincial travel corridor for several centuries, the Yellowhead corridor through MRPP contains multiple land uses and industrial developments. Constructed prior to park establishment, CN Rail holds several parcels of land (BC Parks, 1992). The Trans Mountain Oil Pipeline (now Kinder Morgan Canada's Anchor Loop Project) was constructed through the park in the 1950's along the Yellowhead Highway following a 1952 Order in Council allowing construction of one or more pipelines (B.A. Blackwell and Associates *et al*., 2001; BC Parks, 2011). Based on today's standards (BC Parks, 2013), this construction would require a use permit with Ministerial permission beyond the Class A legal protection of the park. Subsequently in 1987, a fibre optics line was put in by BC Tel (B.A. Blackwell and Associates *et al*., 2001). In the 1990's, 15 rights of way agreements were in place, including those with CN Rail, BC Hydro, BC Tel, Highway 16 and Trans Mountain Oil Pipeline (BC Parks, 1992).

[7] "The Swiftcurrent addition adds important Interior Cedar Hemlock variants to improve ecosection representation. The main Swiftcurrent River valley is interior cedar-hemlock moist mild (ICH mm) and the higher elevations are Engelmann spruce-subalpine fir moist mild (ESSF mm1). The low elevations near the Fraser River corridor are sub-boreal spruce dry hot (SBS dh). Rock and ice dominate the alpine areas." (Mount Robson Provincial Park (Swift Current Addition) Purpose Statement and Zoning Plan, 2005).

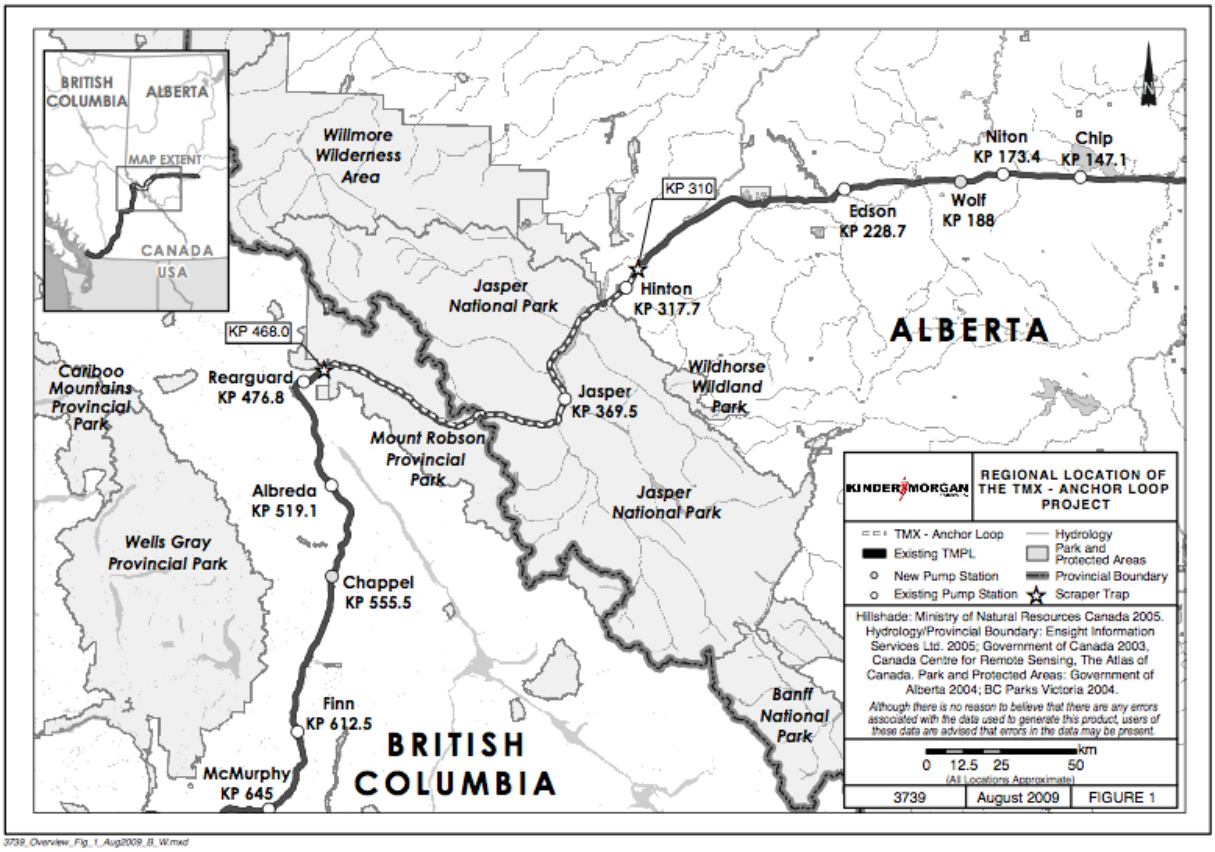

Figure 10: Kinder Morgan Canada Inc. pipeline route (Adapted from Novak and Fryer, 2009)

Today, a 60 km long section of the Kinder Morgan pipeline travels through the park, running parallel several hundred meters off the Yellowhead Highway (see Figure 10 above). In order to allow construction for the pipeline's twinning in 2008 (158 km total), a section of the park was officially relinquished its Class A Park protection status and designated as Mount Robson Protected Area. This decision fell under the *Environment and Land Use Act* and the subsequent designation allowed for construction and land development that would otherwise have been unfeasible on parkland. Following the construction's completion, the land has remained under the same designation despite recommendations to have it returned to the MRPP Class A Park designation, and use permits have been allocated (BC Parks, 2011). As a result, 911.32 hectares or 9.1 km^2 of land was added to the park in 2010 as compensation of sorts, connecting the NW corner of Terry Fox Provincial Park to the western boundary of Mount Robson Provincial Park (see Figure 11 below).

The development of the Kinder Morgan pipeline through the park has left BC Parks with a park benefit program for MRPP. This included donations of $350,000 for initiatives in MRPP, and $2.2 million for "ecological improvement projects" in MRPP and JNP (BC Parks, 2011:37). The former has been invested as the Mount Robson Park World Heritage Endowment Fund; the latter awaits recommendations for best use from Kinder Morgan.

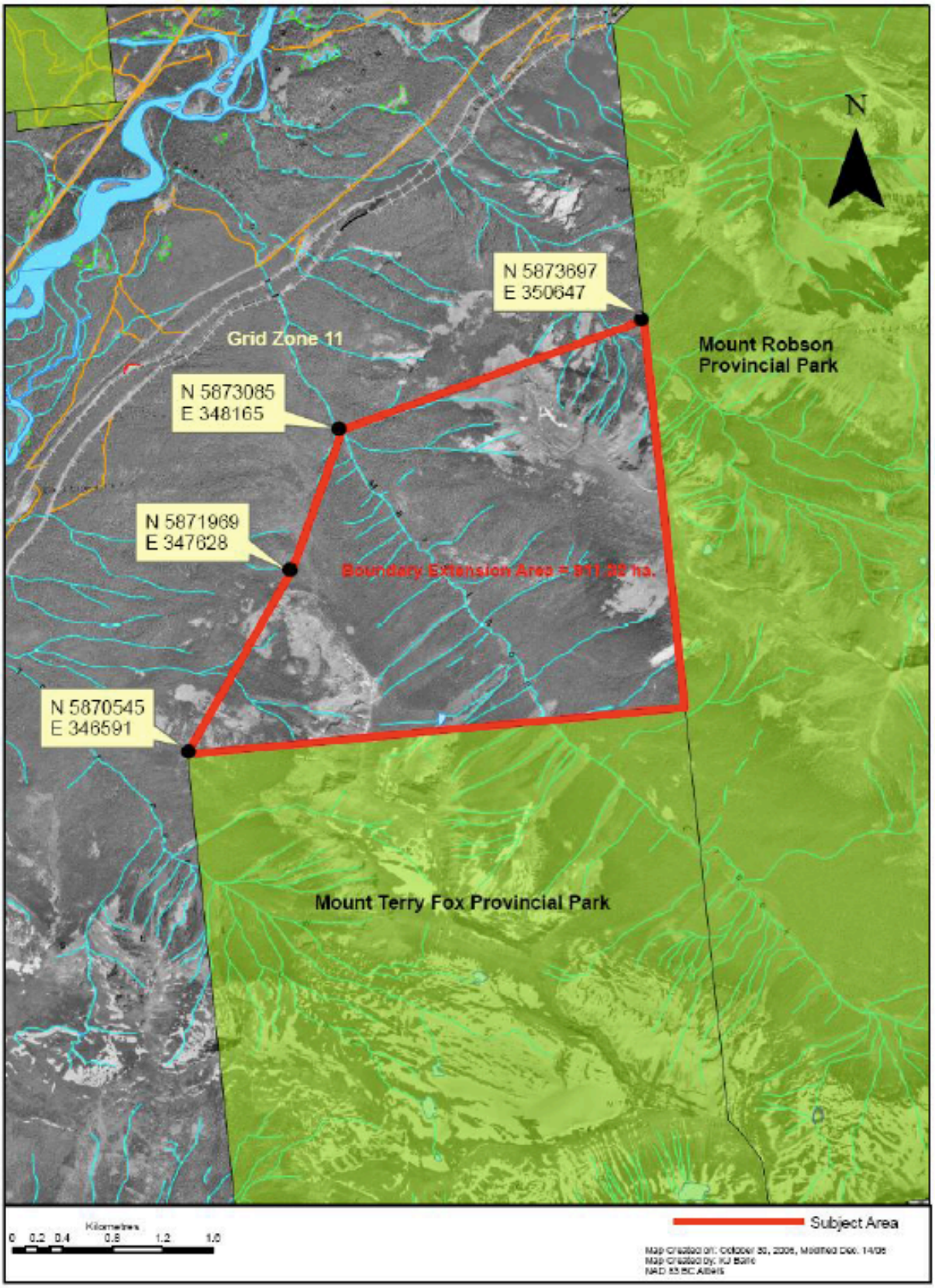

Figure 11: Mount Robson Provincial Park additions 2010 (Adapted from BC Parks, 2011)

2.1.4 Current Management Aims

After a century of public use, policy and environmental change, the present management aims of MRPP are in essence to balance multiple values through a holistic ecosystem-based approach (BC Parks, 2011). These include natural, cultural heritage, and recreational values. Guiding principles for this management approach include conserving and maintaining ecological function while considering ecological boundaries and a changing environment, and incorporating adaptive management and inter-agency collaboration (BC Parks, 2011). Key indicators (e.g. wetland condition, cultural heritage site conditions, interpretive programming, forest fire hazard, guided recreation) and their targets serve to inform management and evaluate performance (BC Parks, 2011).

Economic, ecological and social factors are accounted for when making decisions. Effectively protecting natural, cultural and recreational values makes it essential for managers to incorporate factors beyond park boundaries. Socioeconomic demands in the region and park visitor use require public safety and other land use interests to be included in park decisions in a meaningful way.

Ecological values in the park include those of vegetation, wildlife, fish, aquatic and terrestrial ecosystems, geology and scenery. Several management challenges surround the protection of these values. At the broadest scale, there are challenges surrounding climate change impacts on park ecosystems, and whether we should actively buffer less resilient species from these impacts. A landscape approach is used across the BC Parks system to monitor environmental and ecological elements over time, and the most sensitive species are being monitored (BC Parks, 2011). The protection of species at risk remains of primary importance, as well as managing invasive species and protecting wildlife from traffic along the corridor (BC Parks, 2011).

Cultural heritage values protection involves preserving cultural and archaeological heritage sites, and maintaining a respectful relationship with local First Nations. The Park has a rich history of early mountain recreation and mountaineering, as well as traditional significance to indigenous peoples. Park managers have tried to involve the local First Nations in management planning and consultation. The development of cultural heritage interpretation materials and programs with the Simpcw First Nation is a goal for the future. Recreational values are self-explanatory, and management of these values is concerned with providing safe, high-quality recreational experiences in the park while reducing any potential impacts on natural values. Zones denote aircraft, hiking and camping access. Other activities include angling, boating, horse use, mountain biking, caving and mountaineering, guided recreation and winter sports (BC Parks, 2011).

Forest Health Strategy. In 2005, the Forest Health Strategy was developed in partnership with several agencies, and offered recommendations for the next decade of forest management. The strategy's objectives are varied and numerous. Primary objectives include the maintenance and improvement of biodiversity, the reduction of wildfire risk, and the reduction of mountain pine beetle in MRPP and its spread into JNP and Alberta (BC Parks, 2011). Several large-scale actions have already taken place following the strategy's recommendations. These include the Moose Lake prescribed burn in 2004, firebreaks at Swift Current Creek and Yellowhead West, selective tree removal at Lucerne. Several other prescribed burns have been postponed, because

the above actions have lead to a reduction of wildfire risk and an improved seral stage distribution for biodiversity goals (BC Parks, 2011). Significant public pushback occurred following the 2004 prescribed burn at Moose Lake due to concerns of not being informed of the plans and losses in tourism (Hoekstra, 2004).

Overall, fire management in the park is guided by the BC Parks and Ministry of Forests' (1998) Memorandum of Understanding for Fire Management within Parks Management Areas and Adjacent Lands, the Prescribed Fire Evaluation Plan for MRPP (B.A. Blackwell and Associates and Compass Resource Management, 2003) and the MRPP Ecosystem Management Plan (B.A. Blackwell and Associated *et al*., 2001). Fire Weather stations have been established.

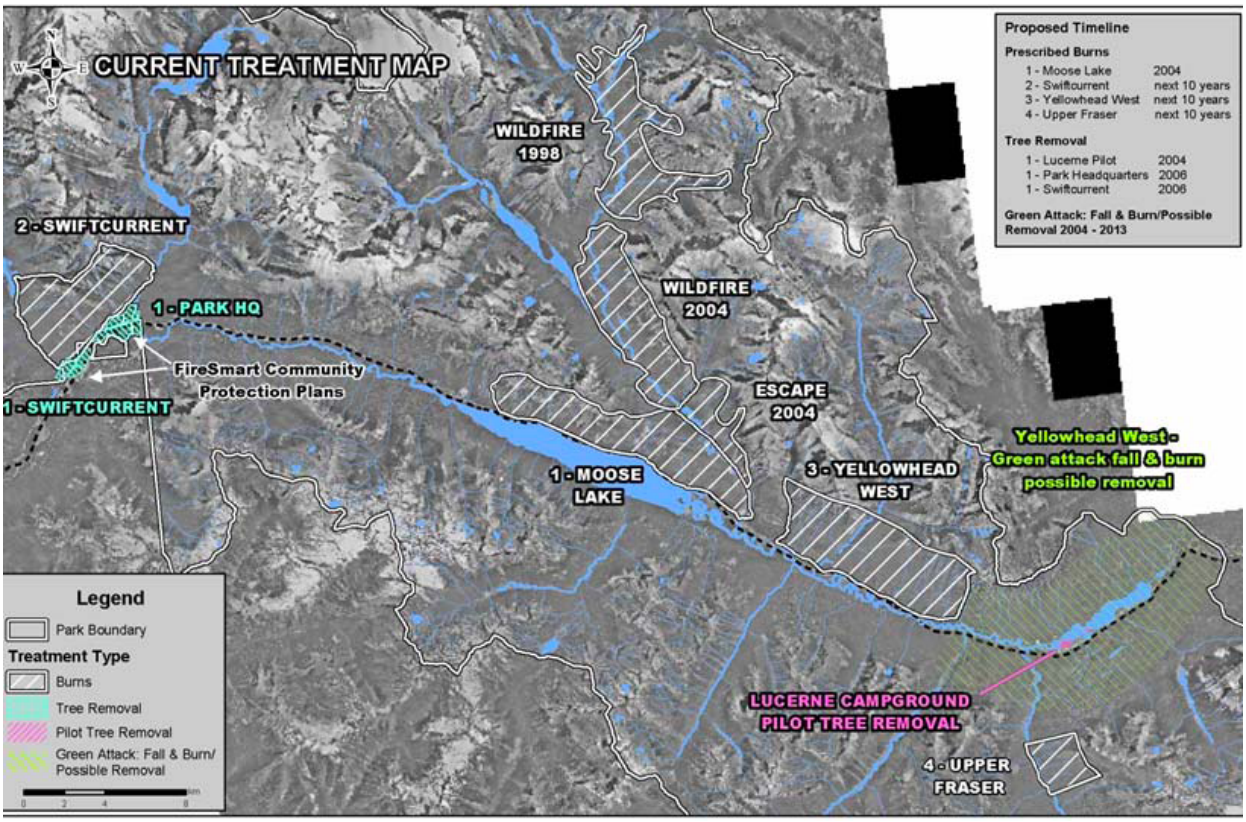

Figure 12: Orthographic photo showing proposed treatment zones in Mount Robson Provincial Park, as recommended by the Forest Health Strategy, 2005 (Adapted from B.A. Blackwell and Associates and Compass Resource Management, 2005)

As Figure 12 illustrates, there were a variety of proposed actions from the Forest Health Strategy. The majority of which were focused along the Yellowhead corridor. Following the 1913-1915 railway construction and resulting fires, the uniform seral stage distribution along the valley corridor has become increasing dangerous for wildfire and mountain pine beetle infestation as the forests are aging. The following two figures illustrate the seral stage distribution and wildfire threat in MRPP. The figures demonstrate the threat of wildfire in the localized area along the Yellowhead corridor, as a result of the large-scale burning that followed the railway construction.

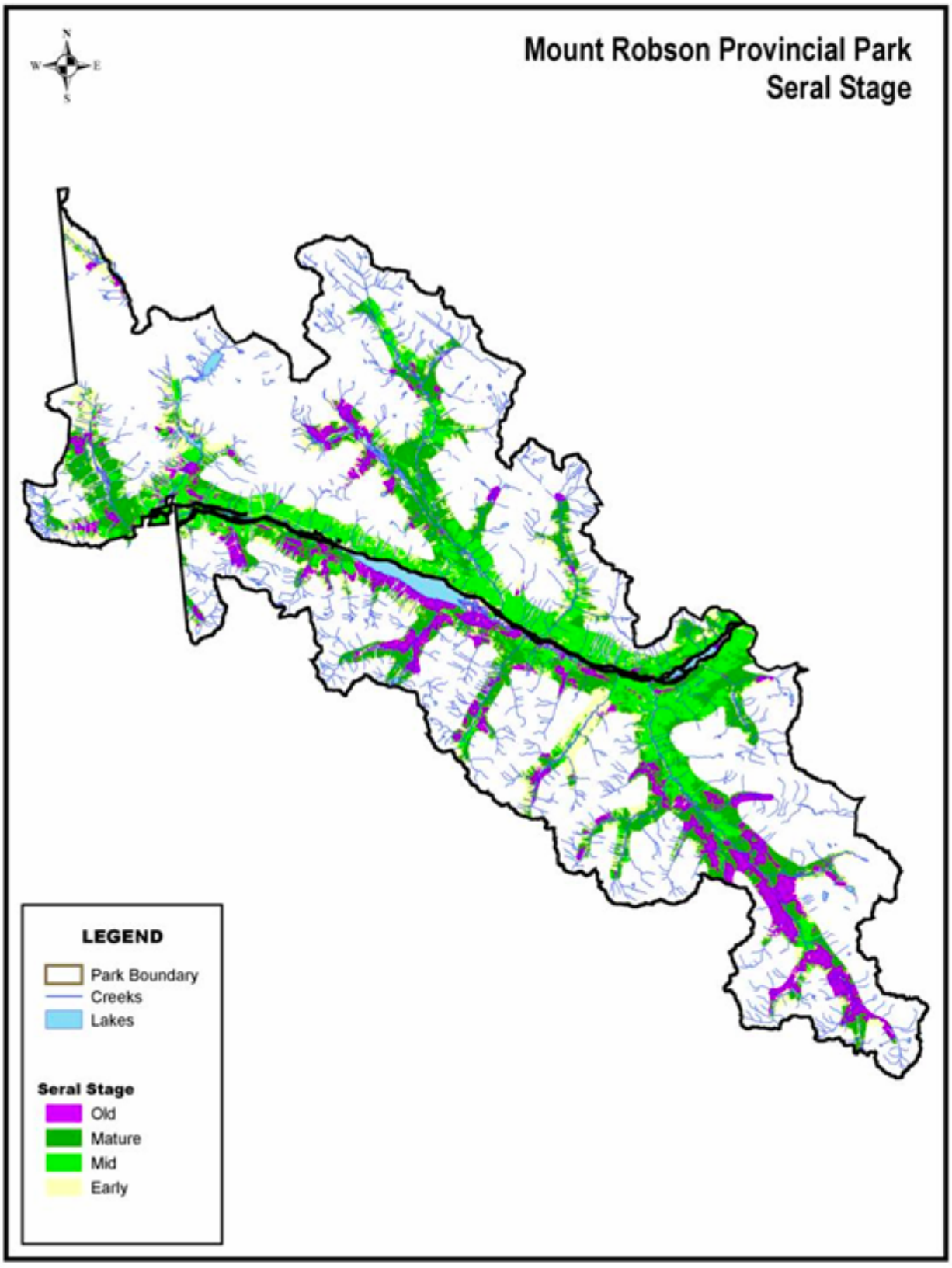

Figure 13: Mount Robson Provincial Park forest seral stage distribution (Adapted from B.A. Blackwell and Associates and Compass Resource Management, 2005)

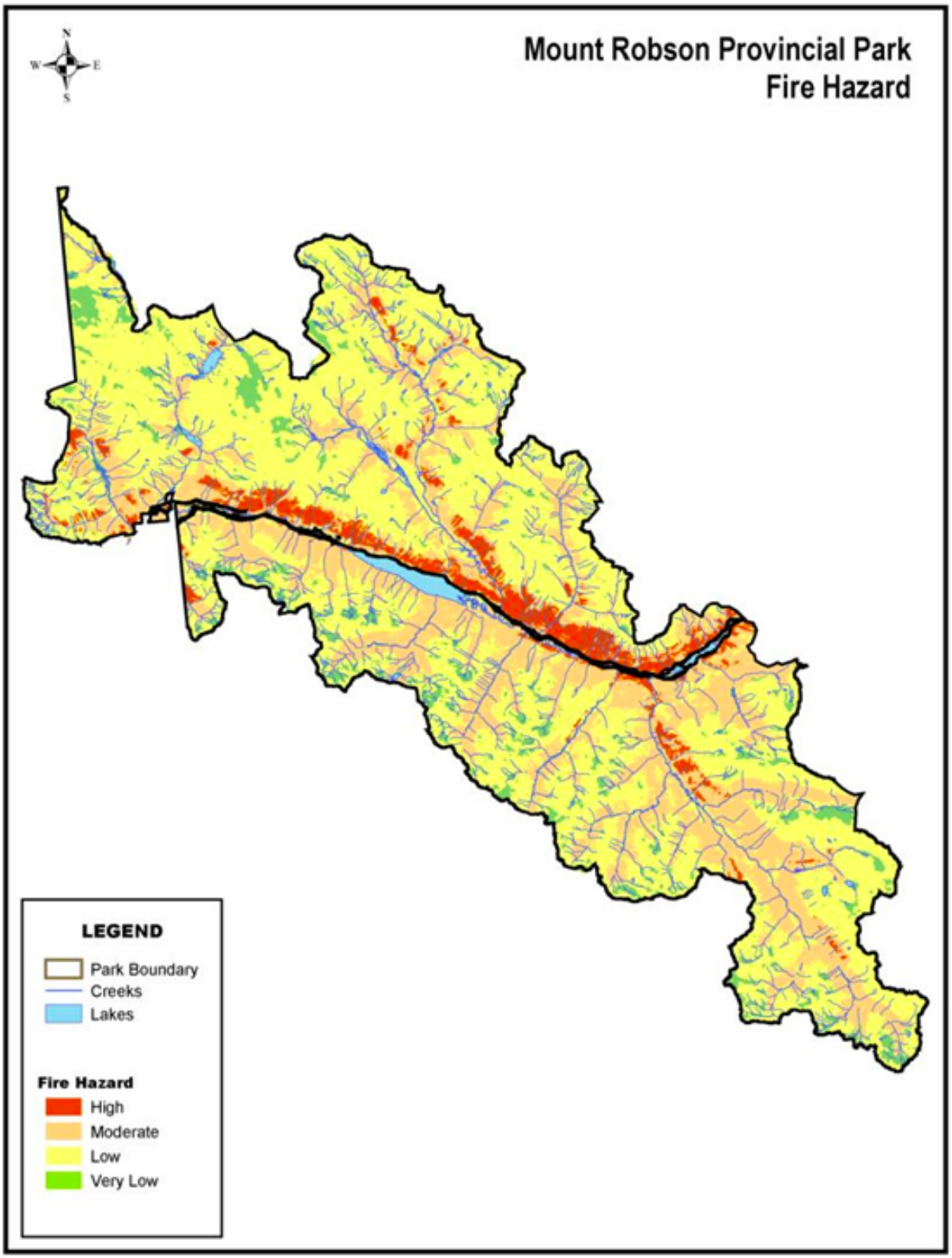

Figure 14: Mount Robson Provincial Park fire hazard (Adapted from B.A. Blackwell and Associates and Compass Resource Management, 2005)

Park Zoning. Having become increasingly specific in recent decades (e.g. BC Parks, 1991; 1992; 2011), park zoning allows managers to specify a range of acceptable activities in certain areas. This approach requires much less on-the-ground support and enforcement, as access, visitor support and encouraged activities varies accordingly. For planners, this offers a method to communicate to the public their goals for the park's natural environment and visitor experiences alike, by dividing an area into clear zones for varying management objectives therein. Objectives may relate to existing or desired levels of land use, human use, development or management involvement (BC Parks, 2011).

The current management zones in MRPP (from greatest to least human involvement) include the following: Intensive Recreation Zone, Nature Recreation Zone, Special Feature Zone, Wilderness Recreation Zone, and Wilderness Conservation Zone (BC Parks, 2011) (Figure 15 below). This variation offers flexibility for management relating to their conservation and recreation priorities in different areas of the park. These zonations have evolved in specificity from the 1992 Master Plan, which identified 4 distinct zones (BC Parks, 1992). The only change is the loss of the Natural Environment Zone, being replaced by the Nature Recreation and Special Feature Zones.

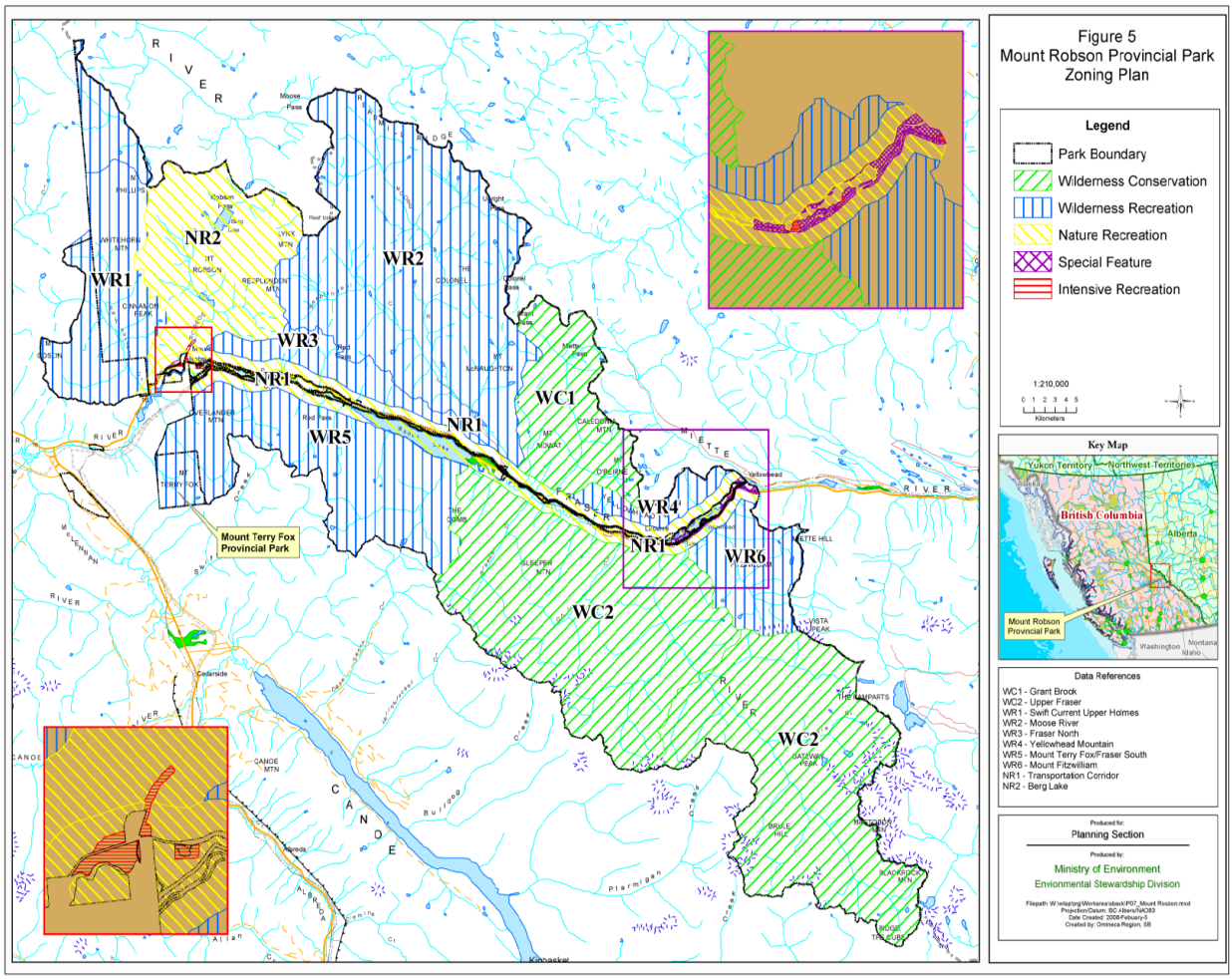

Figure 15: Mount Robson Provincial Park zoning plan (Adapted from BC Parks, 2011)

In relation to the IUCN protected area designations, the BC Parks zones designated within MRPP are more specific. While MRPP is designated as a Class A Park, there are sections (as described in section 2.1.3) of the park under slightly more lenient legislation. These include the Mount Robson Protected Area and Mount Robson Corridor Protected Area. The following table offers descriptions of each BC Park zone followed by comparative descriptions of the corresponding IUCN zones.

Table 3: Mount Robson Provincial Park zonations as compared to IUCN zones

MRPP Zone	Description
1) Wilderness Conservation Zone	• 40.4% of park land; backcountry • Most heavily protected from resource use and human involvement • Objectives support a "remote, undisturbed natural landscape" and prevalence of natural processes and lack of facilities (BC Parks, 2011:46-47) • Passive or active management, case dependent • Disincentive to visitors for the protection of ecological and other values
IUCN equivalent: Wilderness Area Ib	• Generally larger than IUCN Strict Nature Reserve Ia • Protected for the maintenance and flourishing of biodiversity and ecosystem processes and evolution (UNEP, 2014) • Ecological restoration is permitted when applicable • Limited human use; no assisted visitation/tourism but visitors may enter the area on their own accord or for traditional use
2) Special Feature Zones	• Protection of cultural values such as monuments; sightseeing • e.g. Yellowhead Pass National Historic Site
IUCN equivalent: Natural Monument or Feature	• Generally small area focused around a special natural feature and its habitat (can have elements introduced by humans) • If strongly based on human elements, better classified as a historical or spiritual site (UNEP, 2014)
3) Wilderness Recreation Zone	• 46.1% of park land; backcountry • 6 unique areas; e.g. Mount FitzWilliam, Yellowhead Mountain and the Moose River • Site-specific objectives all support a "remote, undisturbed natural landscape" and backcountry recreational experiences (BC Parks, 2011:46-47)
4) Nature Recreation Zone	• Provides buffer between Wilderness zones and Intensive Recreation zones • Safe backcountry experience with facilities along maintained trails (e.g. Berg Lake Nature Recreation Zone) (BC Parks, 2011:46)
5) Intensive Recreation Zone	• Enables more intensive development and recreational uses on park land

	• e.g. area around Mount Robson Park Visitor Center (Figure 15); Yellowhead Highway corridor (Figure 16) • Site-specific and contained within a relatively small area of park
IUCN equivalent: National Park II	• Similar to Wilderness Areas in that biodiversity and ecosystem processes and functions are prioritized for protection • Human visitation/tourism and supporting facilities are allowed within sustainable limits for local ecosystems (UNEP, 2014) • Contribution to local economies through education and tourism

Note: Zoning and protected areas designations from BC Parks and the IUCN gathered from Mount Robson Provincial Park Management Plan (BC Parks, 2011) and United Nations Environment Programme World Conservation Monitoring Centre website (UNEP, 2014).

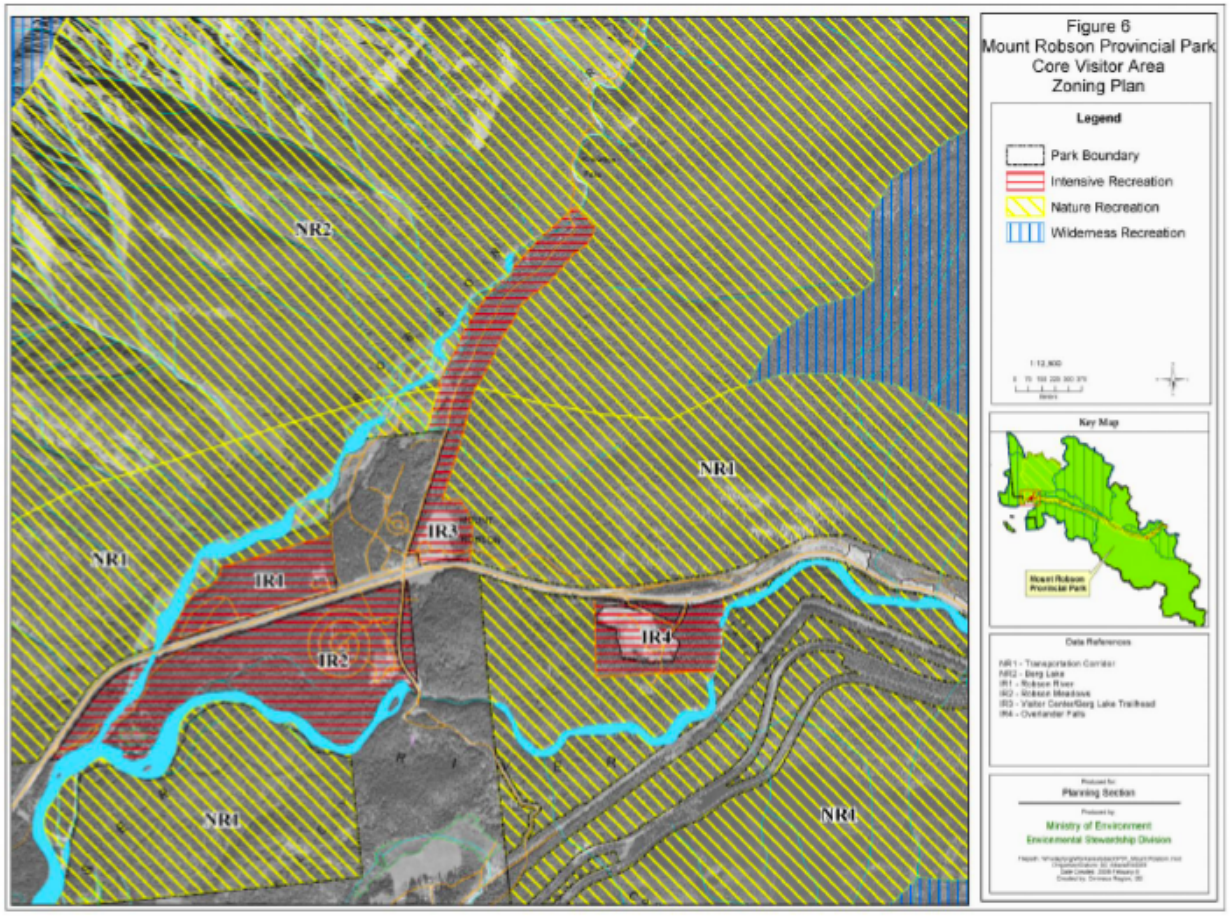

Figure 16: Core Visitor Area Zoning Plan, Mount Robson Provincial Park Management Plan 2011 (Adapted from BC Parks, 2011)

While a landscape-level approach was largely taken for denoting zone boundaries, the Yellowhead Highway corridor presented a complication. The result was 213 hectares divided into 8 Transportation Corridor Intensive Recreation Zones, making up 0.1% of the park (BC Parks, 2011). These can be seen in Figure 18 below. A buffer is provided between intensive use

and wilderness areas by the Nature Recreation zones. In the case of the highway and railways, a 13,170 hectare Transportation Corridor Nature Recreation Zone was created with a 1 km width along the corridor. The Berg Lake Nature Recreation Zone offers a "safe…backcountry experience" (BC Parks, 2011:46), with established facilities, graded trails and a reasonable ranger presence in the summer.

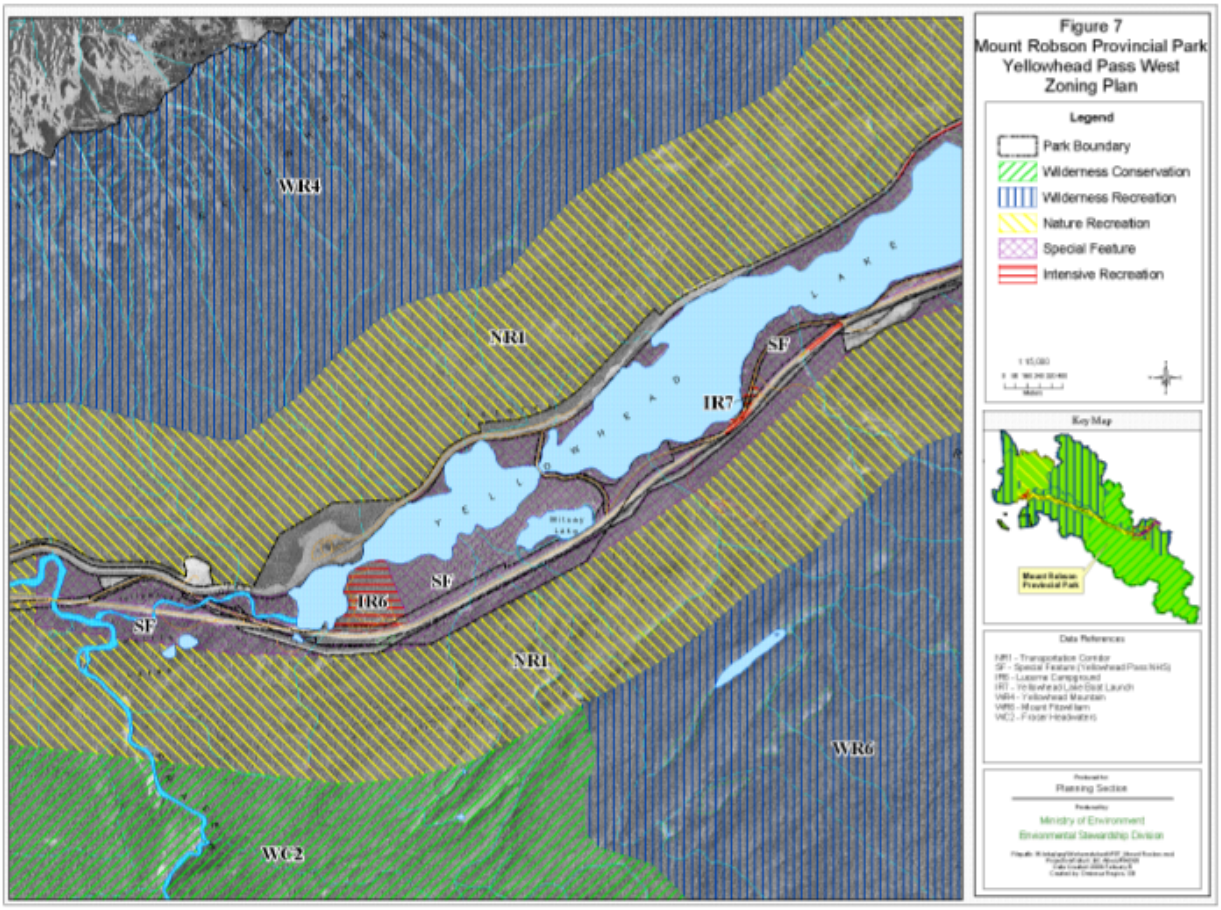

Figure 17: Yellowhead Corridor West Intensive Recreation Zoning Plan, Mount Robson Provincial Park Management Plan 2011 (Adapted from BC Parks, 2011)

Alpine Club of Canada Hut Development. For over a century - since before the park's establishment - the Alpine Club of Canada (ACC) has held a great interest in MRPP. As discussed in section 2.1.3, its members were instrumental in the initial park designation in 1913. In recent years, interest has grown to build additional alpine huts in popular areas in the Rockies. A Fixed Roof Accommodation Strategy was proposed by the Province and the ACC in 2006 (Alpine Club of Canada, 2006; BC Parks, 2011). With interest in developing the Berg Lake Trail further, an 'alpine hut' stationed at Robson Pass was identified as a good location. This was due to its previously disturbed condition and location past the trail's last campground. The use restrictions found in the 2011 MRPP Management Plan allow for backcountry huts and shelters in Nature Recreation Zones and Wilderness Recreation Zones. The Berg Lake Trail is presently zoned as Nature Recreation (BC Parks, 2011). A Hut Strategy was developed as a result. The

consultation period for this proposal yielded many concerns (including impacts to visitor experience and increased footprint at Robson Pass) and final decisions are outstanding (BC Parks, 2011).

Summary. In summary, the current management aims for MRPP involve the careful interweaving of multiple values, uses and policies. Zonations have gone far to safeguard particular reaches of the park from certain uses, however management challenges such as climate change, mountain pine beetle and fire risk reach beyond park borders. Park staff out of the Mount Robson Visitor Center and the Prince George Ministry of Environment office continue in their efforts to collaborate with other agencies, neighbouring parks and visitors to make these objectives successful. With growing interest from third parties to develop additional facilities, and large-scale actions being recommended to improve forest health and community safety, the importance of careful long-term park planning is increasing.

2.1.5 Local Socioeconomic Conditions

Mount Robson Park is situated within the Robson Valley. The Robson Valley encompasses the land southeast of Prince George, BC, east to Yellowhead Pass along the Fraser River, and south following Kinbasket Lake. The valley sits between the Rocky Mountains (northeast) and the Caribou Mountains (southwest). The Robson Valley is categorized as a Timber Supply Area (TSA) and as such, land and resource management plans for the region are scoped within the valley (Robson Valley Round Table, 1999). Several provincial and national parks are found within and around the greater Robson Valley, which influence regional planning. These protected areas can be seen in dark and light green in the map below (Figure 18).

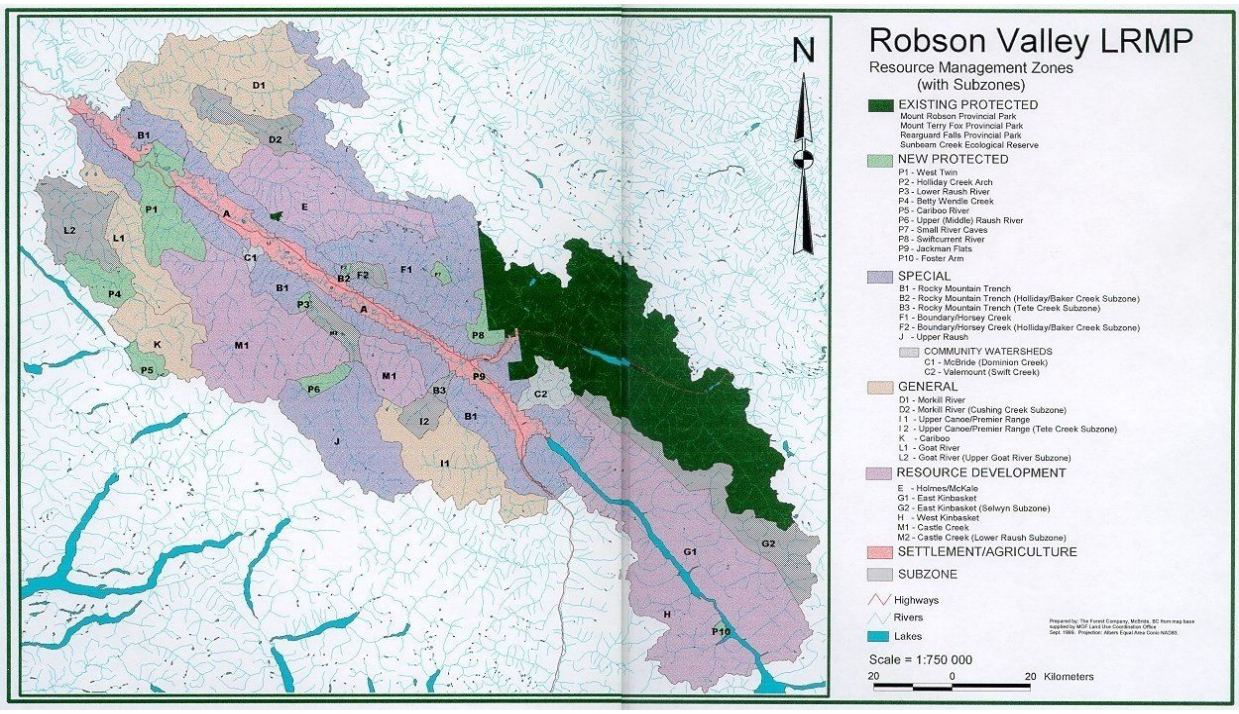

Figure 18: The Robson Valley, as organized by the Robson Valley Land and Resource Management Plan (Adapted from Robson Valley Round Table, 1999)

The socioeconomic conditions of the Robson Valley are heavily influenced by resource extraction, and in particular forestry and mining. Populations are centered in McBride and Valemount, BC which are both small towns under 2,000 people. In 1999, around 4,000 people lived in the Robson Valley and over half were in McBride and Valemount (Robson Valley Round Table, 1999). By 2001, Valemount had declined to around 1,200 people and McBride had declined to around 700 (Stamm, 2004). While there has been a rapid socioeconomic shift in recent decades beginning in the 1990s, there has been little official analysis of this beyond two key documents: The Robson Valley Land and Resource Management Plan (LRMP) (1999) and A Socio-Economic Profile of the Robson Valley (2004) which the Fraser Headwaters Alliance assembled.

Forestry has had a long-standing stronghold throughout BC. While the mountain pine beetle devastation and decreasing timber supplies in recent decades has greatly influenced the industry, forestry remains an important economic component in the Robson Valley. Contributing around 30% of regional income and employment in the 1990's (Robson Valley Round Table, 1999), forestry in more recent years has remained important but continues to decline (Stamm, 2004). Being the largest source of jobs in 1986, by 2001 forestry and agriculture combined were the 5th largest employer (Stamm, 2004). Under the most recent Robson Valley LRMP (covering 1.4 million hectares), a 1.2 million hectare timber supply area was identified. Plans for sustainable harvest over multiple years was emphasized for the longevity of the industry, health of wildlife populations and recreational benefits (Robson Valley Round Table, 1999).

Mining opportunities for precious metals and industrial minerals remain in the valley, however the industry was more prominent in the valley's economy in the past. Resource Management Zones for forest and mining interests accounted for 31.4% of the Robson Valley plan area (Robson Valley Round Table, 1999). Special Management areas, such as town watersheds or critical wildlife areas, are managed with greater attention to these values.

Agricultural activities contributed 6% of the region's income and 13% of employment in the 1990s. Many farmers are also involved in the forestry sector as loggers or truckers, as average incomes from agricultural activities remains low in a very competitive industry (e.g. dairy and beef) (Robson Valley Round Table, 1999). Due to the geography of the region, agriculture and settlements are largely confined to the valley bottom of the Rocky Mountain Trench, and made up 4.9% of the plan area in 1999. This extent aligns well with Crown Land plans.

Government work and transfer payments accounted for 27% of regional income, while pensions and investment incomes were 11% of income in the 1990s. Manufacturing, transportation and construction constituted the remaining 17% (Robson Valley Round Table, 1999). This quickly dropped in the coming decade and more service sector employment was recorded (Stamm, 2004). In 2001, accommodation and food/drink services accounted for the largest industry in Valemount.

Recreation and tourism contributed only 6% of income and 16% of employment in the 1990s, but represents the largest growth factor in the regional economy. Largely because of the close proximity of several renowned protected areas (MRPP and JNP), over 1 million visitors travel through the valley annually. Nonetheless, no notable increases in regional income or economic stability have been seen (Stamm, 2004).

Overall, a gradual but consistent socioeconomic shift is being seen in the Robson Valley. While part-time and seasonal employment increases slowly, full-time positions are decreasing.

Self-employment is also slowly increasing (Stamm, 2004). This is unsurprising for an economy transitioning from forestry and agriculture (primary sector) towards more part-time work. A greater proportion of income is also coming from non-employment income. This is mostly in the form of investments, pensions and private sources, which hints at an aging population retiring from work, and more population growth due to retirees from urban areas coming to the valley instead of younger people coming for primary sector employment (Stamm, 2004).

2.1.6 Ecological Restoration and Remote Ecosystems

While ecological restoration is not stated as a primary management aim in MRPP, the practice of such is nonetheless an implicit component of park management and has taken place in several locations in the park. Overarching agency mandates promote the protection of values and enhancement of ecological resilience. In short, there are different goals in different areas. The management approach to ecological restoration is highly varied based on visitor safety, staff capacity, and severity of the environmental damage or disturbance. In some ways similar to triage, this depends on location within the park. In areas that are heavily used by visitors, safety is paramount and immediate actions must be taken if a disturbance has impacted the areas in use.

For instance, seasonal flooding of the Robson River and Kinney Lake flats is relatively common. While the ensuing environmental disturbances are arguably natural, the management action required is immediate remediation to restore land around the Berg Lake Trail for visitor experience and safety. Plantings, shore stabilization and hydrological adjustments (e.g. flood overflow stream redirecting) would be appropriate in a case like this, and trail closures follow. For example of flooded Berg Lake Trail see Figure 20 below.



Figure 19: August 2011 flooding on the Berg Lake Trail, Mount Robson Provincial Park (Photo credit: Jenna Falk, 2011)

On the other hand, managers don't actively intervene in the backcountry wilderness areas beyond specific incidents that impact visitor experience. Exceptions to this exist for events such as wildlife occurrences or carcasses on trails; park rangers are quick to remove wildlife remains from trails due to the negative effect on visitor experience, and safety to not attract other wildlife scavengers. This passive management in backcountry areas is due to zoning guidelines of levels of intervention as well as limited staff capacity and resources. These challenges are not uncommon in parks (Timko and Innes, 2009).

When site-specific restoration projects take place, volunteers are often sought after to help. This is with the goal of increasing public awareness and education about ecosystems and natural disturbances. Community engagement is a well-supported success mechanism for restoration activities in parks (Parks Canada Agency, 2008a).

Industrial Development Within Park Boundaries. In recent years, there have been larger-scale restoration activities taking place due to industrial development in the transportation corridor. Following the 2008 Kinder Morgan Canada Inc. Trans Mountain Expansion (TMX) Anchor Loop Project, both JNP and MRPP had significant areas seriously damaged by construction. The restoration initiative involved the propagation and planting of over 220,000 native plants in sensitive sites and riparian areas (Novak and Fryer, 2009). Several different restoration seed mixes were used, and intensive irrigation and plant protection from grazing followed in 2008-2009. The following year, the 5-year Post Construction Monitoring Program began to evaluate restoration success (Novak and Fryer, 2009).

Climate Change and Long-term Ecological Monitoring. Intertwined with the above pipeline restoration efforts, climate change is amplifying already-complicated conservation challenges (Lemieux *et al*., 2010). Long-term ecological monitoring has become widely accepted as a "priority response to climate change" (Wright and Stevens, 2012:2), yet few Canadian park and protected area agencies have done so at the necessary scope temporally and geographically (Lemieux *et al*., 2010). In BC Parks, steps are being taken to monitor climate-driven ecological changes and ecological integrity across the provincial protected areas system (Wright and Stevens, 2012). MRPP will likely have at least one monitoring plot within its boundaries. Simultaneously, this can help increase on-the-ground staff involvement in the more remote, backcountry areas of the provincial parks system.

Through a Long-term Ecological Change Monitoring Program, staff are monitoring several ecological indicators at plots in their park using a scientific/citizen science model. Plots are chosen based on broad biomes (regions) and fall within alpine/subalpine, coastal, wetland, forest, freshwater and grasslands (Wright and Stevens, 2012). For each region, two plots are required to be installed and annually monitored for indicator changes. Indicators of biodiversity and ecosystem processes were chosen for their ability to show adaptation to and mitigation of stressors. Elements being evaluated within monitoring plots are described in Table 4 below, using two biomes for example.

While this research and monitoring program is too young to be informing decision-making around adapting long-term changes in parks (and the potential role for ecological restoration), it offers a solution to capacity and resource limitations in the agency. Plots can be set-up on patrol routes, thereby not necessitating special trips on already-thin staff time. An estimated 3 days/area/year will be required. Monitoring programs have been found to increase

effectiveness in addressing priorities areas, but it has been found in several Canadian national parks that many identified priorities are not being monitored (Timko and Innes, 2009). Due to budget, staff training and other logistical constraints, this is a similar story to provincial parks (Wright and Stevens, 2012).

Table 4: Elements incorporated into the BC Parks Long-term Ecological Change Monitoring Program

Biome	Select changes	Indicator/ protocol	Indicator type	Protocol source	Status
Wetlands	Changing hydrology (Cool, moist stable hydrology wetlands like bogs most heavily impacted as well as shallow-water interior wetlands)	Water level/surface extent	Stressor/ function	Parks Canada	Pilot test 2012
	Abundance/composition for breeding and migratory birds (also amphibians)	Bird productivity (breeding pairs)	Structure/ composition	B.C. Resources Information Standards Committee	Pilot test 2012
		Amphibian egg masses	Structure/ composition	U.S. Geological Survey	In development
Alpine and Subalpine	Composition and distribution changes: Includes invasives and species at risk	Plant cover transects	Structure/ composition	Brian Starzomski University of Victoria	Pilot test 2011
	Phenology concerns insects/alpine plants	Pollinator phenology	Function/ structure/ composition	California Pollinator Project (Xerces Society)	2012: Preliminary species collection is first step
	Alpine species of concern: marmot, wolverine, caribou, pika	Pika colony occupancy and relative abundance	Structure/ composition	University of British Columbia–Okanagan and U.S. National Park Service/North America Pika Consortium	In development
	Temperature increases	Productivity (soil temperature)	Function	Global Observation Research Initiative in Alpine Environments Protocols	Review and evaluate
	Glaciated extent, snow duration, and snow pack	Glaciated extent, temperature, precipitation	Stressor	Western Canadian Cryospheric Network	Default to ongoing monitoring or specific research initiatives

(Adapted from Wright and Stevens, 2012)

2.1.7 Summary

In summary, the previous sections have discussed the first case study of this research project, MRPP. As the flagship park to the provincial protected areas system, MRPP protects 2,248 km^2 of the Yellowhead ecosystem along the continental divide. While first established for the grandeur of its geological features, including Mt. Robson itself, the park protects invaluable ecological values including the headwaters of the Fraser River and important habitat for species at risk in BC (BC Parks, 2011).

Indigenous communities had inhabited the Robson Valley region for thousands of years before European expansion brought the fur trade through Yellowhead Pass. Traditional territories held in and around MRPP include those of the Texqakallt First Nation, and subsequently the Shuswap First Nation, (Glen *et al*., 2008), Simpcw First Nation, the Red Bluff Indian Band and the Lheidli T'enneh Nation (BC Parks, 2011). Since the late 1800's the Pass has served as the northern travel route into BC from AB, and now the Yellowhead Highway runs through it and cuts through MRPP roughly along the Fraser River's path.

Today, management efforts continue to minimize the impact of the travel corridor (and surrounding industrial developments) on the ecosystems of the park. Detailed zonations guide management actions in different park locations. Restoration efforts are limited to intensive use areas and, more rarely, a prescribed burn, which was completed along Moose Lake in 2004 (BC Parks, 2011). A new BC Parks Long-term Ecological Change Monitoring Program has been developed (Wright and Stevens, 2012) and holds great promise to increase long-term monitoring efforts in the parks system to better understand how climate change is impacting protected areas in the province.

2.2 Willmore Wilderness Park

This chapter offers a detailed description of the second case study, Willmore Wilderness Park (WWP). Divided into six sections, relevant conditions of the park will be discussed, and as relevant compared to the first case study of MRPP as the reader is now familiar with that case study from section 2.1. Beginning with the biogeography of the park, a shift to historic conditions of local settlement is made followed by the park's development and management history. The last three sections focus on current conditions, including management aims, socioeconomics in the local area, and lastly the ecological restoration efforts taking place in the park and an overview of management efforts in more remote landscapes.

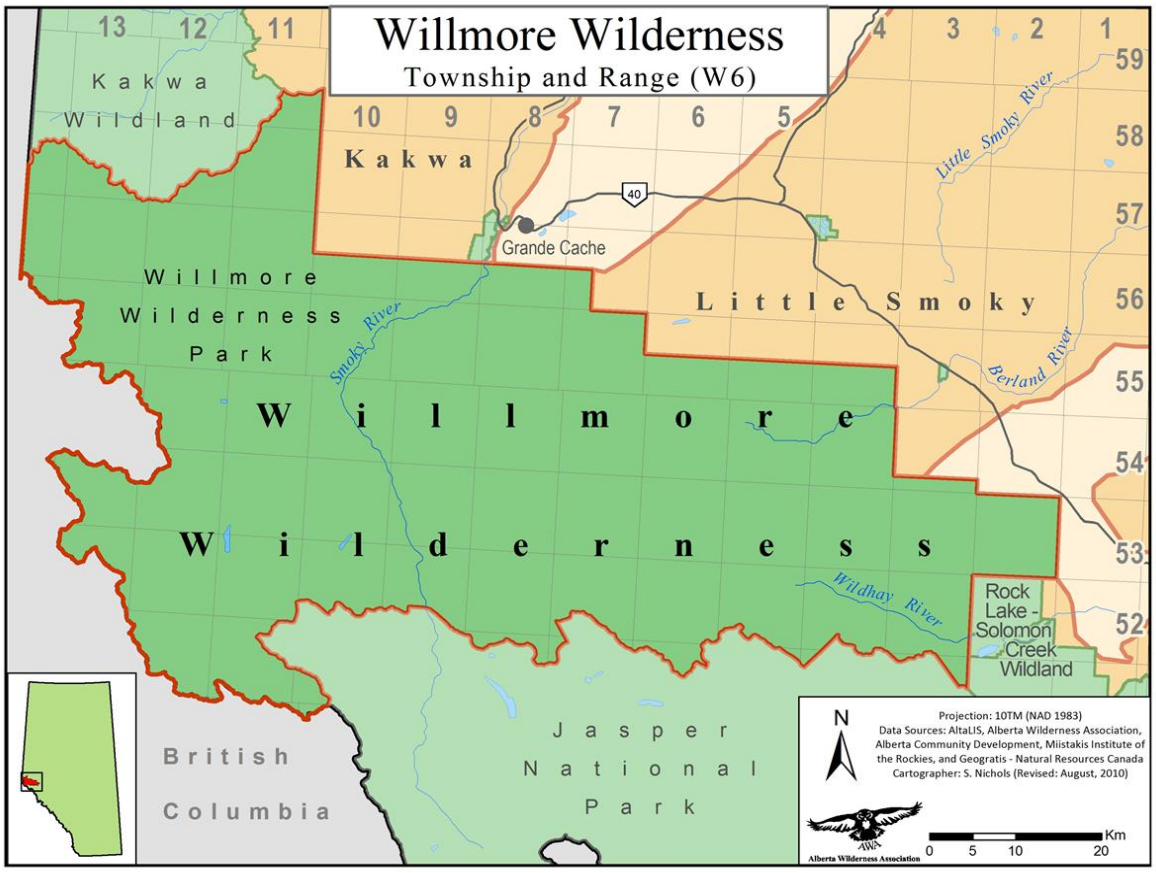

Figure 20: Location map of Willmore Wilderness Park (Adapted from AWA, n.d.).

To begin, WWP is 4,596 km^2 in size. As compared to MRPP's 2,248 km^2, WWP is twice the size and covers a vast area. The park boundaries follow township lines along the northern and eastern borders, and topographic delineations to the south and west. The park is south of the town of Grande Cache and its southern boundary meets the northern boundary of Jasper National Park (JNP). The city of Edmonton, Alberta (AB) is a roughly 3.5 hour drive east. Both MRPP and WWP have a topographically delineated boundary against the continental divide at the provincial border between AB and BC, and are connected through JNP.

There is a very actively engaged - but relatively small - community of users including outfitters, hunters and hikers. While originally established to conserve the hunting and fishing opportunities for generations of Albertans into the future, Willmore retains a wider appeal for recreational use. Seen as undisturbed wilderness by visitors and managers alike, visitors can observe biodiversity and mega fauna population densities now rare in many parts of Alberta. The grizzly bear (*Ursus arctos)* population in the Grande Cache unit,[8] for example, is estimated at 353 individuals, as compared to a mere 42 and 90 for the region east of Jasper National Park and Banff National Park, respectively (ASRD and ACA, 2010a). Retaining the original vision for the park's establishment, the hunting, fishing and trapping in the park are unparalleled, reminding visitors of the "good old days" experienced in other areas of Alberta, which no longer retain those conditions. Compared at times to Kakwa Wildland Park further north, Willmore has a rugged and extensive presence, offering unpredictable weather typical of the northern Rockies.

Access into the park is difficult even with packhorses, and hiking infrastructure is commonly overgrown or nonexistent. In stark contrast to the well graded and ranger patrolled Berg Lake Trail in MRPP, trails in WWP are user-maintained and devoid of signage and park-maintained infrastructure. As MRPP's Berg Lake Trail was established predominantly for recreational mountaineering and sightseeing, WWP's trails come from a long tradition of hunting, trapping and fishing by means of horse packs.

This authentic wildland experience draws international visitors from many European countries. While some arrive expecting maintained, serviced routes throughout, others come for the increasingly rare solitude that has escaped more popular destinations both throughout Europe and increasingly so in other areas of the Canadian Rockies (e.g. Kananaskis). The following discussion will illuminate WWP by examining several key aspects also used to structure the previous discussion of MRPP.

2.2.1 Biogeography

Due to jurisdictional differences, the scientific classification systems used for the two parks differ. While British Columbia's Ecoregion Classification System and biogeoclimatic zones describe MRPP, WWP is described by Alberta's Natural Regions and Subregions (Figure 21). There are a total of six natural regions and 22 subregions found in the province (Natural Regions Committee, 2006), the AB system is less specific than the BC classification. As it was described in 2.1.1, the Ecoregion Classification system in BC (Figure 8) has 116 ecosections within 43 ecoregions within 10 ecoprovinces in the BC system (Demarchi, 2011), and MRPP's

[8] AB ESRD has designated population units in southwestern Alberta. The Grande Cache unit includes bears found in the northern reaches of Jasper National Park north to Grande Prairie and east to Whitecourt. More information can be found in the 2010 report Status of the Grizzly bear (*Ursus arctos*) in Alberta at: http://srd.alberta.ca/fishwildlife/speciesatrisk/DetailedStatus/Mammals/

conservation role is framed within its protection of certain ecosections and biogeoclimatic zones (BC Parks, 2011).

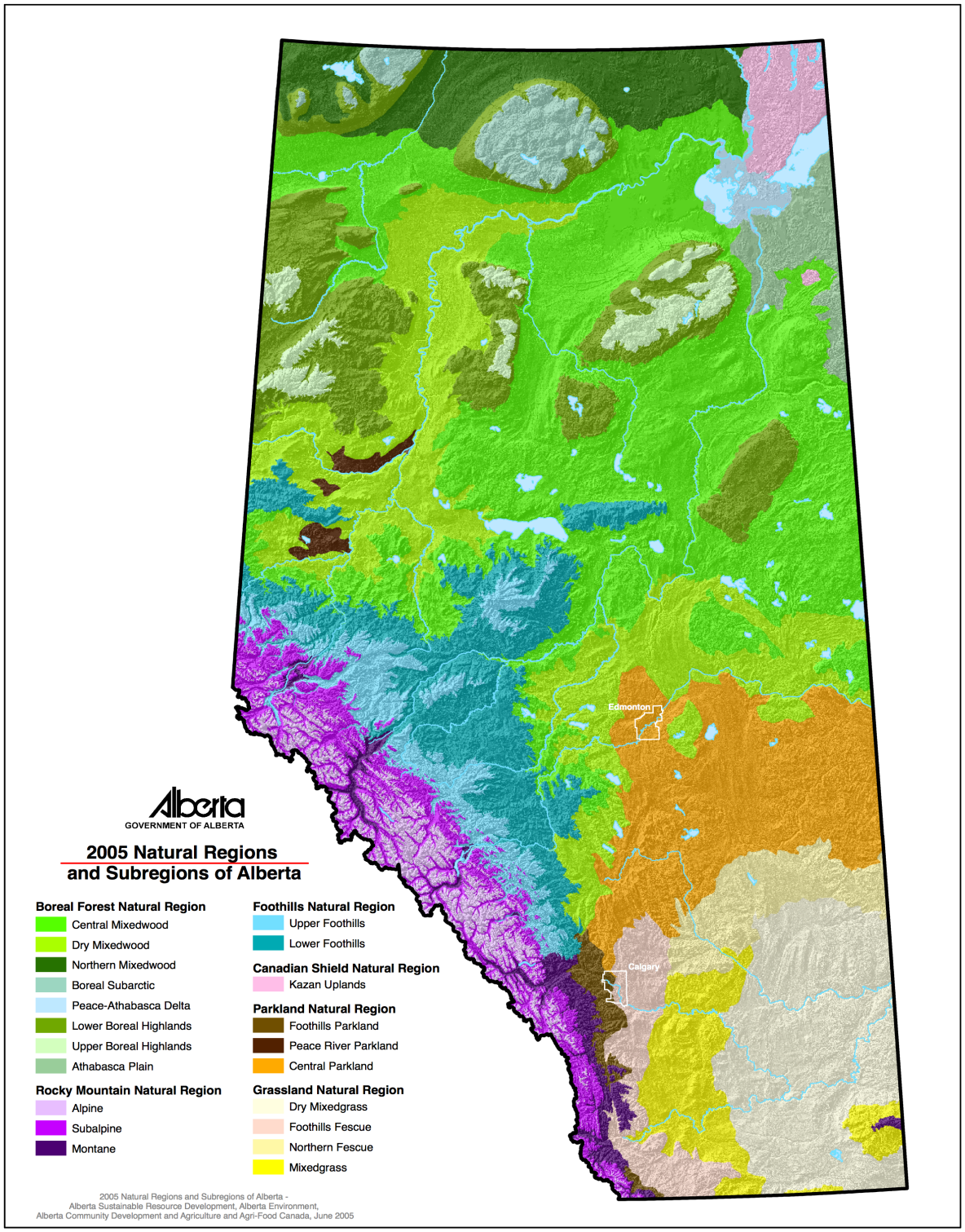

Figure 21: Natural Regions and Subregions of Alberta Map (Adapted from AB SRD *et al*., 2005)

The physiographic regions of WWP include the Rocky Mountain and Rocky Mountain Foothills natural divisions. Subregions include the Montane, Subalpine, Alpine and Upper Foothills respectively (Fenton *et al*., 2013; Graham and Quintilio, 2006). The Alpine Subregion is above the treeline, and includes rockland, glaciers and other vegetated areas. The Subalpine is between 1500 m and 2000 m, below the alpine and covers the largest proportion of WWP. Upper Foothills and Montane are below 1500 m and are represented only by narrow strips along the Smoky and Lower Smoky Rivers (Graham and Quintilio, 2006).

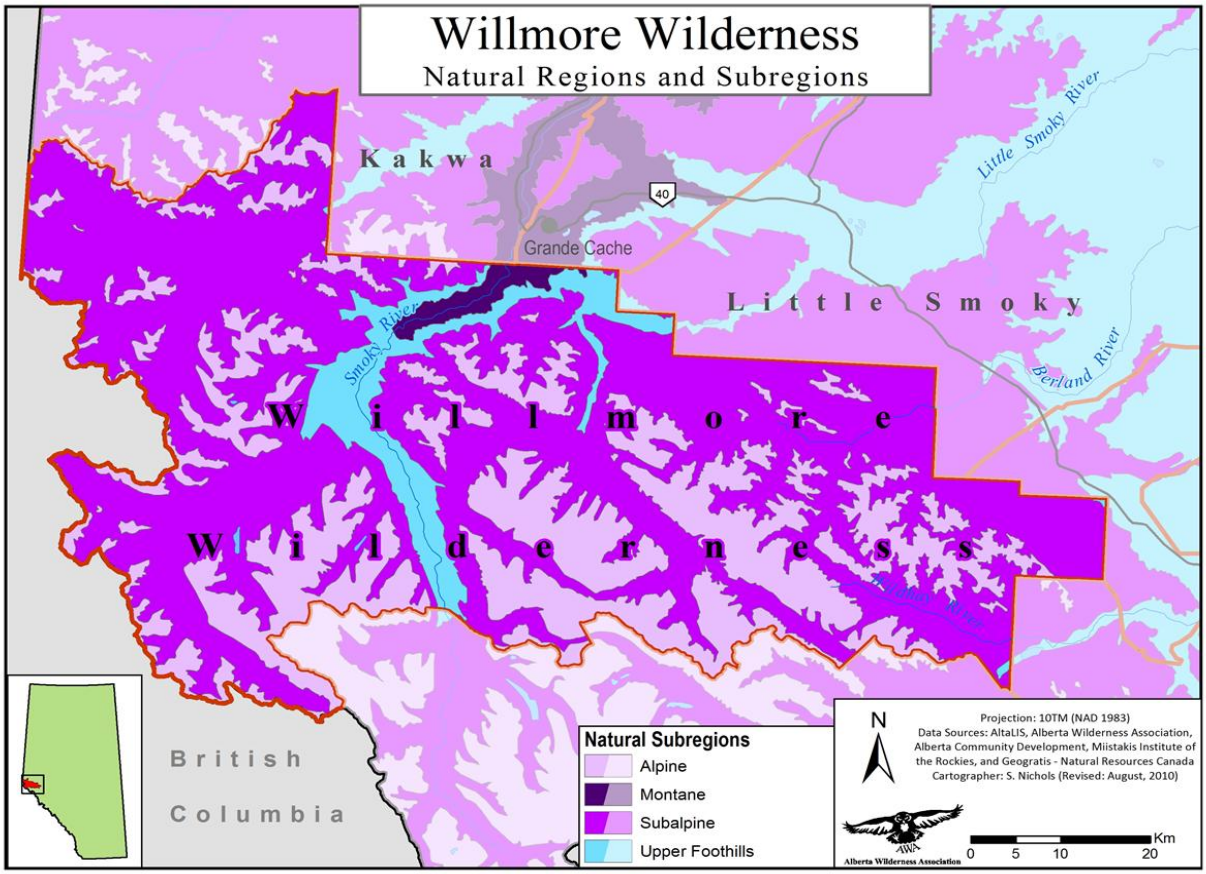

Figure 22: Natural Regions and Subregions of WWP (Adapted from AWA, n.d.)

Geology. These regions offer notable landscape diversity and are characterized by high relief mountainous terrain and orogenically uplifted shale, siltstone, sandstone and calcareous deposits such as limestone and dolomite. Surface sediment in the park is highly varied, but is predominantly colluvial (gravity), preglacial fluvial deposits and glacial moraine deposits. The majority (60%) of the alpine subregion, and commonly in the subalpine is exposed bedrock. In the alpine this is because soil formation processes are negligible due in part to low temperatures and little biological activity. In the subalpine colluvium is common on steep slopes due to rockslides (Natural Regions Committee, 2006). Similar geological conditions exist in MRPP. Sediment is thin (majority <10 m) in the eastern foothills and quickly becomes discontinuous moving west across the park due to the deformed geological belt of the Rockies (Fenton *et al*.,

2013). To the northeast, mountain structure is more rounded; moving to the west and southwest, peaks become more pronounced and craggy (Graham and Quintilio, 2006).

The majority of the mountain ranges within WWP are classified as the Northern Continental Ranges. The division between the Front Ranges and Main Ranges runs Northwest-southeast from the continental divide (Graham and Quintilio, 2006). Subcategories include the Persimmon, Hoff, Starlight and Berland Ranges. The Berland Range extends well into the northeast portion of the park, covering the area north of the Wildhay River northwest of Rock Lake. This range is well documented in the repeat photographs taken in summer 2012 by the Mountain Legacy Project (MLP). The Persimmon Range extends south from the Wildhay and west of Rock Lake (Graham and Quintilio, 2006). The range is bisected by Eagle's Nest Pass heading southwest towards JNP. Having overlap with MRPP's geology, the southwestern extension of WWP includes a section of the Rainbow Range. As a result of heavy mineralization, vivid tones of red, orange and yellow can be seen through the range. Full provincial geological maps are available online[9]. Topographic mapsheets 83 E6 through E10 cover the park.

Hydrology. The park protects numerous rivers and creeks, including the Berland, Muddywater, Wildhay, and Jackpine Rivers, and Sheep Creek. Wide grassy flats are often alongside the major rivers, within well-drained valleys surrounded by steep forested slopes (Graham and Quintilio, 2006). There is very little standing water in any of the subregions within WWP. A small percentage (around 2%) of land area in the natural subregions is covered by wetlands, including rich calcareous fens in the Montane subregion. Small lakes can occur in the higher elevations (Natural Regions Committee, 2006). Park hydrology is illustrated by Figure 24 below.

[9] Fenton, M.M., Waters, E.J., Pawley, S.M., Atkinson, N., Utting, D.J. and Mckay, K. (2013): Surficial geology of Alberta; Alberta Energy Regulator, AER/AGS Map 601, scale 1:1 000 000.

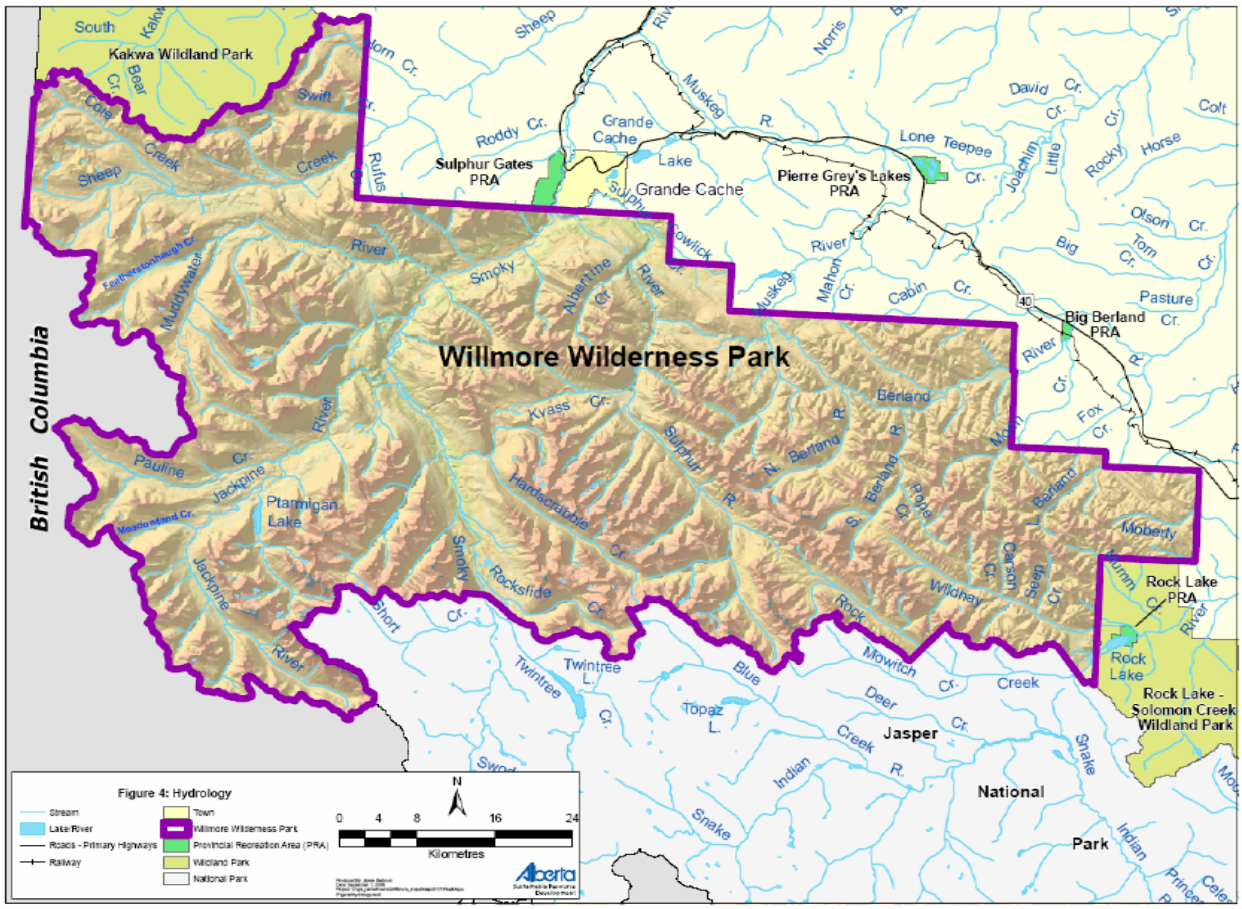

Figure 23: Willmore Wilderness Park Hydrology (Adapted from: Graham and Quintilio, 2006)

Climate. WWP, as part of the Rocky Mountain Natural Region, experiences the Cordilleran ecoclimate province, which is one of three major climate regimes in AB (Natural Regions Committee, 2006). On average (based on data from 1971-2000), WWP receives over 600 mm of annual precipitation (Chetner and Agroclimatic Atlas Working Group, 2003), as is typical of the Cordilleran ecoclimate average of 800 mm/yr (Natural Regions Committee, 2006). During the months when precipitation is normally in the form of rain (April 1 - October 31), the 10-year average is 450 mm, with more precipitation generally on windward slopes (Graham and Quintilio, 2006) or the west and north aspects (Natural Regions Committee, 2006). As is the case for Mount Robson, long-term changes in winter snowpack show reduced snow cover in the second half of the snow season (Feb. to July) and a smaller proportion of total annual precipitation falling as snow (Zhang *et al*., 2011).

Average annual temperature for the region is 3.5 degrees Celsius. In the alpine natural subregion this drops to - 2 degrees Celsius (Natural Regions Committee, 2006). Average temperature minimum and maximum ranges from -14.6 to 21.6 degrees Celsius (1971 - 2000) (Environment Canada, 2011). In general, no month is considered frost free, and winters are cold and long. Summers are often quite wet and cool, however due to the size and topographic variations within the park, climate and weather can vary considerably (Graham and Quintilio, 2006; Natural Regions Committee, 2006). The WWP region has experienced the same general

warming trend as the Mount Robson region following climate change, with mean annual temperature increases of 1.5 to 3 degrees Celsius between 1950 and 2007 (Zhang *et al*., 2011). Figure 8 in section 2.1.1 shows mean annual temperature changes across Canada. Greatest mean annual temperature increases were seen in summer and winter. These temperature changes correlate to the reduced snowpack from February to July, and have impacted annual hydrological trends. Average monthly streamflows from 1950 to 2007 indicate a faster spring melt (increased runoff/discharge in March and April) and most significantly reduced streamflow occurring in August and September (Zhang *et al*., 2011).

Ecology. While there are significant environmental variations across the park, diverse species assemblages present have adapted to these conditions. At the highest alpine elevations, species adapted to harsh winds, dense snowpacks and negligible soil development dominate. This includes lichens, sedges, mosses and alpine grasses (Graham and Quintilio, 2006). A similar situation is found in the alpine zones in MRPP, with ecologically similar communities shaped by the difficult environmental conditions (BC Ministry of Forests and Range Research Branch, 2006).

Subalpine communities are characterized by closed forest. Most prevalent species include lodgepole pine (*Pinus contorta*), subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). Community composition and presence of species varies with aspect (moisture, radiation) and disturbance frequency (fire). Similar conditions exist in MRPP. As discussed in 2.1.1, forest communities in MRPP are representative of several variants of the ESSF biogeoclimatic zone, with both Subalpine Fir and Engelmann Spruce in strong representation. Ecological differences do exist once crossing the continental divide, however. Interior Cedar Hemlock (ICH) communities are not noted as present in WWP. One reason for this is the wetter conditions that often exist moving west into British Columbia; the high mountainous barrier of the continental divide forces pacific air masses to rise, condense and release the majority of their moisture before crossing into Alberta (Parks Canada Agency, 2012). While this can happen in the opposite direction with air masses from the east, this is much less common.

Grasslands on steep slopes and black spruce or wetlands in moist depressions are also seen. In the Montane subregion, landscapes are a patchwork of grasslands and forests dominated by Douglas fir and white spruce. The upper foothills subregion features coniferous forests, deciduous forests in wetter areas, and a developed understory of shrubs and mosses varying with moisture (Graham and Quintilio, 2006). While different classification systems are used, comparisons can be drawn to MRPP in these ecological communities. More information on the ecology of the Rocky Mountain and Foothills Natural Regions can be found in Appendix G Table 7.

Species at Risk. There are numerous species at risk in Alberta. As of November 2012, Alberta Environment and Sustainable Resource Development (AB ESRD) compiled a short list assessed under Alberta's *Wildlife Act*, the Endangered Species Conservation Committee (ESCC) and its Scientific Subcommittee (SSC) included 17 endangered, 13 threatened, 15 species of special concern, 8 data deficient species and 5 in process (Wildlife Management Branch, 2012). The assessment and status designation cycle promotes proactive management (see Figure 25). These designations are very influential in management decisions, following provincial mandates for protection and population restoration (Fish and Wildlife Division, 2008).

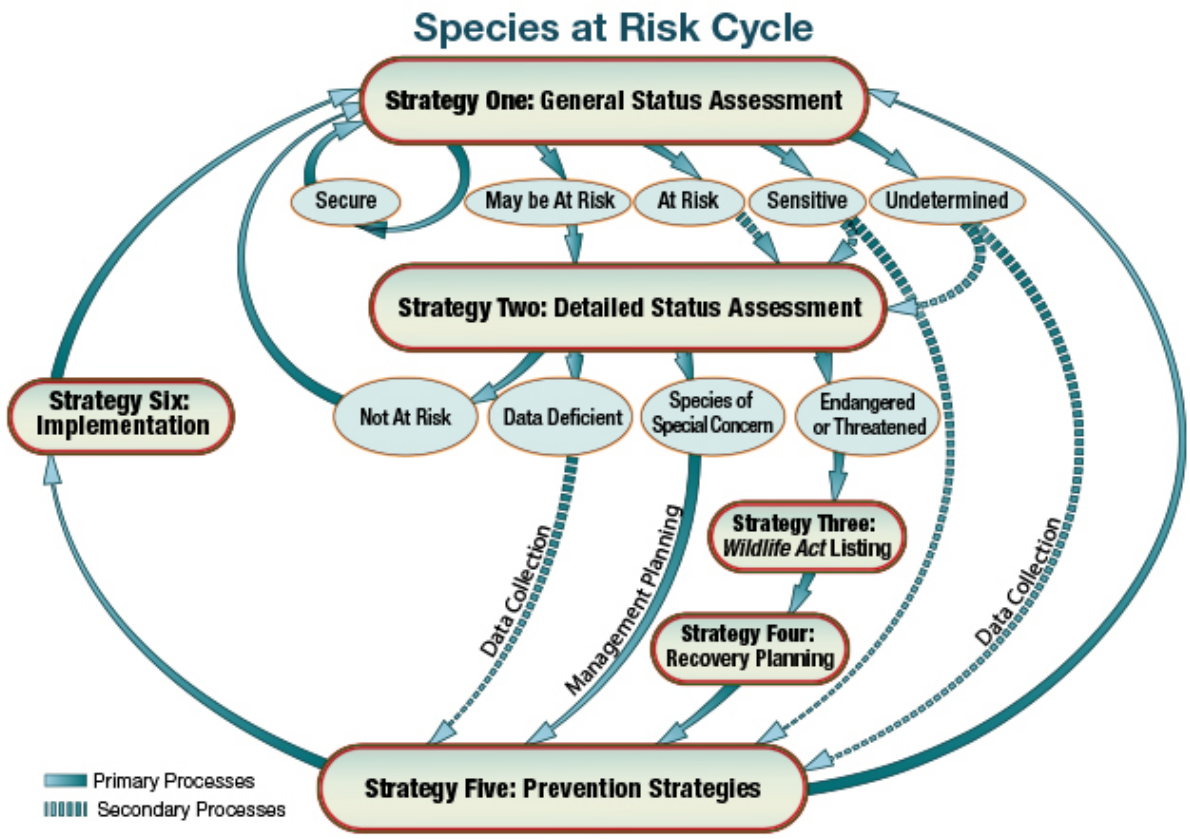

Figure 24: Species at Risk Cycle (Adapted from AB ESRD updated May 22, 2013) Retrieved from: http://srd.alberta.ca/FishWildlife/SpeciesAtRisk/AlbertasSpeciesAtRiskStrategy/Default.aspx November 1, 2013.

In WWP, plant species at risk include rare lichen and moss species such as alpine broom moss (*Dicranum scoparium*) and Lindberg's bog moss (*Sphagnum lindbergii*). Over 60 rare plant species have been recorded so far, several of which are protected under Canada's *Species at Risk Act (*SARA) and include Porsild's bryum (*Bryum porsildii*) and Haller's apple moss (*Bartramia halleriana)* (Graham and Quintilio, 2006; Pearson and Healey, 2012). WWP provides critical habitat for Porsild's bryum, with two of seven known provincial populations located within the park (AB SRD and ACA, 2006). While systematic documentation of the status of wildlife continues in AB, no management efforts in western Canada have directly focused on the vast majority of these plant species, and only periodic monitoring occurs in select protected areas (AB SRD and ACA, 2006). An exception is the recent recovery (research) campaigns for Porsild's bryum, however (Alberta Porsild's Bryum Recovery Team, 2010). Another exception is whitebark pine (*Pinus albicaulis*), which, as discussed below, has seen monitoring and restoration efforts in recent years (AB SRD and ACA, 2007)).

Also found in WWP are harlequin duck (*Histrionicus histrionicus*), wolverine (*Gulo gulo*), and grizzly bear (*Ursus arctos*). Ungulate species including bighorn sheep (*Ovis canadensis)*, mule deer (*Odocoileus hemionus*), white-tailed deer (*Odocoileus virginianus*), elk

(*Cervus canadensis*), moose (*Alces alces*), woodland caribou (*Rangifer tarandus caribou*) and mountain goat (*Oreamnos americanus)* are found in WWP. However, among these only woodland caribou are considered at risk. Grasslands at varying elevations throughout the park continue to provide excellent grazing habitat (Graham and Quintilio, 2006). Bighorn sheep and mountain goats are found in high abundance in the park, and continue to provide an internationally renowned hunt.

As described by Senior Wildlife Biologist Jeff Kneteman, AB ESRD does not apply quotas for hunting in WWP and instead harvest goals are based on a proportion of the estimated population from recent surveys. Hunting is not meant to maintain certain population sizes or states, but rather as a recreational opportunity without impacting population trends. No limited access to hunting exists within WWP since the populations of game species are strong (personal communication, December 4, 2013). It is estimated that 20% of Alberta's goat and sheep populations currently reside in WWP (AB Parks, 2013). The grizzly bear, wolverine, woodland caribou and whitebark pine are discussed in more detail below, as a selection of species under current management focus in WWP.

The grizzly bear is considered threatened in Alberta, and of special concern by COSEWIC (AB ESRD, 2013). Recent estimates suggest that the province has a total of 691 grizzly bears with varying densities between 5-18 bears per 1,000 km^2; populations experiencing habitat alteration thought to be likely struggling while others are stable (AB SRD and ACA, 2010a). Within the "relatively undisturbed" Grande Cache unit (which includes the region around and partially within WWP), population estimates were at the highest density and appeared stable (AB SRD and ACA, 2010a, p. iv). The report estimated 353.3 bears out of 581.8 (60.7%) provincially to be in the Grande Cache unit.

A similar story is that of the wolverine, with a relatively high abundance within park boundaries, and very few beyond. Recent studies have found a density of 6.8 wolverines per 1,000 km^2 in Willmore, and as few as 1.8 per 1,000 km^2 in the developed area east of the park (predominantly forestry, oil and gas) (Fisher *et al*., 2013). ESCC listed the wolverine as data deficient or "may be at risk" in 2012, leaving the Willmore population to be of potentially very high importance. Declining at an undetermined rate across Alberta, <1,000 breeding individuals were estimated to remain a decade ago, and trapping remained permitted (AB SRD and ACA, 2003).

Woodland caribou are of high concern. The species is provincially designated as threatened under Alberta's *Wildlife Act* and nationally by COSEWIC and the federal Minister of Environment under SARA (AB SRD and ACA, 2010b). Under SARA legislative guidelines (Sections 32, 33) it is a federal offense to kill, harm, harass or damage the residence of individuals of a listed species. As a consequence of habitat loss outside the Park, the A La Peche population now lives within the park year-round, and together with the Little Smoky population contributes provincially 12% of the population and occupies 6% of the current range. Both are being kept stable by annual wolf reductions (AB SRD and ACA, 2010b). Figure 26 illustrates the historic and present national range distributions of woodland caribou.

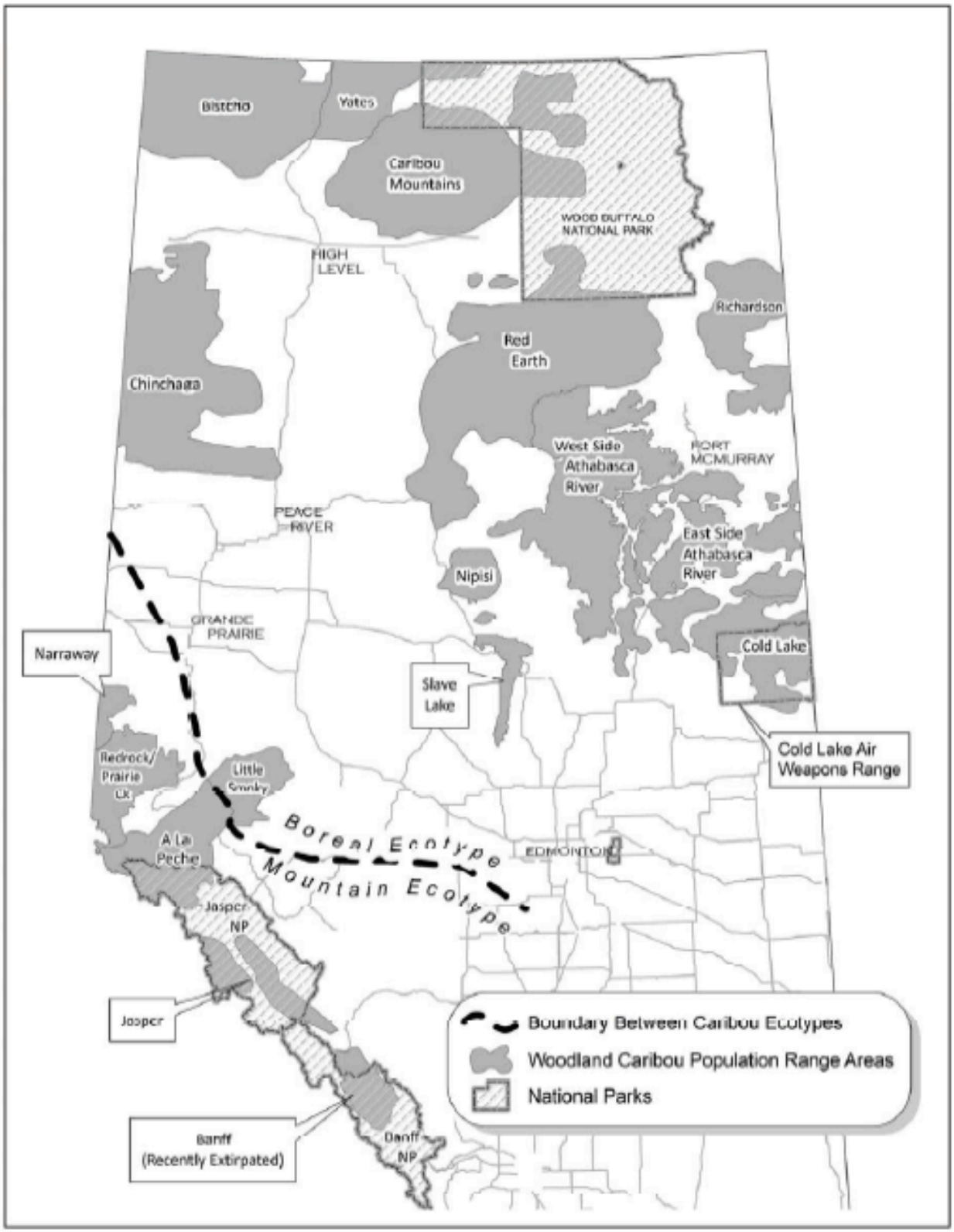

Figure 25: Historic and current range distributions of Woodland caribou in Alberta (Adapted from AB SRD and ACA, 2010b)

Extensive research has been done on Albertan caribou populations, and indicates that ongoing declines are resulting from habitat alteration due to human activities and at times forest fires, which increase predation by wolves (AB SRD and ACA, 2010b). As such, woodland caribou are tightly interwoven in WWP fire management strategies (Graham and Quintilio, 2006), and will be discussed in more detail to come. This species is frequently brought to our attention and has garnered public attention for being a charismatic mega-fauna needing protection. However, participants were sure to point out that while caribou are of high concern, they are far from being the only species under consideration.

One such species is whitebark pine. Similar to caribou in that they often persist where other species simply cannot, whitebark pine can be found in the mountains of western North America on rocky slopes of high elevation forests, and is considered a keystone species as its seeds provide a valuable food source for numerous species from squirrels to bears (AB SRD and ACA, 2007). The Clark's nutcracker is a significant species for whitebark pine regeneration, as they bury and consume seed from the pinecones (Graham and Quintilio, 2006).

While this tree species is ecologically significant in many ways, population distributions and size are unknown. The merits of increased monitoring efforts have been put forward following concern of several pertinent pressures on the species. Pressures from white pine blister rust (*Cronartium ribicola*), climate change, long-term fire suppression, and mountain pine beetle (AB SRD and ACA, 2007) have culminated into a major landscape-level impact that is still not fully understood. While more notable in southern Alberta, white pine blister rust has been identified as the most significant threat to the species. Restoration efforts include seed collection and rust-resistant tree identification (AB SRD and ACA, 2007).

The Willmore constitutes an increasing rare combination in Alberta, and Canada. The park landscapes are dramatic and rugged, enduring difficult climatic and weather conditions. The flora and fauna residing therein are diverse and resourceful, and coming to rely more heavily on the park for survival in an increasingly industrialized, developed Alberta. Alongside JNP to the south and Kakwa Provincial Park to the north, Willmore offers some of the last remaining wildland areas in the Rocky Mountains of Alberta. Coming to be over millennia, the mountains and wildlife have been simultaneously shaped by a growing human presence. The settlement history of the Willmore area is given next.

2.2.2 Settlement History

Prior to European settlers and colonization, indigenous peoples with a semi-nomadic hunting and gathering way of life inhabited the lands of Canada's northwest. Mountain travel was on foot, aided by canoe or horse (Glen *et al*., 2008). Hunting and trapping focused on abundant sheep, moose, deer and buffalo. Following seasonal resources and trading across the larger region, families travelled throughout present day JNP, MRPP, WWP and surrounding area (Glen *et al*., 2008). Fire was used as landscape modification to support the above activities. Archaeological evidence suggests habitation dating back at least 10,000 years (Feddema-Leonard and Cheverie, 2007). These ways of life continued largely unabated until the late 1700's when European expansion pushed westward, which had dramatic repercussions on the indigenous communities therein and ultimately increased poverty and violence.

In the early 1800's trading companies further expanded their working territories. Indigenous peoples traded furs for food, blankets, guns and food. By 1821 the Hudson's Bay

Company had expanded the fur trade into the Smoky River valley, now partly protected within WWP (Feddema-Leonard and Cheverie, 2007). From the 1870's to 1890's Treaties 6 through 8 had been signed and reserves were subsequently designated (Larmour, 2005). Upon signing Treaty 8, an estimated 2,700 full and 1,700 mixed blood indigenous people were involved (Madill, 1986). The local First Nations are the Aseniwuche Winewak Nation of Canada (AWN) and the Grande Cache Metis Local, and they have ties with Cree, Beaver, Stoney and Iroquois people due to relocations and uprootings since the late 1700's. The Cree translation of Aseniwuche Winewak is the Rocky Mountain People (AWA, n.d.). As the only non-status First Nation in the province, the AWN is not a part of Treaties six – eight which dictate various terms of agreement between the federal government and the indigenous communities having signed and ratified. As shown in Figure 10 in 2.1.2, the Simpcw First Nation, based now in BC also had traditional territory in what is currently the western reaches of WWP.

Shortly following the fur trading companies were the trans-continental railways, pushing forward to the Pacific. Coming west with the intention of preceding the railway lines, survey and road crews proceeded to establish township grids and reservation boundaries. Tensions grew high with aboriginal residents following tactless crew behavior and community concerns about the transfer of Rupert's Land from the Hudson's Bay Company to Canada (Larmour, 2005). The surveyors had the difficult job of balancing western residents' interests with government policy and changing politics. By 1883, construction of the CPR entered southern Alberta (Larmour, 2005). In present-day MRPP, this construction began in 1913 after having traveled through JNP.

The railways soon brought tourism to the Rocky Mountains and as a reaction numerous outfitting businesses sprang up. Much outfitting had begun around Jasper, and interest in the north country was increasing (Feddema-Leonard and Cheverie, 2007). Trips reached north and west; north to the Athabasca and Sunwapta confluence, and west to Tete Jaune and Yellowhead Pass. Leading trips for the Alpine Club of Canada, outfitters like Adolphous Moberly brought parties up the Moose River and over Moose Pass to Robson Pass with the hopes of ascending Mount Robson. Many place names in and around Willmore reflect this period of exploration and use, with famous trapper names like Kvass, Adolphous and McDonald instilled in peaks, creeks, lakes and flats. However, few reflect indigenous guides despite their invaluable support to many expeditions (Feddema-Leonard and Cheverie, 2007).

When Jasper Forest Park was established in September 1907, guiding and outfitting opportunities boomed, but Metis families living on the land were labeled squatters (Feddema-Leonard and Cheverie, 2007). Protests ignored, the majority of families eventually travelled north to settle in Grande Cache by 1910 (AWA, n.d.). Old hunting trails were cleared for a road north. The route taken crossed WWP as we know it today, and followed Solomon Creek to the Wildhay River, past Rock Lake to the Sulphur River. Then called the Moberly road (after the prominent family involved), the trail is now called the Mountain Trail (Feddema-Leonard and Cheverie, 2007). Figure 27 below shows the traditional land use and current land holdings of the AWN. This territory extends across the provincial border into BC, and overlaps with traditional territories of First Nations local to MRPP, as described in 2.1.2.



Figure 26: Traditional land use and current land holdings of the AWN (Adapted from AWN, n.d.)

At the time of WWP establishment in 1959, there were no established families living within park boundaries. Into the 1960's, the evicted homesteading Metis families from Jasper (Moberly, McDonald, Wanyandie and others) continued to live in the Sheep Creek, Kakwa River and Smoky River valleys and exercise a largely traditional hunting and trapping lifestyle. This was greatly impinged upon when in 1969 Grande Cache was established as a new town, along with the neighbouring McIntyre-Porcupine coal mine. Park boundaries were reduced to accommodate the town site.

By the late 1970's, only small communities of Metis were located NE of Grande Cache in the Muskeg River valley (Barnes, 1977). Nonetheless, cultural values remain strong in the region today. The AWN is a strong and resilient community presence in Grande Cache and Alberta. They have been involved in consultation with developers and in 2007 published a set of consultation protocols to assist in achieving adequate consultation procedures with First Nations communities dealing with industry and resource development (AWN, n.d.). They also offer environmental services and consultation for landscape management, incorporating traditional knowledge with western science for a balanced approach committed to a long-term sustainable use vision (AWN, n.d.)

2.2.3 Park Development and Management History

WWP is not a common household name like Jasper or Banff, yet it boasts scenery and abundant wildlife that have lured visitors from around the world. WWP has been managed for sustainable use conservation for most of its time as a park. While created under provincial legislation and part of the AB Parks system, it retains a unique park class apart from provincial parks and wilderness areas. The permitted and limited uses under this designation are discussed below.

The area now established as WWP experienced several other designations over the last century. From 1910 to 1959, the region was part of the Rocky Mountain Forest Reserve. The Reserve encompassed 5 new regions ("forests") for management purposes (Glen *et al*., 2008). The most remote and least attended to was the Athabasca Forest Reserve, of which great similarity is found with the current boundaries of WWP. Ironically, the forest officers brought in to govern the reserves quickly sought the expertise of indigenous outfitters and guides recently expelled from the Forest Reserve (Fedemma-Leonard, 2007).

By the late 1940's, the Imperial Oil Company was searching the foothills east of Grande Cache for petroleum. Guides were hired and oil and gas leases were given for land within current park boundaries. Concern over the impacts of this exploration was passed to MLA Norman Willmore, and he responded by advocating for the area's designation. In 1959 an area 5,565 km^2 was deemed Wilderness Provincial Park, and governed through the new Wilderness Provincial Park Act (AWA, n.d.). This allowed hunting, trapping and fishing to continue unabated by motorized vehicles and resource development (Feddema-Leonard and Cheverie, 2007). The park has its own individual legislation and is the only wilderness park in the province.

Meanwhile, no oil and gas was discovered; upon lease expiration industry pulled out of the area. Nonetheless, it took until 1972 for a moratorium on surface-disturbing exploration to come, and until 1995 for industrial development to be illegal within park boundaries. Only 4 years had passed before the park was reduced in size by 17% to 4,597 km^2 in 1963 for coal extraction and the establishment of Grande Cache Town in 1969 (AWA, n.d.). By 1965, the Wilderness Park Act was changed to the WWP Act following the tragic death of Norman Willmore. It still remains the fourth largest park provincially, following Wood Buffalo National Park at 44,802 km^2, Jasper National Park at 10,878 km^2 (Parks Canada Agency, 2008b) and Caribou Mountains Wildland Park at 5,910 km^2 (AB Parks, 2013a).

Following the establishment of the park, the Alberta Forest Service was placed in charge of its management, and the Fish and Wildlife Division completed inventories on particular species. Wildlife management was very indirect and was based on catches, trap lines and hunting quotas. In recent years, several notable shifts have occurred for the park management agencies involved. Alberta Sustainable Resource Development (AB SRD) merged with the Ministry of Environment and Water to become AB ESRD. The vision of this amalgamated Ministry is to be "proud stewards of air, land, water and biodiversity, will lead the achievement of desired environmental outcomes and sustainable development of natural resources for Albertans" (AB ESRD, 2012).

In 2000, the decision was made to place Alberta Parks (AB Parks) Division from the Alberta Ministry of Tourism, Parks and Recreation (TPR) as the primary decision-maker for the park. The mandate of AB Parks for WWP is "To preserve and protect natural heritage and provide opportunities for compatible backcountry recreation" (AB Parks, 2013b). Management

decisions are guided by the Plan for Parks (2009), Land use Framework (2008) and Science Strategy (2010). As a result, today there is a balance between AB Parks and AB ESRD for various components of the park system. Fire management in the park remains the responsibility of the AB ESRD Wildfire Division (following management decisions and priorities of AB Parks), and the Lands and Forests Division remain involved in issues relating to forest health such as the mountain pine beetle epidemic. The Fish and Wildlife Division have been involved for quite some time and remain responsible for surveying and monitoring wildlife populations and establishing systems for hunting, fishing and trapping.

The management approach towards endangered species, fire and other factors varies between agencies. Most simply, it is often suggested that a shift from sustainable use management to that of conservation has been made. Challenges exist in finding and building bridges of communication and collaboration between agencies with philosophical differences; important steps to further develop this relationship have and continue to be made. The Willmore Fire Management Plan (2006), discussed in 2.2.4 to come, offers a strong example of the potential for inter-agency cooperation in developing cohesive and practical management objectives in WWP, in the face of ecological and environmental challenges that agencies have multiple values and priorities for.

2.2.4 Current Management Aims

WWP does not have an overall park management plan. Depending on the situation, this absence of park-specific planning can offer flexibility or rigidity. Nonetheless, as a provincially legislated protected area, WWP is currently managed under several provincial protected areas initiatives, including the Plan for Parks 2009 –2019 (Government of Alberta, 2009). This plan presents a regional planning approach to parks management in order to achieve recreation and conservation goals in the provincial parks system into the future. A corresponding document, the Land Use Framework (Government of Alberta, 2008), shares the vision of wanting healthy communities and ecosystems alongside sustainable resource development and use.

AB Parks is responsible for proceeding with four overarching strategies for achieving the mandates set by the Land Use Framework and Plan for Parks (Government of Alberta 2008; 2009 respectively). Similar to those emphasized in the MRPP 2011 Management Plan (as discussed in 2.1.4), these strategies include the responsibility for managing user needs, recreational opportunities and conserving and protecting biodiversity. As there are overlaps in the land management interests of AB Parks and AB ESRD, these agencies continue to strengthen their collaborative interdependence both in WWP and province-wide. A brief overview of wildfire management and its impacts on biodiversity management will follow.

Wildfire Management. Exemplifying this is the WWP Fire Management Plan, produced by Alberta Community Development and AB ESRD in 2006. The 4 main goals of the Fire Management Plan offer an overview of current management aims and priorities (less recreation). Goals include, broadly; natural fire processes, community protection, ecological integrity and protection of landscape values, and forest health (mountain pine beetle control) (Graham and Quintilio, 2006). Figure 28 illustrates the wildfire distribution in WWP from 1931 to 2006. Contrastingly as discussed in 2.1.4, wildfire management in MRPP is guided by the policies of BC Parks and the Prescribed Fire Evaluation Plan for MRPP (B.A. Blackwell and Associates and

Compass Resource Management, 2003) and the MRPP Ecosystem Management Plan (B.A. Blackwell and Associates *et al*., 2001).

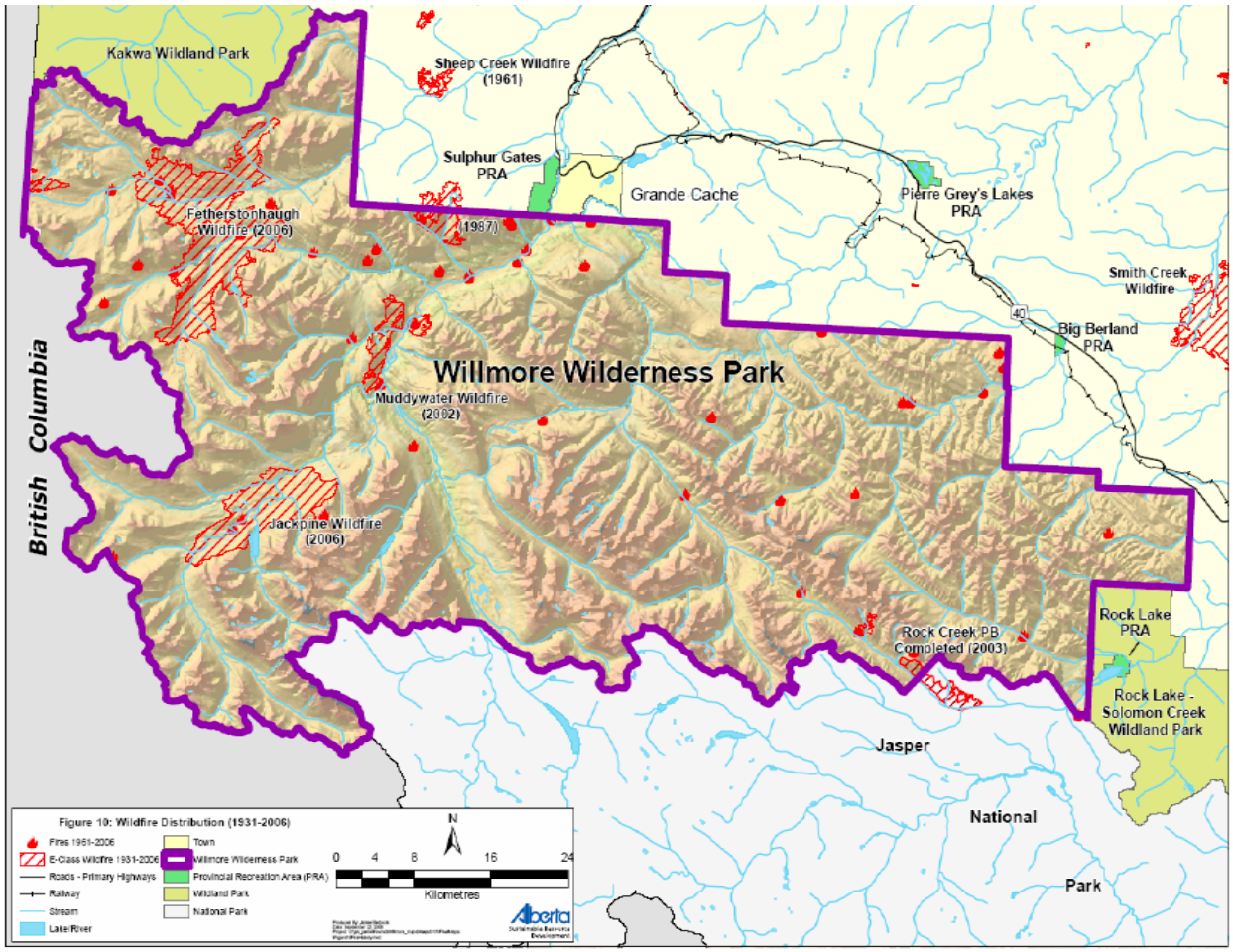

Figure 27: Wildfire Distribution in WWP 1931-2006 (Adapted from Graham and Quintilio, 2006)

The fire management strategy in WWP for wildfires is framed within two park zones - the natural fire zone and the managed fire zone (Figure 29). As the names imply, if a wildfire starts in the natural fire zone there is preference to allow natural fire processes to ensue and efforts to suppress the fire are a last resort (Graham and Quintilio, 2006). Exceptions include wildfires that will alter critical habitat for endangered or threatened species such as woodland caribou. In these cases, the final decision lies with AB Parks, an agency with a biodiversity mandate to uphold. In the managed fire zone, most fires are actively suppressed for public safety and other land use interests surrounding the park (e.g. Grande Cache town or timber supply areas (TSAs) (Graham and Quintilio, 2006).

As a consequence of widespread fire suppression for many decades, stand age and densities present significant risk of massive, catastrophic fires. Accordingly, fireguards will be put in place before the natural fire zone can be truly managed as such. Nevertheless, certain areas of the park make it very difficult to suppression fires. This is due to their remoteness, steep slopes and seral stage distribution of forests among other factors (Graham and Quintilio, 2006). Figure 30

illustrates the geographic distribution of risk associated with levels of suppression capability across the park.

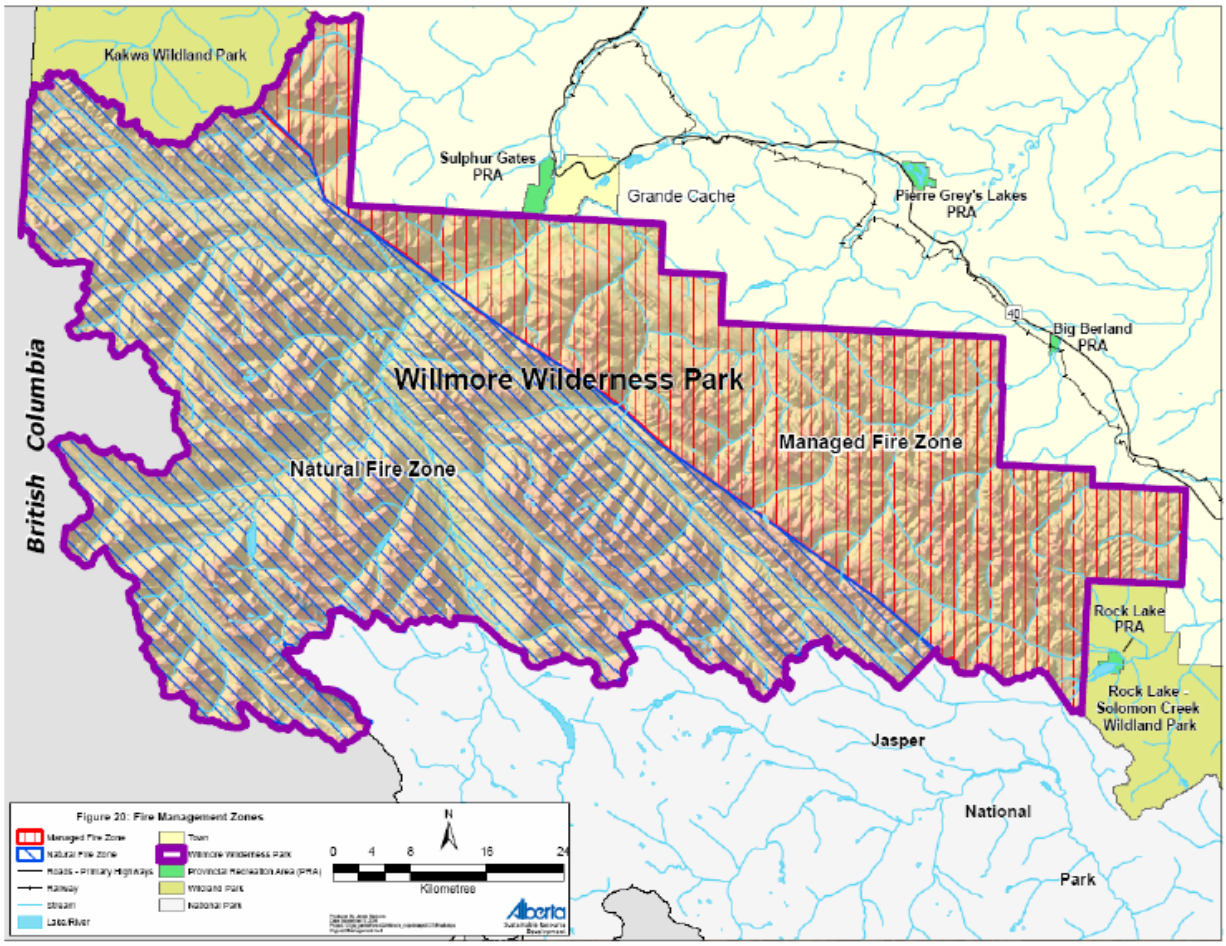

Figure 28: Fire Management Zones, WWP (Adapted from Graham and Quintilio, 2006)

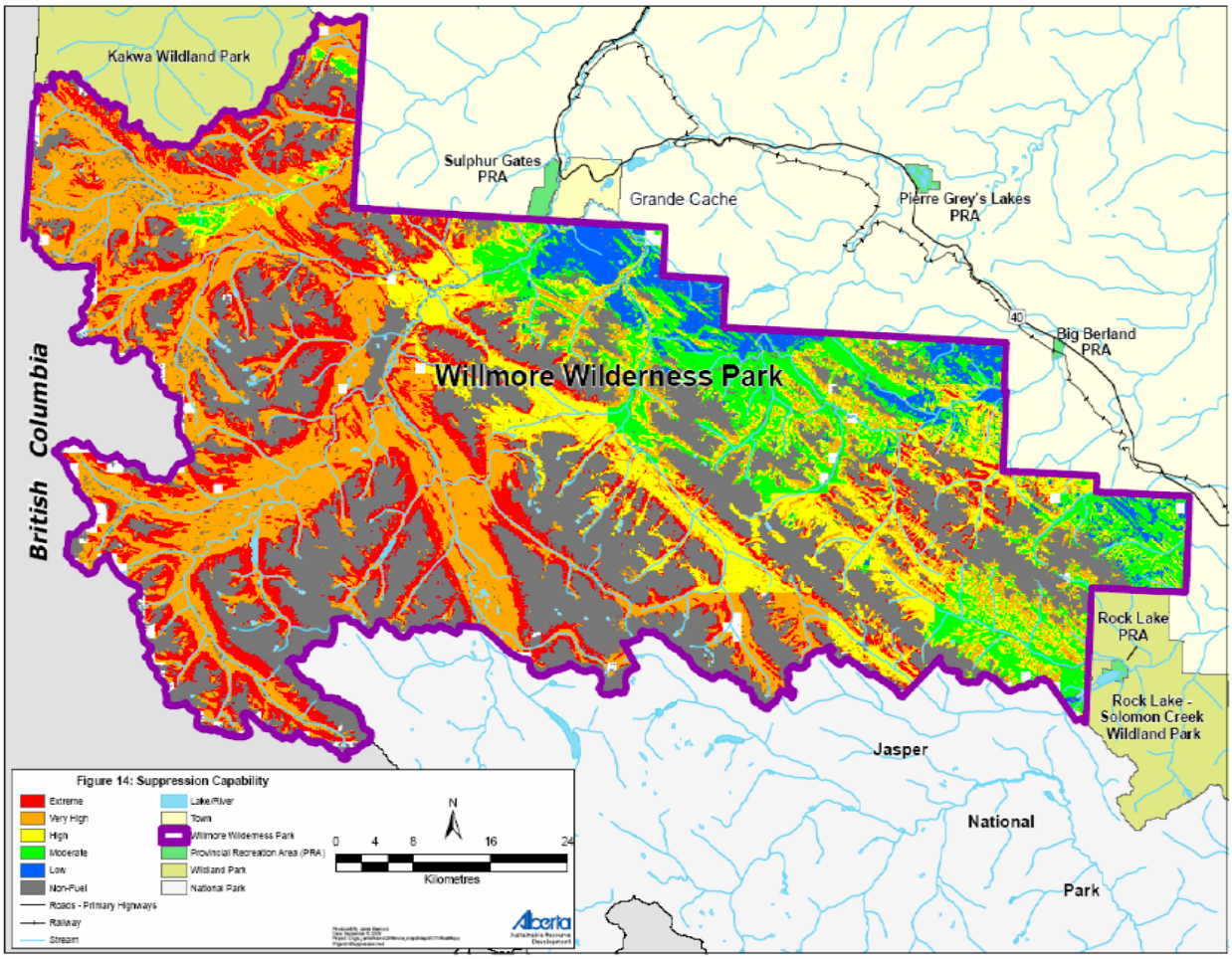

Figure 29: Fire Risk and Suppression Capacity in WWP (Adapted from Graham and Quintilio, 2006)

Protecting and Maintaining Biodiversity. Willmore serves as a critically important ecological benchmark for species populations and biodiversity for the rest of Alberta. With several endangered species in the park, such as woodland caribou, grizzly bear and whitebark pine, both government and university biologists are working hard to find ways to help support and rebuild the delicate populations of these species. The details of this work were discussed in 2.2.1. Monitoring efforts have taken place for many years by Fish and Wildlife Division scientists, and in the past decade have increased in light of threats from mountain pine beetle, elevated fire risk, climate change concerns and through several key biodiversity research initiatives such as the Willmore Biodiversity Research Project (e.g. AB Parks, 2010; Fisher *et al*., 2011; 2013).

Fire management goals have at times run at odds with biodiversity aims in the park. In WWP, certain habitats serve as critical refuges for endangered or threatened species. Unfortunately, some of these landscapes have also become of increasing concern for wildfire risk. This can be a difficult balance, and general strategies of operation for these circumstances are outlined in the Fire Management Plan (Graham and Quintilio, 2006). While natural fire can have a role in protecting ecological values (such as timber, wildlife, endangered species and so forth), fire management activities should protect these ecological values from catastrophic fire if

necessary. While the exclusion of fire can also have a negative effect on these values, under the current circumstances of aged forests following many decades of suppression, the risk of devastating wildfire is significant and could remove some of the last critical habitat for threatened species. Overall, the Fire Management Plan recommends "minimal interference in natural fire processes" due to the complexity of ecological processes at hand (Graham and Quintilio, 2006:40), and each fire in the park will be addressed on a case-by-case basis.

2.2.5 Local Socioeconomic Conditions

The socio-economic profile of the local area around WWP is based heavily on resource development and extraction. Primary industries of mining, forestry, oil and gas dominate the foothills landscape, leaving a patchwork of seral stage stands, logging roads and well pads. As such, boundary use pressures are significant around the Willmore, with commercial forest allocations, oil and gas development, and coal mines all quite close to its borders. The impacts of these activities necessarily reach into the park, and the cumulative effects have not been assessed.

The closest community to WWP is the town of Grande Cache. In 1975, there were 3,460 residents of Grande Cache, which comprised the only population centre near the park (Barnes, 1977). The population of Grande Cache has increased slowly, and was recently estimated at 4,200 (Town of Grande Cache, 2010). Similar conditions exist in MRPP, with the closest population centre being Valemount, a town of under 2,000 people (Stamm, 2004).

In recent years, average income-brackets differ from those of Alberta overall, with median earnings in 2005 of $36,671 compared to $29,738 for the province overall. The percent of persons within the low-income bracket before tax was 6% as compared to 12% for the province (Statistics Canada, 2007). The population fluctuates following coal development projects, leaving some economic instability that is gradually being replaced by other sectors such as tourism, to be discussed shortly. Established in the 1970's to accommodate the development of a coal mine, natural resources have played a primary role since the beginning (Town of Grande Cache, 2010). Coal mining has remained to this day, but only 19% of the population is employed by mining or oil and gas development.

Presently, the companies developing coal resources based in Grande Cache include Milner Power and Grande Cache Coal Corporation, which employ 75 and 500 local people respectively. Milner Power is expanding and building a new $1.4 billion thermal-electricity power plant in the area, employing up to 800 people during construction (Town of Grande Cache, 2010). Oil and gas development is increasing and currently employs around 120 people in the area. Locally active companies include EnCana Corporation, Paramount Resources, Tourmaline Oil Corp., Suncor Energy, Husky Energy and Conoco Phillips Canada (Town of Grande Cache, 2010).

Beyond the natural resource industries, Grande Cache also capitalized on recreation and outdoors tourism. 12% of the population is employed through the service sector in accommodations and food services (Town of Grande Cache, 2010). WWP is a prime attraction for visitors, as well as the world-renowned North Face Canadian Death Race, Passport to the Peaks hiking program and the Grande Cache Wild River Rendezvous paddling event. The town is also experiencing some growth in residential property development, as well as property demand for industrial and commercial purposes for the resource extraction industries (Town of

Grande Cache, 2010). A federal medium-security correctional institution is located just outside of town, and employs several hundred people (Town of Grande Cache, 2010).

2.2.6 Ecological Restoration and Remote Ecosystems

Ecological restoration in WWP has, to date, been mostly passive. While localized areas of the park have in the past experienced damage from industrial exploration (e.g. Crowsnest Pass and Rock Lake coal exploration), the implied management philosophy has been to allow wilderness to renew itself, as intervention was neither pressing or pragmatic. As the park is legally protected from any further exploration or industrial activities of any kind, there is no immediate threat of further damage of that kind. Additionally, with a relatively small user base that is for the most part cognizant of the backcountry ethic, direct impacts from human use appear to be minimal.

Monitoring of invasive species has occurred, but no direct removal efforts have been planned. Monitoring and research on the health and range of species at risk continues at a provincial scale for species such as Porsild's bryum (Alberta Porsild's Bryum Recovery Team, 2010) woodland caribou (AB SRD and ACA, 2010b) and whitebark pine (AB SRD and ACA, 2007). The latter two are discussed briefly below.

For whitebark pine, restoration efforts are province-wide. Efforts to battle the introduced fungus species white pine blister rust (*Cronartium ribicola)* include a rust-resistant tree identification program and seed collection program. Fire suppression, climate change and mountain pine beetle are additional threats to the species, and research efforts in and around WWP have taken place examining cone serotony in several tree species. This will improve understanding of the relationship different species have with fire and the ecological value of prescribed burns, as certain species such as whitebark pine require fire for their dispersed seeds to become viable.

For woodland caribou, restoration efforts have taken place for several years in order to keep the local caribou populations - the Little Smokey and A La Peche herds - stable. Annual reductions in wolf populations are the sole means of doing this, and only one monitored herd in the province is thought to be stable without predator control measures (AB SRD and ACA, 2010b). In WWP, fire suppression is the only other means of supporting the caribou populations, however this is a difficult balance as continued suppression maintains habitat in the short-term while increasing the risk of catastrophic losses in the future if a runaway fire should occur (Graham and Quintilio, 2006).

Alongside and at times interwoven with these actions, restoration efforts in WWP have been focused around wildfire. These management efforts are in the form of prescribed burns, and suppression when threatened or endangered species' habitat is at risk of decimation from wildfire. These efforts are described in the following subsection.

Fire Management. In WWP, fire management is a key ingredient in restoration efforts. Restoring more natural fire regimes to park landscapes is a priority objective in the Fire Management Plan (Graham and Quintilio, 2006). The vast majority of this work is in the backcountry reaches of the park, in the "natural fire zone." Prescriptive fire is used as a restoration tool in WWP for several primary objectives: to enhance habitat for ungulates and other species; to manage vegetation; to mimic natural fire regimes; to enhance forest health; and,

to manage specific areas of mountain pine beetle infestation (Graham and Quintilio, 2006:64). Historic photographs (such as those from photo-topographic surveys) can be used to ascertain historical references for setting restoration objectives.

Efforts to restore fire processes involve multi-year planning and research to ensure that a prescribed burn is the appropriate action to take for a given location in the park. For WWP this involved in-depth discussion and inter-agency collaboration between AB Parks and AB ESRD, with the aim of having management priorities of those involved balanced satisfactorily. In 2006, seven prescribed burns were proposed, located across the park and just outside its boundaries in JNP and along the BC-AB border. Burn extents ranged from 1,085 to 11,185 hectares (Figure 30) (Graham and Quintilio, 2006).

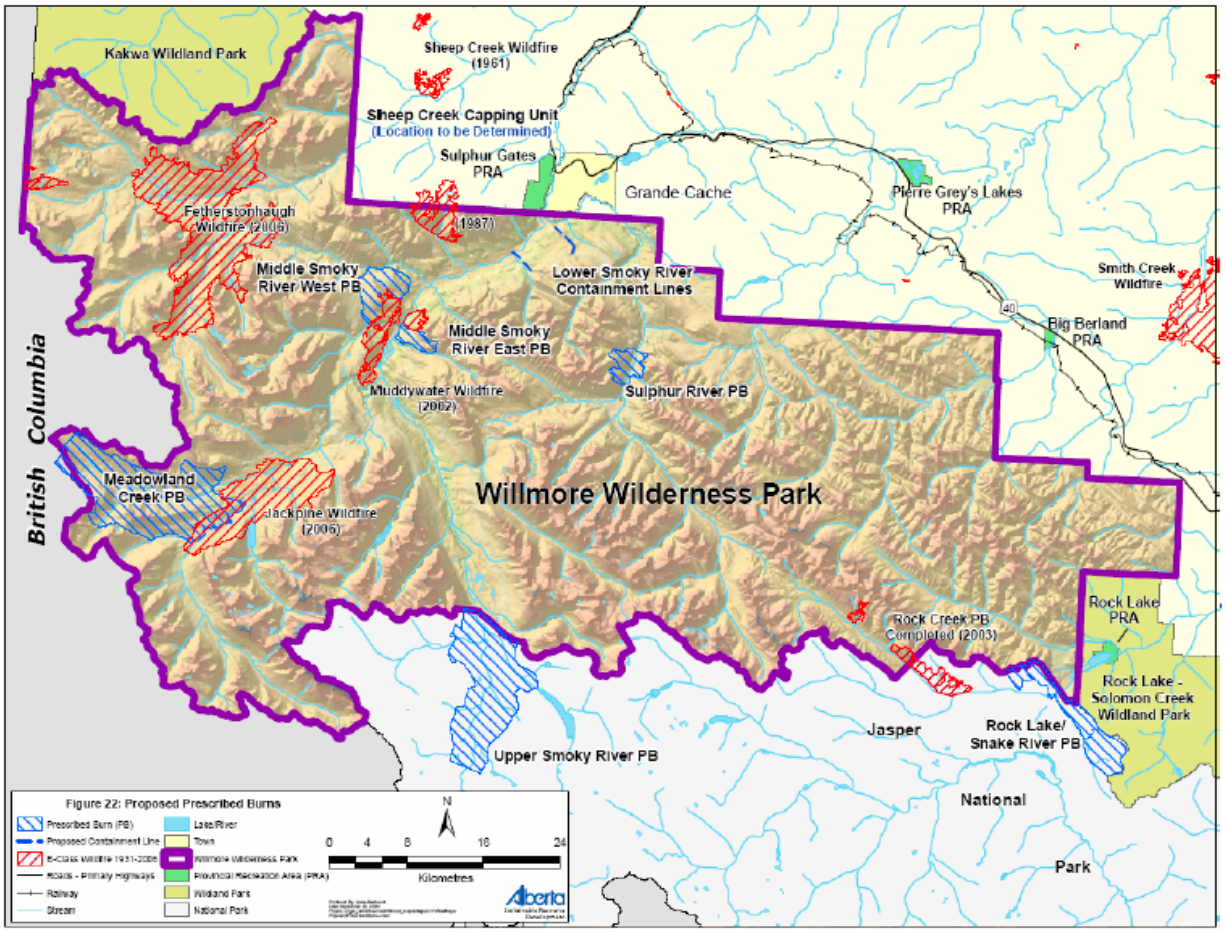

Figure 30: WWP Prescribed burns, capping units and containment lines (Adapted from Graham and Quintilio, 2006)

The Jackpine fire on July 4, 2006 was responsible for burning 6,300 hectares with a 47 km perimeter (Morrison, 2006). Along with 20 other fires the same day in the foothills, the Jackpine fire began from a lightning strike, but the fire soon became quite strong. Cold air and wind coming across Resthaven Glacier and Ptarmigan Lake created intense fire dynamics, including a fire whirl. The progression map of this fire is shown in Figure 32.

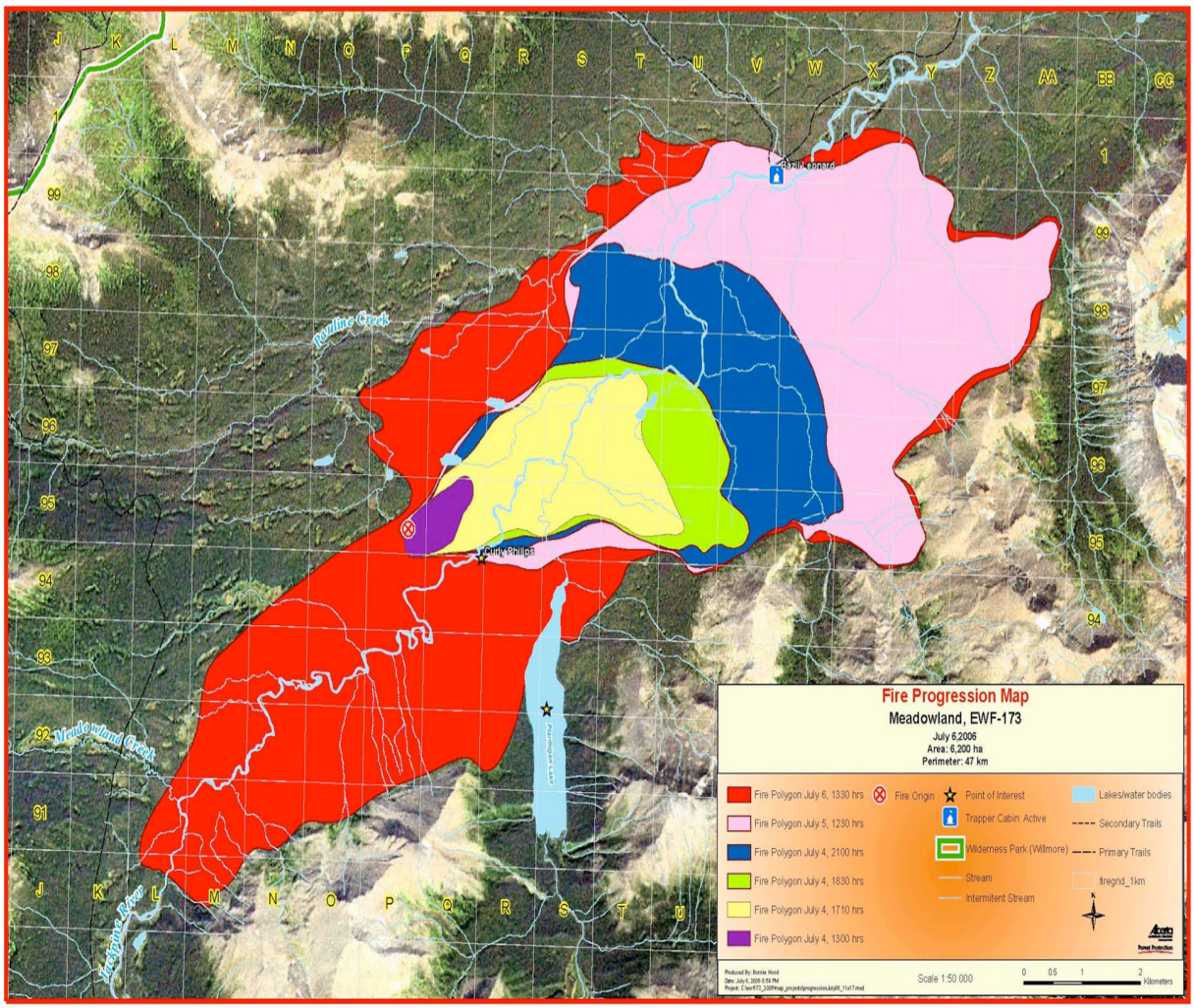

Figure 31: Fire Progression Map of July 4-6, 2006 Jackpine Fire (Adapted from Bonnie Hood, 2006)

In the best-case scenarios, fire can help biodiversity through habitat variation and introducing new seral stages into increasingly homogenous forest cover. In 2006, there was a large push provincially to address the insurgence of Mountain Pine Beetle into AB from BC. Managers of WWP worked together on a prescribed burn in the Sheep Creek drainage, at the far western reaches of the park. This burn concluded at 14,500 hectares and was extended in area by high temperatures and strong winds. Some feel the burn "got away" and was unnecessarily large, destroying invaluable habitat along a caribou migration route into JNP. Nonetheless, the threat of Mountain Pine Beetle in the park has subsided considerably since 2006 and management efforts are no longer focused on it to that extent.

Balancing the Risks and Benefits of Fire. It is necessary to find a balance between protecting surrounding human investments and allowing fires to burn. While fires can play "a vital role in maintaining the health of natural ecosystems" (Parks Canada, 2008a:57), increasing habitat variation and seral stage distribution, communities cannot be put at risk when avoidable. Prescribed burns for firebreaks are intended to protect the town of Grande Cache from runaway

wildfires (Graham and Quintilio, 2006). The risk of removing fire from historically fire-driven landscapes is that it can inhibit recruitment of fire-reliant species, increase invasive species, alter nutrient cycles, lead to increased stand density and homogeneity, forest ingrowth and subsequent habitat loss, and greater risk of intense wildfires (Parks Canada Agency, 2008a).

The benefits of fire for ecosystem processes (Bond *et al*., 2012; Graham and Quintilio, 2006; Hutto, 2008) and as a forest management tool (Graham *et al*., 2004; Peterson *et al*., 2005; 2007) are well documented and are being taken seriously by agencies such as Parks Canada through the Action on the Ground initiative. "Maintaining and restoring ecological integrity therefore requires the Agency to both manage wildfires and safely re-introduce fire to the landscape. As a result, Parks Canada is now using prescribed burns to re-establish historical ecological conditions into national parks across the country" (Parks Canada Agency, 2008a:58).

Other restoration efforts concern species at risk in the park. Maintaining or increasing habitat for COSEWIC or SARA listed species is a top priority for AB Parks. Thorough and systematic ecological monitoring has been done province-wide by the Alberta Biodiversity Monitoring Institute (ABMI) and several plots are located within WWP (ABMI, 2011). The data supplied by this initiative and other monitoring offer insight for managers as to which areas are best preserved for certain species at risk. In these areas, fire risk is often strictly controlled - or encouraged - depending on the ecosystem and habitat requirements. Containment lines, capping units and prescribed burns, control fire; Figure 31 shows proposed actions, above.

2.2.7 Summary

In summary, the previous sections have discussed the second case study of this thesis, WWP. As a park renowned for its rugged landscapes, unpredictable weather and abundant wildlife, WWP stands as a special example of wilderness in west-central Alberta. Protected in the park are landscapes having supported indigenous communities dating back 10,000 years, and most recently the Aseniwuche Winewack Nation of Canada and local Metis. Today the closest community is the town of Grande Cache, with just over 4,000 people (Town of Grande Cache, 2010).

WWP offers backcountry recreational opportunities that are increasingly difficult to find, with user-maintained trails and no in-park facilities. The park stands alone in its legal designation, and has been managed for sustainable use conservation under its own act - the Willmore Wilderness Park Act - since its inception. With recent shifts in agency involvement, AB Parks now guides management decisions under the Plan for Parks (AB Parks, 2009), Land use Framework (Government of Alberta, 2008) and Science Strategy (AB Parks, 2010). Management priorities are focused around managing user needs, recreational opportunities and protecting biodiversity.

These values are carefully integrated with management planning for wildfire risk and burn prescription. Restorative burns have taken place, and planning continues for fire breaks and capping units. Prescribed fire is a tool used both for mountain pine beetle or spruce budworm control, and for community protection and commercial values outside park boundaries. Fire also can benefit biodiversity conservation within the park, however suppression has been required for certain circumstances. Monitoring efforts for the status of species of concern continues.

Chapter Three: Methods

Chapter Three offers a detailed account of the data collection methods used in this study, and the analysis techniques that followed. This discussion is organized into four main sections. First in 3.1 the comparative case study approach is described, which serves as the overarching framework for this study. Next, the data collection methods are discussed in 3.2, which include; repeat photography, photo elicitation, focus groups and individual follow-up interviews. Following that is a description of content reductive analysis (3.3) and the limitations of the study with respect to these methods and modes of analysis (3.4).

3.1 Comparative Case Studies

This thesis investigates observable long-term remote landscape change in two protected areas in the Canadian Rockies. Using a comparative case study approach, MRPP and WWP are used to compare both the long-term remote landscape changes, and the resulting implications for parks management and restoration. The primary research question of this study is "how do long-term landscape changes influence conservation and restoration objectives in remote mountain ecosystems?" This also incorporates subsidiary questions: "what are the inherent challenges in managing (and restoring) remote ecosystems?"; and “how could managers of remote ecosystems best approach these issues in the face of rapid environmental change?”

This study has been shaped around these particular questions with the purpose of forwarding the state of research surrounding remote ecosystems, with a particular focus on the Canadian Rocky Mountains. Today, human activities extend around the globe, and the protection of natural landscapes devoid of direct human participation is of high priority to parks and protected areas management in Canada and beyond. Parks and protected areas in Canada are internationally acclaimed and protect incredible landscapes and ecological communities. It became apparent to me that while we recognize the importance of our nation's parks and protected areas, and while we are aware of the increasing pressures on natural systems worldwide, there is a void of understanding for what that means for managers - on the ground, day-to-day - in the backcountry parks we so treasure. Therefore, with a specific focus on agency work in or relating to the more remote reaches of these two parks, this study aims to increase our understanding of management circumstances and challenges in remote ecosystems under conditions of rapid change.

This study is framed within two case studies. Cases are exploratory and descriptive, with in-depth discussion of park characteristics, past and present management circumstances, and a thorough evaluation of long-term landscape change through the primary data collected for this study. The investigation is guided by an interdisciplinary arrangement of methods. Primary data was collected through repeat photography with the Mountain Legacy Project in the form of repeat photo pairs. Focus groups and individual semi-structured interviews were completed with parks managers. Photo-elicitation activities using the photo pairs provided guidance throughout these discussions.

These methods were chosen for their ability to provide complementary insight into the topics examined by my research questions. Each method offers a different angle of investigation, yet has aspects that overlap with another method being used. The repeat photography is used

within photo-elicitation, serving as the medium for discussion. The focus groups and interviews revolve around discussing long-term landscape change, as observed within the repeat photo pairs made available through photo-elicitation. Overall, as a method photo-elicitation serves as the guiding force in this study, bridging several methods into one unifying process of investigating my research questions.

3.2 Data Collection

To bring together perspectives on long-term landscape change, and contribute to greater understanding of changes occurring in remote mountainous protected areas (sociopolitical, ecological and environmental change), I chose to separate my data collection strategies into four separate but complimentary methods. Scientific repeat photography and photo-elicitation are tightly bound to the repeat photo pairs. Focus groups and individual semi-structured interviews allowed me to bring park managers into the conversation surrounding these photos and the long-term change they illustrate.

While each method can stand alone and offer significant new information regarding changes observed in WWP and MRPP, the mutually inclusive nature that has developed between the four methods for this study offers a strength to understand and assess long-term landscape changes and what they mean for parks management at a deeper, interdisciplinary level.

Moving forward, this discussion begins in 3.2.1 with a description of scientific repeat photography for the 2011 and 2012 field seasons, and the Mountain Legacy Project. Next, 3.2.2 offers a description of photo-elicitation techniques using the repeat photo pairs during focus groups and individual semi-structured interviews. 3.2.3 offers an introduction to focus groups as a qualitative method, and an explanation of why this method proved suitable and most appropriate for this project and its goals. A brief summary of the current developments, characteristics and criticisms of focus groups will then follow, and the most notable benefits and potential downfalls of the method will be examined. Finally, the use, structure and logistics of this method in the context of this project will be discussed in detail. Lastly, in 3.2.4 I present a detailed description of the semi-structured individual interview method.

This research project required Human Ethics approval from the University of Victoria for its use of focus groups and individual interviews. The Certificate of Approval is attached in Appendix C. This research also required research permits for repeat photography work within Alberta and British Columbia parks. For research in WWP, an AB Parks permit (12-081) was acquired June 7, 2012 and expired September 24, 2012. For research in WWP, a BC Parks permit (106189) was acquired June 15, 2012 and expires August 31, 2014 (renewed permit for potential future fieldwork).

3.2.1 Repeat Photography

Images allow us to "captur[e] the details of a changing world" (Webb *et al*., 2010:314). While these details are often fleeting and malleable without context, photo pairs produced through repeat photography can serve to remind people that landscapes are constantly changing, evolving, and are seldom static. This technique is ideal for educating the public on complex issues of change over time, and can be very valuable for restoration projects needing more scientific underpinnings for the extent of ecological changes having occurred. Depending on

photo resolution and quality available, historic photographs can offer insight into habitat reference conditions for ecosystems from the mid 19th century on.

Repeat photography serves as the dominant method in this study. Having a history as diverse as the images used therein, repeat photography began with the documentation of annual glacier ice changes in the Alps and swiftly expanded into other applications over time. The use of repeat photography has become widespread and diverse in recent years, being internationally recognized across a variety of disciplines (Webb et al., 2010). This has largely been due to the flexibility and versatility of the technique for documenting long-term change and landscape modification over time. Repeat photographic methods have been used in urban planning and research endeavours in geography, landscape ecology, environmental science, and anthropology. It can facilitate ecological monitoring and track public concern for landscapes through an understandable and poignant medium (Hall, 2001).

The method of repeat photography has been made possible for this study through the Mountain Legacy Project. The following sections will discuss the use of repeat photography as a key method in this study, and the Mountain Legacy Project of which a brief history will be given. Following that, the discussion will move on to the data processing and field work involved. The section will close with a discussion of repeat photo pairs as a method to understand and evaluate remote landscape change.



Figure 32: Location photo showing me lining up the repeat photo, Bull Creek Station, Kananaskis Country, Alberta July 2012 (Photo credit: Heike Lettrari, 2012)

3.2.1.1 The Mountain Legacy Project

First formed in 1996 at the University of Alberta as the Bridgland Repeat Photography Project, the Mountain Legacy Project (MLP) is a broad-based research initiative to systematically repeat historical survey photos from Canadian photo-topographic surveys of the mountain west from the 1860's to 1950's. Early efforts were focused in Jasper National Park, but soon expanded to other locations throughout the Canadian Rocky Mountains and the western Canadian cordillera. The history of photo-topographic surveying was discussed in 1.1.1.

When repeating a historic survey image, there are several critical factors, not least of which is the type of camera used. The camera impacts research applications beyond the physical influences of respective technologies on resulting photographs. The camera apparatus itself necessarily influences the act of photography, the way in which we perceive and view the landscape through a camera lens.

When the Mountain Legacy Project began, those involved, namely Eric Higgs and Jeanine Rhemtulla, found it important to use a medium format film camera to repeat the historical images in Jasper National Park. As each camera system will necessarily produce images of different specifications, distortions and various qualities, having a repeated image from a different camera than that used for the original can create issues for comparative use. Current computer processing abilities can adjust digital image files for distortion, however it is of greatest benefit to appropriately select a field camera and lens, thus reducing the extent of computer distortion adjustments as much as possible. Beginning in 1996 with a Linhof Technika 4x5" large-format camera (Rhemtulla, 1999), from 2003 to present MLP has been using the Hasselblad H2 and H3 digital medium format camera systems.

The work of MLP is strongly linked to archival photography, which is the acquiring of old images and storing of repeat images for future use. In 2002, Library and Archives Canada (LAC) joined as a partner and the scanning of the glass plate negatives began with photographs from Bridgland's 1913-1914 Crowsnest Forest Survey. Experimental repeat photography using a large-format digital camera began, and immediately offered solid results. At this time known as the Rocky Mountain Repeat Photography Project (RMRPP), the following years saw fieldwork continue in various areas with increasingly diverse survey collections. Formal partners joined the work, including the Alberta Forest Protection Branch and the Alberta Conservation Association. In 2003 the MLP relocated to the University of Victoria (UVic) in BC and remains there to the present.

The digital curation of this vast collection of images is a significant focus of the MLP. At present, images are maintained as digital copies of full resolution scans from LAC, and are housed securely on University of Victoria servers. In the coming months the collection will become available online for research and public viewing through the new MLP database, with more photos being added as they are scanned and resurveyed. This database is intended as a long-term digital repository. The partnership between MLP and LAC has ensured the digitization of many collections and thus the long-term preservation of photos from glass plates otherwise continuing to degrade with time.

Since 1996, MLP has repeated over 5,000 photographs from 18 historical surveying crews and at least 30 surveys spanning nearly 50 years. This thesis joins several others in documenting and evaluating protected area landscape change through the repeat photography of the MLP. Previous works have focused primarily on Jasper (Rhemtulla, 1999; Smith, 2004;

Webb, 2003), Waterton Lakes (Levesque, 2005; Shaw, 2009; Watt-Gremm, 2007), and Kootenay (Roush, 2009) National Parks.

Many studies have used MLP photo pairs in a retrospective manner. Original photos represent certain aspects of historic points in time and repeating them allows a comparison looking back (Tinkler, 2013). However, the photo pairs present a significant opportunity for land managers in AB and BC, which is becoming increasingly realized. While on-the-ground ecological studies can offer insights about past landscapes and ecosystems, repeat photography can give both broad strokes of vegetation cover and illuminate timelines for disturbance. Fire managers in Alberta have found the photos to be very useful for prescribed burn and fire management planning.

3.2.1.2 Data Processing and Fieldwork

Just as the original photo-topographic surveys required significant logistical coordination and planning, repeat photography today is far from a casual endeavour. Behind each historic photograph was a surveyor, assisting crew, system of technology and months of preparation and post-processing work. Replacing surveyors with researchers, this remains the case today. The seeming simplicity of a photograph easily shields the unsuspecting viewer from the many steps and efforts required to bring that product into being. The following section describes the steps and procedures involved in the repeat photographic fieldwork of this study.

3.2.1.2.1 Pre and Post-Fieldwork Image Computer Processing

Pre-field Image Processing. Pre-field lab processing of digital image files involved several stages typical to the Mountain Legacy Project's lab workflow. Before any work was done, the original scanned images were saved in a 'raw' version. Any changes subsequently made were saved as separate TIFF files. Next, original images were cropped to exclude the black border from the film negative strip or plate edge. They were then adjusted for contrast when necessary for quality, and saved as 'original masters'. A grid was overlayed for field purposes, and a copy was printed to be taken out to the station. These adjustments were made in Adobe Photoshop.

Some images used in this study (notably those of the Nidd 1944 Willmore east boundary survey) initially came to MLP in inadequate resolution. A subsequent order to LAC was placed in late 2012, and the full resolution scans have been incorporated into figures in this document. In cases of this kind, the low-quality images generally stay as JPEGs, are not used for MLP fieldwork and cannot be deemed 'masters'. This study presented extenuating circumstances, needing the images for the nearing summer of fieldwork. While of a lower resolution, the jpegs proved sufficient for repeating in the field.

Post-field Image Processing. Upon return to the lab following fieldwork in late August 2012, repeat images were converted from Hasselblad-native 3FR files to 16-bit TIFF files. Using the Mountain Legacy Registration Tool, each repeat image was individually overlayed in the computer program Hugin using manually selected corresponding control points in each image. With each new control point, greater precision is possible to match the images (Boyer *et al*., 2010). The repeat images were cropped, resized and rotated to overlay the original images.

In most cases, the resolution of original images was better (with exception the Nidd 1944 original JPEGs). In these cases, the original was the image to be reduced in scale to match the repeat image. The registration (alignment) allows for a precise crop of the repeat image to match the original image's field of view. The repeat images have a much larger field of view due to lens differences.

Following these procedures, repeat photo pairs were stored within the larger MLP digital library. A selection of the 2012 photos were used in photo-elicitation activities for this study (Table 5 below). As mentioned above, the Nidd 1944 survey required small adjustments to specific aspects this lab workflow, as only JPEGs were available for the 2012 field season. The details of preparing this collection for fieldwork follows in 3.2.1.2.2.

The Process of Selecting Photo Pairs for Analysis. The selection of photo pairs for analysis began by evaluating the relevance of individual surveys. Surveys were selected based on image quality and geographical coverage. Photographs within a given survey were sorted first with broad strokes; all available photographs from a survey were sorted based on which had available repeats, as of fall 2012. From this, photographs were removed for poor quality or having little landscape visible. For instance, images in panoramas showing only foreground and midground scree around a photo station would offer little information for landscape-scale change over time. Photos were not removed based on having a particular landscape feature or change more/less visible, as this would bias the selection and subsequent focus group discussion based on what participants saw in the photo pairs. Reflecting on my sampling design throughout, I remained cognizant of the fact that the selection of the original set of images could greatly influence the variety and number of similarities and differences noted by participants and during my own image analysis (Tinkler, 2013).

After a list had been produced of these remaining photo pairs (58), a random sample was selected from the Willmore photos. A random number generator was used to produce 6 numbers ranging from one to 58. Eight stations and a total of 13 photos were selected for WWP, offering six individual photos and seven photos split four to three between two panoramas. Panoramas were used for WWP because the particular sets of photos at those stations offered a much improved visualization of the surrounding landscape when combined. In particular, when viewed as a panorama, the wide valleys and vast extent of the Willmore landscape could be more effectively conveyed. While both MRPP and WWP are large protected areas, the latter has several valleys that are particularly wide and long, with notable flat expanses of open grassland and forest cover between the valley walls. These include the Sheep Creek, Jackpine and Smoky River valleys.

For MRPP, the number of available, high quality photo pairs was more limited. Therefore, to ensure effective use in photo-elicitation activities, the final six photo pairs were not selected randomly. Using an even spread of three stations, two photos were used from each. Photos were chosen based on quality and how well they showed the surrounding landscape.

For the purposes of photo-elicitation, photo pairs needed to convey a reasonable cross-section of the vegetated landscapes in each park. Changes seen in the images (whether of large or small extent) served to invite discussion about different park areas and long-term changes occurring therein. The exception was the Robson Glacier, as this showed change apart from vegetation. The images can show very significant changes in some cases such as recent wildfires, upward movement of the treeline ecotone into the subalpine, and meadow encroachment by

forest. In others, changes seen appear negligible without further surveys at the site. Both of these extremes offer insight into the current circumstances in the parks. Examples of photo pairs used in discussion will be given in Chapter Four. Table 5 below serves as a comprehensive list of all photos analyzed. The majority of these photo pairs are discussed in Chapter Four, and will appear as figures in-text. Any exceptions are located in Appendix F.

Photos Analyzed. All photos used for MRPP were based on Wheeler's 1911 Mount Robson Survey, and include six pairs of historical and repeat images. The park was also covered in part by photographs completed in the 1922 Jasper-Robson Survey from the 1913-1924 Interprovincial Boundary Survey completed by A.O. Wheeler and R.W. Cautley. Photographs from this survey were not repeated. It was decided that for effective photo-elicitation activities, the 1911 Mount Robson Survey would offer sufficient representation of the park landscape. Please refer to Wheeler's original 1911 map for station locations, elevations, and local topography (Appendix F Figure 70).

For WWP, photo pairs were used from three surveys; Wheeler and Cautley's 1913-1924 Interprovincial Boundary Survey (IPBS), Nidd's 1944 eastern Willmore survey, and Lambart's 1927 Jasper North Boundary Survey. Please refer to Figures 56 and 62 in 4.2 and 4.5 respectively for detailed topographic maps of station locations from the IPBS. See Table 3 5 below for all repeat photo pairs used.

The photos were qualitatively analyzed in two ways. First, I completed a comparative analysis on each photo pair to evaluate for long-term landscape changes. Following post-fieldwork processing, this was done visually using digital master (i.e. full resolution) copies of the images using Photoshop software. Participants also analyzed the photo pairs visually during focus groups and interviews. This interactive analysis and discussion was through photo-elicitation, which is described in more detail in 3.2.2.

Table 5: Repeat photo pairs used

Mount Robson Provincial Park					
Survey	Station	Original	Date	Repeat	Date
Wheeler 1911 Mount Robson Survey	Ptarmigan Peak #1	WHE1911_6-11	Aug. 10 1911	MLP2011_6-11	Aug. 25 2011
		WHE1911_7-11	Aug. 10 1911	MLP2011_7-11	Aug. 25 2011
	Moose Lake West #1 (Pano.)	WHE1911_2-16	Aug. 24 1911	MLP2012_2-16	Aug. 15 2012
		WHE1911_3-16	Aug. 24 1911	MLP2012_3-16	Aug. 15 2012
		WHE1911_4-16	Aug. 24 1911	MLP2012_4-16	Aug. 15 2012
	Moose Lake West #2	WHE1911_9-16	Aug. 24 1911	MLP2012_9-16	Aug. 15 2012
		WHE1911_11-16	Aug. 24 1911	MLP2012_11-16	Aug. 15 2012
	Yellowhead Pass	WHE1911_1-19	Sept. 2 1911	MLP2012_1-19	Aug. 4 2012
		WHE1911_8-19	Sept. 2 1911	MLP2012_8-19	Aug. 4 2012
Willmore Wilderness Park					
Wheeler and Cautley 1923-1924 Interprov-incial Boundary	245. Holmes North	WHE1923_W23-185	1923	MLP2007_W23-185	Aug. 6 2007
	247. Spider	WHE1923_W23-202	1923	MLP2007_W23-202	Aug. 6 2007
	251. Courier Mtn.	WHE1923_W23-237	1923	MLP2007_W23-237	Aug. 14 2007
	292. Sheep Creek South	WHE1924_30-A-O-W-1924-X	1924	MLP2011_30-A-O-W-1924-X	Aug. 19 2011

Survey	(Pano.)	WHE1924_31-A-O-W-1924-X	1924	MLP2011_31-A-O-W-1924-X	Aug. 19 2011
		WHE1924_32-A-O-W-1924-X	1924	MLP2011_32-A-O-W-1924-X	Aug. 19 2011
		WHE1924_33-A-O-W-1924-X	1924	MLP2011_33-A-O-W-1924-X	Aug. 19 2011
Lambart 1927 Jasper North Boundary Survey	51.	LAM1927_L27-390	1927	MLP2007_L27-390 2	Aug. 16 2007
Nidd 1944 Eastern Willmore Survey	11.	Nidd1944 33	1944	MLP2012_N44-33	July 29 2012
	15. (Pano.)	Nidd1944 51	1944	MLP2012_N44-51	July 29 2012
		Nidd1944 53	1944	MLP2012_N44-53	July 29 2012
		Nidd1944 55	1944	MLP2012_N44-55	July 29 2012
	20.	Nidd1944_86	1944	MLP2012_N44-86	July 28 2012

Note: not all original captures dates are known beyond the year; if known this information has been added to the table above

The Integration of Photo Pairs in the Findings. In Chapter Four, photo pairs are described based on their relevance to particular coded themes. While not all of the planned images were discussed in focus groups and interviews due to time constraints, the researcher analyzed all photo pairs. All photo pairs used in this study are included in Table 5, however only those photos that yielded insights and results most relevant to study findings are discussed in Chapter Four. Findings discussed are from researcher observations and/or from participants of the focus groups, and the individual interviews.

3.2.1.2.2 Locating Historic Nidd Survey Photos

The Nidd 1944 Willmore Survey required extensive lab processing and detective work upon arrival as JPEGs. The collection was of varying quality and nearly all of the images had yet to be placed geographically. Sometimes, a unique peak or ridgeline can provide strong clues to locate photo stations. In this case, the topography in the images offered little consolation, as it exemplified the upper foothills of the Rocky Mountains, and could be from a variety of areas, spanning hundreds of kilometers. With the invaluable knowledge of Rob Watt (retired park warden, Waterton Lakes National Park), we began to connect the images to more precise locations on the Alberta landscape. Soon, the northeastern Willmore was decidedly where Nidd had focused his 1944 work.

Various tools aided our efforts of locating historic images in the lab, including topographic maps and Google Earth. Digital Elevation Models (DEMs) can also be helpful, but were not used in this case. While time-intensive, Google Earth was the primary tool used and enabled incredibly accurate (within a few hundred meters) station locating to be done remotely from the lab.

When scanning the region for potential station locations in Google Earth, geological features were most useful, as vegetation patterns had potential to change more dramatically over time. There still remain photographs in the collection that may be from 1945, and have not been matched with physical locations. For images that could not be located in the lab, local residents have at times played an important role. While correct assessments are not guaranteed (Boyer *et*

al., 2010), local knowledge of the mountains - particularly that of helicopter pilots - aided the 2012 field crew in locating several photo stations. The field crew would also discover a few photo locations while we were flying to previously located stations; having the unidentified photos on hand as printed copies allowed for this.

3.2.1.2.3 Overview of Repeat Photography Fieldwork

This chapter will provide a detailed description of repeat photographic fieldwork through the MLP. It begins with a summary of past field crews involved in the collections used in this study. Subsequently, it offers an overview of the common steps involved and typical events of fieldwork. The sub-chapters (3.2.1.2.3.1 and 3.2.1.2.3.2) will discuss in detail the repeat photographic fieldwork efforts by my MLP crewmembers and myself in 2011 and 2012. Divided by park, significant moments and insights during fieldwork will be described.

Photo Pairs from Multiple Field Seasons. While the MLP fieldwork of 2012 is the focus in this paper, the repeat photo pairs used in this study are the result of several years of fieldwork and field crews of MLP. Before offering an overview of repeat photography in its fieldwork stages, it is important to acknowledge and describe the great efforts of past field crews having contributed photos now used in this study. Overall, this includes fieldwork of 2007, 2011 and 2012.

2007. In 2007, the MLP field crew consisted of Mark Edwards, Mandy Annand, and Ian Gibson. The photo pairs from Lambart's 1927 Jasper North Boundary Survey Station 51 used here for the WWP case study were completed on July 16, 2007. The photo pairs from Wheeler and Cautley's Interprovincial Boundary Survey (1923 season) were taken over several days. The crew completed Station 245 Holmes North and 247 Spider on August 6, 2007. Station 251 Courier Mountain was completed on August 14, 2007.

2011. In 2011, the MLP field crew was more condensed, and was made up of Stuart Higgs and Ellie Stephenson. Six photos completed in that season have been used in this study. Four of which are from Wheeler and Cautley's 1923-1924 Interprovincial Boundary Survey, which made up the Sheep Creek South panorama showcasing a valley in the western reaches of WWP. An extended field crew of Stuart Higgs and Ellie Stephenson accompanied by Bruce Mayer and Bill Tinge completed this station on August 19, 2011.

The remaining two photos of 2011 used in this study were also completed by an extended field crew at the closing of the field season. This crew consisted of Stuart Higgs, Ellie Stephenson, Chris Gat, Claire Higgs and myself. The photos taken in MRPP were from Wheeler's 1911 Mount Robson Survey, Ptarmigan Peak #1 Station capturing Mount Robson and the Robson Glacier. We completed this station on August 26, 2011. The details of this fieldwork are discussed in greater detail in 3.2.1.2.3.1.



Figure 33: The extended MLP field crew for the Mount Robson Provincial Park expedition before heading up the Berg Lake Trail, late August 2011. From Left to right, Stuart Higgs, Chris Gat, myself, Claire Higgs and Ellie Stephenson. (Photo credit: camera auto-timer)

2012. In 2012, the MLP field crew was a trio of Heike Lettrari, Mary Sanseverino and myself. I led the 2012 field season. Eric Higgs joined us for one week, and participated in the memorable bushwhacking leading to Wheeler's Yellowhead Pass Station, used in this study. Rob Watt also joined for a few days in Clearwater, Alberta for survey photos not used in this study. Nine photos used in this study were taken in the 2012 field season.

For WWP, all photos were repeats of Nidd's 1944 survey of the eastern Willmore. Five photos from three stations captured a large area. Three photos were used as a south-facing panorama from station 15, overlooking the Sulphur River Valley and Eagle's Nest Pass. The remaining four photos taken in 2012 and used in this study were from Wheeler's 1911 Mount Robson Survey, from two stations. These included Moose Lake West #1 and Yellowhead Pass. The former offers views of a u-shaped valley housing an offshoot from Resplendent Creek, which drains to the Moose River. Photos from Yellowhead Pass captured the changing Yellowhead Valley from the provincial border.

Field Procedures. Field procedures for repeating a historic image include various steps. First, the original camera location must be found. For the 2012 field crew, this experience ranged from an efficient hike to a notable ridge-top cairn, to an hour long crisscross walk, trying to find the exact spot where the original surveyor(s) once stood. Sometimes survey cairns are surrounded by

recreational hikers' cairns, marking their summiting successes; sometimes cairns have been destroyed over time and can't be found at all. The latter was the case most often in both WWP and MRPP, as backcountry hiking is less popular than in other regions of the Rocky Mountains. In these cases, using every keen eye available on the field crew was critical for us to find the most accurate position for the tripod.



Figure 34: Survey cairns can be extremely helpful in locating a photo station. Example of a prominent survey cairn in WWP, July 2012 (Photo credit: Heike Lettrari, 2012)

Once the general location was reached, we used the principle of parallax to pinpoint a very precise location for the tripod. This was done by aligning assumedly persistent foreground and background features, and then moving forward or backward to bring other features into view to match the alignment shown in the historic image (Boyer *et al*., 2010; Malde, 1973).

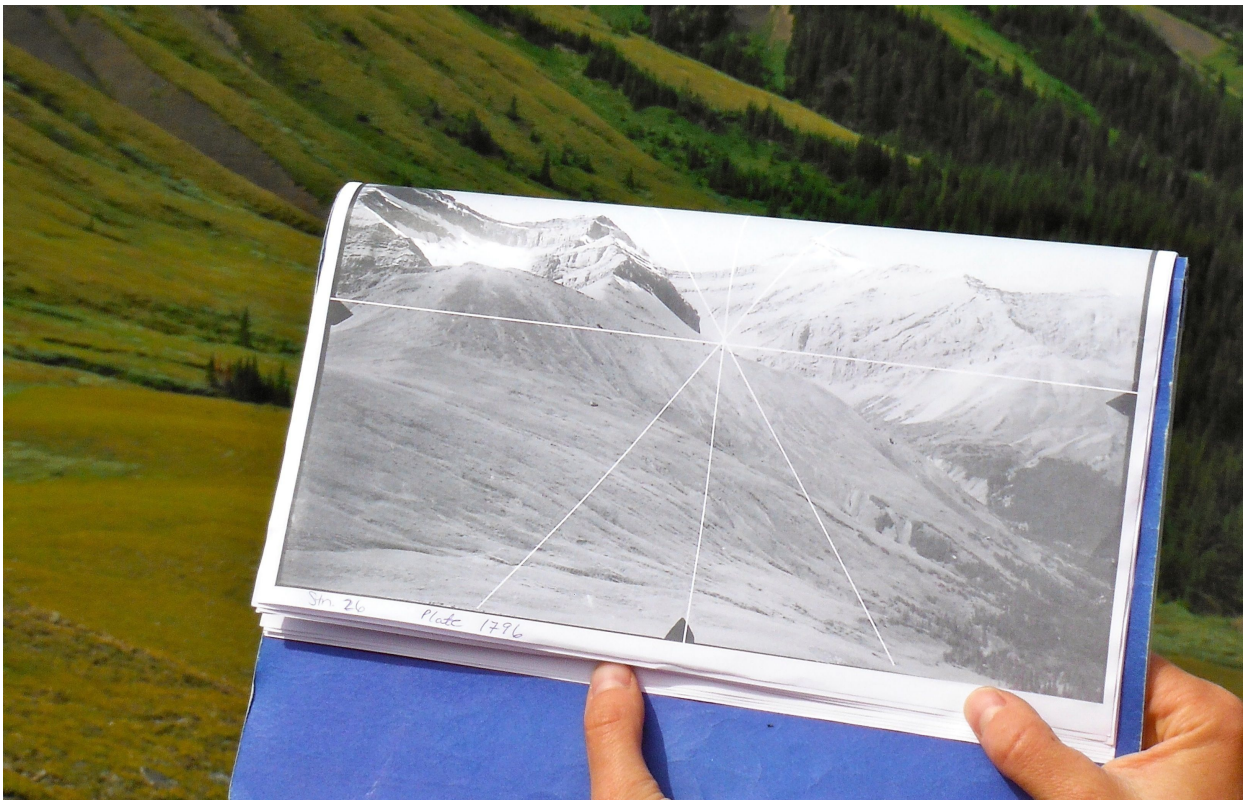

Figure 35: Historic image with cross-hairs is used to locate camera station and align tripod (Photo credit: Jenna Falk, 2012)

Once the tripod location was determined, the historic image(s) for that station (with lab-added cross hairs) aided in adjusting to the precise height, camera tilt, perspective (portrait or landscape) and azimuth (if available) (Webb *et al*., 2010). Having field prints of original images of the best quality was necessary for effective alignment, because with precise rephotography, the devil is in the details.

If the historic station location was blocked by vegetation, destroyed by rockfall or erosion, we would set up the camera as close as possible to the original location, and was noted as such in the fieldnotes. This was the case for several stations during the 2012 field season. In both parks this was due to ingrowth of the forest, making it impossible for us to position the tripod with exact accuracy due to trees having grown up in the way. While historic survey crews would cut down any offending foliage, MLP crews do not carry tools for this purpose. In some instances, having crewmembers hold down branches is enough.



Figure 36: Mary Sanseverino holds down a small tree while I line up a photo (Photo credit: Heike Lettrari, 2012)

When repeating the historical photographs in summer 2012, there were several challenges inherent to the method that necessitated attention. Fagre and McKeon (2010) and Pickard (2002) discuss some widespread challenges when repeating historic photographs in northern mountainous regions. There are various conditions they found important to account for, which were highly relevant to the repeat photography for this study. These conditions include sun angles and contrast reduction, season, haze, and reflective surfaces (snow, water, ice) (Fagre and McKeon, 2010). Pickard (2002) emphasized the dangers of interpretation subjectivity and bias, incomplete site coverage and misleading characteristics in photographs.

To accommodate the above limitations largely inherent to outdoor photography, we tried to repeat images at times of day when dramatic lighting issues were minimized, and completed our photography in the late summer months, which corresponds well to the seasonality and dates of the original images. The majority of field sites are simply inaccessible until mid to late summer, which left only a small window for fieldwork. It is probable that the historic surveyors experienced similar climatic limitations, even when exact dates of capture of most images are unavailable for us to account for.

Exceptions existed in the daily timing of photography largely due to logistics. Helicopter use in WWP was due to the generous support of AB ESRD, and as such was subject to quick change based on fire occurrence and hazard throughout the province. Daily weather (notably rain and wind) had to be within acceptable ranges for both safety and usefulness for photography.



Figure 37: Large storm moving into eastern Willmore, August 2012 (Photo credit: Jenna Falk, 2012)

As mountain weather is notoriously quick to change, we became accustomed to early morning starts. This often guaranteed at least a few hours before winds increased and convective storms developed. Nevertheless, photographing stations at 360 degrees in the morning left us with difficult sun angles and sharp contrasts for images looking east.



Figure 38: Jenna and Mary setting up WWP station, July 29, 2012; morning sun angles led to difficult sun angles for photography (Photo credit: Heike Lettrari, 2012)

With each photo station, a detailed set of field notes was taken using the Mountain Legacy template. Measurements of current weather conditions, GPS coordinates and station narrative were included in fieldnotes. The following two sections will offer a brief description of the field experiences in WWP and MRPP. Excerpts from fieldnotes and location photos (photos taken to show the general site and tripod's exact location) will punctuate the discussion.



Figure 39: Heike completes fieldnotes and takes environmental measurements at a photo station, July 2012 (Photo credit: Jenna Falk, 2012)

3.2.1.2.3.1 Fieldwork in MRPP

Ptarmigan Peak #1: August 25, 2011. The 2011 field efforts in MRPP were focused on the repeating of just one - very important - station. Ptarmigan Peak #1 sits along the continental divide close to Roger's Pass. With Jasper National Park to the northeast, this station offers a spectacular panoramic view of the Robson Glacier, Mount Robson, Berg Lake and the Valley of a Thousand Falls (which the Berg Lake Trail follows), and Adolphus Lake on the Alberta side. A brief narrative of our field experience for this station follows.

After a night of torrential rain and a morning check-in with the rangers at the Visitors Centre, our hiking party of five started up the trail. Making camp at Emperor Falls by the first evening and Robson Pass by the second, on the third day we set off before sunrise to Snowbird Pass. Beyond all expectations, we were greeted on the 25th to a cloud-free peak on Mount Robson, following several days of continuous cloud cover. After reaching the top of Snowbird Pass, it became apparent that the approach to Lynx Station would be too hazardous, so we focused on Ptarmigan Peak #1 instead. Following Tatei Ridge for several km, we reached the station by shortly after 4:00 pm, located at the highest southwestern point on the ridge.

The prominent cairn helped us locate the exact place for the tripod. While the late afternoon sun left Berg Lake in a sharp reflection, reducing the quality of the photo for comparison, the photos of Mount Robson and Robson Glacier offered little difficulty from sun angles and turned out very well. Finishing by 6:15 pm we lingered only a short while, knowing the long return hike to Robson Pass and the dangers of hiking in the dark. We descended directly to the meadow complex instead of retracing our path along the ridge, as this was much more direct and less demanding - especially when heading downslope.



Figure 40: 2011 field crew at Ptarmigan Peak #1 Station, with the Robson Glacier in the background (left to right) Myself, Clare, Ellie and Stuart (Photo Credit: Chris Gat, 2011)

2012 Field Efforts. The 2012 fieldwork efforts in MRPP were divided between two stays in the park. Beginning on August 2nd, the team travelled to the Robson Valley and put up camp at the Robson River Campground. After touching base with parks managers and preparing field materials, we were joined by Eric Higgs and the four of us hiked to Yellowhead Pass Station on August 4th. After a 45-minute drive to the bottom of Yellowhead Trail, we began at 10:15 am. The trail was well established, and once we needed to diverge we saw over an hour bushwhacking, including plenty of slide alder. It was a sunny and warm day with persistent mosquitoes.

After a few hours of traversing the ridge - now densely forested - we reached a rock outcrop with a small but unmistakable cairn. Tree cover had increased considerably since Wheeler's 1911 visit, as was apparent by the historic survey photos. Luckily, the camera station was in a location that still allowed us to set up the tripod with reasonable accuracy to the historic position. We began our work at 3:20 pm and were finished in an hour. Due to the incredible ingrowth, some photos were completely blocked. We could see significant changes in the valley below, with more development (railway, highway, bridge) and a denser forest cover.



Figure 41: (left to right) Myself and Mary lining up a photo, while Heike records fieldnotes and takes environmental readings at Yellowhead Pass Station (Photo Credit: Eric Higgs, 2012)

Following our hike to the pass, we left for a week of work in Alberta and returned on August 14th. Finishing off the 2012 field season with our longest day, we hiked to the Moose Lake West #1 and #2 stations. After gathering some local advice around the best routes to ascend and traverse the ridgeline, we set off early on the 15th from a gravel pit off of the Yellowhead Highway. It was a grueling few hours up the steep forests slopes of the valley, and we were

relieved to reach the ridgetop. After some steep unvegetated slopes leaving us scrambling and banging knees, we reached the top of the next ridge. We traversed it for about 2 km and were surrounded by incredible views on either side. The stations are found in the Rainbow Range close to Red Pass, as depicted by the iron rich rocks. With a few false peaks and other cairns to get our hopes up, nearly eight hours after we began we saw the right spot, accompanied by a giant cairn.

Beginning at 4:30 pm, we finished the station in under an hour after capturing some breathtaking photos of a subalpine meadow next to a wide u-shaped valley with a small stream offshoot that connects to Resplendent Creek and the Moose River. The light was perfect for the direction of our shots, which were predominantly facing north and east. We were on our way to the second station of the day - Moose Lake West #2 - by just after 5:00 pm. This worked out well, as it was on the way down from the previous station.

We were thrilled to find only a few hundred meters distance between the two stations, which saved us critical time in a day that had already become much longer than anticipated. Similar to our initial ascent up the main ridge, it was an extremely rocky and loose descent to the second station. We suspected that some notable disturbance had happened, as the foreground would simply not line up for us. Surrounded by massive granite boulders, it seemed probable that some erosion and rockfall had sent several large chunks of boulder down the ridge. We set up with our best estimation of the original location, and were dismayed to find most of the photos facing south and west, directly into the early evening sun. The lighting conditions were not in our favour at this station, and if we had been able to return at an earlier time of day, the photos would have been much improved.



Figure 42: (left to right) Mary and I lining up a photo at Moose Lake West #2 Station, with Moose Lake in the background (Photo Credit: Heike Lettrari, 2012)

The hike down was much more direct than our route up. Although we had first suggested taking the narrow and steep route up following the stream gully, local residents and park rangers emphasized the difficulty and dense vegetation there. So instead we had taken a longer, wider approach over the ridgeline from the east. After that route had proven to be quite disconcerting due to unstable slopes, we decided to take the gully down. While it was only 3 km to the highway as the crow flies, it took us nearly five hours to reach the road. We found ourselves in dense forest and on several occasions upon skirting the gully too far down, in dense devil's club and shrub cover. During this section we lost our Spot device, ripped right off my back by the vegetation we were pushing through beside the stream.

That eventful day served as the final day of our field season. In the morning, following a visit to say goodbye to park managers and local residents we had met, we headed for home happy, sore and exhausted. As far as I know, the Spot is still up that gully.

3.2.1.2.3.2 Fieldwork in WWP

2012 Field Efforts. The following section describes the 2012 fieldwork in WWP. Particular highlights will be mentioned, however the basis of this description is to illustrate the field experiences relating to the photo pairs being used in this study. Therefore, specific emphasis will be placed on the Nidd stations 11, 15, and 20. All of which are located in the northeastern Willmore.



Figure 43: Heike and I taking a snack break close to the Rock Lake station (Photo Credit: Mary Sanseverino)

One of the first stations we completed in WWP was Station 14 on July 20. Following a long day hike in via the Mountain Trail from Rock Lake Provincial Park, we crossed the Wildhay River and cut up a steep forested slope. Based on Google Earth imagery, we had some hope that the summit would not be overgrown. This was not the case, and no photos were readily useable for comparison. Figure 46 below shows Mary and I trying to line up the tripod through a dense forest stand. I took a few scenic photos (Figure 47) from nearby vantage points, to give an idea of what the valley now looks like.



Figure 44: MLP Director Eric Higgs joins us in the field in Clearwater, Alberta (left to right: the author, Mary Sanseverino, Eric Higgs, pilot Allison Smit) (Photo credit: Heike Lettrari, 2012)


Figure 45: (left to right) Myself and Mary trying to line up the photo through a dense forest stand (Photo Credit: Heike Lettrari, 2012)



Figure 46: Scenic photo taken from near Station 17, looking east along the Wildhay River Valley (Photo Credit: Jenna Falk, 2012)

While hiking enabled an invaluable feel for the eastern landscapes in the park, as a team of three we couldn't feasibly do all of the stations by foot without horses to help carry supplies. Alternatively, thanks to AB ESRD we were fortunate enough to have helicopter support for many stations in WWP. This was the case for the three stations used in this study. On July 28, we had helicopter support and reached Station 20 shortly before 9:00 am. Landing in the same spot as we had for repeating Station 21 the day before, we took off hiking in the opposite direction towards a toppled over cairn on the easternmost side of the ridge. The tripod easily fit on top of it, which was convenient. It was quite a brisk day on the ridge, and we bundled up as we took the photos.

On July 29, we reached Station 11 by late morning. Our helicopter pilot, Allison, dropped us off at a small leveled section of an alpine meadow covering the slope of the ridge. We hiked a short distance up the ridge and began to set up at 10:00 am. We found no obvious cairn at the site, but the coordinates determined through Google Earth were accurate and the views were a clear match to the historic images. The station went smoothly and took us only a half hour to complete. Large boulders near our tripod location were adorned with bright green and black lichens.

Upon completing Station 11, Allison picked us up and we jumped over a few ridges to Station 15. Putting our hover exit training to use, we were dropped on the ridgeline and made our way over to the station. A large cairn aided in the locating of the station. The station went very smoothly and we were impressed by the technique of the historic Nidd images. Significant cloud development was beginning in the distance. The late morning was also bringing haze in the

southeast and our first image showed this. For both the danger of high energy convective storms and for the impact of haze on image quality, we began our field days as early as possible. Both of those complications were less of a concern in the morning.

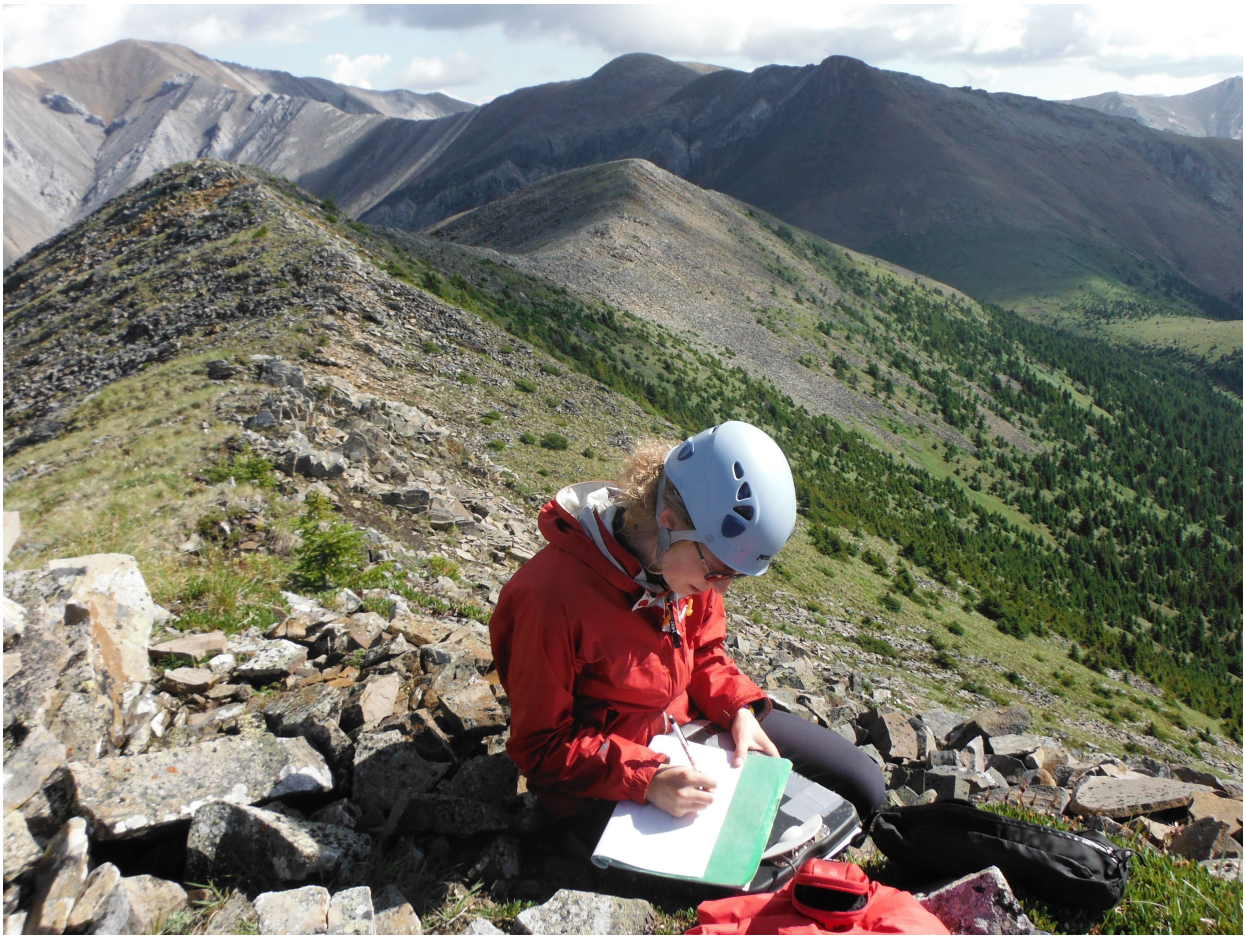

Figure 47: Heike takes fieldnotes at Station 15 (Photo Credit: Jenna Falk, 2012)

3.2.2 Photo Elicitation

In this study, photo pairs can be characterized as supporting a "specified generalization"; "photos are specific instances of the general argument" (Becker, 2002:5). Becker's argument is that while photographs may appear to represent very specific instances, they have the ability to support and demonstrate larger truths or circumstances. Here, photo pairs were used in a supportive capacity with photo-elicitation activities. As such, the photos were presented as evidence to answer a research question (Rose, 2006). In this study, the primary research question is "how do long-term landscape changes influence conservation and restoration objectives in remote mountain ecosystems?" This also incorporates subsidiary questions: "what are the inherent challenges in managing (and restoring) remote ecosystems?"; and "how could managers of remote ecosystems best approach these issues in the face of rapid environmental change?" Bringing visual examples of changes occurring in these parks supported and encouraged discussion on what long-term ecological change means for the work of parks management.

Photo-elicitation (photo-interview) techniques are an integral part of this project, providing a methodological bridge between the other three methods. The focus groups, as discussed at length in 3.2.3, were centered around photo-elicitation, which is the use of photographs to drive discussion and ignite thoughts, ideas and perspectives on a given topic (Harper, 2002). Without giving precedence to one discipline or another, the photo pairs brought participants together through illustrative examples of changes occurring in their respective parks. Utilizing photo-elicitation to weave together repeat photography and management perspectives, the group discussions shed light on the significance and implications of observable landscape changes in remote areas of these two protected areas.

The photographs also act as a means of communication between the researcher and participants (Clark-Ibanez, 2004). They are a bridge for communication, reducing tension by focusing away from any particular participant, while at the same time building rapport and trust through collaboratively searching for meaning in the photographs (Harper, 2002). While I had photographed the majority of repeat photographs being discussed, the participants held more knowledge of the cultural and ecological history of the captured landscapes. This knowledge differential can serve to empower participants and increase their comfort (Tinkler, 2013). At the same time, photographs gave participants a flexible outlet to express aspects of their lives and points of view (Clark-Ibanez, 2004; Tinkler, 2013), and can ignite multiple meanings and anecdotal memories otherwise not brought up in a solely verbal interview or focus group (Schwartz, 1989; Tinkler, 2013). The same photograph can bring up contrasting opinions between participants as well (Clark-Ibanez, 2004).

Bringing photographs of long-term landscape change to the table, as the researcher and facilitator, I offered examples of changes that I was curious about. I wanted to know what they meant to participants personally, and what the implications were for their work as lands managers in a protected area. Did they mean anything at all? Had these changes been noticed before? Participants' previous knowledge of landscape changes, and thoughts on what these changes meant to their work, were illustrated through photo-elicitation. The comments that the photo pairs incited closely tied into the primary research questions of this study.

Photo-elicitation During Focus Groups. The incorporation of the photographs into the focus groups follows. Prior to each focus group, a selection of image pairs were sent to the participants to give them time to study the images in advance. For consistency, the same image sets were sent to all participants. Photos were distributed in both a digital and hardcopy form, with electronic versions being the default option. When electronic copies were inconvenient or inaccessible to participants, hard copies were sent on regular 8.5x11" matte photo paper. Regardless of the medium, the photo pairs were sent to the participants a minimum of 1 week prior to their respective focus group session. This gave the opportunity for participants to feel less pressure once in their focus group by adding familiarity with the material being discussed and to help the focus group discussions flow better.

It was important to have physical copies of the image pairs present in the focus groups. Having copies on-hand exemplifies what Gillian Rose calls the "materiality of seeing" (Tinkler, 2013:16). As Samuels describes, "knowing and thinking are not merely mental processes; feeling (holding the pictures) and seeing (looking at the pictures) are intimately connected to remembering, learning, and expressing" (Samuels, 2007:216-217).

During each focus group, laminated copies of image pairs were distributed to the participants for interactive, hands-on evaluation through photo-elicitation. These laminated copies varied in size from letter size to poster size, and represented a subset of the images having been distributed to participants prior to focus groups meeting. Therefore, the photographs remained familiar to the participants, having been sent ahead of time. While printing expense played a role, it was preferential to print a strictly limited number of photographs. This enabled the focus group and interview participants to discuss each photo pair in greater depth, as this would hopefully yield detailed perspectives and more valuable data.

In the group setting the photo pairs were presented in a large hand-held format. Participants were able to draw with dry-erase markers on the images directly, to show others particular areas of interest or details they found noteworthy. This approach enabled interactive marking and note making on the images themselves, without permanently marking the photographs. This allowed for the reuse of materials within and beyond the study. For the two focus groups discussing Willmore in particular, having reusable study materials was quite practical. Participants were encouraged to engage in this activity, whether in a role of commentary for other participants' mark-ups, or actively drawing on the photographs themselves.

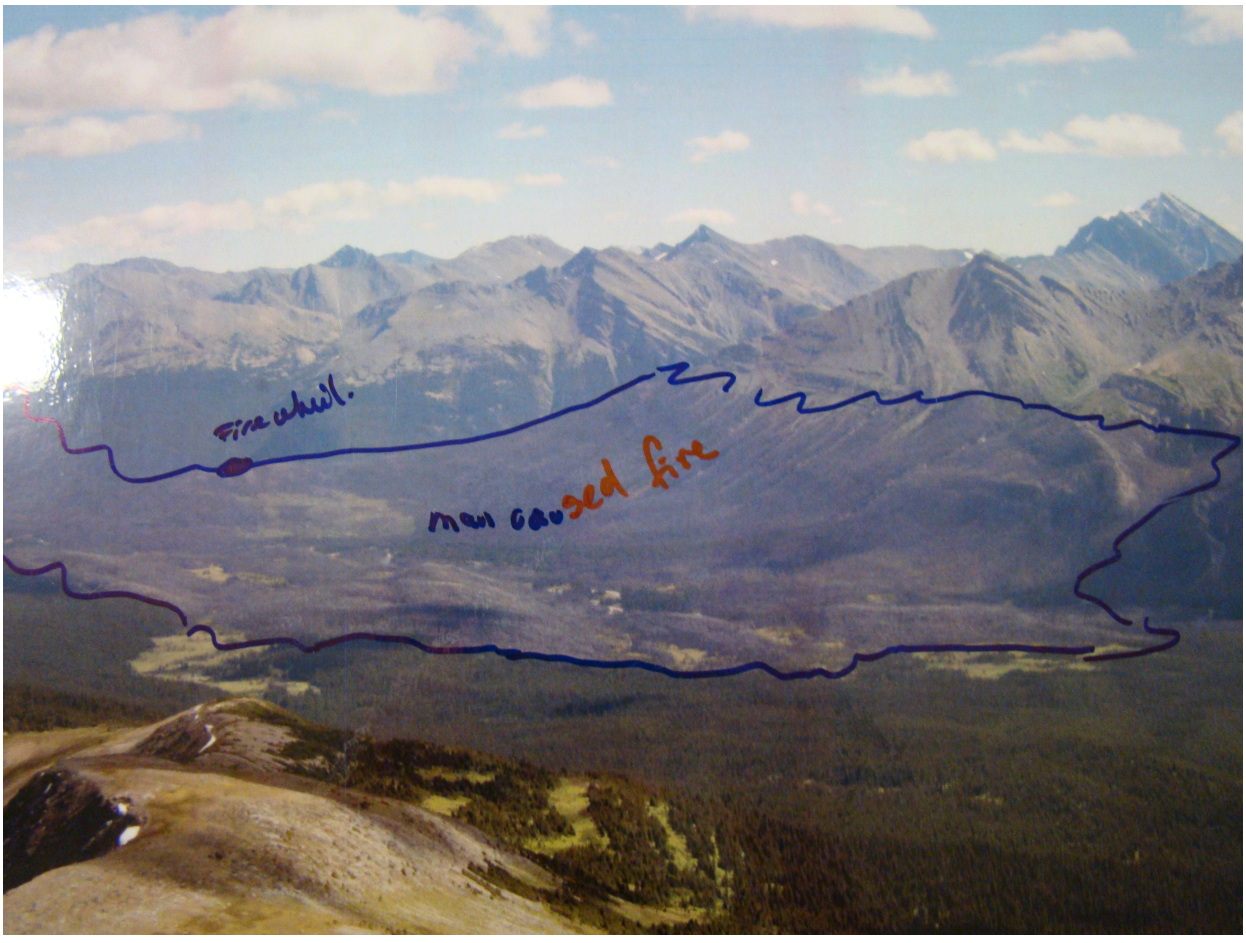

Figure 48: Example of participant annotations on laminated photo pairs (Photo credit: Jenna Falk, 2012)

Photograph annotations were recorded for incorporation into later analysis. Photos were taken of the laminated pairs following each focus group, and with as much specificity as possible, annotations were colour-coded based on participant. While this system was explained early on with the intention of keeping one marker to each participant, some participants moved around during the discussion and inevitably switched or shared markers. Detailed notes were made throughout discussion, further attributing specific annotations with individual participants. Annotations proved useful in analysis for their ability to provide an explicit geographic reference to match with the landscape changes being described by participants.

Overall, the repeat photo pairs served to pull the local landscapes into the group discussions in a vibrant, meaningful way. Participants became very engaged with the laminated photo pairs and each other during discussion. While annotations provided a tangible outlet for participant expression during the focus groups, they offered only minimal direct benefit to subsequent analysis. The invaluable benefit of the photo pairs was through the rich conversation and discussion they elicited.

Beyond Photo Elicitation. This project's use of repeat photo pairs is but two of many potential uses. Here, the photos are used as tools for photo-elicitation and to examine long-term landscape change in remote ecosystems. Beyond these approaches, these images could be used in many projects and initiatives ranging from public education and outreach to ecological or cultural research. One of the most recent initiatives has been to begin the process of making repeat photo pairs available for public viewing in the Mount Robson Visitor Centre. 10 photo pairs were described in detail. The technical details (photographers, dates, location) were accompanied by an interpretation of the prominent ecological conditions in each photo, and changes seen from the historic to present day. I worked with Area Supervisor Wayne VanVelzen for this project and it is in the process of being implemented, subject to funding.

3.2.3 Focus Groups

Focus groups served as the structure upon which photo-elicitation activities took place, bringing groups of participants together to discuss change occurring in their parks. As defined by Krueger and Casey (2009:2), a "focus group study is a carefully planned series of discussions designed to obtain perceptions on a defined area of interest". Focus groups have now been adapted for use in various disciplines including anthropology and human geography (Barbour, 2007; Kitzinger, 1995). Inherently flexible to be tailored to research topics, the approach used in focus groups for academic pursuits is versatile and case specific (Barbour, 2007). Beginning in the 1940's, focus groups aided communication studies, marketing and sales research often for the private sector. A notable early study involved testing reactions to World War II propaganda and radio broadcasts; the method was referred to as 'focused interviews' (Merton and Kendall, 1946).

3.2.3.1 Focus Groups as Compared to Interviews

Focus groups as a qualitative method are similar to group interviews in that they involve several participants in one session discussing a particular topic with the researcher or facilitator. However, a critical difference is the explicit use of group dynamics and interactions for data

generation in focus groups (Barbour, 2007; Kitzinger, 1995). This is done through facilitation strategies aimed at encouraging the discussion to develop organically amongst participants, rather than having participants focusing on the researcher or moderator (Barbour, 2007). Kitzinger (1995) explains that these facilitation techniques are unique to focus group methods because; "instead of the researcher asking each person to respond to a question in turn, people are encouraged to talk to one another: asking questions, exchanging anecdotes and commenting on each others' experiences and points of view" (Kitzinger, 1994:1). Focus groups can even bring people together; it has been seen that "the interaction occurring within the group accentuates empathy and commonality of experiences and fosters self-disclosure and self-validation" (Madriz, 2000:842 cited in Franz, 2011), offering a truly positive experience.

While there have been studies involving over fifty groups, the majority include just a few (Kitzinger, 1995). When fewer focus groups are used, studies may also incorporate other methods such as a precursory questionnaire (e.g. O'Brien, 1993) or interviews (Eysenbach and Köhler, 2002; Michell, 1999). The latter arrangement has proved most appropriate and suitable for this project and its goals.

Some argue that focus groups dig deeper than individual interviews or group interviews (Kitzinger, 1995; Watts and Ebutt, 1987). Personal views can be further explored in a discussion than in a more highly structured individual interview. New ideas may develop and unexpected tangents may yield valuable insights. Group values and norms may be illuminated through interpersonal communication (Kitzinger, 1995). By embracing group dynamics and the influence our interactions have on our thoughts and behaviors, a researcher can help to uncover people's experiences and knowledge in a self-aware, reflective context. Through this acknowledgement of the various (and sometimes confounding) factors influencing qualitative data collection, the richness of qualitative investigation can be unearthed. That is, focus groups can allow you to "examine not only what people think but how they think and why they think that way" (Kitzinger, 1995:1).

3.2.3.2 Criticisms of Focus Groups

Criticisms of focus groups have been as diverse as those that partake in and conduct them. These include the potentially high costs and significant time demands involved. Portraying an empirical reality and coming to a consensus on study topics are not achieved through focus group techniques (Krueger and Casey, 2001). Therefore, case studies may remain more isolated in time and scope, as the information gathered emphasizes depth over breadth. This leaves the majority of focus group use to be for specific issues rather than generalization and broader application.

The group dynamics that can offer clarity and insight can also lead to "runaway trains"; tangents going nowhere and taking everyone along for the ride. Group dynamics can be risky for data collection, and even more seriously, can cause suffering for participants if behaviors are not kept in check and aggression, antagonism and bullying occur. Even if no one becomes difficult, many topics are sensitive in nature and can be a challenge to discuss one-on-one, let alone in a group setting.

Nevertheless, the participants are not the only variables to consider. The facilitator's style will necessarily impact the focus groups (Packer-Muti, 2010). The directedness with which the facilitator steers and reroutes discussion will influence how focused the resulting data will be.

How actively engaged verbally the facilitator is with the participants is critical as well for keeping discussion on track (relevant to research aims). A general trend when conducting many sessions is an increasingly "interventionist" facilitator once the saturation point has been reached on certain discussion topics. If comments become repetitive after five to ten sessions, then filling in other knowledge gaps with the remaining sessions is more valuable (Packer-Muti, 2010).

In addition, there are downfalls to group discussions. These include the immediate loss of confidentiality and anonymity once a group has met (Kitzinger, 1995). While the researcher can take strict precautions to support this confidentiality (such as removing names and direct references in resulting documents, and storing associated data securely), participants will be aware of the other individuals having participated in their session, and their respective opinions and views.

There is also the possibility for certain points of view to be underrepresented or unheard, due to introversion or pressure to conform with views well-supported by the group (Krueger & Casey, 2009; Kidd & Parshall, 2000). If certain participants are quite outspoken or aggressive, it is possible other individuals will censor opinions or withhold perspectives; this is more likely when sensitive or controversial topics are involved (Kitzinger, 1995). When coworkers are involved in the same session, workplace hierarchy may carry over and have influence on the amount and kinds of information shared by participants; hierarchy can impact discussion even if participants do not work together (Kitzinger, 1995). Using simple facilitation probes such as "are there any other thoughts?" can help balance participant input (Barbour, 2010).

All data received from a focus group session is necessarily shaped and influenced by the group dynamics present and participant interactions throughout. This is a less tangible factor to account for, but is critical for a meaningful analysis. Paying close attention to these dynamics throughout the discussion itself, and documenting key conditions as much as possible is suggested as a way to improve upon focus group analysis through incorporating the underlying social dynamics (Boon & Farnsworth, 2010). Subsequent analysis acknowledges these dynamics and attempts to incorporate their influence accordingly; several analysis tools for doing so have been offered (Halkier, 2010).

3.2.3.3 Preparations Before Focus Groups

An important step in preparing for the focus groups in this study was to familiarize myself with the dynamics and possible areas of conflict ahead of the meeting. If recent political, social or personal changes have occurred that impact participants, there is a possibility of conflict or uncomfortable tension (Franz, 2011). The relatively recent involvement of multiple agencies in the management of WWP suggested that the focus groups would run more smoothly if they were generally separated based on agency backgrounds. Along with individuals being familiar with one another, this organizational decision aided in the comfort of participants, and their experience during the discussion. In addition, this allowed for basic interagency comparison during my analysis.

In addition, I needed a reliable audio recorder. The audio recorder used for this study was a Zoom H2n portable recorder. Offering 2 or 4 channel surround-sound and associated uploading software, this recorder made transcribing focus groups with multiple participants more possible. Using multiple channels allowed me to decrease audio volume on certain channels when focusing on others.

Following each session, the audio mp3 file(s) of the focus groups and interviews were uploaded using the computer software WaveLab LE 7 made by Steinberg Media Technologies. WaveLab is a powerful program and allowed me to balance out the sound levels and save the files in a variety of formats. Transcriptions of recordings were subsequently created using the computer software ExpressScribe 5.50 intel, made by NCH Software. A strong benefit of ExpressScribe was its simplicity and streamlined structure; I was able to write the transcripts and stop/play the mp3 files simultaneously and adjust playback speed to match my typing speed.

3.2.3.3.1 Participant Selection and Recruitment

Meeting in early December 2012, I conducted three focus groups with individuals from BC Ministry of Environment and BC Parks, AB Parks, AB Forest Service and AB ESRD respectively. The first group was composed of individuals familiar with MRPP and the surrounding Omineca region. The second and third focus groups were directed towards people familiar with WWP and west-central AB. The number of participants in each focus group ranged based on availability and logistical constraints largely. I invited approximately twice as many individuals as were able or interested in attending, and this resulted in groups of 4, 3 and 6 respectively. See Appendix B for initial participant contact email script.

The scope of potential participants was limited to government employees or recent retirees directly involved in one of the respective parks in a planning, research or management role. Backgrounds included specializations in park planning and zoning, forest health, fire management, scientific programming, fish and wildlife biology and conservation management. This population is most directly involved in parks and protected areas management and decision-making in either AB or BC. While focusing on this specific population helped to maintain a reasonable scale and scope for the project, as a consequence I was not able to incorporate the views and opinions of community groups or local First Nations on these issues, of which there are several. While this offers a limitation, this participant selection is cohesive with my research questions.

Recruitment was purposive and nonrandom. Statistical generalizability was not a goal for this research, and the individuals invited to participate came from a subset of government employees embodying specific, predetermined criteria that were relevant to the research at hand - namely, working in or directly relating to one of the case study parks in either a planning, research or management role. As discussion would necessarily be influenced by the backgrounds of participants present, I aimed for a balanced distribution of participants from each discipline or background (e.g. not all participants were wildfire experts). Through these guidelines, I was able to include a representative sample from the relatively small population of employees.

For WWP, I delved into the AB Government Employees Directory and came up with potential participants from AB ESRD in offices from Edmonton to Grande Cache. Participants also came from the Ministry of Tourism, Parks and Recreation, within the Alberta Parks Division and were dispersed throughout the region in a similar fashion.

For MRPP, potential participants included those working in various areas across the Omineca region and in the Province-wide office in Victoria. Participants included individuals from BC's Ministry of the Environment and Ministry of Forests, Lands and Natural Resource Operations (FLNRO). Individuals most directly involved on-the-ground in MRPP work out the Mount Robson Visitor Center. This includes the Area Supervisor, Senior and seasonal Park

Rangers. Other individuals involved only for specific projects (conservation planning, etc.) work out of the Omineca Regional Ministry of Environment Office in Prince George, BC. Within Ministry of the Environment, individuals were working within the Parks and Protected Areas Division (PPAD), and the Environmental Stewardship Division and Forests.

While it was especially valuable to have participants with specific knowledge and experience in MRPP, it was not a limiting factor when finding potential participants. In fact, it became more apparent and quite essential to involve individuals having some but not extensive experience in the park, as they brought fresh perspectives that would not necessarily be present in a group very familiar with the landscapes being discussed in the photo pairs. These individuals less familiar with the park would nonetheless offer considerable expertise in their respective subject area, whether forest legislature, wildlife recovery or planning.

This inclusion allowed me to invite a greater number of individuals at the onset of recruitment. Subsequently, the focus groups consisted of both a larger and more diverse group of people. This networking aspect of the focus groups served as a main benefit promoted to participants.

3.2.3.3.2 Human Ethics and Project Documentation

My Human Ethics Certificate is available in Appendix C. Preceding the photo pairs, all participants were sent a document detailing the research project aims (Appendix B) and a human ethics consent form (Appendix C) two to three weeks prior to meeting via e-mail or regular mail. This allowed for an unhurried review of the materials and project goals, along with a detailed account what their participant involved. Subsequently, when participants arrived for the focus group discussion, the same human ethics consent form was signed in-person by all participants. Variation in ethical consent response has led me to not identify any participants by name or job title in this thesis. While the majority of participants gave consent to be identified by name, some did not. Out of respect and as a precaution, no direct quotations are attributed by name to individuals and are noted as "Willmore 1, Willmore 2" and so forth.

3.2.3.3.3 Focus Group Meeting Locations

Determining the most appropriate meeting location for the focus groups was guided by the activities and needs of each session. The interactive photo-elicitation materials, described in 3.2.2, necessitated a meeting room with good light for viewing the photographs, clear acoustics for my audio recordings of the discussion, and enough space for participants to move liberally and feel comfortable. A 10-15 person conference room was therefore chosen to meet these requirements. While I was first reticent about a possibly window-less environment to discuss the sort of things that were deeply interwoven with the winds of Willmore and the need for feet in the grass, the logistical headache of coordinating the technological aspects of the occasion with a hilltop in Willmore or Mount Robson made these romantic ideas dissolve into pragmatism.

Equally important to the logistical needs of each session was that of participant comfort. Discussion is greatly influenced by the level of comfort and security individuals feel in a meeting place. Making sure that each person felt it was an open, welcoming space to share his or her views was paramount. Providing coffee and tea service was intended to further encourage a more

relaxed atmosphere, with encouragement given to participants to get up and take a short break when needed (Barbour, 2007; Packer-Muti, 2010).

Hinton, AB, served as a central location to bring together the individuals discussing WWP. Coming from Grande Cache, Hinton, Edson, Edmonton and surrounding areas, two diverse groups of individuals, from AB ESRD and AB Parks respectively, converged on the Hinton Training Centre (HTC) School on December 7, 2012. The first focus group took place at 9:00 a.m. and concluded just after 11:00 a.m. The second group convened at 1:00 p.m. and was finished by 3:00 p.m.

This location was chosen for several reasons. First, it offered a central location and a good compromise for participant travel times; the maximum travel time was from Edmonton, three hours drive away. Additionally, the HTC School provided accessibility to the necessary amenities for the discussion. It also provided ease and comfort for participants, as it is a familiar location for a majority of participants. Operated by AB ESRD, the HTC is predominantly for the purpose of training provincial forest, land and wildlife managers and personnel.

The Ramada Hotel in Valemount, BC, served as the meeting location for the individuals discussing MRPP. This focus group discussion was the first of three discussions, and took place on December 5, 2012 at 1:00 p.m., concluding at 3:00 p.m. Hosting the focus group locally for BC Parks staff made for the greatest ease logistically for participants working directly in MRPP. While this unfortunately led to the exclusion of a few more participants from Prince George, the individual semi-structured interviews offered an opportunity to capture the opinions and knowledge of those participants as well, despite their being unable to attend the focus group discussion. While being a smaller meeting room than the one in Hinton (see above), a ten-person meeting room was used, which allowed for some degree of venue consistency between focus groups. Amenities, technology and catering were also available at The Ramada Hotel. While perhaps a less familiar setting for this group of participants as was the HTC School for those discussing WWP, the Ramada Hotel meeting room was located conveniently and offered both a private and comfortable atmosphere.

Conducting the Focus Groups. As planned, each focus group session took approximately two hours. More lengthy sessions largely result in disinterest and fatigue (Packer-Muti, 2010; Tang *et al*., 1995). Each session began with around five minutes of my opening remarks, during which time I provided a brief introduction to the project. This introduction brought attention to some broad questions to initiate discussion and ideas for the group. These did not include the primary research questions, as those would come interspersed throughout the discussion itself. Using the Zoom H2n recorder, I began my audio recording of each session right before I began my introductory remarks.

Leading into the focus group discussion, the general structure of the discussion was explained, and ground rules and general codes of conduct were outlined. I helped to guide discussion and keep it on track, but did not to engage directly in the conversation. Participants were encouraged to discuss freely and openly without speaking over others and putting down their views.

The focus group discussions were predominantly free flowing and conversational. Participants evaluated visible landscape changes qualitatively during the discussion. Personal and professional measurements of difficulty, time, and the sometimes-precarious balance of

needs and resources were used. Photographs were slowly rotated through in pairs, the timing of transitions closely following the ebb and flow of conversation.

While the planning process is far more than "preparing a list of questions" (Packer-Muti, 2010:3), discussion nonetheless hinges on the questions asked, how they are asked, and in what order they are offered. A total of seven questions guided the discussions, and included questions such as: "When looking at the photos, does remoteness come to mind to any of you? How would you define a remote ecosystem? How are remote areas in this park being managed, and what restoration and intervention activities are occurring here? Have you encountered any challenges specifically in managing remote areas in the park? What do these remote landscape changes mean for your work here?" The detailed focus group session agenda and active guide can be found in Appendix D.

3.2.4 Individual Semi-structured Interviews

While focus groups served as the primary data collection method in this project, a series of individual semi-structured interviews were also undertaken. These interviews served as a complementary collection method primarily intended to buffer and supplement the focus groups due to several factors having potential to limit or negatively impact the data collected. These factors included group discussion dynamics, logistical constraints and scheduling conflicts.

Interviews were also important to further investigate a series of follow-up questions that arose from the focus group sessions. Gaining further understanding on certain focus group topics, as well as uncovering other ideas or comments, added to the comprehensiveness of data collection and subsequent findings. In this way, interviews were incorporated as both a supplemental method and in acknowledgement of the potential downfalls of group discussions, as described in 3.2.3.2.

In addition, the relative flexibility offered by individual interviews allowed me the opportunity to include individuals who were unable to coordinate their schedules with the focus group sessions. With a few exceptions who were retirees, individuals of the target group were predominantly government employees with very tight schedules. Once planning had progressed to setting specific session dates and times, a benefit in having subsequent individual interviews became apparent. Since the interviews were done remotely over the computer, any logistical constraints for transportation to the focus group sessions were also alleviated, allowing wider involvement.

3.2.4.1 Participant Selection and Recruitment

While there were around 15 individuals of initial interest to interview, this population was reduced to those most familiar and/or most involved in one of the respective parks. These individuals were most likely to offer relevant experience and knowledge of management efforts in the parks. This non-probabilistic, purposive sampling mirrors the focus group participant selection. Once the initial 15 were reduced, seven participants were invited to take part in an interview. Of those contacted, three individuals worked with BC Parks, two with AB Parks and two with AB ESRD. Recruitment resulted in five follow-up interviews with three BC Parks employees and two AB ESRD employees. While five interviews is a small sample size, in this context the sample was adequate as used in conjunction with the focus groups, which included

13 people in three sessions. Studies have shown that samples with as few as four participants can generate very accurate data with a high confidence level, if the informants are competent in the area of inquiry (Romney *et al*., 1986). In addition, purposive sampling denotes a level of similarity between participants in a given criteria; this also suggests reaching saturation sooner (Guest *et al*., 2006), thereby arguably reducing the risk of a smaller sample size.

Recruitment of participants consisted of initial contact via email to publicly available government email addresses. Initial contact involved an invitation to participate, and a short but descriptive outline of the research project and its objectives (see Appendix B for initial contact email script). Individuals were encouraged to contact the researcher by phone or email if interested, and more information would subsequently be available regarding their potential involvement. For those having not responded initially, confirmation phone calls were made after a few weeks to either confirm their interest, or lack thereof. For those interested in participation, the next stage of contact proceeded with a more descriptive Invitation to Participate Letter and a Participant Consent Form (see Appendix B and C respectively). All human ethics procedures were done in a similar fashion to the focus groups, apart from the limitations of anonymity presented by the focus groups.

3.2.4.2 Interview Questioning Route

To summarize the questioning route for the interviews, a tailored selection of five to ten questions were used out of 14 total. Please refer to the follow-up interview question list in Appendix E. Following a few introductory questions similar to those used during the focus groups, the interviews transitioned into a discussion of landscape change. At this time, the photo pairs were made visible through screen sharing in Go-to-Meeting for the participants to view freely. Nevertheless, such landscape changes were discussed at length in the focus groups, and were therefore not the predominant focus in the interviews. As the photo pairs remained visible, the discussion transitioned to remote ecosystems. The concept of remoteness was brought up in the focus groups, and gaining further insight into participants' understanding of remoteness was a consistent component of the interviews across both parks. From the focus groups, particular areas in each park were highlighted by participants as being significantly more remote (or wild) in a variety of ways. The interviewees were subsequently asked specifically about these areas to illuminate any consensus or disagreement.

3.2.4.3 Conducting the Interviews

A total of five interviews were conducted over nine days between February 25, 2013 and March 5, 2013. Each interview was thirty minutes to one hour, and was done remotely via telephone or internet. The online program, Go-to-Meeting, served as an ideal platform for the interviews, allowing participants to join a meeting the researcher created, and to screen-share for photo-elicitation activities using the researcher's computer to show the photographs. This program was at no cost to the participants and with the exception of one participant, was available to use on workplace computers. For the participant unable to access Go-to-Meeting, the interview was recorded from a telephone call, and the repeat photo pairs were sent ahead of time to the participant, to view separately on their own computer. Recording quality varied significantly between participants due to background noise and computer speaker quality.

3.2.4.4 Reaching Data Saturation

It became apparent after the first three interviews that participant perspectives and opinions, however varied, were increasingly overlapped on the given topics in conjunction with the focus groups. New information or themes directly relevant to the research questions were no longer sprouting from discussion. The idea of data saturation was acknowledged when determining sample size for these interviews. However, beyond conceptual guidance little practical direction is offered in the literature for determining the necessary purposive sampling sizes for achieving saturation in qualitative research prior to data collection (Guest *et al*., 2006). Additionally, no explicit guidance is offered for determining it once data has been collected (Bowen, 2008). These are particularly important conditions with which both data collection and analysis ultimately depend. Yet, explicit detailing of these conditions within or between studies is largely unavailable (Guest *et al*., 2006; Morse, 1995).

A critique of qualitative methodology is often that of consistency and replicability, but researchers strongly advocate that many qualitative studies cannot be replicated because of the very nature of their focus and subjects. Each case is different, and in each case the saturation point will be found at a different point in time and in data collection. There is no formula or magic number; that is why the questions qualitative researchers follow can be intriguing and complex.

Nevertheless, many studies and syntheses of studies have examined saturation points in interviews (e.g. Francis *et al*., 2010; Guest *et al*., 2006; Mason, 2010), and many more note the use of theoretical saturation for determining and justifying purposive sample sizes (

e.g. Byrne, 2001; Fossey *et al*., 2002). It is often offered to find saturation inductively, as the interviews or focus groups are conducted, however this is unhelpful when preparing research protocols and plans (Cheek, 2000) or when in the field (Guest *et al*., 2006). One example emphasizes the difficulty in estimating sample sizes needed for saturation. Guest and colleagues (2006) examined their code development for 60 semi-structured interviews, looking for the point at which data saturation occurred. They found that the dominant themes and resulting interpretations would have been possible after the first 6 interviews.

3.3 Content Reductive Analysis

This study employed content reductive analysis techniques (Lamnek, 1995; Rückert-John, *n.d*.) for the data generated by the focus groups and interviews. This process involved several key sequential steps. After audio files were uploaded and transcribed, full transcripts were imported into NVivo (QSR International, Australia), which facilitated the creation of a matrix of topics.

In NVivo I uploaded my transcripts and situated them as sources. Each focus group and interview transcript was kept separate for subsequent coding. From each transcript, I coded the information relating to general introductions for later reference. These I saved as free nodes, unattached to any subsequent codes from the same transcript.

I then created a series of hierarchical tree nodes. The broadest separation was by focus group or interview (the latter grouped by park), which created five trees. Within these, the five initial categories included; conceptual, environmental changes observed, photography, park

characteristics, and rhetorical statements. Additional themed nodes were created within each of these categories. A full list can be seen in Appendix G.

In total, for the three focus groups of BC Parks, AB ESRD and AB Parks, I created 48, 49 and 49 nodes and sub nodes respectively. The variation in discussion was much greater during the latter two focus groups, which resulted in many more nodes. For the interviews, I created 11 codes for each of three BC Parks participants, and 13 and five nodes for the two AB ESRD participants respectively. This number of codes was much lower as the interviews were largely intended as a follow-up to fill specific information gaps. After I completed the coding of each transcript, I went back through the nodes to double check my decisions. This helped to ensure greater consistency and logic in the codes and themes, and I did end up altering (either adding or removing individual coded comments) approximately seven to ten nodes.

Next, the topics (themes coded into nodes) were transferred from exported NVivo Microsoft Word documents into Microsoft Excel spreadsheets where an additional round of coding took place to further distill the data. I reduced the relevant data to 44 nodes and the following number of coded comments for each spreadsheet is shown in table 6 below. Cross-case generalized analysis followed, where I looked for general results and findings in the remaining data and compared these findings between spreadsheets and parks.

Table 6: Number of individual codes within final Excel spreadsheets

Spreadsheet	Codes (comments)
MRPP Interviews	57
MRPP Focus group	88
WWP Interviews	53
AB ESRD Focus Group	148
AB Parks Focus Group	117

Qualitative data analysis using computer software is in its essence the same process as coding textual data by hand. Creswell (2007) discusses the common steps in computer assisted qualitative data analysis. First going through the data for specific text segments relating to an idea, issue or topic, I coded (highlighted) each relevant section as a specific code. I then combed through the rest of the data for other text segments relating to that same code, and other codes that become apparent. Once the data had been reviewed several times for this process, I made printouts of the collections of text segments for each code. This was my first step in categorizing the data into codes and then overarching themes for analysis. While computer software can aid in the storage and careful systematic organization of large data sets and increasing levels of abstraction of codes and themes, the computer is merely an outlet for the researcher to do the analysis (Creswell, 2007).

Serving as a final round of coding, I then created a matrix of topics using Microsoft Excel for Mac 2011 version 14.2.3. Microsoft Excel spreadsheets were created for each focus group and the interviews were combined into two spreadsheets based on park. Data was added to spreadsheets from exported NVivo word files for individual themes. While time consuming, this

second thorough processing of the transcript materials helped me to further refine the information. I was more able to decipher comments most useful for analysis and that offered more insight than simple relevance to circumstance (e.g. just because the participant mentions fire doesn't mean the comment offers insight into what fire management means in/for remote ecosystems). In this way, the spreadsheet creation served as an additional round of coding and transcript analysis. See Figure 75 in Appendix G for visual representation of theme distillation.

Additionally, many comments from participants could be associated with multiple themes. This is both a statement on the broad strokes of my initial themes and on the statements themselves, covering several interwoven issues simultaneously. An example of this is the discussion of upward movement of the treeline ecotone into alpine meadow ecosystems in Willmore. While most directly discussing treeline changes, these comments also related (implicitly or explicitly) to climate change, long-term landscape changes, biodiversity conservation, fire hazards and species at risk protection efforts (e.g. whitebark pine). In transferring coded data from NVivo documents into the Excel spreadsheets, I was further able to remove duplicated statements and place them in the most fitting theme, while simply noting that it related elsewhere. This minimized the amount of data I would be interacting with directly during my final steps of analysis and subsequent synthesis.

Using the above analysis techniques, I conducted intra-case analyses for each interview and focus group, treating them as unique cases. To describe the hierarchical level of analysis, there were two main cases (WWP and MRPP) containing three sub-cases (AB ESRD, AB Parks, BC Parks) each as a focus group, and two of which also split between five interviews (since no interviews took place with AB Parks). When coding textual data into themes, I sifted through the data and pulled out important comments. In concentrating and reducing the data, I began interpreting the data from each interview or focus group, respectively. Next, I evaluated interviews and focus groups as a cohesive whole for each park. This was a combination of the data distilled via coding and my annotations and interpretations along the way. This generalized cross-case analysis looked for commonalities and differences among datasets, and was applied both within and between the two parks. For instance, I evaluated the MRPP interviews and focus group for similarities and differences, and subsequently compared them to those for WWP. Chapter 4 will offer a description and interpretation of my results from this cross-case thematic analysis.

3.4 Limitations

Conventionally, the credibility of research studies is assessed through conditions such as generalizability, reliability, validity and objectivity (Denscombe, 2010). These conditions present a problem for qualitative research, however, which largely cannot be verified using the same criteria as quantitative studies. In light of this, alternatives have been offered to replace these quantitative-driven evaluation criteria (e.g. Lincoln and Guba, 1985). Transferability replaces generalizability, and asks for a judgment call about how far results *could* apply to other cases. Dependability replaces reliability, and is referring to a study led by reasonable decisions and replicable procedures. Confirmability replaces objectivity, as interpretation of data is necessarily interwoven in qualitative pursuits (as well as all other research) (Denscombe, 2010).

In this study, I approached the above limitations in several ways. To approach transferability, I maintained a conservative estimate of how far my results could apply elsewhere.

Due to the specific nature of case studies, some conditions (e.g. socioecological, political) that were important in this study would not be relevant to other parks and protected areas in Canada. Meanwhile, the more broad philosophical challenges of parks management may be more broadly applied because they in some ways transcend the specific cases. For instance, managing changing landscapes under rapid climate change, and managing for sustainable recreational use while protecting conservation values. In order to maintain a sufficient level of dependability, I have remained as transparent as possible with the thought-processes, decisions and procedures of the study, to allow for careful external scrutiny and confirmation that the project has evolved in a reasonable and logical way. Lastly, to support confirmability, I have kept a close record of my steps of analysis and interpretation so that others can see the steps taken to reach my conclusions.

Maintaining and improving rigor in qualitative research can be done through a variety of steps and measures, and I have followed several of the suggested actions. These have been outlined extensively in the literature (Barbour, 2001; Denscombe, 2010; Golafshani, 2003; Seale *et al,* 1999; Tracy, 2010) and include; purposive sampling, multiple coding, triangulation and respondent validation. Other markers of quality include having a topic worthy of research, sincerity (transparent and self-reflective), strong ethics and resonance (Tracy, 2010).

In this study, I have utilized purposive sampling in a reflexive way to ensure that my selection of participants was balanced between relevant government agencies and fields of expertise. A gender balance was difficult to achieve, however my selection indeed mirrored well the demographics found within the agencies involved (male majority). This sampling approach also reduced the impact of having a few invitees not interested and/or able to participate. In addition, respondent validation of the primary data was achieved, as participants were all given the opportunity to listen to the audio recording of their discussion or interview, read the transcript, and submit feedback to me at any time prior to the final completion of the thesis. A few comments were not clear to me, so in order to interpret them more accurately, I received detailed clarification on each from the participants.

I also completed multiple rounds of coding in NVivo and a subsequent final round in Excel. This enabled me to find inconsistencies in my coding decisions, theme selection and structure, and to prune back less relevant data. I also triangulated my research findings between three sources - data from the participants, data from my literature review document analysis, and data from the repeat photo pairs.

In conclusion, while there are certain limitations that are impossible to completely remove from a study such as this, I have made efforts throughout this process to ensure that these limitations have not caused any avoidable or debilitating weakness to the research process or results. This serves to close Chapter Three. It has followed a detailed discussion on comparative case studies in 3.1 and the data collection methods (3.2) of repeat photography (3.2.1), photo elicitation (3.2.2), focus groups (3.2.3) and semi-structured interviews (3.2.4), and a description of the content reductive analysis techniques used (3.3). Moving forward to Chapter Four, I will now discuss the findings of this study, divided by the dominant themes having emerged.

Chapter Four: Findings

Overview of Chapter. The following chapter will describe in detail the repeat photo pair findings for both parks, organized by theme. As mentioned in Chapter Three, findings from the photo-elicitation and discussions during the focus groups and individual interviews are discussed in conjunction with my findings from my own analysis of the photo pairs. Through an image-rich discussion organized by the dominant coded themes, Chapter Four will highlight areas of particular change and/or significance in the photos, as expressed by the participants and observed by the researcher.

Answering My Research Questions. The primary research question of this study is "how do long-term landscape changes influence conservation and restoration objectives in remote mountain ecosystems?" This also incorporates subsidiary questions: "what are the inherent challenges in managing (and restoring) remote ecosystems?"; and "how could managers of remote ecosystems best approach these issues in the face of rapid environmental change?" The following section offers a summary of how I approached an answer to each question.

To answer the first question, I first had to understand two things - what long-term landscape changes are occurring in MRPP and WWP today, and what the current conservation and restoration objectives are for parks management in more remote, backcountry reaches of the two parks. Beginning with the latter, a literature review in Chapter Two covered the various management objectives in the two parks, and the surrounding circumstances and conditions that influence these objectives (and local parks management overall).

Subsequently in Chapter Four, I discuss the long-term landscape changes being seen, as analyzed from the photo pairs, my direct experience in the parks, and from focus groups and interviews with park managers. The focus groups and interviews provided invaluable insight into both of these components, with participants discussing what the present (and overarching) conservation and restoration objectives are in the two parks and what changes they are experiencing in the parks. Following my questioning route, participants were able to situate these aims within the context of remote ecosystems and rapid change. Flowing from the culmination of these three sources of data it was possible to interpret how long-term landscape change can influence conservation and restoration objectives in the parks. This discussion came together in Chapter Five.

The subsidiary questions of this study were "what are the inherent challenges in managing (and restoring) remote ecosystems?"; and "how could managers of remote ecosystems best approach these issues in the face of rapid environmental change?" To answer the first of these questions, I used the focus groups and interviews as an opportunity to probe for insights from participants working both directly and indirectly in remote backcountry ecosystems in one of the parks. Photo-elicitation activities during the focus groups allowed participants to in some cases physically point to an area on a photograph they were referring to verbally. Through these discussions I probed for information on what remote ecosystems meant for management efforts, broadly in terms of inherent challenges, opportunities and within the frame of ecological restoration.

The second subsidiary question of this thesis is in some ways the most pertinent to this thesis as it points to a way forward with these challenges. This question is "how could managers

of remote ecosystems best approach these issues in the face of rapid ecological change?" To answer this question I looked to several sources for guidance and insight. Primary data from focus groups and interviews offered some suggestions and participants gave a few examples of what is presently being done (e.g. monitoring). Guidance was also available from recent publications by Parks Canada Agency and the Canadian Parks Council (2008; 2013), the IUCN (Hamilton and McMillan, 2004; Ikkala *et al*., 2009; Keenleyside *et al*., 2012), MacKinnon (2013), Cole and Yung (2010), Higgs (2003), Higgs and Hobbs (2010), and Higgs and Roush (2011). This discussion is found later on in 5.8 Recommendations and Future Work.

Key Themes. As discussed in section 3.3, using NVivo and Microsoft Excel spreadsheets, I distilled my data down to 44 themes and subthemes in Excel. From that selection, I further refined the themes. Table 7 below represents the ten most significant overarching themes for my findings, as distilled from those 44. Each theme is given a very brief summary. More detail is given in the following chapter, which is structured by subsections dedicated to these themes. With the exception of the first theme, which serves as an overarching theme for the entire thesis, there is no ranking meant by the ordering of themes in Table 7, and in this chapter overall. For the purposes of this table, themes 2-10 are arranged alphabetically.

The colour coding of the theme column represents the relative similarity or difference between the parks within that theme. Greater differences found in the theme's impact on management activities between the parks is shown by darker shades. The middle shade represents a neutral relationship, and the lightest shade of green represents strong similarity. The theme of philosophical differences and interagency collaboration only refers to WWP, and is therefore not shaded. The shades are as follows:

	Strong Differences		**Neutral**		**Similar**		**N/A**

Table 7: Key Themes of Analysis

Management of Remote Ecosystems			
Frequency of Mention			
MRPP		WWP	
Focus Group	29	Focus Groups	AB Parks: 28; AB ESRD: 50
Interviews	9	Interviews	10
Summary			

- Conceptual descriptions of remoteness and remote ecosystems by participants strongly aligning with current management approaches
  - Much similarity between parks
  - Subjectivity and personal value
  - Remoteness important in parks for conservation objectives and significance within perceptions of wilderness
  - Emphasis on indirect management; letting more areas in the parks 'go natural' to their own devices
- Debates around the appropriateness of intervention
- Above challenges felt to greatly outweigh inherent access/logistical difficulties

MRPP	WWP
• No overall uniqueness beyond summary above	• Lack of information emphasized as presenting limitations for WWP park managers in particular • Main exception to indirect management being fire management • Debates on intervention often related to varying perspectives and priorities between agencies

Changing Visitor Use (societal shifts)

Frequency of Mention

MRPP		WWP	
Focus Group	34	Focus Groups	AB Parks: 17; AB ESRD: 32
Interviews	1	Interviews	0

Summary

- Interpreted as due to larger societal shift over time
  - Fewer backcountry visitors in both parks, however lacking empirical studies
- user-maintained trails growing in (e.g. Moose River Corridor in MRPP, majority of trails in WWP)

MRPP	WWP
• shifting user expectations and needs • Growing expectations of luxury wilderness experiences and fast-paced visits	• Majority of use in eastern reaches and for game hunting • External pressure to increase trail access in WWP

Climate Change			
Frequency of Mention			
MRPP		WWP	
Focus Group	23 (10 glacial recession)	Focus Groups	AB Parks: 8; AB ESRD: 9
Interviews	1 (2 glacial recession)	Interviews	2

Summary

- Impacts of climate change not fully explored scientifically in the parks
- A variety of climate-induced changes being observed
- Predominant focuses for both parks included:
  - Faster spring melt, river wash-out
  - Pest epidemics such as mountain pine beetle
  - Treeline creep and encroachment into subalpine and alpine meadow complexes
  - Increased safety risks
  - Asking whether climate change presents an issue beyond all others for parks management

MRPP	WWP
• Climate-induced changes being observed include: o More significant flooding o Glacial retreat	• Managing for species at risk (following treeline creep)

Industrial Development and Capacity			
Frequency of Mention *(Ordered industrial development first; capacity second)*			
MRPP		WWP	
Focus Group	10; 11	Focus Groups	AB Parks: 4, 6; AB ESRD: 8, 10
Interviews	1, 2	Interviews	1, 0

Summary

- Historical industrial activities occurring in both parks
- Parks capacity decreasing while industrial development continues to increase
- Capacity not increasing to match development and industrial activities

MRPP	WWP

• ongoing industrial activities in the park along Yellowhead corridor which today is highly developed • Long-term landscape changes having begun with railway era valley fires o Increasingly problematic for fire risk and homogeneity in forest stands	• land use activities (forestry/oil/gas/coal) impacting wildlife distributions • Managing fire to protect commercial interests

Philosophical Differences and Interagency Collaboration

Frequency of Mention

MRPP		WWP	
Focus Group	N/A	Focus Groups	AB Parks: 9; AB ESRD: 22
Interviews	N/A	Interviews	4

Summary

- Joint management efforts of AB ESRD and AB Parks
- Difficulties have arisen when balancing multiple perspectives and management priorities in WWP
- Inter-agency collaboration efforts are improving with time
- Seen as a more significant challenge to managing remote ecosystems than the inherent logistical and access issues present in WWP

Public Education

Frequency of Mention

MRPP		WWP	
Focus Group	24	Focus Groups	AB Parks: 4; AB ESRD: 9
Interviews	1	Interviews	0

Summary

- Focus predominantly on MRPP

MRPP	WWP
• Challenges managers face in dealing with public's understanding/perceptions of natural disturbances • Insufficient interpretation	• No interest or concern shown over lack of education materials beyond Grande Cache Visitor Centre • Park managed as backcountry and outreach is negligible outside of consultation for

programming for MRPP • Major concern for park managers • Little opportunity and capacity for hands-on outreach/interaction with public about natural processes, park ecosystems and conservation objectives	planning

Stand Homogeneity			
Frequency of Mention			
MRPP		WWP	
Focus Group	11	Focus Groups	AB Parks: 1; AB ESRD: 1
Interviews	1	Interviews	0
Summary			
• Increase in stand structural and compositional homogeneity • Growing danger of massive fires, disease and pest epidemics • Decades of the "Smoky the Bear" mentality • Necessity of returning fire now well accepted • While seen in photo pairs from both parks, this long-term change given much greater emphasis in MRPP			
MRPP		WWP	
• Fire suppression and forestry offered as reasons for this change • Managers want to prescribe burns to increase ecological diversity and robustness		• Fire suppression offered as reasons for this change	

Treeline Creep			
Frequency of Mention			
MRPP		WWP	
Focus Group	4	Focus Groups	AB Parks: 11; AB ESRD: 11
Interviews	0	Interviews	2
Summary			
• Greatest emphasis given in WWP, but changes nonetheless observed in both parks • Treeline advance up valley slopes towards the subalpine and alpine zones			

<table>
<tr><td>MRPP</td><td colspan="3">WWP</td></tr>
<tr><td>• No overall uniqueness beyond summary above</td><td colspan="3">• Difficulties for restoration and management of whitebark pine (encroachment, increased blister rust pressures)
• Diverse alpine meadow communities of concern due to encroachment
• Evolution of fire behavior due to creep is of significant concern, due to:
o Increasing risk of multi-valley fires
o Easier pest and disease transmission/spread
o Potential impacts on other disturbance regimes</td></tr>
<tr><td colspan="4">Valley Infill</td></tr>
<tr><td colspan="4">Frequency of Mention</td></tr>
<tr><td colspan="2">MRPP</td><td colspan="2">WWP</td></tr>
<tr><td>Focus Group</td><td>2</td><td>Focus Groups</td><td>AB Parks: 13; AB ESRD: 20</td></tr>
<tr><td>Interviews</td><td>0</td><td>Interviews</td><td>2</td></tr>
<tr><td colspan="4">Summary</td></tr>
<tr><td colspan="4">• Observations of vegetation encroachment into valleys and trails
• Changes not uniform in or between parks</td></tr>
<tr><td colspan="2">MRPP</td><td colspan="2">WWP</td></tr>
<tr><td colspan="2">• Observations of vegetation encroachment into valleys and trails, potentially due to:
o Reductions in visitor use
o Perennially wet conditions (subalpine meadows)</td><td colspan="2">• Observations of vegetation encroachment into valleys and trails, potentially due to:
o Reductions in visitor use
o Moisture increase/pooling water
o Changes in predator and ungulate populations
• Meadow complexes in valley bottoms that displayed negligible change in boundaries or extent, potentially due to:
o Frost-mediated tree encroachment, high moisture levels, mechanical</td></tr>
</table>

		disturbance, temperature extremes	
Wildfire and Prescribed Burns			
Frequency of Mention			
MRPP		WWP	
Focus Group	10	Focus Groups	AB Parks: 55; AB ESRD: 71
Interviews	3	Interviews	2
Summary			
• Difficult balance of multiple priorities • Ecological conditions increasing risk o Aging forest increasingly homogenous and dense – larger fuel load available • Sociopolitical barriers and expectations of management			
MRPP		WWP	
• Sociopolitical barriers emphasized: o Disconnect from public and stakeholders around need of fire in park; some notable push-back experienced in 2004		• Treeline creep connects valleys over ridge-tops – enables greater fire spread • Sociopolitical barriers emphasized: o Protection of communities, users and commercial land use interests o Legal mandates for species at risk protection (e.g. woodland caribou) • Risks of prescribed fire to species in park	

4.1 Management of Remote Ecosystems

This section will discuss the overarching theme of management of remote ecosystems. This theme description is given before the other themes because of its overarching qualities and most direct relevance to this study's focus. The concepts of remoteness and remote ecosystem management act as a framework for this study's primary research questions.

Beginning with a list of what remoteness and remote ecosystems meant conceptually to participants, a discussion will follow of several subthemes. These include; the importance of remoteness in parks, an emphasis on indirect management, a lack of information, and lastly debates around the appropriateness of intervention. While all of the above subthemes will be interwoven in Chapter Five synthesis discussions, they are included here because each was explicitly and repeatedly brought up during focus groups and interviews. Through my subsequent analysis I found that these subthemes, when used in conjunction, best illuminate the present management circumstances in remote ecosystems in WWP and MRPP.

What are Remote Ecosystems? To begin, it is important to outline what parks managers in WWP and MRPP think remote ecosystems are, and what remoteness implies. Distilled from focus group and interview data, the following table describes these views.

Table 8: Participant views of remote ecosystems and remoteness as a concept

An area is deemed remote when…	Remoteness is…
Mount Robson Provincial Park	
• Typically let-burn • Species are prioritized over visitors • Zoned Wilderness Conservation • High in elevation (impeding access) • Further from population centers • Not many people are going through area • Not disturbed by human-transported invasive species • Connected to other areas considered remote • Difficult to access • Roadless (relative to BC Parks "5km width, 2,000ha polygon" standards)	• Relative • Difficulty of access • Levels of management • Buffering from human activities • Functioning with ecological independence • A paradox • Contagious (landscape connectivity) • A defining feature of the park (e.g. Fraser River Headwaters) • Tied to values (e.g. intrinsic worth) • A good thing • Changing (in its meaning) • Wildness
Willmore Wilderness Park	
• Difficult to access • Ecologically independent • Lacking (direct) human influence • Only reachable by horse or foot (no motorized vehicles permitted) • Contains keystone species in notable densities (e.g. wolverine, grizzly bear) • Notable distance from access roads	• Difficulty of access • Solitude • Wilderness • Quietness • Uninterrupted views • Three days back by horse • Lack of impact from human activities • Beautiful (relatively untouched landscape) • Willmore (one of the most remote parts of AB) • Places like Chown and Resthaven Glaciers, Ptarmigan Lake • Lack of trails

As seen in the responses from participants, there is significant overlap between the parks when managers described characteristics of a remote area. These included; difficulty of access, functional independence ecologically, distance from infrastructure and access points, and a lack of human involvement or impact. All of these conditions denote a stark distance and removal of humans from the given landscape. Participant opinions of the concept of remoteness were largely subjective and framed by intangible measurements such as solitude, beauty and intrinsic value.

Specific places in the parks were highlighted in attempts to exemplify the participants' expression of remoteness. In MRPP the Upper Fraser and Giette Creek drainages were emphasized. In WWP the far western reaches around Ptarmigan Lake were focused on.

In some cases, there were contradictions. For instance in BC, an ecosystem with industrial development a few ridges away would be seen as less remote, however since very few people ever visited the area it was also described as remote. This suggests that the more direct impact of hikers going through a valley was a larger factor in removing the (perceived) remoteness of an ecosystem. Arguably, there is less impact from hikers on the ecosystems than neighbouring clear cuts or mining operations a few valleys over. In addition, definitions of remoteness and remote ecosystems did not explicitly acknowledge the long-term indigenous land use in these areas preceding park development.

The Importance of Remoteness in Parks. While there were a number of descriptions offered for what remoteness means in parks and protected areas, and conditions that make an ecosystem more or less remote, there was a cohesive undertone (and at times explicit) acknowledgement of the importance of remoteness in parks. One participant expressed that "Mount Robson is named after this big chunk of rock we've got. But really, the defining conservation feature, not just in Mount Robson Park, but in the park system, is the headwaters of the Fraser River" (MRPP 2, December 2012). There was complete agreement in the MRPP focus group that these areas of MRPP are considered more remote and are highly important for conservation (MRPP 1, 2, 3, 4).

The importance of remoteness for park ecosystems and conservation objectives runs alongside public opinion. It was expressed in an interview that the remoteness of ecosystems in and of themselves are a factor in the public's valuation and support for their protection (MRPP 5). But even remote ecosystems are under pressure from industrial development, climate change, and other far reaching activities and management practices. This leaves a potential sociopolitical fallout for conservation in the face of rapid change if protecting wilderness and "untouched" nature is what is most valued. What happens if remoteness is lost in the eyes of the public?

This ties back to Bill Cronon's 1996 essay *The Trouble With Wilderness*, as the very identity given to wilderness by the North American post-frontier culture is a historically inaccurate vision of an unscathed nonhuman Nature, only true or wild when beyond human agency. Sublime authenticity and self renewal is only possible when removed from the trappings of modern civilization. One participant echoed this closely, saying that remoteness is tied to our value systems. Even those urbanites who never expect to see the areas place intrinsic value on them to be there and be protected (MRPP 5). As seen in Table 8 above, participant perceptions of wilderness have remained close to this vision.

An Emphasis on Indirect Management. The general approach in remote areas is indirect management. This is overwhelmingly the case for MRPP. However for WWP there are some inter-agency discrepancies due to differing priorities and philosophies guiding management. This leaves WWP having experienced more direct management in backcountry areas than MRPP, predominantly relating to prescribed burns and mountain pine beetle control. Nonetheless, with AB Parks now the lead agency, an approach of more indirect management is being favoured with few exceptions beyond the protection of species at risk habitat from wildfire.

Participants from MRPP felt that a specific approach to wilderness management could mean letting things go freely along independent natural trajectories. This correlates to other

participants' comments, expressing that the approach of BC Parks in remote ecosystems going forward is to see what is happening ecologically in these areas, little by little, but managers will not be going into these areas anymore than they already do. Most simply, staff capacity and limited resources in BC Parks has greatly influenced the extent to which on-the-ground staff can get involved in initiatives beyond the Intensive and Nature Recreation Zones. Ranger hours are precious and most often spent on projects in the front country. As one participant expressed about remote ecosystems in MRPP,

> "Well...if there are no other people going there, then we don't have issues. We just let things manage themselves. [W]here it would come up in terms of difficulty would be if we were trying to… put in a plot or something… [S]o remoteness is actually a good thing. Because it keeps things more pristine. And much of our system is remote, and we like it that way. It's one of the reasons why it's even possible [emphasis] to manage the system with such a tiny staff. Is that our front country areas are really really small compared to the whole package." (MRPP 7)

In Mount Robson, balancing user needs with ecological stability necessitates the majority of capacity and resources be allocated to high use areas, leaving more remote areas to their own devices, trusting in their ecological independence. With changes being seen throughout the park, managers do not want to intervene, even if they could. Many changes seen could be attributed to climate change, which as one participant from WWP said, is far beyond parks management. As discussed in 4.8, these include the upward movement of the treeline ecotone and glacial retreat. Other forest ecosystem changes are most likely tied to fire suppression and forestry.

Returning to Cronon's (1996) arguments, I see parallel tendencies in the hands-off approach commonly taken in these two parks, but particularly MRPP. While one participant from MRPP was adamant in their beliefs surrounding ecosystem management and that humans are a part of nature, overarching BC Parks management decisions nonetheless follow within the paradoxical wilderness vision Cronon describes. This vision is dualistic as it sees authentic, true nature as wild and free of humans. To become involved in this kind of nature would be the loss of it (Cronon, 1996). As one participant from MRPP put simply, "I see remoteness as being such a good [emphasis] thing. It means that places are out of reach of development… it's so [emphasis] important to have places that are truly wild. Which, to me means remote" (MRPP 7).

Correlating to this view, I have found that in WWP and MRPP, park ecosystems seen as remote are valued highly for this quality, and managers wish to keep them that way. However, to bring the park and its ecosystems into the future resilient and healthy requires what one participant deemed "evolutionary elbow room". They felt that, as protected area managers, this less direct management approach would enable ecological adaptation into the future.

> "We have to allow [emphasis] the ecosystems and the organisms that are associated with them the elbow room in order to evolve. And, one thing for sure is that we have to keep the gene pool as big as possible. [O]therwise they have a hard time evolving. [T]he other [thing] is heterogeneity is just so [emphasis] important ..... That's why we need those remote [emphasis] areas, Jenna, to keep them remote." (MRPP 7)

A Lack of Information. A challenge expressed ten times in focus groups was that of a lack of information. This was predominantly relating to WWP. In MRPP, several participants mentioned situations where ecological information could be gathered (MRPP 1, 3, 5, 7) or would be desired (MRPP 2), however only one stated that there was a need for additional information in order to improve decision-making. With relation to prescribed burning plans, this participant focused briefly on a lack of information relating to natural fire regimes and First Nations burning in the

region (MRPP 5). As another MRPP participant explained, there was a management decision to close the trails in the Upper Fraser as it has had little direct manipulation and could be very useful for scientific studies. Participants emphasized that they "can't say it enough to our powers that be, that as far as encouraging studies, we're hungry [emphasis] for information on some of these areas" (MRPP 2).

For WWP, regardless of affiliation and individual field of expertise participants exhibited a general consensus that not enough information was currently available on the fine-scale ecological conditions in large areas of the park, particularly in the far western reaches (WWP 3, 4, 6, 7, 8, 9). Most research has focused on the eastern slopes, where the heaviest visitor use takes place and popular game species inhabit.

Participants discussed this in terms of having no official park management plan, and therefore having greater difficulty in decision-making and prioritization (WWP 2, 7). There was also a general consensus between AB Parks and AB ESRD that more research was needed for the western reaches of the park, and that a general research bias existed for the front ranges, which sees the vast majority of visitation and public use (WWP 3, 7, 8, 9). Exceptions for this are for high profile species at risk including grizzly bear, woodland caribou and whitebark pine (WWP 7) and in the last decade or so, mountain pine beetle dynamics in the park (WWP 8). The majority of ecological monitoring on rare or endangered plant species in the western reaches was enabled by helicopter sharing during mountain pine beetle investigations around 2004, and much less has been possible ever since (WWP 6).

While Fisheries and Wildlife Division have inventories dating back to the 1970's (game species, caribou, etc.), monitoring datasets for broader ecological conditions in more remote areas are negligible. Restrictions when using resources and capacity wisely (i.e. for the higher use areas) was offered as a reason for this. A general assumption stands that since very few people get into the back ranges, the impact on wildlife and fish populations is minimal and sustainable (WWP 4). A similar view was offered for wildlife management around MRPP. One participant explained that while populations are monitored by biologists, the assumption is that having the land protected for them is the main thing (MRPP 5). Having more information would be helpful in knowing what is out there, and what should be accounted for in planning. However as one participant left it, there is a trade off of having more information (WWP 6). Sometimes having more information is more burdensome than advantageous, and decision-making can become over-weighted by factors to consider.

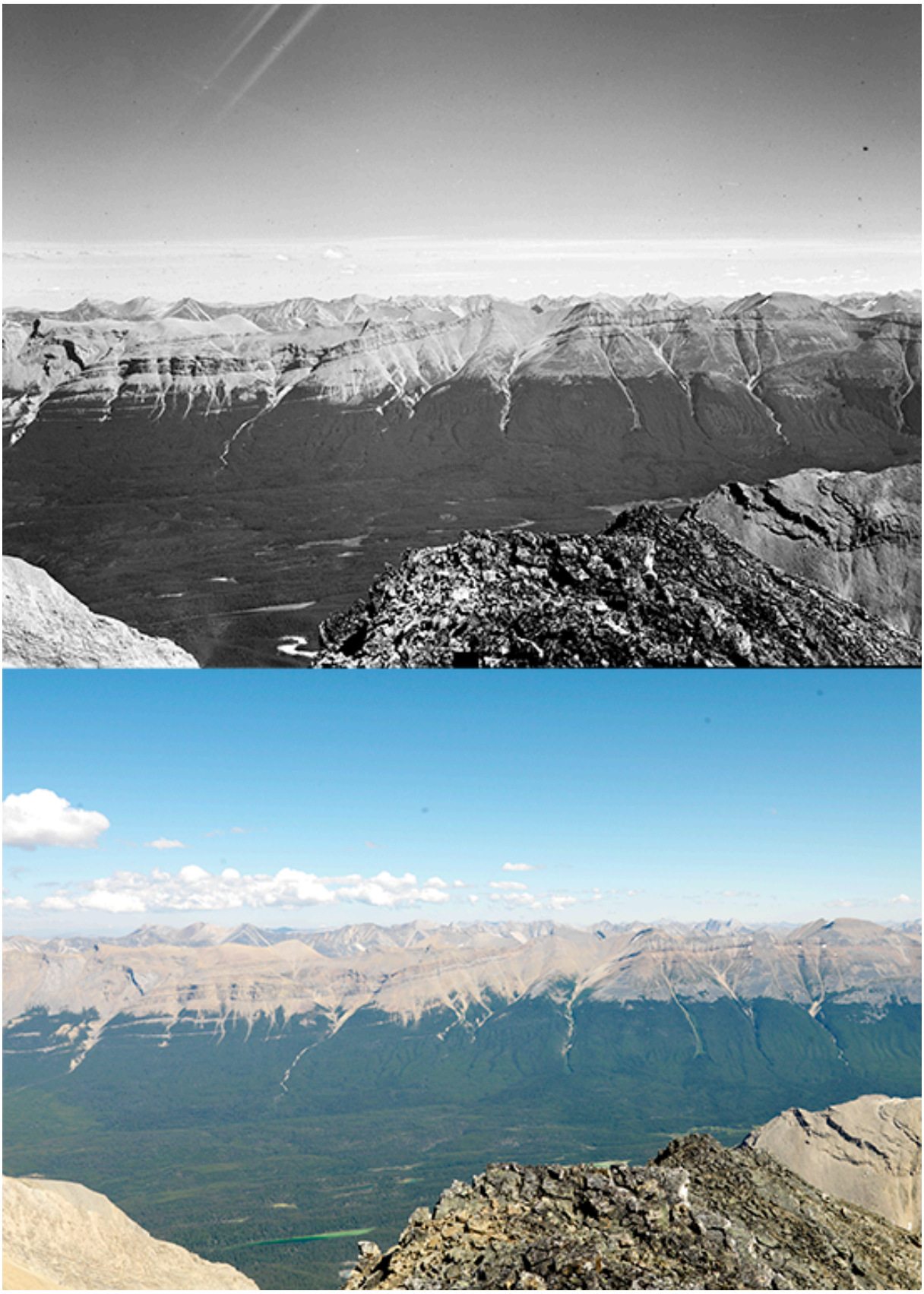

Figure 49: Lambart's Station #51; Lambart 1927 (top) and MLP 2007 (bottom)

One WWP photo pair exemplifies the barrier that insufficient information can be for managers. Lambart's Station 51 is located centrally along the southern border looking towards Hardscrabble at approximately 8,958 ft. Described as eerie and incredibly lonely, this valley is quite wet and difficult to travel through (WWP 3, 8, 9). A notable lack of whitebark pine cone serotony was found in this area (WWP 8), hinting at a lack of fire historically that several participants suspected (WWP 1, 8). A few indeterminate patches of fire scars were noted, but overall participants saw little evidence of fire (WWP 7, 8, 9).

One participant felt that this offered a notable management challenge. The Willmore landscapes are commonly referred to as fire dominated, however scientific studies determining where fire is - and isn't - the dominant force have not been completed. This long-term information is much needed for clarity in fire management decision-making (WWP 8). Repeat photo pairs can improve understanding of historical conditions, including natural disturbance events like fire.

Debates Around the Appropriateness of Intervention. While resources and capacity are important factors for managers evaluating the appropriateness of intervening to wilderness areas, there is evidence here that managers in WWP and MRPP in particular would not necessarily intervene if practicality allowed it. Sometimes, even if changes are indirect consequences of human actions, intervention isn't a convincing option.

In MRPP, managers are struggling with the idea of maintaining naturalness (a widespread discussion for protected areas management, see Cole *et al*., 2008; Cole and Yung, 2010), and where the line should be drawn for appropriate intervention. One participant explained, "as landscape managers really, where do you draw the line with managing and where do you leave the landscape to function in its natural cycles without altering those cycles?" (MRPP 5). Many years of altered cycles have visibly accumulated by way of ecological change on the landscape. As circumstances exist today, there is increasing potential for that line to be blurred following catastrophic fires or climate change induced effects. One participant felt that stepping back was the logical way to allow processes to run their course.

> "Yea, you want to maintain them intact as ecosystems, but at the same time you need to understand that within that sort of area that you've drawn a line around, there's dynamics. And you've gotta let it change within there, otherwise, it'll just implode on itself, eventually. And climate change is actually speeding up that process. Cause the things that actually disturb [emphasis] forests, in terms of stand replacing events, are generally insects and fire. And those two things thrive with the way things are going. You know, so we gotta stop feeding them." (MRPP 1)

Contrastingly in WWP, managers are much more actively involved in the remote reaches of the park. Nonetheless, certain circumstances have caused this involvement to be put into question. Agency management approaches and priorities differ where wilderness intervention is concerned. This has caused considerable tension with regards to operations in the backcountry. Participants from AB ESRD were much more likely to express support of direct intervention as opposed to those from AB Parks. The theme of philosophical differences is discussed in 4.6.

Summary. To conclude, this section has discussed the first and overarching theme of remote ecosystem management. Beginning with a brief overview of how this broad theme is situated within this study, the discussion was then divided between several subthemes. Each subtheme helps to illuminate the present management circumstances in remote ecosystems in WWP and

MRPP. The subthemes included; the importance of remoteness in parks, an emphasis on indirect management, a lack of information, and lastly debates around the appropriateness of intervention.

Within the first subtheme, I found that participant perceptions of remoteness and remote ecosystems were closely in tune with Cronon's (1996) arguments around wilderness as a cultural construction of authentically wild nonhuman Nature. Upon examining the subsequent subthemes, it became apparent to me that these perceptions were deeply interwoven in management approaches in remote ecosystems in both parks. This is seen particularly in the park agencies as compared to AB ESRD, which approaches similar challenges in an inherently more utilitarian and pragmatic way due to its differing mandates and sustainable use philosophy.

Within the second subtheme, these views of wilderness were expressed most dramatically through participant comments from MRPP. A hands-off management approach was at times in stark contrast with acknowledgement of the pressures and impacts being felt in the park. As mentioned above, a more hands-on approach has been taken by AB ESRD in WWP.

The third subtheme was predominantly focused on WWP, as the vast majority of comments relating to a lack of information (and need for more) came from those participants. In MRPP, there is inarguably a similar lack of information, however only one participant mentioned this as a limitation to management in relation to fire regime history and First Nations burning. I have found one potential explanation for this stark difference, as managers in both parks are aware of the information gaps they are working with. It seems likely that the ability for managers in WWP to act on new information is greater than in MRPP, where capacity and resource limitations greatly impact management aims and efforts (as discussed in 4.7.3).

The final subtheme surrounded the debates among managers around the appropriateness of intervention. There was notable variation both between agencies and individuals about how far (if at all) managers should intervene in remote ecosystems. Several participants struggled with this topic, working through it out loud during discussion. I found these opinions to correlate to both agency priorities and philosophical differences for intervention in wilderness areas. BC Parks and AB Parks participants were quite hands-off and prioritized species at risk before fire management; AB ESRD managers sincerely acknowledged those values, however emphasized the necessity for careful fire management over the long-term.

4.2 Valley Infill

Photo pairs from both parks have illustrated a densification of forest stands. Likewise, certain valleys are seen to change very little as far as can be discerned from the photo pairs. Participants' observations in WWP in particular mirrored this variation. Beginning with a small subtheme of trail infilling, this section will then discuss valley infill as sorted by photo pair examples showing both significant valley infilling over time, and also in some cases negligible change.

Encroachment onto Trails. One specific topic within the theme of valley infill is vegetation encroachment onto trails. In WWP, backcountry trails are user-maintained, and if outfitters (or users, broadly) stop using a certain trail, there is no pressure to clear it. Participants from the MRPP focus group discussed the frustration of trail clearing along the Moose River corridor,

which serves as backcountry access north off the Yellowhead corridor around the back of Mount Robson and eventually up into Jasper National Park. As a result of lack of use and minimal drainage leading to pooling water, efficient forest infill has occurred along the slightly depressed trail. Participants noted that recruitment was predominantly by pine species.

Cases of Valley Infill

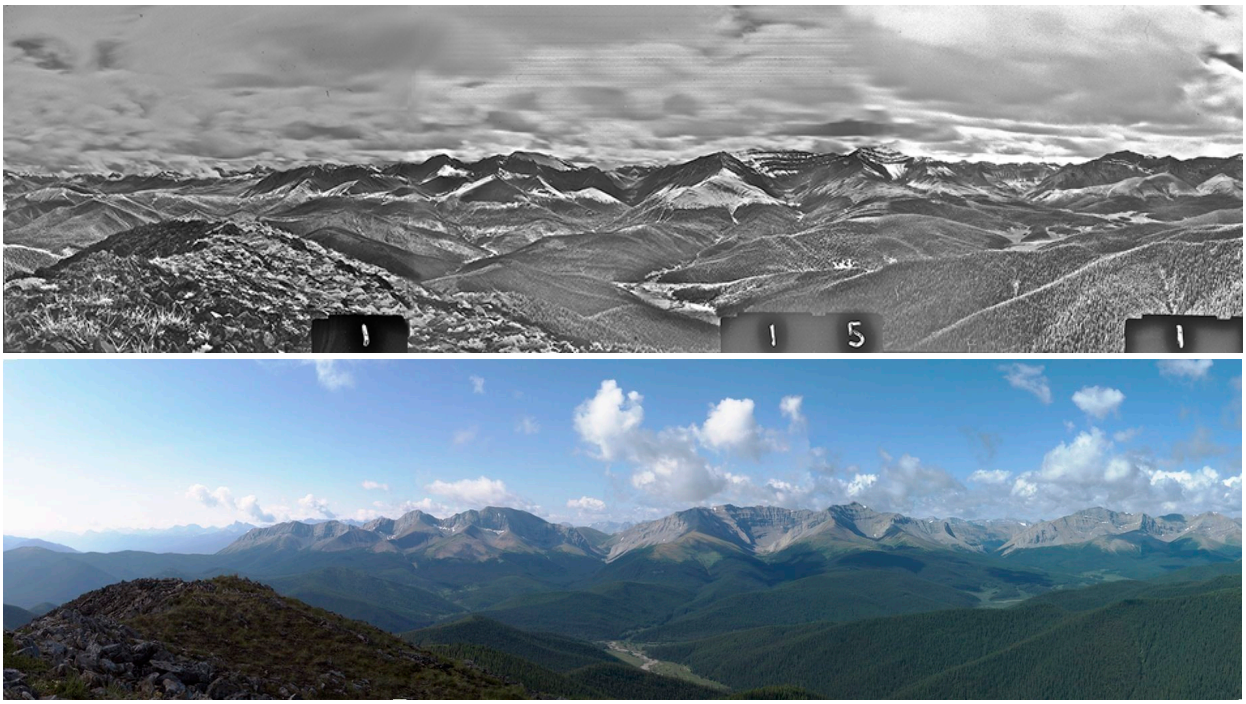

Figure 50: Nidd Station 15 Panorama Pair; Nidd, 1944 (top) and MLP, 2012 (bottom)

Valley infill was also apparent in a panorama of Nidd's Station 15. This panorama pair covers a significant area in eastern WWP, and participants had a variety of comments relating to the photos. The panorama is looking south towards JNP, and shows the land from Rock Lake past Eagle's Nest Pass along the Wildhay River. Minimal change was observed in the valley meadows, and this was attributed by one participant to late spring frosts keeping trees from establishing in the cold air drainages of the meadows (WWP 9). Significant temperature swings were also noted, along with an anecdotal experience of the extreme temperature swings possible there. The meadows close to the eastern slopes are used more heavily by visitors, as the majority of park access is to the east of the park. There is the potential that horse grazing maintains the ecosystem boundaries along with tree mortalities to frost.



Figure 51: Annotated copy of Nidd Station 15 historical capture showing participant emphasis on the similar valley bottom forest boundaries and nearby slope infill

While the valley bottom meadows appear nearly identical between the images, there is potential for compositional changes to have occurred over time, which is not easily visible from the photos. Contrastingly, in meadows where encroachment is quite visible, one participant suggested the predator-ungulate dynamics were responsible, rather than an absence of fire (WWP 8). Top predators in WWP are at a very high density, and ungulates are being reduced both through predation and hunting.



Figure 52: Wheeler's 1923 Courier Mountain Station #251; Wheeler 1923 (top) and MLP 2007 (bottom)

Some valley infill was shown over time by a repeat photo pair from Wheeler's Courier Mountain Station. Located at the far western reaches of the park, this station overlooks the Jackpine River Valley. The station's elevation is 7,877 ft. ASL as noted in Wheeler's 1923 map (Appendix F Figure 69). Participants noted that while there was evidence of fire between photos, there was surprisingly little change in the extent of forest coverage in the valley bottom (WWP 1, 2, 3). They agreed that this was likely due to high moisture levels limiting vegetation growth. Anecdotes were shared about horse packing through the valley from Mount Robson in the 1930's. With the forest infill so dense, the horses had so little to graze on down below that they would be found half way up the mountain the next morning, going after the open meadows (WWP 1). These stories suggest that the forest stands in the valley were already becoming quite dense at the time of the original survey photographs.



Figure 53: Wheeler's 1911 Moose Lake West #1 Station, panorama; Wheeler 1911 (top), MLP 2012 (bottom)

In comparison to WWP, a panoramic photo pair from MRPP also showed minimal valley infill. The above photo pair (figure 53) was taken from Moose Lake West #1 Station. The photos show a tributary to Resplendent Creek, and a large u-shaped valley leading towards the Moose River Valley. The upper reaches of the Resplendent Creek are important habitat for mountain goat birthing and rearing, and are seen as very remote and very rarely visited. Visitors are not encouraged to venture into this area, and very rarely do.

Some tree infill was visible in the lower valley along the stream heading to Resplendent Creek. However, very little change was seen in the extent of the forest patches in the subalpine meadowed bowl. Participants offered that perhaps this lack of forest ingrowth was due to it being a perennially wet area, or that repeated mechanical disturbances such as avalanches could be slowing the vegetation establishment along the subalpine slopes (MRPP 4). These ideas were speculations from participants; no site studies have been done in this area.

Summary. In conclusion, this section has discussed the theme of valley infill, which was a notable change observed in several photo pairs. Managers from both WWP and MRPP have experiences and examples of dealing with vegetation encroachment into valleys and trails. Reductions in visitor use are an important component. Other factors emphasized were an increase in moisture and pooling water, and changes in predator and ungulate populations. However, these changes are not uniform in or between the parks. Shown vividly by the repeat photo pairs, there were also meadow complexes in valley bottoms that displayed negligible change in their boundaries or extent. Potential explanations from participants varied and included frost-mediated tree encroachment, high moisture levels, mechanical disturbance and temperature extremes.

4.3 Upward Movement of the Treeline Ecotone

The photo pairs in both MRPP and WWP showed visible changes in treeline into high elevations. Upward movement of the treeline ecotone was seen much more prominently in WWP, likely due to the presence of the Upper Foothills subregion which in the past was frequently burned under indigenous use and has a more frequent natural fire return interval. Discussed very little for MRPP, treeline advances are nonetheless occurring, but to a lesser extent, possibly due to the different topography, climate and ecological conditions. The particular photo pairs available for MRPP did not highlight this kind of long-term change to the extent that they did in WWP. Only one participant from MRPP discussed treeline advance up valley slopes, which is detailed below. In WWP, upward movement of the treeline ecotone and infilling up slopes was observed by several participants (WWP 5, 7, 8, 10). However as one participant explained, they saw no consistency between ecotones and while some valleys and slopes had undergone dramatic change, others had very little (WWP 8). This section is organized within two subthemes; the threat to high elevation ecosystems, and treeline advance influencing fire behavior. Relevant photo pairs are interwoven within each.

While not resting within each of the following subthemes, one MRPP photo pair brought discussion around upward movement of the treeline ecotone. Shown in 4.2 in Figure 53, the Moose Lake West #1 station panoramas display upward movement of the treeline ecotone along the valley walls leading to the Moose corridor, as well as some infill around the valley bottom creek. Climate change was mentioned as a potential cause, as well as a theory that a reduction in mechanical disturbances like avalanches could have allowed more slope ingrowth to occur over time (MRPP 4). From my evaluation of the photo pair, there appears to be some ingrowth into well delineated avalanche paths, however a densification and expansion of lower elevation stands is more prominent.

The Threat to High Elevation Ecosystems. In WWP, restoration and monitoring efforts for species at risk are being challenged by treeline advances into the subalpine. As one participant expressed, the "upward movement of subalpine fir and Engelmann spruce will make rehab[ilitation] work on whitebark [pine] difficult. Screening for blister rust resistance [is] ongoing elsewhere, [and] planting programs will be difficult due to access" (WWP 10).

In WWP, upward movement of the treeline ecotone into the higher elevations is illustrated by the Nidd Station 15 panorama pair (see Figure 50 in 4.2). Tree infill and stand aging were noted as appearing quite widespread (WWP 8). One participant found a dilemma in seeing the area from 1944 having a much less dense and younger forest cover. They explained that in managing for various species in the park, different forest types and maturities are preferred. For woodland caribou, the assumption is older forests, while several other species prefer younger stands and more open areas to graze (e.g. bighorn sheep, elk, deer, mountain goat) (WWP 8). Without data from those years to know caribou distributions, it is hard to tell how the larger areas of younger forest were affecting them historically.

Upward movement of the treeline ecotone was seen to reach ridgelines in these panoramas, which concerned participants. In particular, several participants discussed the ecological risk resulting from forest cover encroaching into the highly-diverse subalpine and alpine meadows (WWP 7). The treeline advances were deemed a threat to biodiversity, as the alpine meadows were estimated at ten times the diversity as a typical mixed conifer valley bottom community (WWP 7, 8).

Treeline Advance Influencing Fire Behavior. The upward movement of the treeline ecotone visible in the Nidd Station 15 panorama was accompanied by Lambart's Station #51 photo pair showing similar processes occurring up the slopes of a remote valley at the far southwestern boundary of WWP (Figure 49 in 4.1). Both of these stations brought concerns over multi-valley fire potential (WWP 9) and climate change was mentioned as a potential cause (WWP 5, 8), but a challenge well beyond parks management (WWP 8).

Through piecing together the insights of participants, I've gathered the following explanation for why this causes such concern. When treeline increases to the point of connecting valley systems via alpine ridges, there are massive implications for fire behavior and natural disturbance cycles. The spreading potential for fire into the future with climate change and continuing treeline advance would be unprecedented. Fires would no longer be bound by valleys or rocky alpine zones, and widespread spotting[10] could occur. Insects and disease would also spread more easily (WWP 7), and perhaps all disturbances would be influenced (WWP 9) such as avalanches and rock slides. In conjunction with valley infill occurring, as discussed in 4.2, denser forests and continuous fuel are seen as a precursor for large fires and serious community concerns (WWP 9). In discussing the danger of these long-term changes, one participant expressed their concerns by comparing the Lambart photo pair:

> "So depending [on] where you are in the Willmore, in this case there's a lot of rock and this creep up [referring to treeline elevation increase], isn't an issue from the fire standpoint. In other [emphasis] areas of the Willmore, if that treeline creeps through the alpine, that implies larger fires. That is, it could be the mechanism for moving fire from [one] valley to another. And my observations in there [are], most of those fires were generally [emphasis] associated with a valley for a reason [emphasis]. There's either rock or high elevations and there's moisture differences. And for example here, this old fire looks like it didn't go out of that valley. But, assuming that that was all treed eventually in another 50 or 60 years, then there's a mechanism for fire spread that wasn't there historically." (WWP 9)

[10] Spotting is when fire can jump ahead of the main fire front, often by wind or fire whirls. The fire can jump short to long distances, which range from tens of meters to tens of kilometers (Albini, 1983)

Summary. To conclude, this section has discussed the theme of upward movement of the treeline ecotone in WWP and MRPP. While participants from WWP placed greater emphasis on the significance of these changes for their management efforts, these changes are nonetheless being observed in both parks. Difficulties have arisen in the restoration and management of species at risk such as whitebark pine, which faces encroachment and increased blister rust pressures. Diverse alpine meadow communities are also of concern due to encroachment. Lastly, the evolution of fire behavior following long-term treeline advances has brought significant cause for concern to managers, who see increasing risk of multi-valley fires, easier pest and disease transmission and potential impacts on other natural disturbance regimes.

4.4 Homogeneity of Forest Stands

The fourth theme to be discussed is homogeneity of the structure and composition of forest stands. This landscape level condition was noted for both WWP and MRPP, and participants from each park offered different explanations for what they believed was the cause. To organize the description of this theme, two main subthemes are used. To begin, the issue of homogeneity as a risk to ecological robustness is discussed, with a particular focus on MRPP as this subtheme was limited to those discussions and photo pairs. Secondly, the question of historical homogeneity is addressed following several photo pairs, which to their ability show very little visible change in forest stand composition.

Homogeneity Reducing Landscape Robustness Against Disturbance



Figure 54: Wheeler's Yellowhead Pass Station, looking west across Yellowhead Lake; MLP 2012 (left) and Wheeler 1911 (right)

For the MRPP focus group, photo-elicitation began with Yellowhead Pass Station at 6,203 ft. The photo pair is looking west along the valley corridor towards Yellowhead Lake and the Upper Fraser and Giette Creek areas (Figure 54 above). Participants agreed that there were more forest species and stand diversity illustrated in the 1911 historical image, and more human activity in the valley displayed in the repeat image (MRPP 1, 2, 3, 4). The forest was seen to be aging and losing heterogeneity over time. This uniformity reduces resistance and resilience against natural disturbances such as fire, pests and disease epidemics. Managers said they wanted to prescribe burns to specific areas to increase ecological diversity and robustness (MRPP 1). These findings strongly correlate with long-term fire suppression leading to decreased diversity and the loss of a more varied landscape "mosaic". As one participant noted,

> "Exactly. I mean what you ended up with a hundred years ago, you had a landscape with a whole bunch of jigsaw pieces in it. And over time and human encroachment and development and, the almighty dollar, there's fewer and fewer and fewer and fewer pieces in that landscape and that jigsaw puzzle. So, there's pieces [emphasis] there, but there are huge [emphasis] pieces, and when they get sick, they get really sick" (MRPP 1)

Slope infill was also observed at this station both through the photos and first hand during the field season. As described in 3.2.1.2.3.1, once we located the station, we were almost completely blocked in by trees. The station, having been relatively open when Wheeler chose it in 1911 as a rocky nub, is now being encroached upon by the surrounding forest. This is likely a change also associated with fire suppression.

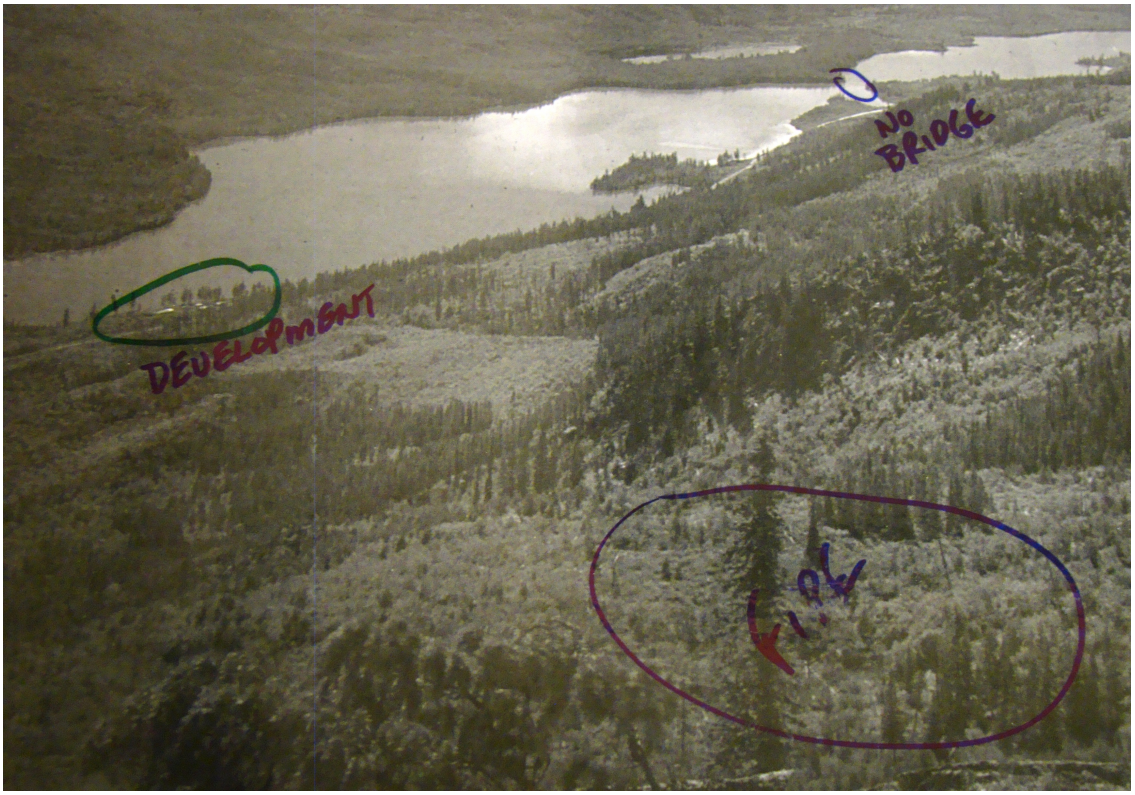

Figure 55: Annotated historic capture from Wheeler's 1911 Yellowhead Pass Station showing historic fire and subsequent forest heterogeneity

Historically Homogenous? The next photo pair is also from Yellowhead Pass Station showing Mount FitzWilliam. The participants and I found the forest cover and composition in this view to be very homogenous in composition and evenly aged (MRPP 1, 2). It was difficult to discern a difference in stand age from that of the 1911 photo, and the photos looked quite similar to both the participants and myself.

However, just because evidence of an event is not shown in photos does not mean it did not occur between the times of historic and repeat capture. Corroborating with other data illuminated the possibility that the forest may have completely burned in as a result of railway construction through the valley, which took place following Wheeler's 1911 survey. By 2012, the forest would have experienced over a century of regrowth. In this particular situation, there is strong potential for landscape change to have occurred between the historic and repeat photo capture dates, with the ecosystems having gone back to a similar state during that period of time. While no concrete evidence exists to confirm this, the first-glance continuity observed in this image pair could in fact just be similarity.

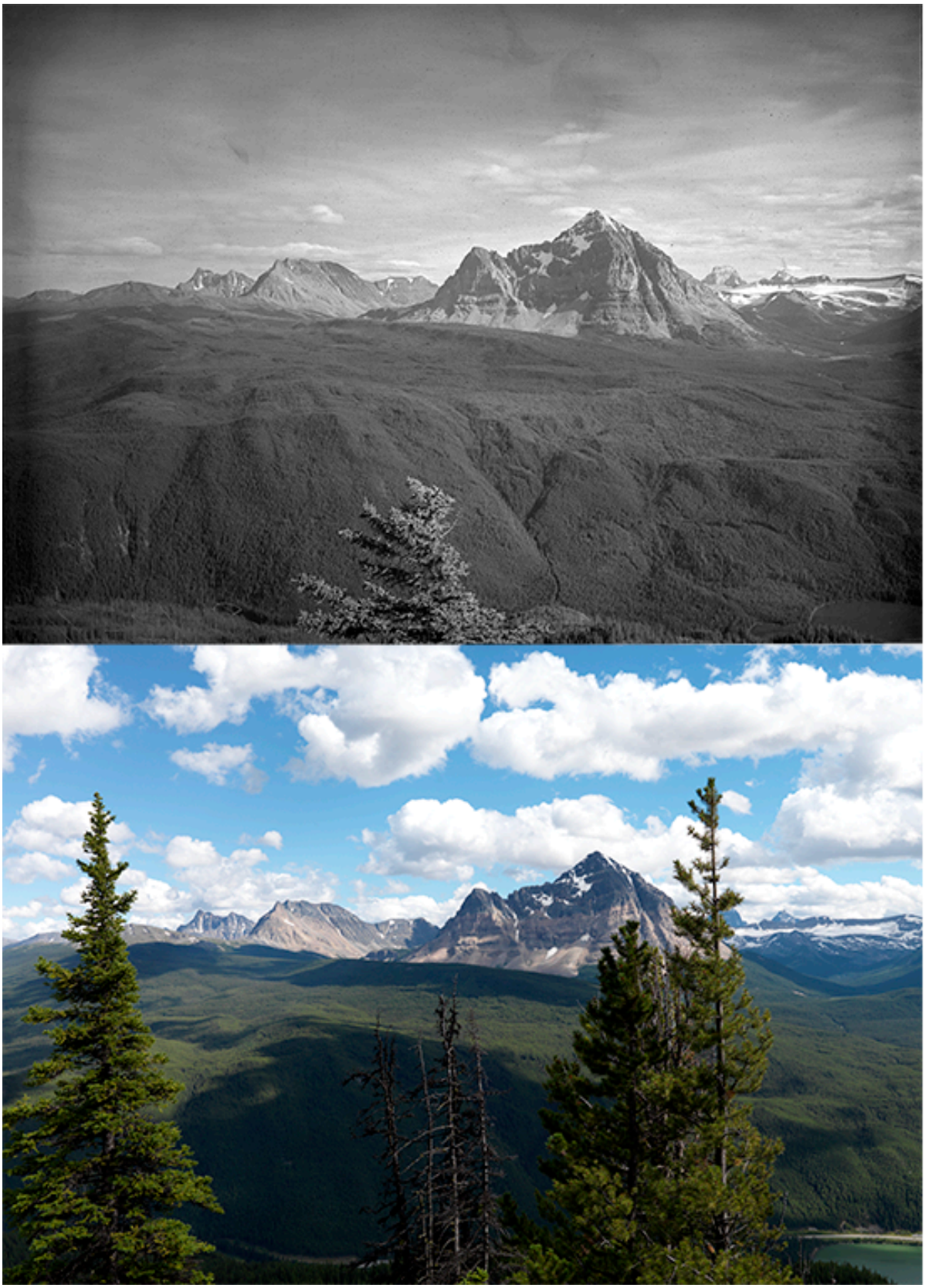

Figure 56: Wheeler's Yellowhead Pass Station, looking south towards Mount Fitzwilliam; Wheeler 1911 (top) and MLP 2012 (bottom)



Figure 57: Spider Station #247; Wheeler 1923 (top) and MLP 2007 (bottom)

The third and last photo pair for this theme is from Wheeler's 1923 Spider Station, which looks north towards Jackpine Bend and the meadowlands from an elevation of 7,688 ft. As shown above by Figure 57, the historical photo displays a valley equally as dense and homogenous as the present day conditions. While the participant discussion of this photo pair was limited and was largely focused on the fire scar visible (peaking out from behind the midground slope), I found several landscape changes worth noting. These included an increase in treeline up the midground slope towards Draco Peak. Also, there is evidence of a recent fire behind the main slope, which participants confirmed was the 2006 Jackpine fire, discussed in earlier chapters. I also noticed a slight densification of forest cover along the Jackpine River and around the small clearings in the valley bottom.

Participants offered the most likely forest compositions and fire intervals based on slope aspect and location in WWP (WWP 3, 9). In general, the west-facing midground slopes shown in this photo pair are most likely a mixture of species such as Engelmann spruce, balsam fir and subalpine fir with a long fire return interval due to more damp and cool conditions. This long fire return interval could explain why the forest composition looked quite similar, accompanied by only slightly denser forest cover and upward movement of the treeline ecotone into the higher elevations.

Summary. Long-term changes in forested ecosystems present a significant challenge for management throughout MRPP and WWP. One of these changes is an increase in stand structural and compositional homogeneity. Participants have offered both fire suppression and forestry as reasons for this loss in stand diversity. These changes have left park landscapes in growing danger of massive fires, disease and pest epidemics. Following decades of the "Smoky the Bear" mentality, the necessity of returning fire to the landscape is now well accepted. Managers want to prescribe burns to specific areas to increase ecological diversity and robustness. The subsequent complexities of fire management are discussed in detail in the following theme in 4.5.

4.5 Wildfire and Prescribed Burns

Attending to numerous ecological needs across a landscape is very difficult, particularly when the agencies involved have different mandates and objectives. In WWP, there are two distinct "camps" when it comes to prescribed burns in the park. Following agency affiliations and responsibilities in the park, participants were divided as to the level of importance and necessity of fire on the park landscapes at an ecological level. As a result, prioritization of returning fire through prescribed burns varied.

Nevertheless, nearly all participants explicitly acknowledged that fire could have benefits ecologically. The importance of managing fire for community safety and outside stakeholder interests was not contested. It became apparent through participant comments that this is more of an issue of incongruous priorities than a different understanding of ecological communities and processes. Managers between the agencies are balancing two sets of management priorities for the challenge of fire management, which necessarily impacts all other management aims. As one participant said, "What might be good for this, is not good for that, or what might be good for this, is not good for that. So to try and strike that balance if you did invoke some type of

management… it's really challenging. Whereas, historically those constraints weren't there" (WWP 3).

Fire and Biodiversity. Long-term forest ecosystem changes are the dominant cause for managers to discuss intervening in more remote ecosystems in the two parks. The role of prescribed burns for supporting biodiversity was discussed. This remained a dominant topic when discussing prescribed burns in MRPP and in the AB Parks focus group for WWP. In the AB ESRD focus group for WWP, biodiversity was discussed much less than other factors involved in fire management decisions. These other factors are discussed below, and include (for both parks) species at risk habitat, catastrophic wildfire risk, and the protection of communities and commercial land use interests.

Following years of fire suppression, what one participant deemed "biodiversity burns" can have great benefit. Accordingly, the areas considered the most diverse in the park are also those having been under “let burn” conditions. In MRPP, this was centered on the Upper Fraser and Geitte Creek drainages. Participants explained that these areas have not been managed; fires are let-burn, priorities are for “four-legged species” over humans, and there is no management assistance for visitors to explore those areas. The Upper Fraser is zoned Wilderness Conservation, and is considered to be remote despite its proximity to the Yellowhead Highway and other linear developments.

While no hard evidence has been collected to support this, several participants from AB ESRD emphasized the improvements in habitat and diversity following several large fires. One participant noted sightings of moose and bear, and increased habitat for those species following a fire. Benefits to whitebark pine recruitment was also mentioned, however also anecdotal (WWP 2).

Seedling recruitment is not the only difficulty stemming from fire suppression. Managers in WWP have observed an increase in blister rust cases in the park's whitebark pine populations. In addition, strong populations of an alternative host for the blister rust, *ribes* (gooseberry) is potentially increasing in number around whitebark pine populations. Participants described this as a forest health issue relating to fire regimes (WWP 6, 10).

Participants from WWP emphasized that as the park is considered a biodiversity benchmark, management is required to balance the needs of multiple species alongside landscape processes of fire, pests and disease. As participants from both agencies explained, when placed in the difficult position to choose, species' needs necessarily receive priority over fire. Fire is managed (limited) for species' requirements, but as seen with whitebark pine, this quickly gets complicated when species require fire. A notable example of this is for woodland caribou.

Woodland Caribou and Fire. In recent years, difficulties surrounding caribou and fire management have peaked in WWP. As discussed in 2.2.1, caribou populations have been declining for many years throughout the province. Simultaneously, the forests in WWP and MRPP have been aging following many decades of suppression. Both of these issues have, over the long-term, reached a tipping point by which managers' hands are tied. The aging forests are seen as a "ticking time bomb".

In WWP discussions, the Jackpine fire on July 4, 2006 was noted frequently. Photo pairs (e.g. Courier Mountain Station Figure 64) showed evidence of the fire's direction and behavior, with a sharp j-hook back upslope towards the end of its run. One participant noted that a previous

fire had occurred on the adjacent slope in 1981 (WWP 1). The importance of protecting pre-existing structures (i.e. an outfitter's cabin) from the fire was emphasized.

Following the 2006 fires (most notably the Featherstonehaugh and Jackpine fires), there have been expectations of full suppression in and around caribou habitat in WWP, regardless of where it is in the park. For instance, following the zoning stipulated in the WWP Fire Management Plan, a large portion of the park has been denoted a natural fire zone. Following the increasing federal and provincial pressure for caribou conservation, suppression may be required in the natural fire zone. Not all participants involved agree on a personal level, but overarching agency support is there for this decision. One participant said of WWP,

> "It's a refuge for caribou right now, obviously. As we get more development on immediate, adjacent landscapes. [S]o, fire's not necessarily good. It was ok, a fire like this, back in the day [referring to historic photo showing a burn in western reaches of WWP], probably wouldn't have much impact on the caribou populations because they had other areas to go to [emphasis]. But now if you had that extensive [emphasis] fire on a place like this now [referring to repeat photo], then likely, it's [going to] have a different result. And impact on your caribou populations potentially." (WWP 3)

A panorama pair from WWP was discussed in relation to wildfire, woodland caribou and prescribed burns. The photo pair is one of three that were combined into the panorama; photos were taken from Wheeler's 1924 Station at 7,500 ft. Local topography can be seen in Wheeler's 1924 map, and the full panorama is downsized (Appendix F Figures 67 and 68 respectively).

On June 26 2006, the Featherstonehaugh fire swept through the Sheep Creek Valley. With a wide valley, strong winds and continuous fuel, the fire had potential to go through a vast area and leave the park in the worst cast scenario. One participant commented that the fire resembled something they would expect 300 or 500 years ago. The fire would be stand replacing, burning all slopes just as well, across and down entire valleys (WWP 9). North slopes were burnt in the fire, visible in the photos. As a result of this fire behavior (less common to have north or east-facing slopes burn), the Featherstonehaugh fire also sparked concerns about human community protection.

The Sheep Creek South panorama encouraged a discussion about caribou in the park. Concern was expressed that since the fire was so severe and covered such a large area (14,500 hectares), there was little residual area for ungulates to use to go around the burn. There have been concerns about applying prescribed burns to areas in WWP that offer some of the last remaining caribou habitat. Worries also exist about not quickly containing any wildfire in those areas. On the other hand, there is some evidence that they don't completely avoid recent burns. A year after the fire, it was seen that a few GPS-collared caribou ventured out into the burn, likely for insect and predator avoidance (WWP 1). This claim was directly contradicted by a participant in another focus group, however, who felt that caribou avoided recent burns (WWP 8).



Figure 58: Wheeler's Sheep Creek South Station #292, first section of panorama; Wheeler 1924 (top), and MLP 2011 (bottom)

Debate as to burn an area or not occurs in MRPP along similar lines as it does in WWP. While only one of several important factors of consideration in fire management planning, caribou habitat is of high priority. For instance, upon seeing the species' use in one more remote area of the park, the Upper Fraser, managers in MRPP decided to cancel the planned prescribed burn. As one participant said of this,

> "[T]he Upper Fraser is a pretty good example because you might think well that sort of defines wilderness in the park. So you might think logically [emphasis] that would be a good candidate for let-burn. But once you look further into that issue and you realize that it's a fairly important, caribou high winter range, and they're terrestrial lichen feeders, they're not crater eaters, they're eating off the trees.[11] We [have got to] put fire out in there. And it's interesting to see that because you've got one species here that might trump what you think is important. And the Upper Fraser is a good example. We had, a prescribed burn scheduled in there that we didn't do because of a couple of years going in there and seeing what kind of use caribou were doing in there." (MRPP 1)

In the case of the Upper Fraser, ecological studies informed managers of wildlife habitat usage, and fire management plans were adjusted accordingly. However, managers feel that there is not always sufficient ecological data to satisfactorily inform decisions. While expressed in both parks, this was given greatest emphasis in the WWP focus groups. As previously discussed in 4.1 in relation to the overall management of remote ecosystems, a lack of ecological monitoring data also adds difficulty for managers planning prescribed burns.

Barriers to Prescribed Burning and Let-burn Areas. As the above two subsections have shown, there can be significant restoration potential when prescribed burns or let-burn designations are used appropriately. Participants from MRPP expressed that they saw this potential in altering fire regimes towards a more natural state, but that multiple barriers were in place, making these efforts very difficult if not impossible.

These barriers are found in both MRPP and WWP and include the ecological, social and political conditions surrounding each park. Implementation of active fire management initiatives is made more difficult by ecological factors of aging and increasingly homogenous forest stands that represent high fuel availability and significant crown closure. With upward movement of the treeline ecotone, the threat of large-scale wildfire, increased by the above stand changes, is worsened yet as fire now has the opportunity to jump valleys over ridges previously unvegetated. These ecological changes have been observed in both WWP and MRPP.

Sociopolitical barriers to fire management present difficult contradictions for managers. On one hand, the protection of surrounding human communities, infrastructure and commercial land use interests is quite high and ultimately is the top priority for all fire management in the parks. However, to do so often requires managers to put in small prescribed burns as fire breaks or capping units within park boundaries. These are preventive measures to reduce the risk of fires becoming too large and/or escaping park boundaries. Meanwhile, there are also increasing expectations of managing for species at risk habitat such as woodland caribou. While fire is of benefit to certain species and habitats, not all respond well. Managers are expected to balance these needs without imperiling vulnerable wildlife populations or surrounding communities.

[11] Caribou that are ground lichen eaters access those lichens in winter by pawing through the snow which is called cratering. When the snow depth is too extreme they focus on tree lichens.

Summary. To conclude, this section has discussed the various challenges and current focuses of fire management in the two parks. Divided into two dominant subsections, we began with an overview highlighting the balancing act that managers face when dealing with fire. With several critically important factors to account for in decisions made, the natural fire regime is at times altered in areas of the parks that managers would prefer to have as let-burn. Prescribed fire can be a very valuable tool in landscape-scale management efforts and provide landscape and habitat diversity. However, there are also several species at risk such as woodland caribou that take priority, even before preventative fire breaks.

While AB ESRD managers in WWP have several prescribed burns, capping units and fire breaks that they would like to complete, and the capacity to do so, AB Parks' mandated priorities tend to leave biodiversity and species at risk goals above those of forest management (seral stage distribution, fire risk, etc.). In MRPP, managers are working on a smaller scale in terms of fire management resources and dedicated staff. As a result, prescribed burns are less of a management focus and were given less emphasis in discussions.

4.6 Philosophical Differences and Interagency Collaboration

This sixth theme is centered on the circumstances in WWP, where multiple agencies are involved in the park's management (see 2.2.4). The influence of multi-agency priorities can complicate decision-making and on-the-ground actions. Philosophical differences between management agencies and the relatively recent changes in agency responsibilities was given great emphasis throughout focus group discussions.

There was clear divergence between agency descriptions from AB Parks and AB ESRD, which perhaps speaks to the perceived philosophical and procedural divides between them, more so than irreconcilable overarching goals. Descriptions of "sustainable use" and "conservation" were offered for AB ESRD (WWP 3, 8), and "protectionism", "preservation", "recreation" and "conservation" were offered for AB Parks (WWP 3, 6, 8). Interestingly, both agencies described themselves as being "conservation" driven, yet felt that priorities did not align satisfactorily. As one participant explained,

> "…when we come into a meeting like this and we're all sitting around, we have a series of MOU's that say, "SRD is the lead on fire, and they consult with Parks" and so on. Sort of clarifies our roles. We come to the table with what I would describe as nothing short of, fundamentally different perspectives. From conservation viewpoints, from operational viewpoints. And it's a good thing, I think the two are both needed and required… giving government mandates and what people expect from natural resources and so on. But we definitely do bring a very different perspective, and so the shift 10 or 15 years ago into Alberta Parks I think is a significant one. [E]verything from fire management to endangered species I think was approached a little differently maybe from a little more of a conservation-based perspective than maybe it was before… I would say, in one sentence it would be managing for sustainable use versus managing for conservation." (WWP 8)

A total of 35 comments directly emphasized these conditions. These comments were interwoven with nearly all other management challenges, particularly in the more remote reaches of the park. The specific challenges that these differences create are discussed when applicable in the other themes. Themes that are directly impacted by this interagency collaboration include the following; management of remote ecosystems (4.1), and wildfire and prescribed burns (4.5).

Summary. Due to the joint management efforts of AB ESRD and AB Parks, the latter of which is the official lead, difficulties have arisen when balancing multiple perspectives and management priorities in WWP. Over time, interagency collaboration efforts are becoming more fruitful, however this relationship was nonetheless noted quite frequently by participants and seen as a more significant challenge to managing remote ecosystems than the inherent logistical and access issues present in WWP.

4.7 Societal Shifts Impacting Management

The social, economic and political conditions surrounding management in WWP and MRPP weigh very heavily on park decisions. Efforts in remote ecosystems are no exception. Participant comments on the influence of societal conditions were mentioned throughout all discussions (WWP 1, 3, 5, 6, 7, 9, 11, 12; all MRPP participants).

MRPP participants shared concerns related to changing social values, as visitor uses and expectations in the park are changing and this has influenced management prioritization of time and energy (MRPP 1, 2, 3, 4, 6, 7). In WWP, participants shared concerns related to changing social values over time (WWP 1, 3, 6), and a resulting loss of connection to the land (WWP 6) and destructive behavior (WWP 2, 5). Changes in visitor use were also expressed (WWP 5, 9, 12), and it was felt that high level decision makers were using a wide academic lens for parks issues that needed to be balanced with a more practical approach incorporating user perspectives (WWP 3, 6). Resource extraction activities were felt to be increasing quickly around WWP (WWP 11), while staff capacity is limited (MRPP 1, 2, 5, 6; WWP 7). Alongside this, an incongruous benefit scale was seen between industry (immediate benefits) and ecological issues (long-term benefits), which left managers at a severe disadvantage to respond to external pressures (WWP 1, 11). As one participant said with regards to managing the multitude of interests in and around the park, "if it was easy [emphasis], we could all be either environmentalists or arsonists, right? …So when we talk about park management and park management planning, it's not about managing parks, it's about managing people" (WWP 6).

The following four sections will discuss each of these topics in detail as individual themes of analysis. For clarity I have grouped these four themes under this broader category of societal shifts impacting management. However this is not in and of itself a specific theme. The themes are as follows: changing visitor use (4.7.1), industrial development and capacity (4.7.2), and public education (4.7.3).

4.7.1 Changing Visitor Use

The first of four themes related to broader social conditions is changing visitor use. This theme became apparent early on, as managers strongly emphasized the fact that park users are a different breed today than they were even in the recent past. The amount and kind of use has changed in both parks. Participants from both WWP and MRPP have deemed this a result of an overall societal shift (WWP 3; MRPP 1, 2, 3, 4).

Changing social values in recent decades has left managers in MRPP with far less visitors venturing into the park backcountry (MRPP 3). Described as "restlessness" (MRPP 3) and "a birder trying to add to his life list" (MRPP 1), the fast-paced "see it and leave" mentality is

becoming increasingly common among park visitors (MRPP 3). One participant described this as a culture of needing to be busy all the time, or you are wasting time; visitors tend to multitask even when in the park, and few people just sit and read at their campsites or have time for introspection (MRPP 1).

A higher level of comfort is expected, more visitors are flying in via helicopter to Berg Lake, and the average age is increasing (MRPP 1, 2). As participants explained, the Berg Lake trail gives a safe quasi-wilderness experience that you can do round-trip in a matter of days (MRPP 2) while still being heavily managed (MRPP 6). A trip into the remote reaches of MRPP requires a commitment of time, effort and patience that is less feasible for a busy lifestyle (MRPP 3). The impacts of social values (changing or otherwise) were mentioned in MRPP discussions 18 times.

A similar story is seen to be unfolding in WWP. Managers there are also noticing fewer visitors going far into the backcountry, and the game hunting seasons are the major draw when they do (WWP 9). With the main road access in the east, the majority of use is in the eastern reaches (WWP 1). Several participants felt that fewer backpackers, horse packers and mountain bikers have been seen over time (WWP 1, 9) but this was not a consensus (WWP 12).

Trail maintenance by users is less consistent, with fewer regular outfitters cutting back the primary trails (WWP 9). With the trails being encroached upon and the rivers washing out in recent years, it is increasingly difficult for hikers and bikers to get around in the park (WWP 9). Nonetheless, there is pressure from external organizations to clear more trails in WWP, and even to build skiing facilities to boost Grande Cache tourism (WWP 1). With AB Parks' wildlife goals and a general decrease in backcountry use, this has raised concerns over the need for these initiatives, and ecological consequences for remote areas preferable for wildlife habitat (WWP 1).

Less Pressure on Managers and Ecosystems. In several ways, this shift in visitor use away from the backcountry is a very good thing for managers already stretched thin on the ground. If people are rushing through and not going as far into the park, there's less area for managers to deal with, in terms of visitor safety and visitor impacts. There was a general consensus that this was a positive for their work and for the parks' ecosystems. One participant felt that this reduction was a good thing as it put "more use in a smaller area, and confining those human impacts" (MRPP 1). This is also of benefit in WWP, where managers are faced with a notable challenge if ever an incident should occur in the backcountry. Helicopters are the only way to get people in and out pragmatically, so there is a hope that visitors who venture out to the backcountry know what they are doing and are being safe (WWP 7). Risk of accidental fires is also reduced with fewer visitors (WWP 12).

Summary. Patterns of human use are changing, and visitor use in parks is no exception. Seen by participants as due to a larger societal shift over time, changing uses include fewer backcountry visitors and shifting user expectations and needs. Following this reduced use of remote ecosystems, there is less demand or need for rangers to go back and maintain trails and keep an eye on conditions. However, ecological changes continue in these areas.

With the Berg Lake trail being one of the most heavily managed trails in the BC Parks system, managers are faced with growing expectations of luxury wilderness experiences and fast-paced visits. In WWP, the majority of use remains in the eastern reaches or for game

hunting, with the user-maintained backcountry trails gradually overgrowing. The backcountry reaches of both parks have become less maintained and more difficult to traverse. External pressure to increase trail access exists despite these changes in visitation.

4.7.2 Industrial Development and Capacity

The next theme to be discussed is industrial development. For managers of both parks, the external pressures of commercial land uses is felt and influences management efforts in different ways. Challenges surrounding limited resources and capacity were mentioned frequently, a total of 11 times in the MRPP focus group and 16 times in the WWP focus groups. Industrial development was mentioned even more, with a total of 14 comments during the MRPP focus group, and 12 comments during the WWP focus groups. Interviews did not cover these topics.

In MRPP, this is predominantly through an increasingly unbalanced relationship between industry and parks and resource management. With industrial development in BC rapidly increasing, the capacity of lands managers is not keeping up, and is generally dropping. In WWP, industrial development around the park is ongoing, and this leaves great expectations on managers to prevent any disturbances like fire or mountain pine beetle from leaving the park and impacting those land use interests. The following discussion is structured within three subsections; an imbalance in capacity, industrial pressures around park boundaries, and industry in the parks. This will be followed by a short summary, and then I will move ahead to the next theme of public education.

An Imbalance in Capacity. An imbalance was felt between resource development in BC and the capacity of Parks and the Ministry of Environment to protect land (compliance, enforcement, ecologists, etc.) (MRPP 4). As industrial resource development continues to ramp up at an unprecedented rate, the number of government employees managing natural resources and protected areas is dropping. One participant expressed that it would be alright if industry wasn't increasing at such a fast pace, but since it is, then parks management needs to be adequately strengthened as well with "an equal backing of scientifically based, sustainable and technical expertise" to effectively manage the land and deal with all of the development (MRPP 4). Another participant from MRPP was in agreement, and acknowledged that while other societal needs necessarily come before parks management, a balance is still important for long-term resource use and conservation.

> "We did a conservation training school at Naramata in the Okanagan to get everyone up to speed on ecological processes and to keep an eye on incremental change and how to measure it. But the focus is now on places that create revenue. [T]here's no money in wilderness. I mean I can understand that. You know, when we've got people waiting 6 months for hip replacement surgery, I can't whine about not having more rangers. I would like [emphasis] more rangers, but I don't think it trumps other societal needs, and I think there [are] other things that are more important at this time in our history. But, I'll preface that by saying... it's fine if we don't screw with it. And we don't alienate it, and we don't allocate it [f]or uses that are unsustainable, or perhaps we're not going to be able to back out of in the future." (MRPP 1)

Many people have left BC Parks in the last ten to fifteen years from attrition and retirement without refilling positions (MRPP 2, 4). Several participants commented that they had personally experienced significant attrition in their workplaces during their own careers (MRPP

1, 4). Concerns exist that this is not sustainable with increased development, and makes effective information transfer, mentoring and maintenance of a deep agency knowledge base very difficult (MRPP 2, 4). One participant felt that despite this having made staff members "generalists" capable of dealing with a variety of things, the mentoring capacity was negligible and the agency was on a cusp of change moving into the future with many staff nearing the end of their careers without mentored replacements (MRPP 2).

If there were increases in capacity for MRPP, it would not be going to monitoring work in the remote areas of the park. Patrols and more staffing in high use areas would be top priority (MRPP 7). This would be both for visitor safety and for park safety from visitors. Currently, there is a heavy reliance on the backcountry ethic and public education to encourage visitors to be respectful while in the park (MRPP 7).

Industrial Pressures Around Park Boundaries. In WWP, boundary use pressures were given emphasis, particularly in relation to fire management and broader ecological inventories and monitoring of game species (WWP 3, 6, 11). One participant expressed great concern over increasing industrial activities around the park. With logging coming closer with time, as well as coal, oil and gas extraction along several boundaries, changes have been seen through wildlife monitoring efforts (WWP 11). Monitoring has shown that the Cadomin coal operations (Teck) in the Athabasca drainage has emptied the area (and parts of Jasper National Park) of bighorn sheep (WWP 11). It was felt that the industrialization of the surrounding landscape (lacking restoration) in conjunction with climate change served as the largest conservation challenge for managers, as this development creates a "disturbance halo effect" (i.e. edge effect) which impacts wildlife and ecosystems in the park (WWP 11).

In combination, the pressures of industrial development and community protection were given particular emphasis 30 times across both focus groups and all interviews. With external influences unavoidably entering the park and impacting wildlife and fire planning, there is little managers can do to reduce those drivers. One participant offered that "the temptation is to put a fence around it there and say, "we [have] got [to] protect this" (WWP 3).

Industry in the Parks. In both WWP and MRPP there have been several instances of industrial development activities within park boundaries. In WWP, this including shaft mining operations and exploration rights for mining in the eastern reaches from roughly Rock Lake to Eagle's Nest Pass. Evidence of these activities remain to this day, however are gradually being overgrown. Seismic and coal exploration roads from the 1950's were constructed in the eastern reaches of the park, and an old steam engine and buildings from the mine remain on Snow Creek (WWP 1).

In MRPP, this involvement began before the park was created and continued to expand today. Discussed at length in 2.1.3 and 2.1.4, there are several linear developments along the Yellowhead corridor including a twinned Kinder Morgan Canada pipeline, the Yellowhead Highway, a fibre-optic line and two rail lines. The pressure of these developments on the ecological communities in MRPP has been long-term and gradually increasing as new activities occur. Managers nonetheless feel optimistic about the restoration efforts of Kinder Morgan Canada following the 2008 twinning operations, and the $2.2 million fund for "ecological improvement projects" (MRPP 1). The earliest and longest standing industrial development in MRPP have been the railways. The photo pair below shows an example of the 1910-1915 period of railway construction and its resulting valley fires.



Figure 59: Wheeler's Moose Lake West #2 Station; Wheeler 1911 (left), and MLP 2012 (right)

This historic photo shows a widespread fire scar localized along the valley bottom, and suggests that a valley fire had already gone through the eastern reaches of the Yellowhead corridor at the time of Wheeler's 1911 Mount Robson Survey. This would correlate to the documented timeline of valley fires associated with the 1910-1915 double railway construction. Several valley fires were set during railway construction to ease operations and clearance through an infamously dense and difficult landscape. Intentionally set, these fires would be departing from the natural fire regimes of the area. The forests now seen in the repeat photo are the result of those widespread, stand-replacing fires, which left large swaths of the landscape at the same seral stage, reducing heterogeneity. As discussed in the previous themes 4.1 through 4.5, the long-term forest ecosystem changes have led to many management challenges in both front and backcountry ecosystems in WWP and MRPP.

Summary. To conclude, the pressures of industrial development in and around the parks, in conjunction with capacity limitations, has left managers facing significant challenges for managing remote ecosystems. In MRPP, industrial activities have come into the park since before its creation, and today the Yellowhead corridor is highly developed. Long-term landscape change having begun with railway era valley fires are becoming increasingly problematic for

managers dealing with fire risk and homogeneity in forest stands. Overall, capacity in parks management is seen to be decreasing (particularly for MRPP) while industrial development continues to increase in both provinces. In WWP, land use activities such as forestry, oil and gas extraction and coal mines are impacting wildlife distributions. Managing fire risk to protect outside commercial interests places additional pressure on managers.

4.7.3 Public Education

As the ninth theme of this study's findings, public education is the final theme that falls within the greater category of societal shifts impacting management. Managers in MRPP and WWP take great care to involve the public in management planning and in decisions that will impact park users. However, sometimes more outreach is needed to inform the public on what the ecosystems of the park need. A total of 24 comments related to public education during the MRPP focus group and interviews, and four during the WWP AB Parks focus group. The AB ESRD focus group did not discuss this theme.

Broken into several subsections, this discussion begins by exploring the challenges that managers face in dealing with the public's understanding of natural disturbances. Subsequently, the issue of insufficient interpretation programming for MRPP is discussed. This theme will then close with a short summary before moving forward to the final theme of this study's findings, climate change.

Understanding Natural Disturbance



Figure 60: MRPP Moose Lake Prescribed Burn, 2004 (Safford and Dobson, n.d.)

Participants shared their views regarding the challenges in managing for ecological processes and fire regimes within the expectations of the general public. Particularly for MRPP, participants expressed concern for a disconnect with the general public, worrying that the public doesn't grasp what needs to be done to achieve conservation goals. This makes some direct actions a "harder sell" at times, especially where prescribed burns are concerned, or something

that may be perceived as damaging the environment, however temporary (MRPP 4). Participants from MRPP in particular placed emphasis on the need to improve public education and awareness about what natural disturbances may look like, and what restoration is trying to achieve, as this could be very beneficial to help smooth the processes of implementing of these efforts.

Having the public on board with management decisions cannot be understated. Experienced in WWP as well, having a social license to operate is important (WWP 6). One particular challenge has been in planning and implementing prescribed burns in the park along the Yellowhead Highway (MRPP 1). While fire regime dynamics and ecological cycles therein may allow an ecologist or park manager to appreciate a recent burn for various benefits, tourists driving by on Hwy #16 may see this as a devastated and destroyed landscape (MRPP 4). Meanwhile, the areas are simply cycling through different stages. A thick, green forest is not necessarily healthier than a recently burned one.

It was seen as important to get away from the idea of having all disturbance as detrimental and long-term. As one participant explained, some changes can seem quite significant and drastic, as damages or scars on landscape. Yet, the land can recover surprisingly fast. They felt that it was good to show people that aspect of disturbance as well, instead of always going to visitors or the public saying "oh you've ruined it forever" (MRPP 2). They expressed that ecological change is inevitable and by suppressing fire there is actually much greater risk down the line (MRPP 4). They emphasized the importance for people to understand that there is significant variability in natural ecosystems and the importance of the many incremental changes that occur through time, ultimately resulting in an endpoint (MRPP 4). That participant gave an example of educating the public about succession post-fire:

> "But having any of this natural disturbances in here, having the public more aware [emphasis] of, A) [u]sing a fire - come in and show [emphasis] them from the road. Driving along just looking at it, [it] looks so bare [emphasis]. [But] you can see that succession was starting. You know, even ingress of conifers and there was birch and everything coming in. But, you look at it from the road, and it looks ugly, and it looks bare. [S]ame as going through Kootenay National Park. [P]eople need to see more of that. They need to get their nose right up to it, have the park facilitate and explain to people - oh I know it's a capacity issue - that "hey, these natural disturbances are important, and here's why"… and then people start to, then you get less political pressure to mitigate everything". (MRPP 4)

One participant added that the public doesn't support what it doesn't understand (MRPP 1); if people understand why something is being done, they can support it. They had seen that by fencing off an area on the Berg Lake trail, people will disregard it. But with a sign saying "this area is closed for ecological restoration, thank you for your cooperation", visitors listen because they understand why the restriction is there (MRPP 1).

Beyond that, people can be pivotal and "they have this vision in their mind of how things should be. And it just takes [snaps fingers] something to pivot them… whether it's an experience in the park or…" (MRPP 4). This had been personally experienced in situations ranging from small scale trail restoration projects to city and council meetings for forestry planning (MRPP 1). Managers felt that engaging the public further about natural disturbance is very important, and would aid in subsequent support of management restoration and conservation goals (MRPP 4).

No Interpretation Program in MRPP. While there is a significant difference between the amount of use MRPP and WWP receive, neither park has an established interpretation program for public outreach and education. Participants from WWP did not discuss this theme, and

focused instead on the need for adequate consultation when planning and implementing park decisions (WWP 3, 6).

However, MRPP attracts a wide range of visitors for an outdoor experience that is heavily managed, and improving education and outreach with this large number of visitors is of high priority to park managers who are unable to do so currently (MRPP 1, 2). The Mount Robson Visitor Center has numerous pamphlets and information books available for visitors, as well as several displays on the lower level with native species information, climate change facts and replicas of historic mountaineering figures. However, this educational outreach is mostly passive and largely ends at the Visitor Center. Participants shared great concern over the educational materials available, and wished they could offer more (MRPP 1, 2). As one participant put quite bluntly,

> "that's one of the anomalies in our agency right now is we have no formal interpretation program. Well no one comes out of the womb understanding that you shouldn't feed a grizzly bear. I mean, it might be intuitive, but, people have to be told that. That, you know, here's the right way to, to conduct yourself in a wilderness situation and have a light footprint." (MRPP 1)

Beyond minimal amounts of direct outreach, getting certain ideas across is far from simple. Participants explained that it is a difficult task to make the link when educating the public about the reality and significance of climate change impacts on human populations and park ecosystems (MRPP 5). This is particularly the case for urbanites who do not experience these environmental changes first hand (MRPP 4), and for discussing indirect impacts (MRPP 5). However, certain changes are gradually becoming much more clear to the public, such as glacial retreat and climate change (MRPP 5), as well as the need for prescribed burns (MRPP 1).

Summary. In conclusion, this discussion has explored the ninth theme of this study's findings, public education. With a focus predominantly on MRPP, I began with a subsection describing the challenges that managers face in dealing with the public's understanding (or lack thereof) of natural disturbances. Subsequently, the issue of insufficient interpretation programming for MRPP was discussed, as this is a major concern for park managers at this time. Beyond the park Visitor Center, there is little opportunity and capacity for further hands-on outreach and interaction with the public about natural processes, park ecosystems and conservation objectives.

4.8 Climate Change

As the tenth and final theme in the findings of this study, rapid climate change serves as perhaps the most significant management challenge today (MRPP 7). Having overarching impacts on all other management objectives and touching every inch of the globe in some way, climate change as an environmental issue may be "beyond parks management" (WWP 8). However, the weight of its influence certainly is not.

Overview of Climate-Driven Changes. Change is constant in the parks. That's nothing new, and participants appreciate the consistent inconsistencies of weather and climate across short and long timescales as just how things are (MRPP 2). Nonetheless, participants shared concerns over the impacts of climate change on park ecosystems. Climate change was mentioned a total of 13

times during the MRPP discussions (MRPP 1, 2, 3, 4, 5, 7), and 12 comments arose during the WWP discussions (WWP 1, 2, 5, 6, 7, 8, 10).

Environmental changes mentioned in relation to climate change included: more significant flooding and a faster spring melt (MRPP 4), river wash-out (WWP 9), amplified pest epidemics (MRPP 1; WWP 2, 10), continued ice retreat (MRPP 1, 2, 3, 5, 6, 7), and upward movement of the treeline ecotone (MRPP 3, 4; WWP 1, 8, 10) and its associated encroachment into subalpine and alpine meadow complexes (MRPP 3; WWP 7, 8). Participants debated whether forest encroachment was due to fire suppression or climate change (WWP 1, 2, 5). Some of the above topics were discussed at length in a more general sense; these references are specific to comments that explicitly linked these changes to climate change.

As one participant explained, the MRPP region is experiencing climate changes related to localized human-induced changes as well as global climate change. This is due to "the moderating effects of flooding the McNaughton Lake. Which is one of the biggest pieces of water in North America now… and that is certainly having an effect on the Robson Valley, but I think the biggest thing that I've noticed is we're not getting those -30, -40 [degree Celsius] events" (MRPP 1). The strengthening of the mountain pine beetle epidemic in the park was suggested as a result of these climate changes, reducing the winter kill-off (MRPP 1). Similar circumstances were seen in WWP with beetles surviving slightly warmer winters (WWP 2) and along with upward movement of the treeline ecotone, threatening whitebark pine populations (WWP 10). In addition, the loss of evapotranspiration from forests killed by beetle means a higher water table and greater flood risk (MRPP 1, 4).

Glacial Retreat

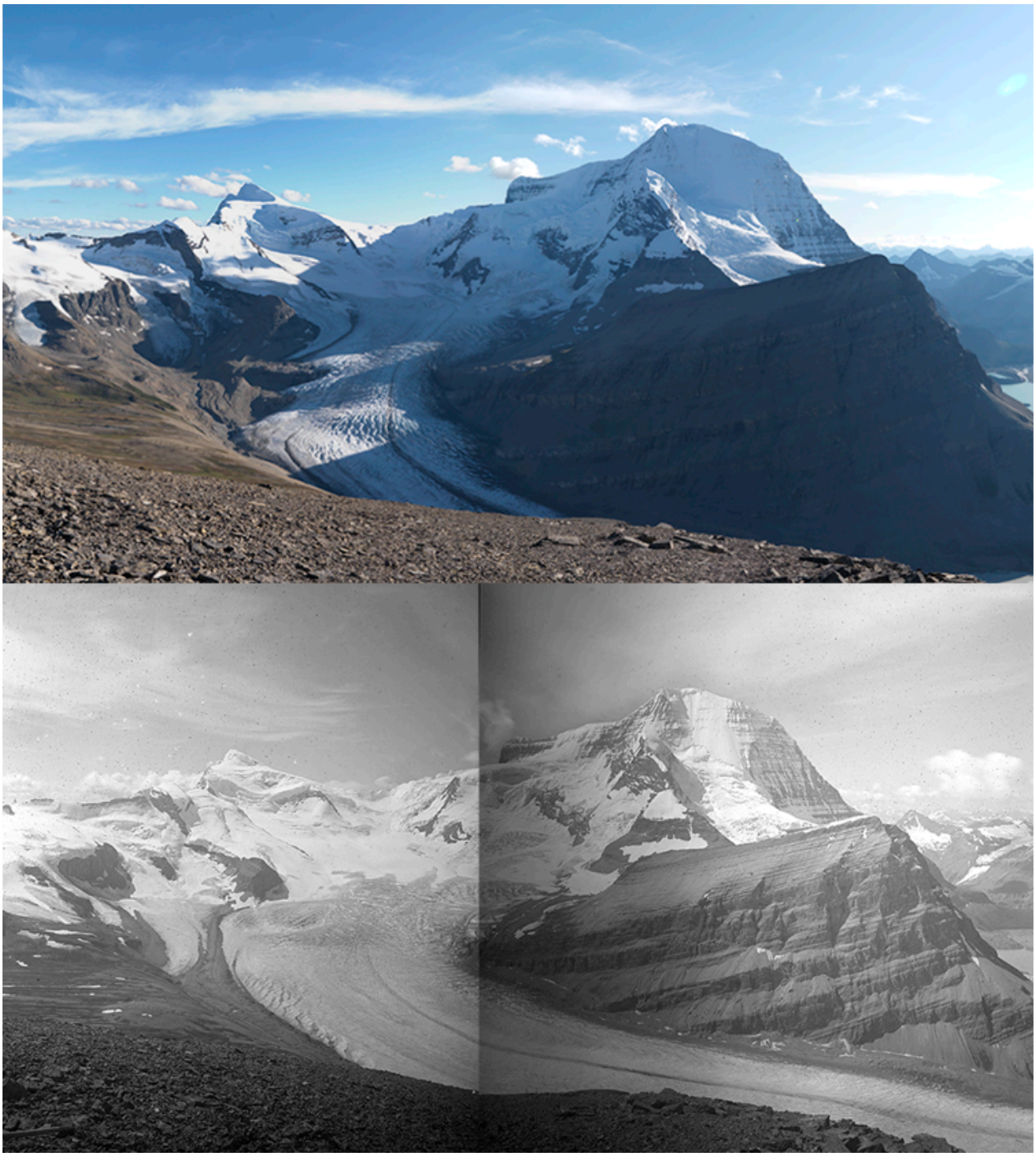

Figure 61: Wheeler's 1911 Ptarmigan Peak #1 Station; MLP 2011 (top), and Wheeler 1911 (bottom)

Glacial retreat was a topic to be expected for MRPP, as the Robson Glacier is a prominent point of interest in the park. Ten comments were focused on this glacial recession for MRPP. Displaying the glacier are two photo pairs used side by side from Ptarmigan Peak #1 Station. At an elevation of 9,320 ft., this station overlooks Mount Robson, the Robson Glacier,

Rearguard Mountain and the Dome, Berg Lake and the AB-BC border to the north. The photos chosen display the Robson Glacier and Mount Robson.

While an iconic location undergoing significant long-term change, the retreat of the Robson glacier revealed little in terms of management or conservation repercussions. Participants noted the dramatic retreat of ice (MRPP 1, 2, 3, 6, 7), and noted that a different trail was blazed around a growing meltwater creek (MRPP 3). The images elicited a comment from one participant about the cyclical nature of change in nature (MRPP 2); the glacier's extent today is in fact greater than it was 5,000 years ago (MRPP 3).

Increased Safety Risk for Management Activities and Park Visitors. The physical dangers associated with potentially climate change induced environmental changes were mentioned 5 times for MRPP and very briefly for WWP. This subsection will discuss participant concerns and experiences relating to these changes, which range from increased flooding to glacial retreat and river wash-out.

While glacial recession is a common topic relating to climate change, for managers the Robson Glacier's melt is most significant in relation to climbers. The risk of people falling into crevasses increases with more melting and cracking (MRPP 1, 2). In response they had to reroute the trail both around and over the glacier to accommodate for the glacier changing (MRPP 2, 3).



Figure 62: The Robson Glacier, showing notable crevasse development (Photo Credit: Stuart Higgs, August 2011)

One participant from MRPP felt that climate trends evolving in the last decade had increased severity of floods in and around the park. Following wetter winters and warmer summers, the larger snowpack is melting faster and creating dangerous conditions for their work

in the less accessible landscapes. Some areas were simply not draining, or too fast; accessing different work sites in recent years has become increasingly worrisome and risk-prone (MRPP 4). These participant observations strongly correlate to long-term climate and weather data for the Rocky Mountains. With average losses of nearly a month of spring snowcover observed from 1950 to 2007 (Zhang *et al*., 2011), the evidence supports park manager observations of a faster and more hazardous spring melt.

In WWP, the dangers associated with climate induced environmental changes were not discussed at length. A participant mentioned in passing conditions of increased risk for hikers and mountain bikers due to rivers washing out in recent years (WWP 9). In general, the most notable safety risks of the park were due to its extent and rugged terrain (WWP 7). Beyond risks of water crossings and encroached trails, participants did not discuss any additional user or manager safety risks associated with climate change. From our 2012 field season, flash storms presented one of the greatest hiking risks, as we experienced when temporarily caught behind the Wildhay River at peak flow following an afternoon storm.



Figure 63: Wildhay River swell (left) and washed out Mountain Trail from flash storm, August 2012 in WWP (Photo Credits: Jenna Falk, 2012)

An Issue or *The* Issue? It seems appropriate to end this theme's discussion with a broad question which will be addressed more fully in the following synthesis chapter. One participant felt that even though remote ecosystems may present unique challenges, they are merely one component to account for in a complicated situation of rapid climate change in Canada. The broader context and forces having led to it are what it comes down to. Giving acknowledgement to the above impacts that managers are experiencing due to climate change, this participant said the following:

> "Oh, well of course. Um, I mean the impacts are things like, loss of ice, change in hydrology, uh you know then the impacts on the organisms that are, dependent on those things or, have evolved with um. And, but it's a part of the much bigger question about, just, you know how are we going to manage, Canada or North America or BC to, maintain as much of this biodiversity as we can? So, yea we think about loss of snow and, the fact that the, pollinators and the, flowering organisms aren't gonna be there at the same time. And, you know all of those, disjunct functions that are gonna result. But it's not something that, the fact that it's remote [emphasis] isn't gonna mean that we can't [emphasis] manage it. It's something much bigger than that." (MRPP 7)

Summary. In conclusion, this theme serves as the final of ten themes in my findings. While the impacts of climate change remain to be fully explored scientifically in the two parks, participants nonetheless were able to share a variety of insights into what they are experiencing, and what impacts (present or future) they are concerned about. This theme discussion began with an overview of what climate-induced changes are being observed in WWP and MRPP. These changes include more significant flooding, a faster spring melt, river wash-out, glacial retreat, pest epidemics such as mountain pine beetle, upward movement of the treeline ecotone, and its associated encroachment into subalpine and alpine meadow complexes. Subsequently divided, the theme was explored through the three subsections of glacial recession, increased safety risks, and, to be answered in the coming synthesis chapter, a broad question of whether climate change presents an issue beyond all others for parks management.

4.9 Chapter Summary

This chapter has described the findings of this study. Organized by ten distinct themes, each section from 4.1 to 4.8 incorporated the insights of the primary researcher and participants from the focus groups and interviews. This summary will discuss very briefly the findings, structured by sections and themes.

Management of Remote Ecosystems: 4.1. This chapter opened with a discussion about the management of remote ecosystems. Serving as an overarching theme in these findings, this began with a list of what remoteness and remote ecosystems meant conceptually to participants, and showed that there was much similarity between parks, and no clear answer free of subjectivity or personal value. A discussion followed of several subthemes, including; the importance of remoteness in parks, an emphasis on indirect management, a lack of information, and lastly debates around the appropriateness of intervention.

The first subsection discussed the importance of remoteness for its conservation value and significance within perceptions and views of wilderness. The second subsection described the trend of letting more areas in the park 'go natural' to their own devices through indirect (passive) management. Overall, the remote areas are not directly managed despite changes being seen in them likely due to climate change and fire suppression. In WWP, an exception to this hands-off management approach has been through fire management and some species at risk goals.

The third subsection discussed a lack of information, which managers particularly in WWP found to be a limiting factor to their work, particularly in more remote areas which have seen the least scientific studies to date. Participants also emphasized the difficult balance of priorities and perspectives they face both within and between agencies involved when establishing conservation objectives and management plans. This was discussed in the final subsection on the appropriateness of intervention. These challenges were felt to greatly outweigh the inherent access and logistical difficulties in remote ecosystem management.

Long-term Forest Ecosystem Changes: 4.2 - 4.5. Long-term landscape changes seen in both parks include upward movement of the treeline ecotone, forest stand aging, densification and homogenization across the landscape (discussed in 4.2, 4.3, 4.4). In 4.2, the theme of valley infill

was discussed. Emphasis was given to encroachment onto trails and into meadows, due to a variety of proposed factors including less visitor use/maintenance of trails and less ungulate browsing. There was significant variation in the changes seen within and between parks. In 4.3, upward movement of treeline ecotone was described. This theme focused on the threat to high elevation ecosystems such as alpine meadows, and influences on fire behavior.

In 4.4, forest stand homogeneity was discussed. Following decades of fire suppression and surrounding forestry, large areas of forest in both parks have become more dense, homogenous and mature. Leaving greater vulnerability to massive fires, pests and disease, this change in turn threatens endangered species' habitat, surrounding communities and land use interests.

Section 4.5 described the fifth theme of wildfire and prescribed burns. Participants from MRPP felt that there was significant restoration potential through the alteration of fire regimes towards a more natural state. This view has been put into action much more extensively in WWP, through the involvement of AB ESRD in the park. Nonetheless, the ecological and sociopolitical conditions in and around the parks create significant barriers to implementing prescribed burns and let-burn areas.

Sociopolitical Influences: 4.6 - 4.7. Some of the most influential changes observed by participants in both parks were not in the purview of proximate ecology, but related to the broader sociopolitical context. Changing values and perspectives both within management agencies and in the broader society were discussed at length and have had significant influence over management efforts in both the front and backcountry. Park managers may be the official stewards of natural lands, but their vocations are nonetheless strongly influenced by the sociopolitical world beyond park boundaries. These themes were discussed in 4.6 and 4.7.

Subthemes within societal impacts included changes in visitor use (4.7.1), industrial development (4.7.2) and public education (4.7.3). In 4.7.1 I discussed the societal shifts accompanying visitor use, and emphasized a reduction in backcountry use and evolving public expectations and needs. In 4.7.2 I described the increasing imbalance in capacity between lands managers and industrial development in BC, as well as the legacy of industry within the parks, and the impacts of industrial activities around WWP boundaries. In 4.7.3 I discussed the challenges associated with the public's incomplete understanding of natural disturbances, and the need for a formal interpretation program in MRPP.

Climate Change: 4.8. Lastly, 4.8 described the tenth and final theme in this study's findings, climate change. This section outlined the climate-induced changes being observed in WWP and MRPP. Observations of glacial recession and increased safety risks were described, followed by a short segway into Chapter Five through a broad statement put forth by a participant offering that climate change presents an issue beyond all others for parks management.

Looking Forward to Chapter Five. Moving into the final chapter of this thesis brings a synthesis. This synthesis will combine the insights gathered from the findings of this study with guidance from my literature review. I will offer a series of sections which bring this information together to answer my research questions, expand the current literature around this topic, and provide recommendations both to parks managers and for future research needed.

Chapter Five: Synthesis

Introduction. This study began with the idea of remoteness (Higgs and Roush 2011). Exploring the management implications of long-term landscape changes in remote ecosystems, two Canadian Rocky Mountain parks were used in a comparative case study methodology. Park managers of Mount Robson Provincial Park (MRPP) and Willmore Wilderness Park (WWP) offered a variety of perspectives on what changes they have observed, and how these long-term landscape changes affect their work, Participants were limited to those involved in one of the two parks or employed by agencies involved in parks management. This included the British Columbia Ministry of Environment (BC MOE), Alberta Environment and Sustainable Resource Development (AB ESRD), Alberta Parks and British Columbia (BC) Parks. Scientific repeat photography through the Mountain Legacy Project was used as a medium to explore some changes in the two parks via photo-elicitation during three focus groups and five interviews. This research offers new insights into the challenges facing parks managers involved with remote ecosystem management, changing landscapes and a changing climate.

In Chapter One I gave a detailed review of the surrounding literature. In Chapter Two, the case studies were described. In Chapter Three, the methods and course of data analysis was discussed, along with challenges and limitations throughout the process. In Chapter Four, findings are described through ten dominant themes having emerged from my systematic interpretation of focus group and interview transcripts. Each of these themes loosely fits into one of three overarching categories: long-term landscape changes seen through the photos; challenges resulting from these changes in remote ecosystems; and the overarching challenges surrounding management within the context of socioeconomic, ecological and climate changes.

This synthesis is not structured solely by those three overarching categories. While they are present in discussion, they are meant more as basic guideposts to tie back to the primary research questions. The synthesis sections also incorporate important discussions about future research and implications, key connections to the surrounding literature, and value gained from a comparative case study approach to long-term landscape change.

The first of these three categories is changes observed. Long-term landscape changes are observed in several ways. As mentioned in Chapter One, for the purposes of this study long-term refers to changes within roughly the last 100-150 years. First, park managers have seen changes over the time of their experience working in the park. Second, the photo pairs illustrate a variety of changes at the landscape level. Third, my personal field experiences have verified these phenomena without having experienced the changes occurring firsthand. In both MRPP and WWP the dominant changes observed were forest ecosystems becoming more homogenous, dense and mature following long-term fire suppression and forestry practices. While both parks have explicit goals of allowing the natural fire cycle to return to certain areas, there are many complicating factors that constrain flexibility, from community safety to commercial land use interests and biodiversity goals.

Additional changes observed in MRPP include forest encroachment into valley bottoms and treeline creep up slopes, glacial retreat of the Robson Glacier and increased flood severity. Managers agreed that no direct management was necessary in the remote backcountry, despite landscape changes observed and attested to. Additional changes seen in WWP include treeline

advance into the subalpine and valley bottoms, and treeline capping over ridges located near the Upper Foothills subregion.

The second category is challenges resulting from these changes in remote ecosystems. Challenges surrounding these changes in MRPP and WWP include greater vulnerability to disease and pests, massive large-scale fires, and loss of habitat and biodiversity. Managers are restricted in actions they can take regarding these changes, as they must balance multiple priorities.

The third category is the overarching challenges surrounding management within the context of socioeconomic, ecological and climate changes. In WWP there is no inter-agency consensus as to which management strategy is the best (e.g. hands-off preservation, intensive intervention, sustainable use, etc.) including the option of passive management. In MRPP, negligible capacity of conservation and outreach have left managers with little flexibility to balance management priorities in ecologically beneficial ways, away from a purely recreation focus. The socioeconomic constraints placed on management agencies has drastically reduced the capacity, knowledge base and budget to meaningfully and concertedly approach these changes for restoration.

Additionally, the ethical debate surrounding intervention in remote ecosystems, and direct management of wilderness areas became interwoven throughout discussions of management implications of these long-term changes. Participants expressed the most concern around the impact of non-ecological changes on their efforts to manage ecosystems in both the front and backcountry park reaches. The broader social context, including changing values and perspectives, public education and engagement, and the balance of recreational use with wilderness conservation was emphasized and felt to be quite influential to management efforts in remote ecosystems.

To Come in Chapter Five. Chapter 5 is a synthesis of my research efforts, and serves as the final chapter to this thesis. Emerging from my findings and from the literature are seven key themes that this chapter will explore. These themes will be discussed in 5.1 to 5.8 and include the following:

5.1 The Two-Park Comparison
5.2 Repeat Photography and Photo Elicitation
5.3 Intervening in Remote Ecosystems
5.4 Values and Perspectives Guiding Parks Management: Managing for What?
5.5 Expanding Ecological Restoration
5.6 Climate Change
5.7 Pushing the Literature Forward
5.8 Future Work and Implications
5.9 Conclusions

Section 5.1 begins with a brief discussion on this study's value and placement within the larger field of landscape ecological and parks management comparative studies. In 5.2, I briefly discuss the significance of combining the methods of photo elicitation and repeat photography in this way. In 5.3, this synthesis moves into a discussion of the ethical and moral dilemmas faced by park managers when managing more remote ecosystems undergoing rapid landscape change.

5.4 asks "what are we managing for?" and digs into some of the underlying and widespread values and perspectives guiding parks management today that have been interwoven in the challenges being faced in WWP and MRPP.

Subchapter 5.5 shifts into a discussion on the potential for repositioning and expanding ecological restoration efforts in these parks, moving away from large-scale interventions and towards smaller scale, focal restoration practices that strengthen societal relationships to place and to these parks. In 5.6 I evaluate the effectiveness (with the current capacity and information availability) of WWP and MRPP to contribute to regional climate change adaptation and mitigation and fulfill the goals emphasized by Canada's recent park strategies (e.g. CPCCCWG, 2013). Next, subchapter 5.7 describes the ways in which this study's findings and conclusions contribute to, and at times challenge, the surrounding literature. Lastly, the chapter moves towards a close with a set of recommendations that have arisen from this study in 5.8.

5.1 The Two-Park Comparison: Across the Continental Divide

This section returns to the park comparison that this study has been structured around. It was my intention in having two parks as comparative case studies to evaluate the influence of differences in jurisdiction, climate and geography, and history of human use and activity on the long-term changes in park landscapes and management efforts therein. This section offers a brief discussion highlighting where this study fits within the broader field of comparative research on ecological phenomena and lands management.

There have been numerous comparison studies done on parks and protected areas focusing on a variety of management challenges and ecosystems. For instance, characteristics investigated worldwide include the effectiveness of parks and protected areas for biodiversity protection (Bruner *et al*., 2001) and the connection between invasive species and human disturbance (McKinney, 2002), etc.). In Canada, a few recent studies have examined parks in a comparative way looking at external risks[12] and the potential for transboundary regional planning for climate change adaptation[13]. There have also been comparative studies evaluating landscape change in different countries looking at human impacts on ecosystems (e.g. Bürgi and Russell, 2001) or evaluating changes in only one location (Byers, 1987). To my knowledge, WWP and MRPP have not been studied from the perspective of long-term landscape change, and no other comparative study has evaluated long-term change in two parks as this study has.

The value of this comparison has been largely in illustrating the extent to which various characteristics of a park can have an influence over landscape change and how managers approach these changes. Management efforts are mandated within agency objectives, however on a park-by-park basis efforts are tailored to specific pressures and goals, within the confines of available capacity and expertise. I have also learned that it is not necessarily ecological conditions that dictate the extent and kind of landscape changes seen. Alongside ecological

[12] External risks of oil contamination from proposed pipelines (Service *et al*., 2012), and human uses impacting wolf behavior (Musiani *et al*., 2010) have been recently evaluated.

[13] O'Neill (2011) examined the challenges and potential for transboundary regional planning and collaboration for climate change adaptation between WWP, MRPP, and Jasper National Park. It was found that little collaboration of this kind is occurring in the region; policies, legislation and management plans would have to evolve to enable this.

conditions, there is a suite of influential factors including regional and local climate, history of land management efforts and industrial activities (resource use, development), and land use patterns by indigenous and local communities. Regardless of well-intended efforts to step back, our influence over these ecosystems remains. This influence is visible through long-term change in repeat photo pairs, and in the memory of those with longstanding relationships to these places.

This comparison is not without limitations. In particular, such comparisons are limited in their inability to account for all influences on each case study's circumstances. By simply selecting two units of analysis (i.e. parks and their inner-workings), the broader context and interplay of influences is not readily acknowledged or incorporated (Azarian, 2011). More general limitations have been discussed in Chapter Three. Nonetheless, this comparative method remains valuable. This study's focus on MRPP and WWP offers a distinctive research design, evaluating landscape change across differing jurisdictional, ecological, socioeconomic and climatic conditions. This study has shown that these differences are influential in shaping the resulting management challenges of long-term landscape change in remote ecosystems.

5.2 Repeat Photography and Photo Elicitation

This study integrated the methods of repeat photography and photo elicitation in a way that has not been done before through a park comparison of historical landscape change. In this way, some of the main challenges and promise of this approach have been newly illuminated through this research. These are discussed briefly below.

As described in Chapter Three, participants during the focus groups were encouraged to draw and label photo pairs to show what they found to be significant. Different colours of dry erase markers were distributed and participants were told to try to use the same colour throughout, so that during later analysis I may be able to subsequently connect markings with specific individuals. While the unique perspectives of participants were maintained in the audio data and transcripts, my ability to ensure that participant drawings and labels could be easily tracked and later evaluated was quite limited. This was both due to a lack of experience in facilitation of focus groups, and the nature of the group environment, where participants actively shared and passed around their markers as needed. In the future, having tighter control over this might allow for an even deeper analysis of manual labeling on photo pairs during discussions.

In addition, another potential improvement upon the use of these methods in this study would be to frame the research questions much more tightly around changes seen in the images. This would allow a heavier and more pointed focus on the images during discussion (be in focus groups, interview, etc.) and would rein in discussion even further. For the purposes of this study, this tightening was not necessary; I did not want to steer discussion to specific landscape changes.

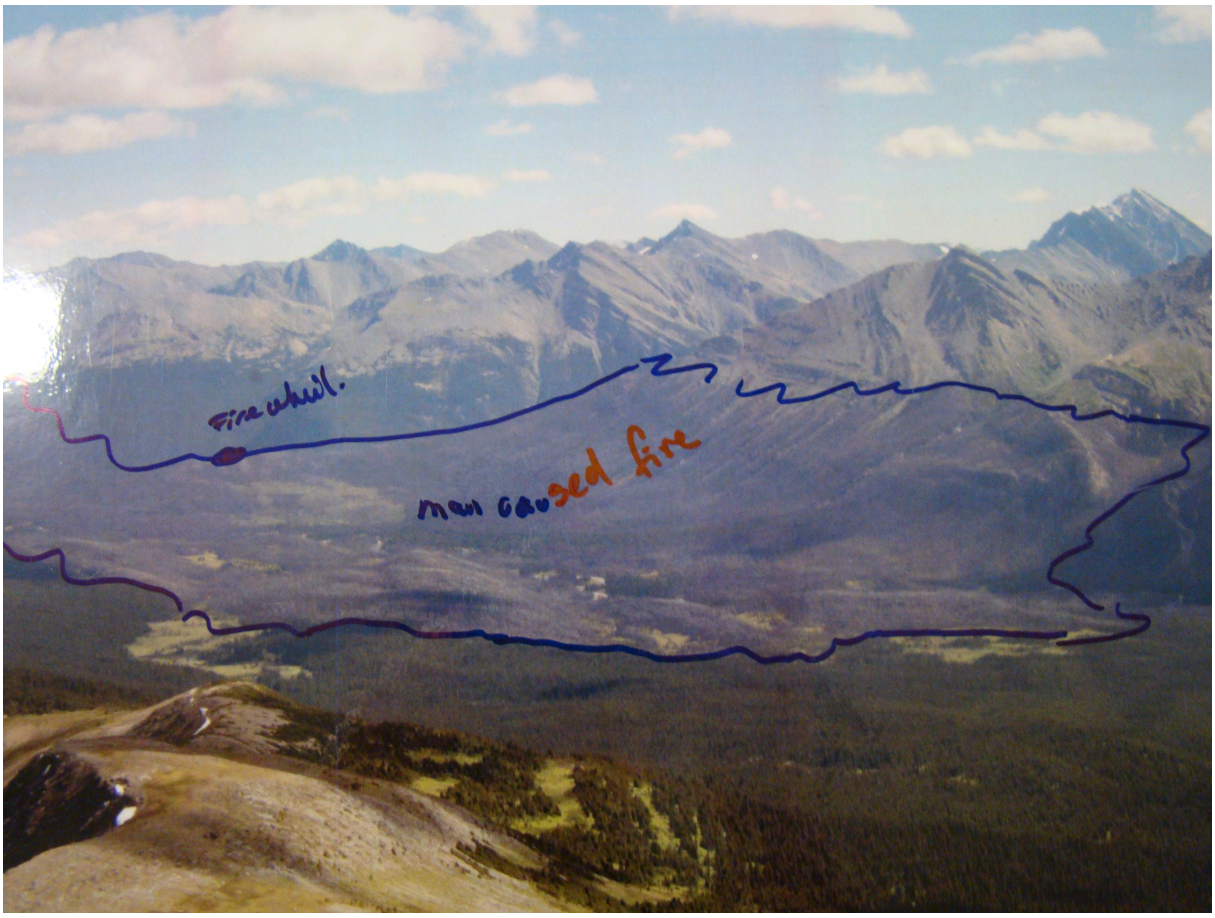

Figure 64: Annotated repeat photo (2007) from Wheeler's Courier Mountain Station showing participant labeling of the 2006 Jackpine fire, noting the fire whirl location and the fire as "man caused"

Overall, this combination was well worth the effort. The distinct time-lapse that can be visualized through the repeat photos enabled a clear glimpse of change lacking the distortion of physical perspective (e.g. looking at the same slope from a different vantage point can greatly influence how the landscape is perceived). With two photos from the exact same place, this complication is largely removed. The physical copies of photo pairs for participants to hold themselves encapsulated the benefits of engaging with the "materiality of seeing" (Tinkler, 2013:16). As described in Chapter Three (Samuels, 2007:216-217), feeling and seeing the pictures are tightly linked to processes of memory, learning and expression and can enable richer and more thought-provoking discussions. This poignant medium allowed this to occur and contributed greatly to this study's findings.

Based on the results of this study, this combination of methods appears to have great potential for future research both in environmental studies and also for other disciplines such as anthropology. The adaptability of these two methods for a variety of research interests is exemplified by the work of Trudi Smith (2004), who used these methods instead to illustrate how multiple narratives are possible from the same photos, and how Jasper National Park is envisioned and represented by the repeat photos.

5.3 Intervening in Remote Ecosystems

This subchapter addresses my research question, "what are the inherent challenges in managing (and restoring) remote ecosystems?" Through investigating remote ecosystem management in this study, it has become apparent that for these two parks, the ethical and philosophical challenges associated with management weigh heavily. This subchapter offers a discussion on the tension between intervening and letting things be in remote ecosystems impacted by human activities. Perspectives and suggested conclusions discussed here are a culmination of participant opinions, my observations of the ways in which participants approach management in these remote ecosystems, and the surrounding literature.

Passive Degradation or Respecting Nature's Autonomy? While resources and capacity are often the primary deciding factors, it is not always the case that managers involved in this study *would* intervene if those barriers were removed. The intervention philosophy ultimately stemming from this is to let ecosystems progress, adapt, and change as they will over time. However, following decades of intervention it is arguable that land managers and stewards have long since given up the option to rescind responsibility in the evolving conditions and processes of these landscapes. After all, it has been a culminating ensemble of human endeavours - fire suppression, climate change, boundary pressures including forestry and industrial development, invasive species and disease dispersal, hunting - that have shaken many ecosystems to the point of near collapse, regime shifts or no-analog states. Can we say, “let them be” and justify that as due diligence? Is this passive (indirect) degradation, or as Ridder (2007) put it, respecting nature’s autonomy? The findings of this study suggest that management efforts in MRPP and WWP represent both perspectives, however participants from both parks repeatedly emphasized the ability of the land to proceed unimpeded if management influence was removed. With the dominant exception being fire management in WWP, management efforts overall were in the “let it be” category. While photographic findings and participant commentary illustrated various conditions in the parks to be the detrimental effects of long-term landscape changes, participants largely expressed this hands-off approach as respecting nature’s autonomy.

Not intervening is nonetheless a deliberate decision and will have corresponding impacts just as active management would. If resource and capacity limitations remove intervention options, this becomes a default choice rather than a selected one. While discussed in greater detail in Chapter Four, the long-term ecological impacts of this management paradigm in wilderness areas range from negligible to quite significant. Landscapes are changing whether direct use or restoration efforts are taking place in them or not. The culminating impacts of the above factors have left their mark on the ecosystems and wildlife in MRPP and WWP. While there is danger in feelings of apathy towards humanity’s destructive presence, taking a step away from the ecosystems under these pressures is insufficient from a restoration standpoint.

Moral debates surround intervention in natural systems (e.g. Ridder, 2007; Higgs and Hobbs, 2010; Hobbs *et al*., 2011) and specifically in wilderness or remote ecosystems (e.g. Higgs, 2006; Throop and Purdom, 2006; Cole *et al*., 2008; Higgs and Roush, 2011). Determining what is appropriate, when, where and how, are difficult questions. Cole and colleagues (2008) offered criteria for finding a threshold for intervention in wilderness areas. They argued that

intervention becomes more necessary as protected area size decreases, and as the scale of stressors, human influence, and the social value of attributes increases.

The way in which we come to decide these conditions greatly influences the answer, as well as who is involved and what they value and subsequently prioritize. In WWP, fire management is fueled by several critical factors including community safety and commercial land use interests around the park. In this case, it is important to ask if we are intervening for the right reasons, and to agree beyond doubt that any ecological consequences are justifiable under larger mandates. Participants expressed tension over this, particularly with balancing multiple mandates that often conflict when operationalized. The influence of sociocultural values in the management of remote ecosystems is discussed in detail in subchapter 5.3.

Is there a middle ground? The hands-off approach of indirect management is arguably - and visibly - lacking the gumption of follow-through to acknowledge and mediate our steady influence. Still, moderating (via intervention) a storm of anthropogenic influence may not leave ecosystems with a leg up if it means suppressing certain processes and cycles, and replicating others under controlled conditions. Resilience management would suggest a nurturing of ecological processes rather than individual species, assemblages or landscapes (Cole *et al*., 2008), however national strategies promote the balance of both resiliency and species at risk protection (CPCCCWG, 2013). Either way, neither conservation nor restoration offers a suitable approach in these two parks on their own. As Hobbs and colleagues explain, conservation should not be entirely passive and restoration does not necessarily need direct action. However as time goes on, active management becomes more necessary for effective conservation of ecosystems increasingly stressed (Hobbs *et al*., 2011:444).

There remains more gray area in this challenge than there are shades of limestone in the Rockies. Yet as time goes on, the treeline keeps getting further up that slope and these management challenges are becoming more complicated. The lines are blurring. Finding that one clear perfect path isn't a realistic goal. Too many things are in the balance now. We need to move forward and recognize our place within the system, and be respectful of that. As Hobbs and colleagues put it, "The central question is whether our interventions can be planned and guided in a way that is beneficial both to humanity and to other organisms" (Hobbs *et al*., 2011). Much of the environmental challenges being faced today have resulted from a dualistic view of humans as separate from the rest of the natural world (Hobbs *et al*., 2011). I would argue that one broad solution is to both strengthen this relationship and restore ecological conditions through focal restoration practices and improved social engagement in parks and protected areas. Subchapter 5.4 approaches these ideas.

5.4 Conceptual Challenges: Managing for What?

This section discusses several key values and perspectives of parks management that I have found to be significant in this study, and have served to influence my responses to my primary research questions. In particular, this subchapter relates to my research question of "what are the inherent challenges in managing (and restoring) remote ecosystems?" The most straightforward management challenges in remote ecosystems of WWP and MRPP are founded in logistics, access and budgetary constraints. These difficulties are also inherent in much of

parks and protected areas work and I will not discuss them beyond saying that participants of this study mentioned them for their presence, and the fact that if those barriers really needed to be overcome, they could be with the appropriate technology and budget.

This section is focused on a broader, less tangible challenge of remote ecosystem management. Though my analysis of participant discussions and secondary literature sources it has become apparent that cultural (and subsequently management agency) values and perspectives surrounding nature and wilderness are situated at the heart of management efforts in remote ecosystems. While it is nothing new to state that values influence our actions and objectives, in these two parks it has led to inter-agency conflict, individual internal conflict for managers, and discrepancies between what managers want to manage for, and what their management efforts result in ecologically.

This discussion is divided between three subsections, and will begin with a brief evaluation of the philosophical differences between AB ESRD and AB Parks in WWP. Next, the main theme of this subchapter, managing for more than ecosystems, will be discussed. Lastly, the third subsection, managing for values, is given with a focus on perceptions of wilderness, naturalness, and authenticity.

Philosophical Differences Between Agencies. Through my observations and analysis of participant discussions, it became apparent that the philosophical differences between AB ESRD and AB Parks have created a long-lasting undertone of tension between the agencies when collaborating in WWP management efforts. While agency authority was redistributed several years ago, it appears to be a continued source of strain and dissonance. Two management agencies with equally good intentions for management continue to approach WWP with difference viewpoints and struggle to merge these for increased benefits in the park.

It is unclear how much this shift in management has distracted from cohesive efforts in the park, however based on this study I would expect improved collaboration into the future despite these challenges. It is hopeful that participants from both agencies acknowledged the importance of incorporating the differing views of the agencies, and that this added to the rigor of decisions made, having stood up to scrutiny from both sides. Through asking participants to describe the philosophical differences, it became apparent (as discussed in 4.6) that their overarching goals were quite similar. Participants from both agencies described their own as "conservation" focused, while descriptions of the other agency became more extreme, suggesting utilitarianism (managing for usefulness) and protectionism (shielding through management). Arguably the definition of conservation and perceptions thereof may have quite a range.

Similarity to this agency relationship can be drawn to the ultimately permanent ideological divide between John Muir and Gifford Pinchot over a century ago (Taylor, 1992). While both men tirelessly rallied for conservation, two competing worldviews were responsible for this rift. Pinchot's "wise use" school was practical and allied with economics; this conservation emphasized the sustainable exploitation of resources being managed wisely so as to both use *and* save them. Alternatively, Muir promoted a land ethic recognizing nature's intrinsic value beyond human utility. The preservationist "righteous management" approach to conservation (Taylor, 1992) is today more representative of parks agencies in general.

Managing for More Than Ecosystems. During the first focus group to discuss Willmore Wilderness Park, a participant made a casual but earnest remark. He felt that if managers left the park to its own devices, then it would be just fine and keep on going. As long as managers aren't trying to change things, the land will take care of itself with no problem.

Following participant discussions it became apparent to me that managers see park ecosystems as quite resilient and adaptable, despite being pressured by human activities. Their descriptions of environmental and ecological change illustrated a dynamic and robust ecological system only requiring management insofar as direct human pressures continue, or particular species at risk require special attention for survival. In essence, the landscapes will continue to withstand fire, frost and flood; indeed, there is a particular flourishing as a consequence of following natural disturbance cycles and processes. The limestone slopes will gradually degrade, their silty debris eventually returning to the sea from under which they were once deposited. Brilliant green and orange lichen will continue to adorn carefully arranged rock cairns, even those over which no one will ever stumble again.

Managers are responsible for more than ecosystems, though, and the weight of sociopolitical pressures is considerable. This load was evident in speaking with participants. As mentioned in 4.7, one participant stated, "I mean, if it was easy [emphasis], we could all be either environmentalists or arsonists, right? So when we talk about park management and park management planning, it's not about managing parks, it's about managing people" (WWP 6). Communities, and visitors are a significant part of parks management and mandates (Parks Canada Agency, 2007). It is a greater struggle to manage for human recreational use, and paradoxically, independence in the landscape to hold fast against disturbance, invasive species, insect and disease outbreaks, and the growing pressures of climate change-related shifts.

Beyond visitors, however, it became apparent through the focus groups and interviews that there was a disconnect between what managers wanted to manage for, and what their management decisions were leading to ecologically. Are we managing for naturalness? Wilderness? If remoteness, remote from what, exactly? There is a blurred line between managing for natural conditions, cycles and disturbance, while also trying to control certain natural processes and regimes like fire, mountain pine beetle, and invasive species.

Alongside the pressures of visitors, the context of First Nations use of parks is important to mention again. While the broader literature increasingly emphasizes the significance of indigenous practices within land management, participants did not actively discuss historical use of park landscapes by indigenous communities. And, although the specific focuses of this study did not pointedly necessitate discussion of that topic, the implied views of separation and isolation of park landscapes away from human use of that kind is interesting to note (particularly when industrial development activities in provincial parks is only increasing).

Managing for Values: Wilderness, Naturalness and Authenticity. Ultimately, protected areas are managed through a complicated social, political and policy apparatus for what we value and what we want to sustain. As land managers and public visitors, many of us value and appreciate these parks and for a variety of reasons. When asked to describe the essence of their respective parks, WWP participants emphasized its wilderness and biodiversity. The Willmore is wild and extensive and that gives it a strength that many people appreciate. The juxtaposition of breathtaking beauty with a rugged, at times quite dangerous natural environment gives WWP a draw that some spend their careers protecting. The areas in MRPP most emphasized by

participants for their importance and representation were farthest in character from the intensive use areas: the remote reaches of the Upper Fraser and Geitte Creek drainages were seen as invaluable to managers for their biodiversity and nearly untouched condition.

Maintaining Wilderness. For the majority of the last century, wilderness areas were not to be encroached or altered. These lands have been "where the earth and its community of life is untrammeled by man" (the Wilderness Act, as cited by Cole et al., 2008:42). Wilderness ethics call for people to "manage wilderness with a light touch - restraint and humility" (Cole et al., 2008:43). The very idea of wilderness is a cultural concept following views of a human separation from nature and true, authentic wildness only where no human influence has been felt (Cronon, 1996). As such, if we are trying to manage for wilderness, we are shaping our expectations of the land within cultural rather than ecological guidelines. As Higgs (2003:42) explains, "the restoration of wilderness parks may be as much about the restoration of an idea as of a place, and of course we must give careful thought to whether wilderness is the idea we want to prevail."

Flowing from these views, wilderness management as a term becomes incongruous. No intervention, however light or self-aware can be without separate intention and impact from the natural processes and cycles that previously guided ecological conditions (Higgs, 2003). Is this a chance or an ultimatum? We know even our most subtle efforts are leaving footprints when in their essence we wanted them to be invisible. But to manage is to control, to manipulate, and to move towards goals. Despite acknowledging at times significant human influence and rerouting of natural regimes and processes, participants from MRPP and WWP commented repeatedly that if the more remote reaches of their parks were completely left alone, then natural processes and cycles would continue along a suitable trajectory. Participant views of wilderness management in their parks spoke volumes about their views of naturalness, authenticity and remoteness, and the indirect impacts of human activities therein.

Maintaining Naturalness and Authenticity. Similar arguments can be made for authenticity and naturalness. Natural systems have traditionally been seen as having a lack of human impact or control and ecological composition, processes and functions remaining intact and consistent with historical benchmarks (Cole *et al*., 2008; Ridder, 2007). The idea of authenticity in nature - however debatable - requires a lack of planning or intention on our part to shape or guide ecological systems (Clewell, 2000). To maintain naturalness, managers must be passively involved in ecosystems and not influence processes, even if the ecosystems are damaged by human activity (Cole and Yung, 2010). Under this logic, if one is restoring, it is not about naturalness or authenticity anymore. The moment one intervenes, the ecosystem is changing prescriptively, methodically, and actively (Cole *et al*., 2008). Some argue the ecosystem becomes anthropogenic domination over nature (Katz, 1992).

However, good restoration can simultaneously alleviate ecological wounds and promote healthy progression towards a new trajectory. This doesn't mean that it is more authentic, or likewise that it is an artifact of human efforts to replicate what once was whole and natural. This removes it from the daggers of being artifice - it is shaping itself through its own processes and patterns and gains *natural authenticity* over *historic authenticity* (Clewell, 2000). Higgs (2003) argues that authenticity is unhelpful for restoration, and that our evolving cultural and social

realities greatly influence what we want to recreate or see, leaving restoration vulnerable to co-opting and artificiality.

While ideals of naturalness and authenticity do not need to be lost when ecosystems are restored (Ridder, 2007), they are no longer appropriate guideposts of desirable ecological conditions in parks and protected areas. Parks management and its intervention approaches must look beyond perceptions of naturalness (Cole and Yung, 2010), authenticity (Dudley, 2011) and wilderness (Cronon, 1996; Higgs, 2003). Focusing on ecological outcomes rather than human causes is more beneficial (Cole and Yung, 2010:86). As discussed in the following subchapter 5.4, I see potential to expand what restoration means for these two parks, particularly with regards to enveloping social change within the ecological.

5.5 Expanding Ecological Restoration in the Parks

My primary research question is "how do long-term landscape changes influence conservation and restoration objectives in remote mountain ecosystems?" This section offers a step forward and builds upon the insights gained from the literature and the primary data collected for this study, to illuminate the impact of long-term landscape change on conservation and restoration in these parks. My subsidiary question looks ahead and asks, "how could managers of remote ecosystems best approach these issues in the face of rapid ecological change?" For this question, I investigate the potential for expanding the use and benefits of ecological restoration within these two parks.

In this section I explore the potential for expanding restoration endeavours in the parks beyond fire management. Over time, the coupling of active fire suppression and rapid climate change have led to what participants and I have found to be the most significant landscape changes resulting in difficult challenges for parks management. These two factors are discussed in the following subsections. Stemming from the ecological observations of this study, the final subsection looks to socioecological restoration to expand the possibility of restoration to focal practices.

Restoration Beyond Prescribed Fire. While there are multitude conservation issues in both MRPP and WWP, prescribed fire has become a dominant tool for active restoration in both parks. Especially in the case of WWP, fire is a tool that managers from AB ESRD are comfortable using. It allows for broad strokes across the landscape, which is arguably quite pragmatic for the more remote expanses in these parks. Nonetheless as participants emphasized, not all ecological components and conditions are best supported by fire. Knowing when to hold back is just as important.

Apart from fire management, managers would not be directly managing or intervening these areas. Looking at the fine ecological details doesn't make sense at that scale when agency capacity, staff resources, and other more pressing management concerns and priorities (e.g. visitor safety, fire leaving the parks) are considered. Beyond that, the undeniable tilt in the conservation-recreation pendulum that participants described further removes impetus for agency-driven ecological monitoring and scientific studies in the backcountry areas of the parks, regardless of overarching mandates and staff interest to do so.

Removing fire through suppression has created several critical conservation challenges for management. As described in chapter four, these include: loss of stand heterogeneity and diversity, upward movement of treeline ecotone, increasing risk of large-scale catastrophic fire, and loss of resistance against pests and disease such as mountain pine beetle. While a multitude of socioeconomic interests are at stake when fires take hold within or outside of MRPP and WWP, there are also significant ecological benefits of returning fire to the landscape (Parks Canada and Canadian Parks Council, 2008).

Into the future, the upward movement of the treeline ecotone threatens to displace many subalpine and alpine ecosystems, as well as increasing risk of multi-valley fires crossing over ridges. As a result, it seems plausible that fire would be used more as a broad stroke management tool to impede multi-valley fires. However, because of changing climatic conditions, there would also be greater risk of fires becoming uncontrollable, such as through temperature spikes in warmer months and faster spring melt leading to drier summers.

WWP participants emphasized these changing circumstances around the use of fire. Within this specific case study, it is important to ask if prescribed fire, as an option in the restoration toolkit of park managers, will become more or less reasonable and pragmatic into the future under rapid climate change. Participants are currently working through difficult questions like this. While this study has not approached questions of future applicability of specific restoration tactics, the circumstances surrounding fire in both parks are becoming increasingly complicated and difficult to navigate. When it comes to large-scale fire, the problem and solution aren't necessarily symmetrical. While removing fire from the landscape has created many management challenges, its prescription comes with logistical limitations, inherent risks and potentially deep compromises with other conservation goals and management obligations beyond the park (e.g. town sites, community safety, FMAs, endangered species' habitat).

Pragmatic Restoration Under Rapid Climate Change. Participant concerns surrounding climate change were numerous, and national and international protected area strategies are increasingly including restoration mandates as both climate change solutions and public engagement tools. Nonetheless, neither of these two parks is currently implementing on-the-ground efforts to mitigate or adapt to climate change through restoration or public engagement. As such, it is important to outline some techniques for guiding restoration planning under rapid change.

The International Union for the Conservation of Nature (IUCN) (Keenleyside *et al*., 2012) states that restoration goals and objectives should be evaluated with increasing scrutiny moving into the future with climate change. Uncontrollable disturbance like climate change may impact restoration outcomes, so targets should be made with variability in mind (Parks Canada and Canadian Parks Council, 2008). While restoration will likely become more important for conservation efforts over time as human pressures continue and natural areas shrink, biodiversity should be maintained as a first priority (Keenleyside *et al*., 2012:12). Practitioners and managers should ask whether restoration objectives are reasonable under rapid climate/environmental change. If the causes of degradation cannot be reduced in pressure with restoration, restoration project maintenance may be unreasonable. If the near future will likely see the ecosystem shifting locations or disappearing, and climatic extremes will occur, restoration may be futile and efforts might be best focused elsewhere. If climate-induced migrations bring new species into the area, new pressures may arise requiring intervention to maintain critical assemblages or

endangered species (Keenleyside *et al*., 2012:64). The Canadian Parks Council Climate Change Working Group emphasized the need to integrate ecosystems services and climate change into restoration plans and practices to improve ecological integrity. Ways to do this include a focus on restoration efforts related to natural disturbance regimes, species and habitat recovery, and reducing the impacts of non-climate stressors in parks such as infrastructure and recreational activities (CPCCCWG, 2013:45)

As regards the likely climate-induced upward movement of the treeline ecotone observed in these two parks, I do not see a pragmatic mitigation solution through restoration. With treeline shifts, restoration is at a loss, as climate pressures will continue to encourage these landscape changes. While photo pairs attested to the shifting of forest ecosystem boundaries upslope into subalpine and alpine zones, these climate-induced changes will not stop. The purely theoretical possibility (discussed by WWP participants) of repeatedly applying prescribed burns to strips along the treeline is not something managers could do. One-off emergency interventions of this sort for critically endangered species may make sense within biodiversity mandates. A few participants from WWP acknowledged that *only* in such an instance could they imagine intervening against long-term changes such as the upward movement of the treeline ecotone. However, the alternative of a continual physical fight against climate-induced landscape changes is unsustainable and ultimately futile. While struggling against climate-induced changes was seen as illogical to participants, they nonetheless emphasized the applicability for restoration for long-term change following other pressures such as fire suppression, even when likely coupled with climate change as a cause.

In particular, observed valley infill and increased wildfire risk in WWP and MRPP have followed decades of suppression and (for the former) changes in visitor use. These long-term changes could also be related to climate change. This study has not determined the causes of these landscape changes, so these possible attributions are based on participants' and my own assessment. Restorative prescribed burns have potential for reducing wildfire risk, however they are also fraught with complications and participants are divided over this approach. The scale of these landscape changes, the momentum behind them, and the potential for additional damage and loss of resilience through direct intervention, suggests restoration as a partial approach.

A Series of Gentle Nudges. As an alternative, I would not propose stepping back entirely, as following decades of intensive influence on these landscapes, it is arguable that we have an obligation as stewards to act as such. Despite the unintended ecological consequences of historical management patterns, a cautious way forward may need to include some level of continued involvement to ensure the protection of various values in and around the two parks (e.g. species at risk, surrounding communities, visitor experience, etc.), and to help ecosystems cope with rapid climate change. A "series of gentle nudges" would be more appropriate as this allows ecological processes the much needed flexibility to carry the ecosystem on its own trajectory and to adapt to climate change, and to improve resilience throughout (Higgs and Roush, 2011:555).

This suite of adaptation measures involves existing restoration approaches that are predominantly less interventive. They more closely resemble diffuse restoration, as they would largely be countering indirect impacts. These measures are numerous and could include assisted migration via facilitated relocation or migration corridors, increasing connectivity across latitudes and altitudes, reducing habitat fragmentation, reducing edge effects through buffers

between remote ecosystems and intensive land use activities, and prioritizing process and function over pattern (Higgs and Roush, 2011:555). The literature supports these less invasive techniques to support ecological adaptation to climate change and other pressures (e.g. Keenleyside *et al*., 2012; Hamilton and McMillan, 2004; Parks Canada and Canadian Parks Council, 2008:37).

As an example, for assisting species migration (i.e. relocation) it has been recommended that human-facilitated seed movement only take place between similar biogeoclimatic zones in BC (Leech *et al*., 2011). The location of some parks may coincidentally serve as the ideal northern range of certain species. Particularly in the case of Yellowstone to Yukon (Y2Y), large protected area networks are ideal for meeting these needs for dispersal, connectivity and buffers from intensive human activities. With continued loss of natural lands beyond protected area boundaries, having habitat options for some species in these future ranges may not be possible (e.g. wide-ranging species such as grizzly bear, woodland caribou, wolverine). However as participants and the literature states, the largest threats to these species ultimately rest well beyond the boundaries and authority of parks management and will require sociopolitical shifts to truly improve (e.g. AB SRD and ACA, 2010a; 2010b; Festa Bianchet *et al*., 2011; Fisher *et al*., 2013). Efforts in these parks, particularly WWP, appear to serve a critical role in their survival, while surrounding pressures continue unabated.

This selection of management efforts is particularly fitting, as more direct and pointed interventions in these remote ecosystems at this time would likely be lacking adequate research to back up decisions. As was revealed in Chapter Four: Findings, and reiterated in 5.1 through a comparison of the two parks, lack of knowledge is a serious issue *if* more intervention is anticipated or desired for the future in response to increasing pressure on and degradation of ecosystems. A lack of knowledge creates difficulty in relation to management and restoration under climate change as well, and is discussed in 5.5.

The long-term ecological change monitoring program (Wright and Stevens, 2012) being put in place within the BC Parks system is a good start. However to improve upon this, the addition of multi-year program-specific funding could enable this monitoring initiative to be quite substantial for improving understanding of ecological change in parks. Being aware of and understanding what is being protected within the parks is important, and having site-specific and long-term ecological information necessarily influences and informs restoration efforts. The lack of ecological information for the far western reaches of WWP may present more of an issue into the future with ongoing pressures on ecosystems. While research studies and monitoring requires repeated visits to more remote areas of the parks, the advantages of having more knowledge to support the ecosystems' adaptation to climate change (and other pressures) might well outweigh any localized impact from researchers.

Socioecological Restoration. Our activities on a planetary scale are scratching the surface. In some respects, we place our efforts with such perceived permanence on the landscape. We build monuments to mark our achievements and build fences to keep the neighbours out (or in). Historically we established parks and never wanted them to change. Yet in other moments we leave lasting environmental damage that we don't think twice about. We want things that benefit us to last forever, and shy away from any unwanted wounds. Moving forward with parks could mean strengthening our society's relationship with the natural world.

Parks and protected areas can contribute to communities through employment, tourism, ecosystem services and recreational opportunities. These are, however, mere bonuses to the deeper benefits possible through a strengthened connection with the natural world. The benefits of nature to human health, happiness and well-being are long-documented in the literature (Charles *et al*., 2009; Durning, 1995; Grinde and Patil, 2009; Maller *et al*., 2008). For increasingly urban populations, parks have quickly become the primary means of experiencing nature and its health benefits (Maller *et al*., 2008). The potential to build socioecological resilience in the face of rapid climate change and other pressures has situated restoration and public engagement as top priorities for Canadian parks and protected areas (CPCCCWG, 2013). These strategies are particularly poignant for indigenous cultures inextricably linked to their land (CPCCCWG, 2013:26).

Some steps are being taken in other parks in Canada to engage visitors and communities. Through nature education, restoration and outreach, social engagement and lasting visitor experiences is a primary vision engrained in management planning and goals in recent years (Parks Canada Agency, 2010). These efforts have predominantly been in national parks, and often came at the expense of conservation and restoration programming. However, for WWP and MRPP, this is not yet the case. In the current context of management priorities and capacity limitations (particularly for MRPP), it seems unlikely that such initiatives would begin anytime soon in WWP or MRPP without larger agency support in funding for planning and collaboration. These feelings of disconnect from the public were expressed as a notable burden to managers in the latter.

Self awareness can separate us from nature, but focal restoration brings us back in emotionally, physically, socially, and begins to set seed to those renewed (strengthened) relationships (Higgs, 2003). Focal restoration has been described as "practices that create a stronger relationship between people and natural process, a bond reinforced by communal experience" (Higgs, 2003:242). Most examples of focal restoration would emphasize public participation in hands-on restoration activities for these purposes of nurturing a deeper engagement.

However, there are inherent difficulties in doing so in remote ecosystems that are less present in front-country park reaches. Factors that make focal restoration less appropriate in remote ecosystems include logistics, perceptions of wilderness, and the potential for more damage than benefit in bringing groups into remote ecosystems for direct interventions. This is not to say that engaging the public with these landscapes is unfeasible or risky. Outreach and restoration can take many forms, and people can be engaged in parks without a large footprint. Programs could support initiatives such as small ranger-led hiking groups into remote areas, educational materials and guides along trails sharing land history and legacy, increased citizen science, visitor participation in bird counts, front-country restoration, etc.).

Public education and engagement may find no budget support, but the repercussions of their success could bring new meaning to our relationship with parks and protected areas. Instead of nurturing our manicured experiences and control of these ecosystems, we should be looking to nurture our happiness within them. The new authentic natural world is not the wild nature of the past, but has humanity deeply interwoven within it (Cronon, 1995; Dudley, 2011).



Figure 65: A man rests and contemplates while storms pass close to Clearwater, AB (Photo credit: Jenna Falk, 2012)



Figure 66: Forest growth over rock gardens from Japanese internment camp workers. Engaging park visitors about both the environmental and human legacies in the park could nurture a stronger relationship to place and to our history in and around protected areas (Photo Credit: Jenna Falk, 2012)

5.6 Climate Change

This section addresses my first subsidiary research question: "what are the inherent challenges in managing (and restoring) remote ecosystems?" What I found is that climate change is a challenge both inherent in remote ecosystem management, and largely beyond parks management at this time. Rapid climate change - and the resulting array of social, ecological and environmental impacts - presents the single most important challenge for managers of WWP and MRPP into the future. As the momentum of climate change is now proven to be beyond our ability to mitigate or weaken, climate impacts will likely only increase in severity (IPCC, 2013). Within the present circumstances of agency capacity and available ecological data within MRPP and WWP, goals of improving ecological integrity and resilience for climate change adaptation and mitigation as promoted in the literature are very difficult to attain.

As described in Chapter One, Canadian parks and protected areas are increasingly being positioned as natural solutions to climate change adaptation and mitigation (CPCCCWG, 2013; Dudley *et al*., 2011). These strategies are largely focused on maintaining and improving ecological resilience and integrity in these natural areas through the guiding principles of protecting (habitat, ecosystem services), connecting (landscapes, communities) and restoring (ecosystem integrity) (CPCCCWG, 2013:45). A variety of actions are proposed and require significant amounts of resources, capacity and expertise across jurisdictions and organizations.

Challenges in Monitoring and Managing for Ecological Integrity and Resilience. The challenge of managing for ecological integrity and resilience is well documented (Parks Canada Agency, 2000). In the report "Unimpaired for Future Generations", the national parks system nationwide was assessed and all 39 national parks were found to be "impaired", and 21 parks had major or severe ecological stress stemming from habitat and species losses to pollution and overuse (Parks Canada Agency, 2000 1:9). From the ensuing top-down pressure of this report, recent years have seen some efforts to sustain ecological integrity, largely through ecological restoration and community engagement (Parks Canada Agency and Canadian Parks Council, 2008; Parks Canada Agency, 2008a). Similar strategies are being offered to improve ecological resilience for climate change adaptation and mitigation (CPCCCWG, 2013).

Many suggested strategies promote increased involvement of park users. Community engagement requires participation, and increased park visitation can diminish ecological integrity (Dearden and Dempsey, 2004). With park funding increasingly focused on recreation budgets, the balance becomes unstable. The findings of this study suggest that under current capacity and resource limitations, managers cannot feasibly approach the variety of conservation backlashes resulting from increased park use pressures.

The need for widespread monitoring of ecological indicators for integrity has been emphasized (Timko and Innes, 2009) for the Canadian national park system. Ecological monitoring - particularly biodiversity - is well established in Alberta through Alberta Biodiversity Monitoring Institute (ABMI) and encouraged in the AB Parks Science Strategy (Government of Alberta, 2010). Widespread monitoring is gradually being applied to the provincial protected areas system in BC (Wright and Stevens, 2013) following a large push from the Auditor General, rather than provincial proactivity. The IUCN (Keenleyside *et al*., 2012:60) has outlined indicators for ecological integrity (Table 9 below). Based on my secondary sources and participant comments, there has not been widespread monitoring of the majority of these ecological indicators in either WWP or MRPP. While wildlife monitoring has occurred in WWP for several decades, a broader base of ecological data over time is not available to the best of my knowledge.

Table 9: Ecological indicators for assessing ecological integrity

Assessing Ecological Integrity		
Biodiversity	**Ecosystem Functions**	**Stressors**
Species richness • change in species richness • numbers and extent of exotics	Succession/retrogression • disturbance frequencies and size (fire, insects, flooding) • vegetation age class distributions	Human land-use patterns • land use maps, road densities, population densities • poaching incidence, number of traps/ poachers recorded • presence of invasive species
Population dynamics • mortality/natality rates of indicator species • immigration/emigration of indicator species • population viability of indicator species • population density of individuals or species	Productivity • remote or by site • biomass • growth rates	Habitat fragmentation • patch size, inter-patch distance, forest interior • evidence of incursions etc. • pressures surrounding the protected area
Trophic structure • faunal size class distribution • predation levels • plant/animal relationships (e.g., pollination, propagules dispersal)	Decomposition • decomposition rates by site	Pollutants • sewage, petrochemicals, etc. • long-range transport of toxics
	Nutrient retention • calcium, nitrogen by site	Climate • weather data and trends • frequency of extreme events
		Other • park tourism pressure • hydrologic and sediment processes

(Adapted from Keenleyside *et al*., 2012)

When evaluated together, the expectations of the literature and the findings of this study suggest that to date, not enough monitoring has taken place in either WWP or MRPP to adequately address national goals of integrity or resilience. Without knowing what exactly they are dealing with, managers are put in a difficult position in making informed decisions on biodiversity goals and improving ecological integrity (Timko and Innes, 2009). Often defined by wholeness and completeness, goals of supporting integrity are not impossible, but immense and loosely defined. This leaves little pragmatic use for integrity goals in parks such as WWP and MRPP. Managers would need more capacity and ecological information before integrity and resilience goals could be made, let alone implemented. An additional challenge is that the advocated restoration efforts promoted nationally to maintain or improve integrity and resilience (CPCCCWG, 2013:23) may likely go against inherent management approaches and philosophies in these parks. As participants emphasized in Chapter Four, the dominant management approach in both parks is indirect or hands-off management.

Climate Change as a Challenge Beyond Parks Management. Mandates, vision statements and plans encourage us to protect values and enhance integrity - but are the accompanying sociopolitical expectations and financial commitments reasonably aligned to these goals? Can managers truly manage (for) what they are expected to? The results of my investigations suggest otherwise. The challenge of climate change being faced by park managers is something bigger than management, and broader than the provincial or national sociopolitical system as well.

In his book *Living Through the End of Nature*, Wapner (2010:15) offers that "many view the end of nature as an inevitable result of age-old human intervention into nature, and contend that whether we like it or not, we must now rise to the level of responsibility that taking over nature entails." These parks, and the significant long-term ecological changes therein are but one piece of a much larger story. The repercussions of global climate change going forward will be innumerable. Nearly half of Canadian parks and protected areas are predicted to undergo significant changes in vegetation communities following rapid climate change (Lemieux and Scott, 2005). Climate impacts are already being seen today in the vast majority of protected areas in Canada, yet agencies lack the capacity to meaningfully address their growing concerns (Lemieux *et al*., 2011) while still being heralded as part of the solution by national and international councils alike.

These parks will continue to provide natural benefits to the region such as by buffering local climate and extreme weather events, and providing ecosystem services, erosion control and water purification (Keenleyside *et al*., 2012). However, beyond these baseline benefits there is little present ability to improve or monitor ecological integrity, resilience, and climate-induced ecological change in these parks, as proposed by national strategies discussed in 1.4.2.1.4 and 5.5 (CPCCCWG, 2013; Colls *et al*., 2009; Dudley *et al*., 2011). This does not come from a disagreement with the proposed strategies, but rather a caution that many of the proposed actions are far out of reach for managers working within legislation, policies and agency mandates and capacities that hinder steps forward of this kind.

Sociopolitical variables that will need to evolve to allow for parks and protected areas to serve their full potential in this capacity include the following: reduced boundary pressures; increased funding and capacity for widespread long-term monitoring, research and educational outreach; and increased flexibility to follow park-specific concerns. These changes would theoretically allow managers to evaluate the ecological integrity and resilience of park ecosystems, and subsequently to gauge the suitability of restoration efforts within that context. Increasing public understanding and awareness of the impacts of climate change and natural disturbance on park ecosystems would allow for conservation objectives within the context of climate change, ecological integrity and resilience to be more readily accepted. Restoration efforts involving a wider public of volunteers could further build this connection. Reduced boundary pressures from industrial development would allow ecosystem processes, functions and services within parks to be bolstered. Limitations in the above factors were given emphasis by participants from WWP and MRPP as challenging their management efforts.

Increasing Transboundary Collaboration and Planning. Therefore, while protected areas *can* offer a noteworthy part of the "natural solution" to climate change adaptation (CPCCCWG, 2013:40), a larger sociopolitical shift will be necessary to allow the full benefits to be accessed. The Canadian Parks Council offered that to adapt and realize this potential "will require new strategies, new partnerships and broad engagement with all sectors in Canadian society" (CPCCCWG, 2013:47). Significant adjustments to climate and sector planning are needed to integrate protected areas and enable maximum benefits to be gained (Ervin, 2011). The need for cross-jurisdictional collaboration and information sharing regarding climate change is strongly emphasized in the literature (Colls *et al*., 2009; CPCCCWG, 2013:20; Keenleyside *et al*., 2012). These two parks (and the surrounding region) currently lack the legislation, policies and management mandates to engage this potential (O'Neill, 2011). Strengthening the regional

capacity to build these cross-boundary partnerships and information transfer is a critical component to moving forward with regional adaptation to climate change.

Engaging the Public Around Climate Change in Parks and Protected Areas. What I discern from my research is a turning point for parks with regards to public engagement and climate change. Pressures will only increase into the future, and strengthening socioecological ties is increasingly important. The importance of having increased capacity to develop interpretative/education programs, strategies for sustainable and meaningful public involvement, and outreach and general awareness about parks and protected areas, cannot be overstated. Interweaving climate change challenges with public engagement has been offered as part of the natural solution to climate change; outreach programs can education the public on where parks and protected areas are situated within adaptation and mitigation strategies (CPCCCWG, 2013:46).

Parks and Protected Areas as Natural Solutions to Climate Change: Are we there yet? If park managers are to meaningfully and adequately address agency mandates and concerns, and surrounding sociopolitical expectations, they need to be met half way with realistically aligned commitments and support. Regional climate planning must integrate protected areas in a way that enables managers to acquire the capacity, socioecological information and multi-sector partnerships they need to meet these contribution goals (Ervin, 2011). If so, the potential for reconnection, climate adaptation and biodiversity protection within Canada's protected areas network could be much improved.

Taken from my literature review and findings from Chapter 4, I have compiled a short list of commitments and changes that would make the above goals more attainable. This list focuses on agency capacity/support and does not incorporate the sociocultural shifts that have influenced parks management in WWP and MRPP, as discussed in 5.3 and 5.4. Commitments and changes needed to better enable parks and protected areas to attain mitigation goals include the following:

Table 10: Commitments and changes recommended

1) Agency capacity needs to be increased to balance growing industrial pressures	• Pressures on WWP are mostly around the park • Pressures on MRPP are mostly within the park • Primary pressures include those from forestry, coal mining and exploration, oil and gas wells, pipelines, railways, highways
2) Funding needs to be aligned to ecological goals	• Recreation does not inherently aid conservation goals/efforts • Ecological goals and conditions are being placed as the saving grace for climate change adaptation and mitigation into the future • Sustainable and dependable long-term support for conservation, monitoring and restoration
3) Funding needs to support interpretation and outreach programming	• Visitors may enjoy recreational pursuits, but they will go elsewhere to find other venues and experiences • If public engagement and focal restoration becomes a part of outreach programming, park staff can bring the public in closer and create long-lasting relationships and support

	between the park and the community (Higgs, 2003) • Key safety/education tool; enhance "sense of discovery" without patronizing (Hamilton and McMillan, 2004)
4) Funding needs to support proactive long-term monitoring	• Longitudinal monitoring of ecological indicators to evaluate structure, composition, stressors and functioning of ecosystems throughout the parks (Wright and Stevens, 2012) • Monitoring wetland and forest carbon storage (potentials and change over time) (Keenleyside *et al*., 2012)

One of the primary ways to address climate change within existing ecologies is ecological restoration. The restoration documents by Keenleyside and colleagues (2012) and Parks Canada Agency and Canadian Parks Council (2008) offered guidance throughout this study and were discussed at length in section 5.4. The findings of this study suggest that there is limited feasibility in expanding restoration efforts in WWP and MRPP to incorporate proposed strategies. This is predominantly due to the current socioeconomic climate.

Likewise to the proposed actions for bringing parks and protected areas into the future as contributors for climate solutions, the strategies and approaches offered by Keenleyside and colleagues (2012) and the Parks Canada Agency and Canadian Parks Council (2008) are very appropriate for these two parks. Of particular significance are the recommendations of increasing public support and involvement through engaging restoration projects, ensuring long-term capacity for monitoring restoration, and increasing capacity for restoration through nurturing meaningful relationships with outside stakeholders, partnerships and the public (Keenleyside *et al*., 2012).

5.7 Restoring Remote Ecosystems - Additions to the Literature

My interest in remote ecosystem management largely began when reading an article by Higgs and Roush (2011), *Restoring Remote Ecosystems*. Asking what intervention (if any) is necessary, and to what extent, Higgs and Roush fleshed out moral and logistical difficulties when working in remote ecosystems. They also started a discussion of what constitutes a remote ecosystem, which is conceptually more elusive than it first appears. This study has taken steps to extend that dialogue by producing a systematic and carefully interpreted body of land manager perspectives on what constitutes remoteness and remote ecosystems in general and in WWP and MRPP specifically. This study has illuminated the fact that such definitions are varied and subjective; participant descriptions were interspersed with contradictory if-then statements. For a relatively simple idea, remote ecosystems remain out of reach of a direct and agreed upon definition in the context of parks and protected areas management.

Higgs and Roush's proposed "series of gentle nudges" (2011:555) for intervention in remote ecosystems remains a snug fit when evaluated against the two case studies of WWP and MRPP. There are certain long-term landscape changes observed in these two parks (e.g. increasing stand density and species homogeneity, valley infill) that could arguably be approached with more direct interventions such as prescribed fire. However for many management goals, there are simply too many factors under consideration for intensive

interventions like fire to be without deep compromise. The example of woodland caribou and fire management in the Willmore is perhaps the most obvious.

In addition to the work of Higgs and Roush (2011), the arguments of Cole and Yung (2010) in their book *Beyond Naturalness* place protected areas management in a precarious but flexible position moving into the future detached from historic ideals of naturalness and untouched wilderness. A chapter within this book offers ideas for ethical intervention through "wild design" (Higgs and Hobbs 2010). There are many parallels with this study, not the least being the difficult balance between maintaining ecological integrity and finding an appropriate degree of appropriate intervention. In the remote ecosystems of MRPP and WWP, this ethical debate continues to influence management efforts and decisions.

While park managers readily acknowledge the long-term ecological changes seen, several participants from each park nonetheless stated a wish to intervene as little as possible and let ecosystems evolve as they will. A significant trust is placed in the deep resilience of park landscapes to withstand and adapt to continued human pressures and impacts. While it is not clear if managers are consciously embracing this paradoxical situation of the opposing natures of intervention and wildness, this approach of "less is more" may be suitably conservative under current park circumstances.

5.8 Recommendations and Future Work

Through a series of discrete recommendations, this section addresses my second subsidiary research question, which addresses practical issues: "how could managers of remote ecosystems best approach these issues [long-term landscape change in remote ecosystems] in the face of rapid environmental change?" Primary data from focus groups and interviews offered some suggestions, and guidance was also available from nearly a dozen recent publications from academia and government agencies. I present recommendations in two tables, the first being a synthesis of general recommendations provided earlier in the chapter, and the second peering into future research possibilities.

Table 11: Synthesis of general recommendations

Restoration	
Context Recap	• Remote ecosystems pressured by climate change and indirect impacts • Potential for more harm done than benefit for large-scale restoration projects to be started in these remote areas o Restoration efforts would primarily be focused around climate-induced changes or long-term suppression, which would largely require large-scale, intensive intervention • Disconnect with the public around natural disturbance and conservation objectives (and means to achieve them)
Recommendations	• Employ a "series of gentle nudges" (diffuse restoration) (as proposed by Higgs and Roush, 2011) instead of more invasive techniques • E.g. assisted migration via facilitated relocation or

	migration corridors, increasing connectivity across latitudes and altitudes, reducing habitat fragmentation, reducing edge effects through buffers • Create outreach and education programs for both parks o Increase public awareness of long-term change in our parks and what this means ecologically and socio-politically under climate change (as proposed by participants, Parks Canada Agency, 2008a, and CPCCCWG, 2013) • Bring focal restoration into provincial parks in a meaningful and sustainable way to strengthen socioecological connections (as proposed by Higgs, 2003 and Keenleyside *et al*., 2012) • Through the above approaches, facilitate changes in visitor use and expectations to reduce pressures on park ecosystems
Repeat Photography for Ongoing Photo Monitoring	
Context Recap	• In addition to research uses, repeat photography could also be much more involved in lands and park management in the future • Photo pairs offer snapshots of historical and current conditions • Photos could aid in various efforts such as fire management and restoration decision making • e.g. use in conjunction with dendrochronological studies to triangulate and confirm evidence for past conditions, ranging from historic burns to indigenous land use practices • High quality and resolution of images illuminates many details in the landscape ranging from species distributions to fire patterns • The hard work of locating and repeating historic images the first time is completed from this study – the work in the future for others repeating the same photos again would be much easier
Recommendations	• Continued repeats of a survey station could offer monitoring support into the future for landscape level challenges like climate change and the implications of long-term changes such as those investigated by this study • Public engagement (citizen science) could facilitate this without pulling on management capacity and resources • Simultaneously increase engagement and understanding of long-term change
Prescribed Burns	
Context Recap	• A tool for years in WWP • Moose Lake burn (2,900 hectares) in MRPP completed in 2004

	• Costly and not without compromise for other management goals • Increasingly tense circumstances of massive fire risk following long-term landscape changes and rapid climate change
Recommendations	• In both parks, prescribed burns should remain in use within limits • For MRPP: o Small-scale[14] burns in areas of high fire risk along Yellowhead corridor would be beneficial for increasing landscape diversity and reducing risk of spread o For better public buy-in, would need to proceed greater outreach and stakeholder engagement to avoid the push-back experienced after the Moose Lake burn in 2004 (e.g. Hoekstra, 2004) • For WWP: o Small-scale burns predominantly for valley-wide fuel or fire breaks rather than for stand replacement and/or increasing landscape heterogeneity (habitat variation/diversity) o While large fires will naturally occur regardless of management efforts, prescribing large fires would place too great a risk for critical habitat in park o Fire is still needed in these habitats, however, and natural fire should be allowed to run its course within limits for species' habitat protection o Breaks would allow for natural fires to run their course within predetermined geographic limits, while protecting surrounding communities and land use interests (as proposed by participants and Graham and Quintilio, 2006) o Coordinated efforts with surrounding land use may improve natural fire breaks without burning outside park
Transboundary Collaboration and Planning	
Context Recap	• The need for cross-jurisdictional collaboration and information sharing is strongly emphasized in literature • Strengthening of these networks is one of the key components in parks and protected areas' contribution to climate adaptation and

[14] Note: When I say "small scale" I am referring to an extent of land that is large enough to influence the overall variation in the surrounding landscape but not so large as to greatly disrupt wildlife flows and increase the likelihood of post-fire risks such as debris flows and landslides.
In MRPP along the Yellowhead Corridor, small scale in my opinion would then be equal to or less than the Moose Lake burn of 2004, at 2,900 hectares. While this burn created significant public unrest (Hoekstra, 2004) and has cleared a notable area from valley bottom to the subalpine, stronger public outreach preceding future burns would likely improve on this challenge.
In WWP when I say "small scale", I would recommend burns predominantly as fire breaks, wide enough to cross a valley and reach up slopes (following treeline creep), with a thickness of 65 – 2800m (as recommended by the literature (Mooney, 2010). Having fire breaks remains critical, however larger fires (e.g. Jackpine fire of 2006 at 6,300 hectares) place too much pressure and risk on endangered or threatened species and become too difficult to control.

	mitigation (CPCCCWG, 2013:20) and for restoration in parks and protected areas (Keenleyside *et al*., 2012) • Managers presented with novel and complex issues that transcend boundaries, requiring regional and trans-boundary partnerships across "traditional political, legal and institutional boundaries" (Lemieux *et al*., 2010 in CPCCCWG, 2013:20) • Findings suggest that regional cooperation is currently very limited o Echoed in a recent planning study (O'Neill, 2011) o AB-BC political boundary seen as a large obstacle o Limited capacity to nurture partnerships and stay updated about activities across provincial border o This information gap and delay causes unnecessary unknowns when dealing with regional effects and impacts
Recommendations	• As a component of a general strategy forward this may be one of the most critical to strengthen (as proposed by CPCCCWG, 2013; Hamilton and McMillan, 2004; O'Neill, 2011 and others) • Having discussion and information transfer happen sooner and with consistency would alleviate stress and enable smoother cross-boundary collaboration and alignment of plans and initiatives • Creating an interprovincial working group with representatives from neighbouring mountain parks and protected areas would allow streamlined information sharing to a larger regional network

Table 12: Potential future research

Future Research	
Research potential stemming from this study	1) Include park users and community members in photo-elicitation studies o While park managers had much to discuss in the photo-elicitation activities in this study, the views of park users and the surrounding communities were not included because it would increase the scope too much o An extension of this pilot study; similar methods o Limitations include finding an appropriate scope for participant inclusion, situating it within the larger project and MLP goals 2) Investigate changes and current trends in visitor use o Need to improve understanding of visitor use preferences, expectations, and what influences these dynamics o Park managers from MRPP in particular would benefit from this knowledge, with ongoing pressure to change operations to meet new user demands

	3) Translating conservation priorities and adaptation strategies from the literature into on-the-ground management efforts within present constraints o Accounting for the need to incorporate additional priorities without pulling on resource needs in other management areas (e.g. Wright and Stevens (2012) have done this with a long-term ecological change monitoring program for BC Parks)
Research relating to this study	1) CLIMB (Climate change, imaging and mountain biodiversity) Project at University of Victoria o Quantitative evaluation of landscape changes within the repeat photo pairs of the Mountain Legacy Project o Computer-assisted landscape classification of oblique repeat photo pairs 2) Possibilities of further use of the repeat photos are extensive and encouraging o E.g. for evaluating post-disturbance landscape change, settlement history, etc. 3) Willmore Biodiversity Research Project o Ongoing project collecting and analyzing biodiversity data
Research directions emphasized by participants	1) Historical fire dynamics of the parks o Fire used to be much more prevalent on the landscape in some areas, while the fire frequency in others is completely unknown o Still existing knowledge gaps that complicate management decisions with contrasting speculations and opinions. 2) Online research project database (proposed by MRPP participants) o Offer academic and other research institutions a "project menu" of specific topics of interest to park managers o Graduate or co-op students could choose topics to investigate with real-world applicability and benefit 3) Ecological impacts of surrounding commercial land-use (proposed by WWP participants) o Surrounding land use (e.g. resource extraction/exploration) pressures have led to habitat and range loss for wildlife o Little direct research on the impacts of these activities on park ecosystems and wildlife in WWP o Cumulative studies specifically focused on WWP needed 4) Long-term ecological monitoring of climate change impacts o As recommended widely (Colls *et al*., 2009; CPCCCWG, 2013; Dudley *et al*., 2011; Hamilton and McMillan, 2004; Wright and Stevens, 2012). 5) Long-term ecological monitoring of post-development impacts o (For MRPP) Multiple stressors occurring along Yellowhead corridor have impacted the surrounding ecosystems to extents not presently known in any detail o Negotiations for Kinder Morgan TMX pipeline brought promises for post-construction baseline ecological monitoring for neighbouring ecosystems (e.g. wetlands) o To the extent of my knowledge, no long-term ecological monitoring of these ecosystems was in place prior to construction of any of the

	linear developments in the valley; therefore are accepted baselines accurate representations of (relatively) undisturbed conditions?

5.9 Conclusions

This study has contributed a close examination of two Canadian Rocky Mountain protected areas under change. Separated by the continental divide, MRPP and WWP differ in biogeography, jurisdiction, local climates and surrounding socioeconomic conditions. The long-term changes observed have resulted in a variety of management challenges. Following years of fire suppression and climatic changes, upward movement of the treeline ecotone, and increasing stand density and age has increased risk of massive multi-valley fires and disease/pest outbreaks.

It has become apparent that many influential factors responsible for the observed landscape changes are beyond the purview of proximate ecology. The weight and influence of socioeconomic and political factors was striking in my observations. Changing visitor use and societal shifts have left managers with a different type of tourist, often expecting more and coming less prepared. In turn, agency philosophies, visions, capacities and mandates were driving forces in shaping on-the-ground approaches taken in managing these changes in remote ecosystems. It has also become apparent that manager on-the-ground efforts and broad agency mandates are not necessarily aligned, largely due to capacity and resource support. In certain cases, there was a disconnect between what managers wanted to manage for, and what their management decisions were leading to ecologically.

While surrounding literature continues to improve understanding of how parks and protected areas are being impacted by climate change and human activities, there remains a knowledge gap around many ecological impacts in these two parks. This grey area necessarily leads to some management indecision, particularly in the more remote areas. This is particularly the case in WWP where managers would use additional information to better understand the factors at play in the western park reaches, where multiple values (e.g. community protection, species at risk, forest health) are currently competing for priority in management decisions. This information gap ultimately supports the predominantly passive management approach taken in MRPP, which appears largely because of imbalanced agency mandates towards recreation and insufficient capacity for sustained long-term conservation efforts and monitoring of ecological conditions in the park. As such, within the current circumstances neither park appears able to contribute to climate change adaptation or mitigation through the proposed strategies, beyond the baseline benefits provided by healthy natural areas. This is a troubling conclusion, but this does mean there is still a great potential for change. These two parks could in time become meaningfully engaged in climate adaptation strategies.

The primary recommendations that have arisen from this study are aimed at enabling managers to best approach these issues of long-term remote landscape change within the context of rapid climate change. Recommendations include: the integration of diffuse restoration, the more constrained - but continued - use of prescribed fire to reduce risk without further reducing critical habitat and refugia; the incorporation of meaningful outreach and mentoring with the public, including focal restoration practices that nurture a sense of place; increases in park capacity for research and monitoring both of longitudinal ecological conditions (indicators for

health and climate impacts) and of post-pipeline construction conditions for MRPP; and lastly the creation of an cross-disciplinary interprovincial working group for cross-jurisdictional collaboration and information sharing for regional climate adaptation and mitigation.

To close, I observed in my study of Mount Robson and Willmore Wilderness parks that management challenges are rubbing uncomfortably against a conventional parks management paradigm. This paradigm has a long history with roots stretching back to the 19th century, holding nature as static and wilderness as something autonomous from human use. This tension reflects emerging literatures about parks management in North America (e.g. Cole and Yung, 2010; Hobbs *et al*., 2011). In particular, the realities of rapid environmental and ecological change are challenging this paradigm, and it arguably no longer fulfills our needs – or those of park ecosystems and species. Simultaneously, cultural shifts have left us with changing views and expectations of parks, for example, seeing protected areas as central to climate change mitigation and adaptation strategies. This study has observed this friction between broader paradigms and on-the-ground management challenges in these two parks. Moving forward into the future, bridging this gap would prove beneficial on many levels.

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Appendix A: List of Abbreviations

AB ESRD: Alberta Environment and Sustainable Resource Development (A Ministry of the Province of Alberta)

AB Parks: Alberta Parks

AB SRD: Alberta Sustainable Resource Development

ABMI: Alberta Biodiversity Monitoring Institute

ACA: Alberta Conservation Association

AT: Alpine Tundra (biogeoclimatic zone)

AWA: Alberta Wilderness Association

BC Parks: British Columbia Parks

BC MOE: British Columbia Ministry of Environment

BGC: Biogeoclimatic Zone(s)

CLIMB Project: Climate Change, Imaging and Mountain Biodiversity Project

CPCCCWG: Canadian Parks Council Climate Change Working Group

ESSF: Engelmann Spruce Subalpine Fir (biogeoclimatic zone)

ICH: Interior Cedar Hemlock (biogeoclimatic zone)

IPCC: Intergovernmental Panel on Climate Change

IUCN: International Union for Conservation of Nature

MRPP: Mount Robson Provincial Park

SBS: Sub-boreal Spruce (biogeoclimatic zone)

TPR: Tourism, Parks and Recreation (A Ministry of the Province of Alberta)

UNEP: United Nations Environment Programme

WWP: Willmore Wilderness Park

Y2Y: Yellowstone to Yukon Conservation Initiative

Appendix B: Participant Recruitment Materials

Invitation To Participate Letter – for both focus group and interview participants

Dear potential participant,

I would like to invite you to participate in a study entitled "Long-term Change and Ecosystem Management in Remote Protected Areas: A Photographic Analysis of Willmore Wilderness Park (WWP) and Mount Robson Provincial Park (MRPP)", which is examining the management and restoration impacts of long-term landscape change in remote protected area ecosystems. Long-term environmental changes will be evaluated through scientific repeat photography. I am conducting this study as part of the requirements for an MA degree in the School of Environmental Studies at the University of Victoria. You hold particularly relevant experience and perspectives on these issues, which would be of much interest in this study. I hope that you will be interested in participating in this project.

The primary objective of this research project is to investigate observable long-term remote landscape change in two protected areas in the Canadian Rocky Mountains, and examine the resulting implications for management and restoration. While remote areas are often protected to in part maintain ideals of 'pristine, untrammelled wilderness', these areas are often influenced by human activities directly (e.g. fire suppression) or indirectly (e.g. climate change, invasive species). This has been documented in various studies, some particularly poignant examples have utilized repeat photography to do so. Furthermore, logistical and moral issues inherent in remote ecosystems intensify challenges presented to management. Protected area management throughout the Canadian Rocky Mountains exemplifies these complexities and difficulties.

I will investigate these issues by contrasting management challenges, ecological changes and circumstances in two remote protected areas – Willmore Wilderness Park in west-central Alberta, and Mount Robson Provincial Park in east-central British Columbia. How do long-term landscape changes (driven by fire suppression, climate change) influence conservation and restoration objectives in remote mountain ecosystems? What challenges do they present for parks management? Within that larger question, what are the challenges inherent in managing and restoring remote ecosystems in these two parks? How should managers of remote ecosystems approach these issues in the face of rapid ecological change? To assess these topics, photo elicitation using the repeat photographic image pairs will take place in focus groups in fall 2012.

Your participation in this study would include attending a focus group session. The time commitment would require approximately 3 hours of your time in total. The image pairs will be shared during the focus groups and will act to structure and guide the discussion. The purpose of the focus groups is to find areas of agreement or disagreement, particular challenges and opportunities for management and restoration in these protected areas, and other lines of thought that the repeat image pairs prompt or inspire.

Following the focus group interviews, individual follow-up interviews will be completed with a subset of the participants. These interviews are to further evaluate participants' views and reflections on the focus group discussions; they are an optional addition to participation in the study's focus groups. If you are interested in participating in a follow-up interview as well, please contact me directly to discuss this option. Both focus group and follow-up interviews will take place at times and locations most convenient to participants. When necessary for a participant to attend an interview, arrangements to subsidize transportation costs may be made. Should you choose to volunteer to participate in the study, more details will be provided prior to the focus groups and interviews. Overall, it is hoped that approximately 10-12 people participate in the focus groups for each park, in order to represent each park sufficiently. Due to the nature

of focus groups, it is not possible to maintain anonymity of participants. However, if requested by a participant, information shared by said participant will be depersonalized in the analysis and results of this study in all forms it might be shared, by not having reference to that individual-by name.

Participating in this study will give you an opportunity to do two things. First, you are invited and encouraged to discuss and share your experience and views about the barriers, opportunities and future prospects for management in remote protected areas, set within the dynamic context of today's rapid climate change and restoration objectives and ideals. Secondly, you will have an opportunity to learn more about these issues from others in similar vocations, and bring back your experiences to share with colleagues in your protected area and region of interest.

PLEASE REVIEW THE PARTICIPANT CONSENT FORM (attached). Should you decide to participate, you will be asked to consent (explicitly – formal signatures) to the conditions outlined in the Participant Consent Form. This form will provide you with details on the aims and objectives of the study, methodology, and arrangements surrounding confidentiality. By agreeing to be a participant in this study, you are stating that you understand the conditions of participating, and that you are giving your full consent to participant therein. Before the focus group interview (and again before follow-up interview should you choose to also take part in that component) you will be asked to reaffirm this consent. If any concerns become apparent to you at any time before, during, or after the study, there will be the opportunity to discuss these at any time.

This project is being conducted under the supervision of Dr. Eric Higgs, Professor, School of Environmental Studies, at the University of Victoria. Dr. Higgs can be contacted by phone at ---------- or by email at ehiggs@uvic.ca.

This research project is funded through the generous support of Alberta Sustainable Resource Development (ESRD), the Social Sciences and Humanities Research Council (SSHRC), and the University of Victoria (Graduate Fellowship).

Thank you for taking this request for participation into consideration, if you have any questions please feel free to contact me (see below for contact details). I look forward, and hope to hear back from you soon.

Sincerely,

_____

Jenna Falk

Initial Participant Contact Scripts – focus group participants

Initial Email:

Dear XXXXX,

I hope you will take part in a focus group discussing [*Mount Robson Provincial Park/Willmore Wilderness Park]* in November 2012. My name is Jenna Falk and I am a Master's of Arts student in the School of Environmental Studies at the University of Victoria. My supervisor is Dr. Eric Higgs, who specializes in ecological restoration issues, landscape change, and philosophies of nature and technology. Dr. Higgs runs the Mountain Legacy Project, which aims to curate, digitize and repeat historical mountain survey photographs. For my thesis research I am conducting a study entitled "Long-term Change and Ecosystem Management in Remote Protected Areas: A Photographic Analysis of Willmore Wilderness Park (WWP) and Mount Robson Provincial Park (MRPP)", which is examining the management and restoration impacts of long-term landscape change in remote mountain protected area ecosystems. In this study, long-term environmental changes will be evaluated through scientific repeat photography (via The Mountain Legacy Project, run by Dr. Higgs), and following this fieldwork (taking place in June-August 2012) I hope to conduct focus groups with a few small groups of [*Parks/ASRD*] employees to discuss the challenges of managing long-term remote landscape change, and how these changes might influence conservation objectives. [You have been specifically recommended to me by XXXXX because] *[the previous section will be inserted only for individuals having been recommended by a previous contact to the researcher]* you hold particularly relevant experience and perspectives on these issues, which would be of much interest in this study.

I hope that you will be interested in participating in this project. If you have any questions or would like to receive more information on this study, please feel free to contact me (see below for contact details).

I look forward, and hope to hear back from you soon.

Sincerely,

Jenna Falk

[Note: In the instance that a potential participant is unreachable by email, this initial contact will be done via telephone. The script will remain the same however will undoubtedly follow a more conversational structure and be less strictly structured as this email script in terms of the ordering of information. However, the same information covered here will be discussed via telephone.]

Initial Participant Contact Scripts – interview participants

Initial Email:

Dear XXXXX,

I hope you will take part in an interview discussing [*Mount Robson Provincial Park/Willmore Wilderness Park]* in February 2013. My name is Jenna Falk and I am a Master's of Arts student in the School of Environmental Studies at the University of Victoria. My supervisor is Dr. Eric Higgs, who specializes in ecological restoration issues, landscape change, and philosophies of nature and technology. Dr. Higgs runs the Mountain Legacy Project, which aims to curate, digitize and repeat historical mountain survey photographs. For my thesis research I am conducting a study entitled "Long-term Change and Ecosystem Management in Remote Protected Areas: A Photographic Analysis of Willmore Wilderness Park (WWP) and Mount Robson Provincial Park (MRPP)", which is examining the management and restoration impacts of long-term landscape change in remote mountain protected area ecosystems. In this study, long-term environmental changes will be evaluated through scientific repeat photography (via The Mountain Legacy Project, run by Dr. Higgs), and following this fieldwork (taking place in June-August 2012) I have conducted focus groups with a few small groups of [*Parks/ASRD*] employees to discuss the challenges of managing long-term remote landscape change, and how these changes might influence conservation objectives. Following the focus groups, I hope to have a few individual interviews to supplement for focus groups. [You have been specifically recommended to me by XXXXX because] *[the previous section will be inserted only for individuals having been recommended by a previous contact to the researcher]* you hold particularly relevant experience and perspectives on these issues, which would be of much interest in this study.

I hope that you will be interested in participating in this project. If you have any questions or would like to receive more information on this study, please feel free to contact me (see below for contact details).

I look forward, and hope to hear back from you soon.

Sincerely,

Jenna Falk

[Note: In the instance that a potential participant is unreachable by email, this initial contact will be done via telephone. The script will remain the same however will undoubtedly follow a more conversational structure and be less strictly structured as this email script in terms of the ordering of information. However, the same information covered here will be discussed via telephone.]

Appendix C: Human Ethics and Participant Consent Form

University of Victoria

Human Research Ethics Board
Office of Research Services
Administrative Services Building
PO Box 1700 STN CSC
Victoria British Columbia V8W 2Y2 Canada
Tel 250-472-4545, Fax 250-721-8960
Email ethics@uvic.ca Web www.research.uvic.ca

Certificate of Approval

PRINCIPAL INVESTIGATOR	**Jenna Falk**	**ETHICS PROTOCOL NUMBER**	**12-366**
UVic STATUS:	**Master's Student**	ORIGINAL APPROVAL DATE:	05-Sep-12
UVic DEPARTMENT:	**ENVI**	APPROVED ON:	05-Sep-12
SUPERVISOR:	**Dr. Eric Higgs**	APPROVAL EXPIRY DATE:	04-Sep-13

PROJECT TITLE: **Long-term Change and Ecosystem Management in Remote Protected Areas: A Photographic Analysis of Willmore Wilderness Park and Mount Robson Provincial Park**

RESEARCH TEAM MEMBERS: Supervisor: Dr. Eric Higgs (UVic)
Student/Research Assistants: Heike Lettrari (UVic), Mary Sanseverino (UVic)

DECLARED PROJECT FUNDING: **SSHRC-CGS Master's; Alberta Sustainable Resource Development (ASRD)**

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

[redacted]

Dr. Rachael Scarth
Associate Vice-President, Research

Certificate Issued On: 05-Sep-12

12-366 Falk, Jenna

University of Victoria

Human Research Ethics Board
Office of Research Services
Administrative Services Building
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ethics@uvic.ca www.research.uvic.ca

Modification of an Approved Protocol

PRINCIPAL INVESTIGATOR	**Jenna Falk**	**ETHICS PROTOCOL NUMBER**	**12-366**
UVic STATUS:	**Master's Student**	ORIGINAL APPROVAL DATE:	05-Sep-12
UVic DEPARTMENT:	**ENVI**	MODIFIED ON:	04-Feb-13
SUPERVISOR:	**Dr. Eric Higgs**	APPROVAL EXPIRY DATE:	04-Sep-13

PROJECT TITLE: **Long-term Change and Ecosystem Management in Remote Protected Areas: A Photographic Analysis of Willmore Wilderness Park and Mount Robson Provincial Park**

RESEARCH TEAM MEMBERS: Dr. Eric Higgs, Supervisor (UVic); Dr. Peter Stephenson, Committee Member (UVic)

DECLARED PROJECT FUNDING: **SSHRC-CGS Master's (previous); Alberta Sustainable Resource Development (ASRD) (previous)**

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

[redacted]

Dr. Rachael Scarth
Associate Vice-President, Research

Certificate Issued On: 04-Feb-13

12-366 Falk, Jenna

University of Victoria

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Certificate of Renewed Approval

PRINCIPAL INVESTIGATOR:	**Jenna Falk**	**ETHICS PROTOCOL NUMBER** Minimal Risk - Delegated	**12-366**
UVic STATUS:	**Master's Student**	ORIGINAL APPROVAL DATE:	05-Sep-12
UVic DEPARTMENT:	**ENVI**	RENEWED ON:	26-Aug-13
SUPERVISOR:	**Dr. Eric Higgs**	APPROVAL EXPIRY DATE:	04-Sep-14

PROJECT TITLE: **Long-term Change and Ecosystem Management in Remote Protected Areas: A Photographic Analysis of Willmore Wilderness Park and Mount Robson Provincial Park**

RESEARCH TEAM MEMBERS: Dr. Eric Higgs, Supervisor (UVic)

DECLARED PROJECT FUNDING: **SSHRC-CGS Master's (previous); Alberta Sustainable Resource Development (ASRD) (previous)**

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

[redacted]

Dr. Rachael Scarth
Associate Vice-President, Research

Certificate Issued On: 26-Aug-13

12-366 Falk, Jenna

Appendix D: Focus Group Materials

Focus Group Sessions – Agenda

Mt. Robson: December 5, 2012 at 1pm
Willmore: December 7, 2012 at 9am and 1pm

Pre-Session Set-up and Preparation	
8:20am	• Pick up room key from reception desk off main parking lot
8:30am	• Gain access to seminar room, bring in equipment and materials • Ensure everything is clean, secure • Set-up recording devices, one at each end of the table; run a test and hook up to computer to confirm they are both working properly • Have consent forms and other information documents ready • Have reference page ready for additional information if asked for • Have name cards prepared and arrange seating after meeting the participants briefly as they come in – place dominant speakers closer to facilitator and quieter participants directly across from facilitator, etc. • Review what we are asking, how and why
8:45am	• Be prepared to start welcoming participants to the session – home hosts • When each new participant arrives, explain the set-up and steps to get settled (i.e. where to leave coats, forms to sign/take home, coffee/tea), then have them settle, speaking with one of us with simple small talk to bring comfort and ease
9:00am	• Critical first few moments to get everyone comfortable and informed • *Balance formality and informality (too rigid/stifling /not serious enough)* • Introduce discussion: The welcome Topic overview (2-3min.) Ground rules First question (get everyone talking early on, break the ice)
9:10am	E.g. factual information that isn't deep or difficult to share "After a round of introductions, I'd like each of you to share a story or anecdote that, for you, really captures the essence of Mount Robson Park for you" **Q1: "Let's go around the table and each share your name, where you are from, and, if you would like to, what you most enjoy doing when not at work"**
9:15am	• Transition to second question: **Q2: "Can you each share a story or anecdote that, for you, captures the essence of MRPP/WWP?"** • *Watch for direction of discussion flow – anticipate dead ends and beneficial topics - redirect away or probe further accordingly* • *Watch for four key types of participants and try or balance their involvement – experts, talkers, shy, and ramblers*
9:25am	• *Respond to participant comments consciously and carefully* • Transition to third question:
9:35am	**Q3: "Have you noticed environmental changes in the park over the time of your work here?"**

10:00am 10:30am 10:50am	• Transition to photo elicitation: **"These photo pairs show various landscape changes – or lack thereof – occurring over the past century in MRPP/WWP. As we go through a few pairs, please discuss these in terms of what you see, what comes to mind from the photos, and what you see as being significant."** • *If discussion is going strongly, keep going – if focus is waning, offer a ten minute break to check phones/emails, refresh drinks, and regroup* • Transition to key questions while photo pairs are out: **Q4: "Think back to the past few years. Which challenge do you think has been most influential to Park management efforts and goals?"** **Q5: " When looking at these images, does remoteness come to mind for any of you? How would you define a remote ecosystem?"** **Q6: "Have any of you encountered any challenges in managing remote areas in the park? Tell us about them."** **Q7: "Do you feel that the values and perspectives guiding parks management in this region have changed over the span of your involvement? How?"** • Conclude focus group – thank group, offer gift and wish them well • Invite comments, amendments, corrections • **Ask** "Have we missed anything?" (without recorder on anymore) • Collect photos and papers, thank everyone again and say goodbye

Focus Groups Agenda - Active Guide

Modified from 1st Session (Dec. 5, MRPP) for 2nd and 3rd sessions (Dec. 7, WWP)

Welcome

Topic Overview

"Long-term Change and Ecosystem management in Remote Protected Areas: A Photographic Analysis of WWP and MRPP"

SSHRC, ESRD, UVic Fellowship

My project has a focus on the management challenges resulting form long-term environmental change in protected areas. I'll be comparing these (ecological and management) dynamics in both WWP and MRPP. In the summer of 2012, repeat photography work was done in both parks. Using these photos among others, I hope to have those involved in managing these parks come together and discuss the changes being seen, and share perspectives on what the implications and significance of this change is for parks management.

Ground Rules:

Some things to make the discussion more productive:

- Please speak one at a time – we went to ensure that every comment is recorded effectively and everyone feels they have space to speak
- This discussion will be recorded using this audio recorder –the recording will be available to each of you if you'd like, along with the transcripts I'll be making of the recording.
- We'll be operating on a first name basis here
- There are no "wrong opinions/views", and I'm just as interested in areas of agreement as I am in areas of disagreement
- Some will take a lot, and some will talk little – I may call upon you if you are being quiet, or may ask you to let someone else share their opinion on a given topic if you are talking a lot
- My role here is to ask questions and to listen
- I won't be actively engaged in the discussion as a participant, but as a moderator or facilitator
- The aim here is to have a relatively free flowing conversation amongst yourselves
- Feel free to take your time reflecting on a question before answering – we are in no rush to have instant answers

After a round of short introductions, I'd like each of you to share a story or anecdote that, for you, really captures the essence of WWP/MRPP for you.

Intro:

Q1: "Let's go around the table and each share you name, where you are from, and if you would like to, what you most enjoy doing when not at work."

Q2: "Can you each share a story or anecdote that, for you, really captures the essence of the park to you? The aim here is for something personal and reflective – we'll get into the topic details

shortly. A particular memory or moment relating to the park that stands out to you personally, would work."

9:25AM

Q3: "Can you give an example of an environmental change in the park over the time of your involvement? This could be a shift that is visible or not, widespread or not, etc. This is intentionally broad before bringing out the photo pairs, to get us thinking in that direction."

TRANSITION TO PHOTOS

9:35AM

Please discuss these photo pairs for what you see as significant, what comes to mind (in terms of ecological change and management).

Probe: "Why do you think these changes are occurring?"

10:00AM

Q4: "think back to the past few years. Which conservation challenge do you think has been most influential to park management (efforts and goals)?"

Q5: "When looking at the photos, does remoteness come to mind to any of you? How would you define a remote ecosystems?"

10:25AM

Q6: "Have you encountered any challenges specifically in managing remote areas in the park? Tell us about them."

10: 35AM

Q7: "Do you feel that the values and perspectives guiding parks management in this region have changed over the span of your involvement? How?"

Some "Maybe Questions"

10:45AM

Summarize

Conclude:

- Thanks
- Amendments/comments
- Gifts
- Collect everything

"Have we missed anything?"

Appendix E: Follow-up Interview Materials

Interview Agenda and Guide

Follow-up interviews will take up to 1 hour. The interviews will be semi-structured, which provide me with a good balance between finding the information most relevant to the project, and you having the freedom and flexibility to express perspectives on the focus group. The follow-up interviews are being conducted with the aim of providing additional perspectives from participants on topics or concerns approached in the focus groups, or of additional ideas or comments not brought up during the focus groups by participants. Follow-up interviews will also provide me with valuable feedback on the focus group sessions themselves, and aid future improvement in the method. I've drafted a list of questions for the follow-up interviews that will help to guide the conversation.

Questions in black: All interviews
Questions in blue: BC interviews only – new questions having arisen in focus groups
Questions in red: AB interviews only – new questions having arisen in focus groups
(*Note: in the case of this thesis printed or displayed in grayscale, those questions originally displayed in red or blue are accompanied by a single * or double **, respectively.)*

Introductions and opening questions:

1) Would you tell me [a bit] about yourself?
   Get everyone comfortable, set the tone

- Would you tell me about how you came to work in the park, and in what capacity is your current involvement in the park?
  Emphasis on longer answer, stories, personal approach
  What are your predominant roles in working in the park?
- Can you share a story or anecdote that, for you, really captures the essence of MRPP/WWP?
  Worked well in focus groups, and can compare what they see as the core characteristics or "essence" of the park in question
  Promotes open and free-thinking atmosphere, to share what they care about

Transition to change in the park:

4) Could you give an example of an environmental change you have noticed in the park over the course of your involvement?
   - These do not necessarily have to be widespread or very visible
   - What is/are the most significant changes you have noticed?
     Why do you think these changes are occurring?
     Possibly unnecessary – for the most part, became apparent in focus groups that the result of such changes was more significant in terms of spurring on action, rather than the cause (particularly so when the cause was likely climate change, which was out of their control)
     E.g. meadow encroachment – hinders trail use, could be fire suppression issue, or a maintenance issue, either way it causes complaints, difficulty accessing the park and so forth
     This is all before the photos come out/on screen

Photo pairs come out:

- We'll cycle through a few photo pairs now together. Take your time to look at the photos. When you're ready, I'm interested to hear what you see as significant in the images, and what comes to mind in terms of ecological change and management.

Transition to remote ecosystems:

- *First photos being shown via screen-sharing now; give photo details, location*
  Remind participant to freely discuss their impressions, and thoughts regarding the photos, what they see, thought they would see, etc. (this is all being covered in precursory "ground rules" before questions begin, but might be good to reinforce and state again here)

5) When thinking about the park through these photos, does remoteness come to mind for you? How would you define a remote ecosystem?

6) Have you encountered any challenges in managing [the more] remote areas in the park? Tell me about them.
   - In Particular: Upper Fraser, Resplendent Creek areas in Mt. Robson
   - In Particular: Smokey, Sheep Creek areas in Willmore
     Based on emphasis on remoteness/wildness in focus groups

7) Under what circumstances would you intervene and actively restore a remote area of the park? (Restore from x, y, z, etc.) Have these circumstances ever occurred?
   - ***May remove if time constraints exist.*** *This has basically been covered in focus groups – they don't, either because they can't, or can't imagine doing so*
     Resources, planning/public interest pressures, too difficult, low priority over more immediate, reactionary efforts to maintain status quo/use

Transition to management challenges:

8) Think back to the past few years. Which conservation challenge do you think has been most influential to park management efforts and goals?

9) Do you feel that the values and perspectives guiding parks management in this region have changed over the span of your involvement? How?

10) A dominant theme in the focus group last month was a view that management has become more reactive, rather than proactive. What are your thoughts on this?

11) Another dynamic that was brought up in the focus group was that of the balance between recreation and conservation priorities in management; what are your thoughts on this balance?
   - *Socio-economic pressures and public interests*

12) A dynamic that was brought up in the focus group was that of the balance in place between a more preservationist philosophy of Alberta Parks, and a more conservationist/sustainable-use philosophy of AB ESRD; what are your thoughts on this in terms of its impact on management goals and objectives?
   - *This arrangement has been discussed in both focus groups and does not need to be repeated – saturation point reached, definitely getting repetitive with complaints and concerns – more detail needed on what that* ***means*** *for them, when they do work together, in the Willmore*

13) Do you feel that the external pressures on the park along its boundaries are increasing significantly?
   - *Ask more as a follow-up probe, only if it comes up naturally*
   - *Has largely been covered in focus groups*

- *Came up as a probe in focus groups, in all discussions*

Transition to wrap-up:

14) In the time we've spent together today, of all the ideas shared, what strikes you as the most significant for your work in the park?
    - What strikes you as most relevant day to day?
    - *This can serve as a replacement for the handheld notepads focus group participants used to write most key points down at the end of the discussions*
    - *Explicit list (1-3, etc.) from participant if possible*
      Avoids danger of assuming emphasis on more drawn out topics

Appendix F: Repeat Photography



Figure 67: Wheeler 1924 Interprovincial Boundary Survey Map showing Sheep Creek South Station 292 at bottom right (Source: MLP Collection)



Figure 68: Wheeler's 1924 Sheep Creek South Station #292; Wheeler 1924 (top) and MLP 2011 (bottom)

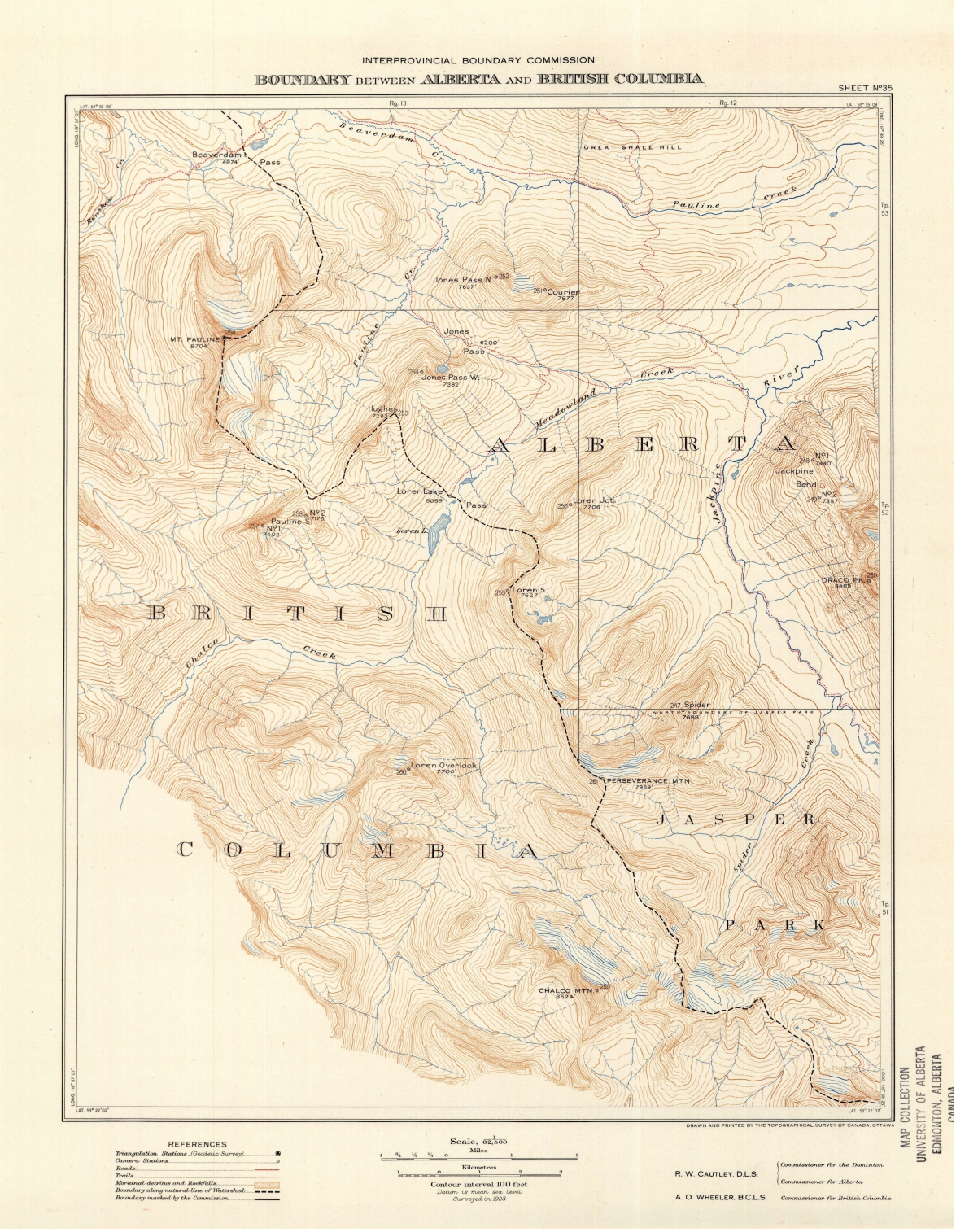

Figure 69: Wheeler 1923 Interprovincial Boundary Survey Map; Courier Mountain Station 251 top center (Source: MLP Collection)

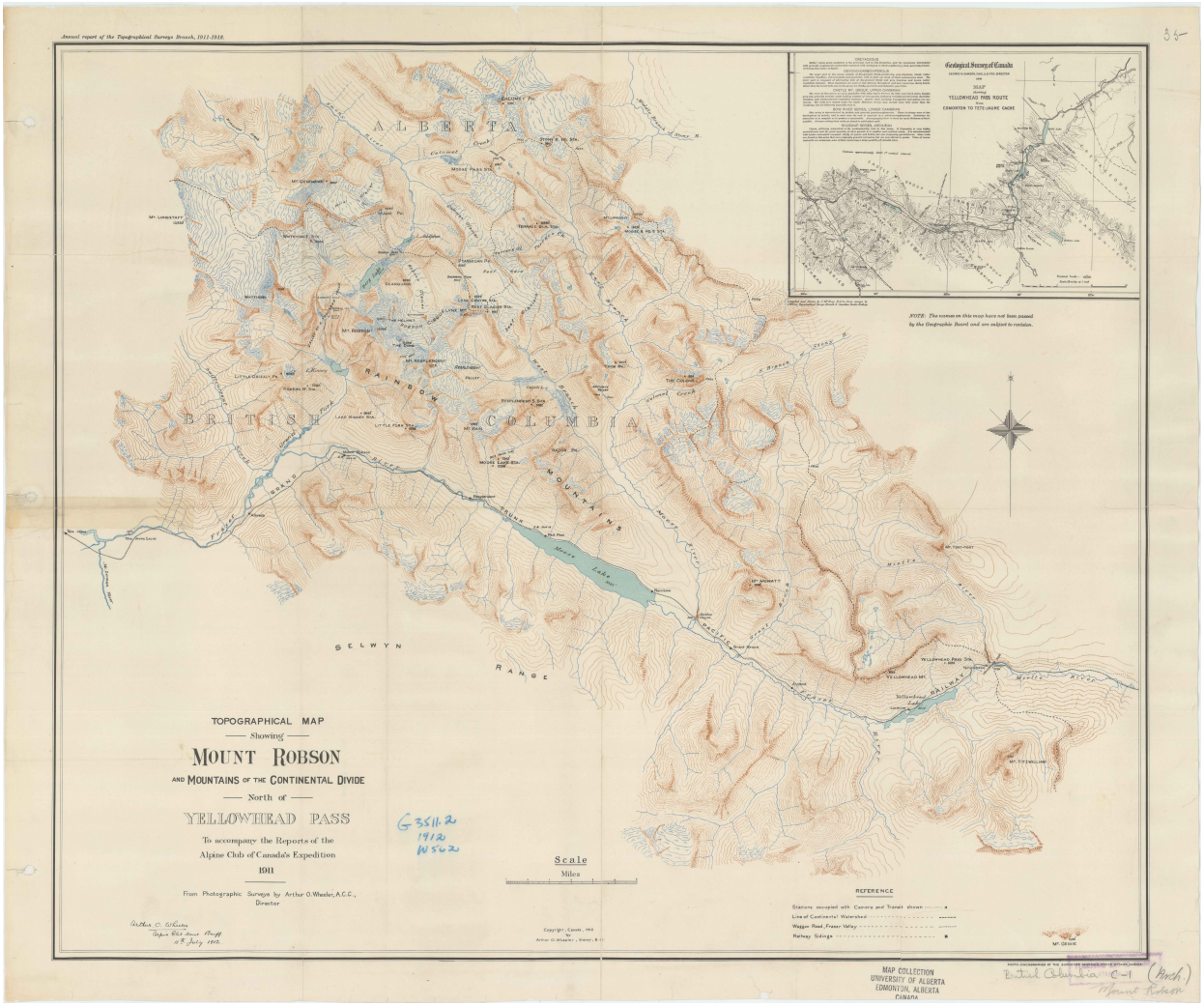

Figure 70: Wheeler 1911 Mount Robson Map (Source: MLP Collection)



Figure 71: Wheeler's 1923 Holmes North Station #245; Wheeler 1923 (top), MLP 2007 (bottom)

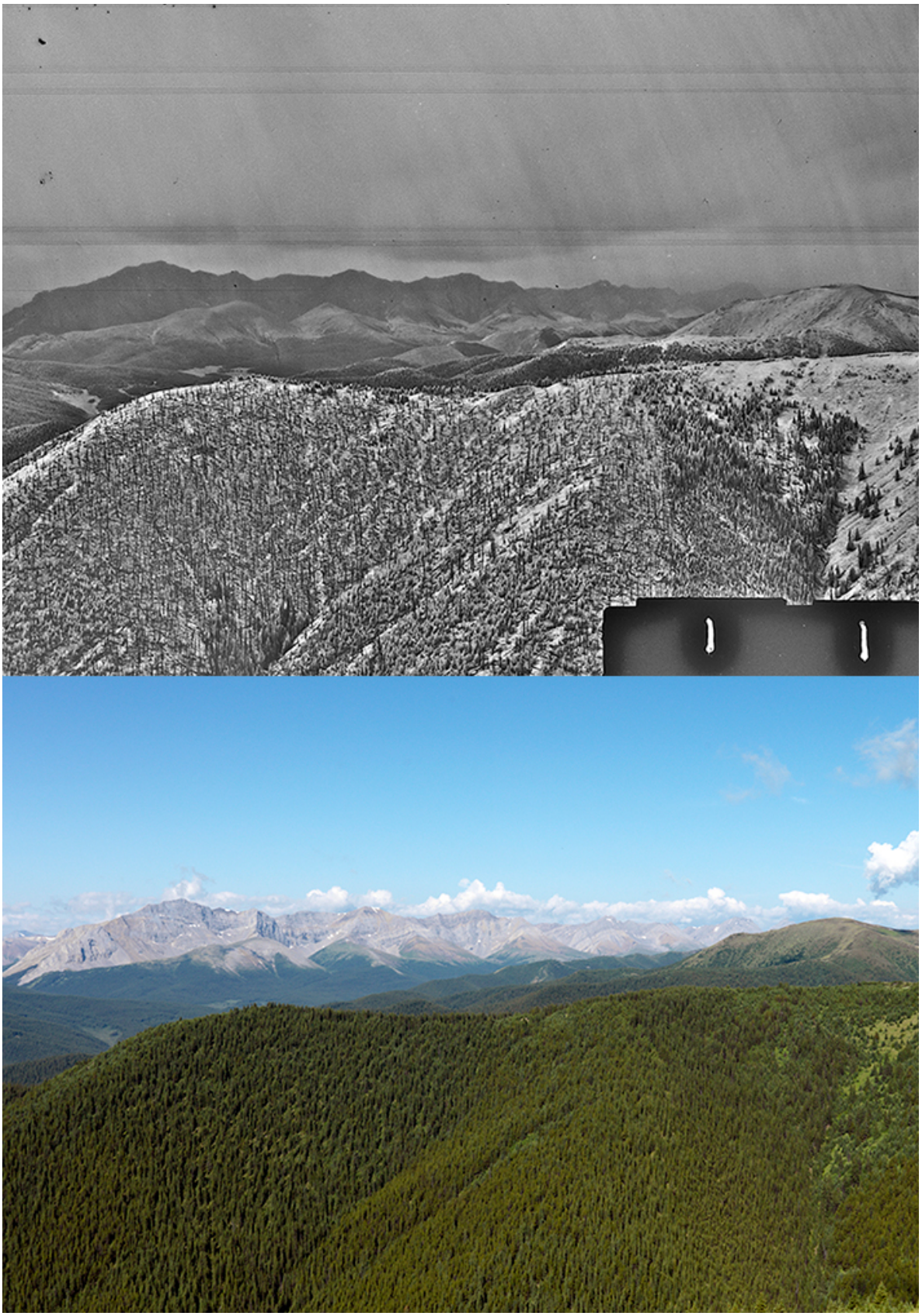

Figure 72: Nidd 1944 Station #11; Nidd 1944 (top), MLP 2012 (bottom)

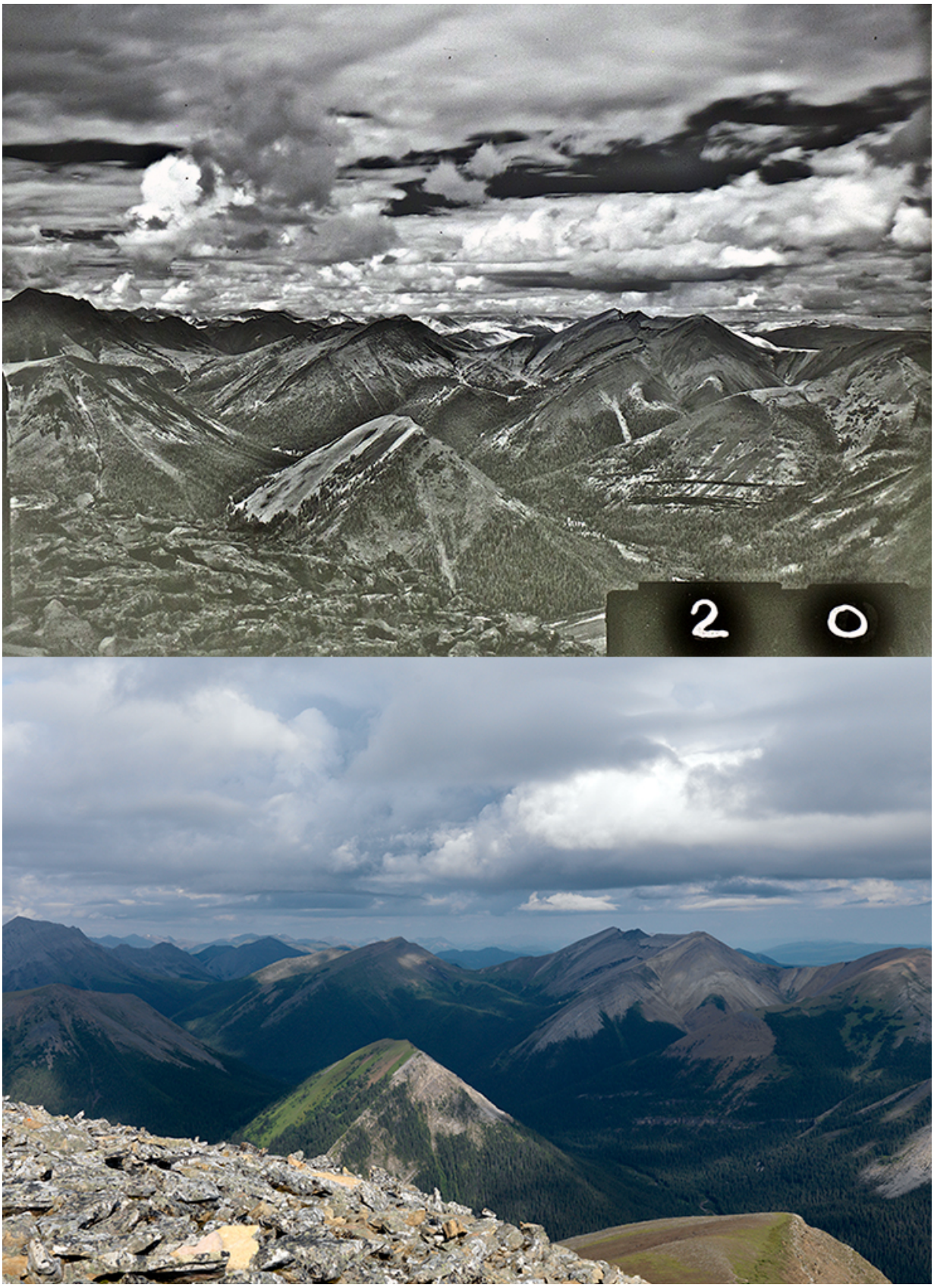

Figure 73: Nidd 1944 Station #20; Nidd 1944 (top), MLP 2012 (bottom)

Appendix G: General Figures

Table 13: Biophysical characteristics of natural subregions of Alberta

Natural Region	Natural Subregion	Area (km²)	Percent of province	Average elevation (meters above sea level)	Physiography	Major soils	Main vegetation types	Wetlands and water	Land use
Rocky Mountain (6% of province)	Alpine	15,084	2.3	2350 (1900–3650)	Steeply sloping bedrock, colluvium, residual materials, glaciers	Nonsoils, Regosols, Brunisols	Largely nonvegetated; herbaceous meadows, shrublands	Wetlands uncommon; 4% of area as glaciers, snow fields	Conservation, recreation
	Sub-Alpine	25,218	3.8	1750 (1300–2300)	Till, residual materials over rolling and inclined bedrock	Eutric Brunisols	Mixed conifer (lodgepole pine–Engelmann spruce) forests	2% (wetlands), 1% (lakes and streams)	Recreation, forestry, oil and gas, coal mining, minimal grazing
	Montane	8,768	1.3	1400 (825–1850)	Valleys and foothills. Till with significant fluvial deposits.	Mainly Black to Dark gray Chernozems; significant occurrences of Brunisols, Luvisols	Mixed or pure aspen, lodgepole pine, Douglas fir, and white spruce forests; grasslands	2% (wetlands), 1% (lakes, streams)	Recreation, forestry, grazing, major transportation corridors
Foothills (10% of province)	Upper Foothills	21,537	3.3	1300 (950–1750)	Rolling foothills, dissected plateaus, till with colluvium on steeper slopes	Brunisolic Gray Luvisols, Orthic Gray Luvisols. Mesisols and Gleysols in wetlands	Mainly closed coniferous forests (lodgepole pine, lodgepole pine–black spruce, white spruce	10% (wetlands in valleys), < 1% (lakes, streams)	Recreation, oil and gas, coal mining, forestry, minimal grazing
	Lower Foothills	44,899	6.8	950 (650–1625)	Dissected plateaus, rolling uplands. Till with significant fluvial deposits.	Orthic Gray Luvisols, Brunisolic Gray Luvisols. Wetlands are Mesisols and Gleysols.	Mixedwood forests (aspen–lodgepole pine–white spruce)	20% (wetlands in valleys), < 1% (lakes, streams)	Recreation, oil and gas, coal, forestry, grazing, some till cropping at low elevations
Grassland (14% of province)	Dry Mixedgrass	46,937	7.1	800 (550–1100)	Undulating plains. Mainly till with significant lacustrine, fluvial, eolian materials.	Brown Chernozems; significant areas of Brown Solonetz. Wetlands are Gleysols	Grasslands (blue grama, needle and thread), shrublands in moister locales	3% (wetlands–marshes or temporary); 2% (lakes, streams)	Oil and gas, grazing, irrigation-based farming
	Mixedgrass	20,072	3.0	975 (650–1450) Highest elevations on Cypress Hills	Undulating plains with some rolling to hummocky areas. Till and lacustrine materials.	Dark Brown Chernozems. Wetlands are Gleysols.	Mainly agricultural; native grasslands are needle and thread, porcupine grass, northern and western wheatgrass; buckbrush shrublands.	5% (wetlands, mainly marshes); 1% (lakes, streams).	Oil and gas, grazing, irrigation-based farming
	Northern Fescue	14,933	2.3	800 (650–1100) Highest elevations to west	Undulating plains and hummocky uplands. Mainly till with significant lacustrine, fluvial, and eolian materials	Dark Brown Chernozems, significant areas of Dark Brown Solonetz. Wetlands are Gleysols.	Plains rough fescue (moist), western porcupine grass (drier). Buckbrush and rose shrublands. Graminoid wetlands.	7% (wetlands, mainly marshes); 3% (lakes, streams)	Oil and gas, grazing, till cropping
	Foothills Fescue	13,623	2.1	1100 (800–1525)	Hummocky and rolling to undulating. Mainly till, significant lacustrine deposits	Mainly Black Chernozems. Wetlands are Gleysols.	Mountain rough fescue on moister sites, western wheatgrass on drier sites. Wet areas often shrubby.	3% (wetlands), 1% (lakes, streams)	Recreation, oil and gas, grazing, till cropping (short-season crops)

(Natural Regions Committee, 2006)

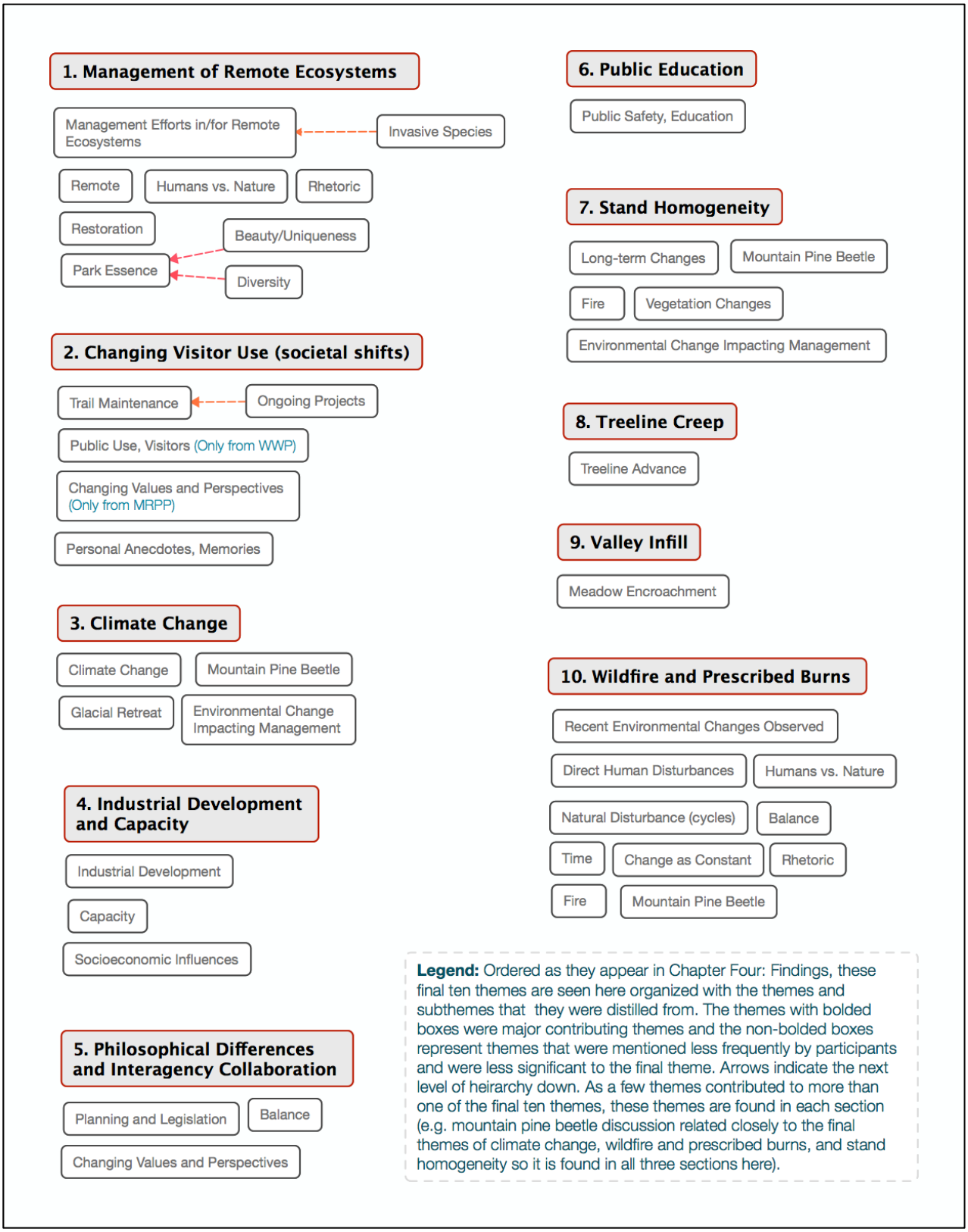

Figure 74: Coded themes of analysis as distilled from Excel