Wildlife Ecosystem Resilience in the Context of Climate Change: A Kootenay Case Study on Stakeholder Perspectives on Conservation Interventions

by

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Bachelor of Science (Agriculture), University of British Columbia, 1973
Master of Science, McMaster University, 1979

A Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of

DOCTOR OF PHILOSOPHY

in the School of Environmental Studies

Supervisory Committee

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Abstract

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The Kootenay Region of British Columbia is an important landscape connection for wildlife diversity in the Yellowstone to Yukon ecoregional corridor. Significant conservation efforts have provided substantial areas designated to protect wildlife ecosystems in this area. Yet climate change and on-going human development threaten the future resilience of these ecosystems. In light of this complex problem, the goal of this dissertation is to evaluate the effectiveness of current wildlife conservation policy mechanisms, their potential vulnerability in the face of climate change, and the motivation of stakeholders to support policy adaptations. In particular, the research undertakes to understand how community support for adaptation strategies that mitigate climate change impacts on wildlife ecosystems may evolve through direct engagement in conservation assessment and design processes. The thesis therefore addresses the overarching question: “How does stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems influence support for appropriate wildlife habitat and species intervention policies?”

The dissertation reviews conservation policies applicable to British Columbia, reviews the efficacy of how those policies are implemented in the Kootenay Region, assesses the potential scope of ecosystem vulnerability to climate change in the region, and evaluates how stakeholder values, beliefs and attitudes motivate support for wildlife conservation and how this is influenced by engaging in a workshop that explores scenarios and impacts of climate change. The efficacy of current conservation policies was evaluated against ecosystem representation, objectives from the Kootenay-Boundary Land Use Plan, the recent ecoregional assessment for the Canadian Rocky

Mountains prepared by the Nature Conservancy of Canada, the Mountain Caribou Recovery Plan, conservation of habitat for Grizzly bears, fisher, lynx, wolverine and wolves, and recent conservation proposals. The potential for climate change impacts was assessed by modelling future ecosystem and wildlife habitat change scenarios. Finally, stakeholder motivation was evaluated by engaging a group of selected participants in a process involving a preliminary survey, attending a one-day workshop, and one-on-one interviews.

Broadly, the research found that 1) that although the Kootenay Region has conservation policies in place that provide substantive protection for ecosystems and wildlife habitat, such policies were not designed to accommodate climate change impacts, and 2) value-based conflicts and institutional shortcomings are barriers to policy reform needed to address resilience in the context of climate change. Perspectives on a conservation design process explicitly addressing the tensions inherent in socio-ecological systems are offered as a framework for considering policy reforms required to contend with climate change impacts on wildlife conservation.

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Acknowledgments

I wholeheartedly thank all of the people who participated in this study and welcomed me into their community. It was through their generous support and inspiration that this project was possible. Alas, for confidentiality reasons they must remain anonymous. Thank you for sharing your stories and ideas on conserving wildlife in such a beautiful place.

I am deeply indebted to Dr. David Roberts and Dr. Laura Gray formerly from the University of Alberta for their remarkable generosity in providing data from their own doctoral research. These data were instrumental to developing the future ecosystems scenarios in this study. I am similarly indebted to Pierre Iachetti formerly from the Nature Conservancy of Canada for providing spatial datasets from the Canadian Rocky Mountains Ecoregional Assessment, Dr. Steve Wilson and Dr. Scott McNay for the caribou habitat suitability spatial data and Bayesian Belief Network model from the Mountain Caribou Science Team, Tony Hamilton for information on the Grizzly Bear Conservation Strategy, Dr. Michael Proctor for guidance on Grizzly bear ecology in the region, and Wendy Francis from the Y2Y Conservation Initiative for her encouragement and the invitation to participate in meetings of the Cabinet-Purcell Mountain Corridor Project. Craig Pettitt from the Valhalla Wilderness Society and Ryland Nelson from Wildsight provided spatial data layers for their new conservation proposals. Former colleagues and friends in the Ministry of Environment, including Nancy Wilkin, Dr. Mark Zacharias, Alec Dale and David Tesch provided their encouragement and access to the amazing wealth of information from the provincial spatial data warehouse. And I was assisted tremendously in the development of the spatial conservation analysis by Brendan Guy who was hired as an intern through the funding support provided by the Pacific Institute for Climate Solutions.

Many people in the Kootenays assisted with advice and logistical support. The team of facilitators for the workshop included Cindy Pearse, Greg Utzig, John Cathro, Cathy Scott-May and Susan Mulkey. Thank you for your professionalism and skill in facilitating the workshop. Dr. Rachel Holt kindly invited me to participate in the West Kootenay Climate Vulnerability and Resilience Project. Greg Utzig has been wonderfully generous with sharing his time and local knowledge of ecosystems in the Kootenays. Both Rachel and Greg have provided me with many needed insights into the complexities of climate change, impacts on ecosystems and managing for resilience for which I am sincerely grateful.

My supervisory committee is comprised of Dr. Eric Higgs, Dr. Peter Keller, Dr. Kara Shaw and Dr. Brian Starzomski. Their stellar scholarship has provided much inspiration to my own research, and their guidance and patience through this journey have been truly remarkable. Thank you very much.

I am grateful for the funding generously provided for this research by the Pacific Institute for Climate Solutions, the Social Sciences and Humanities Research Council, and the University of Victoria.

Many friends and family have encouraged and supported me during the time I have been working on this research, for which I am very thankful. I particularly want to thank my long-time friend Chris Grant who diligently provided needed moral support along the way. And of course to Joy, my wife and life-long partner, thank you… all of this would not have been possible without your love and support, not to mention your incredible editing skill that without doubt is an important contribution to this dissertation.

Dedication

I dedicate this dissertation to my sons, Michael and Christopher,

and my grandson Owen.

Because you inherit the future… value nature, treat it with care.

Chapter One – Introduction and Context

1.1 INTRODUCTION

British Columbia's wildlife habitat conservation policy framework has been implemented over the past twenty-five years through land use planning and other legislative and policy initiatives, and is the result of substantial social-political decision processes characterized by negotiation and compromise. This policy framework has been predicated in part on an ecological paradigm based on the historic range of variability. However, since climate change is expected to have consequential impacts on wildlife ecosystems[1], it is plausible that current land and resource use policies based on the current paradigm may fail to effectively conserve ecological integrity. Effectively responding to climate change impacts on ecosystems is also problematic because communities hold competing values and interests in land and resources, have significant social capital invested in the current land use policy framework, and lack understanding of new and pressing issues related to climate change impacts. This raises the dilemma that while following current policies may result in undesirable ecological outcomes, devising policies for resilient management of wildlife ecosystems taking climate change into consideration is difficult given complexity and uncertainty in both ecological and social regimes.

In light of this complex and multifaceted problem, the goal of this dissertation is to evaluate the effectiveness of current wildlife conservation policy mechanisms, the potential vulnerability of wildlife ecosystems in the face of climate change, and the motivation of stakeholders to support policy adaptations. In particular, the research undertakes to understand how community support for adaptation strategies that

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[1] Morrison, Marcot and Mannan (2006) define an 'ecosystem' as "the set of all abiotic conditions, and biotic entities and their ecological interactions, in a given area" (p. 447). The term 'wildlife ecosystem' is used in this dissertation to include wildlife and their habitat, and the interactions and connexion of both of these within the broader ecosystem.

mitigate climate change impacts on wildlife ecosystems may evolve through direct engagement in conservation assessment and design processes.

This first chapter sets out the core concepts and policy contexts that underpin a critique of wildlife conservation policy approaches in the face of climate change. The complex problems, theoretical constructs, questions and methods that shape the research are addressed in the initial section. These set the stage for a focus in subsequent chapters on ways in which wildlife conservation policy in the Kootenay region of British Columbia will be challenged to adapt in the coming years. The remainder of this chapter explains the research problem and associated questions in more detail, introduces core concepts, case study and research design, addresses ethical considerations and situates the researcher.

1.2 RESEARCH FOCUS AND DESIGN

1.2.1 Challenges in Responding to Climate Change Impacts on Wildlife Habitat

Human impact on wildlife ecosystems should be a cause for concern and action (Heywood & Watson, 2005; Thompson, Mackey, McNulty, & Mosseler, 2009). In North America the ranges of many species have shrunk considerably due to habitat loss (Laliberti & Ripple, 2004). There is recent evidence of extensive climate change impacts on ecosystems, and predictions of much more disruptive impacts in the near future (Hughes, 2000; McCarty, 2001; Parmesan, 2006; Walther, et al., 2002). Globally recent extinction rates have been calculated to be 100 to 1000 times their pre-human level (Pimm, Russell, Gittleman, & Brooks, 1995), and this is expected to accelerate severely due to the combined effects of habitat loss and climate change (Maclean & Wilson, 2011; Pimm, 2009; Wiens, 2013). There is also strong consensus emerging on a range of incremental conservation and restoration intervention measures needed to mitigate such impacts and promote ecological integrity (Groves et al., 2012; Gayton, 2008; Heller & Zavaleta, 2009; Inkley, et al., 2004; Mawdsley, O'Malley, & Ojima, 2009; Noss, 2001). Protection targets in the range of 25% to 75% have been called for to meet biodiversity conservation needs (Noss, et al., 2012; Pojar, 2010; Svancara, et al., 2005). The key to wildlife conservation is the preservation, management and restoration of wildlife habitat (Morrison, Marcot, & Mannan, 2006).

In British Columbia, climate change is predicted to have significant ecological effects over the next century (Murdock, Fraser, & Pearce, 2007; Hamann & Wang, 2006; Spittlehouse, 2008). As this jurisdiction has become the North American refugium for multi-species mega-fauna since European colonization (Laliberte & Ripple, 2004), British Columbia has a global-scale responsibility to conserve large mammal wildlife diversity.

British Columbia's wildlife habitat conservation policy framework dating back to the mid-1990s, while widely recognized as innovative and comprehensive, has assumed a static ecological paradigm and emphasized sustaining the historic range of natural variability (Province of British Columbia, 1999a, 1999b, 1995a & 1993a). It has evolved over the past twenty years through land use planning, new resource management practices legislation, and other legislative and policy initiatives (Cashore, Hoberg, Howlett, Rayner, & Wilson, 2001; Commission on Resources and Environment, 1995; Frame, Gunton, & Day, 2004; Owen, 1998). However, today we know that ecosystems are projected to respond to changing climate in dynamic, complex, non-linear, and unpredictable ways. It is anticipated, therefore, that current land and resource use policies based on static paradigms are likely to fail to effectively conserve ecological integrity (Austin, Buffett, Nicolson, Scudder, & Stevens, 2008; Lovejoy & Hannah, 2005; Gunderson & Holling, 2002; Hagerman, Dowlatabadi, Satterfield, & McDaniels, 2010; Pojar, 2010). The policy dilemma is that while adhering to an assumption of a static ecological paradigm has a high probability of resulting in ecological chaos and collapse, devising policies that allow for more adaptive and resilient approaches to wildlife management is difficult given significant complexity and uncertainty in both ecological and social regimes (Hagerman, Dowlatabadi, Chan, & Satterfield, 2010). Responding to this critical problem demands new and more dynamic ways of understanding and coping with change in these intertwined regimes.

1.2.2 Research Question and Lines of Enquiry

Higgs and Hobbs (2010) advocate that effective conservation and restoration interventions must acknowledge and balance the inevitable influence of peoples' values and priorities in conserving and sustaining nature. Their principles of *wild design* emphasize community engagement and encourage direct community involvement and participation in shaping resilient ecosystems. As they note:

> Wild design refers to intentions and plans that recognize and support free-flowing ecological processes. Thus there is a critical tension between unrestrained processes (wild) and human intervention (design). We believe that this tension is implicit in many of the challenges faced by many protected area managers and that a comprehensive framework is needed to successfully adapt to changing conditions. (Higgs & Hobbs, 2012; p. 235)

The wild design framework adapted in this research from Higgs and Hobbs (2010) and Higgs (2003) integrates concepts of ecological integrity, historical fidelity, and socio-ecological resilience through community engagement and participation in determining appropriate conservation interventions. As the wild design approach suggests, further community engagement may allow for dynamic responses to the complex social and ecological transitions that are expected to accompany climate change. This framework offers a valuable context for considering ways in which conservation policy can evolve in British Columbia. Uncertainty creates the need to approach complex issues such as addressing climate change impacts through adaptive management. Participatory approaches are advocated to build common understanding and objectives, resolve conflicts and incorporate local knowledge, and secure 'buy in' (Bell & Apostol, 2008; Pritchard & Sanderson, 2002). For clarity, 'community' is referred to here as people living in a common area. A community such defined will consist of a number of overlapping interests. A 'stakeholder' would be a person or group who has an interest or could be affected by a matter. The 'public' is defined here as concerning the people as a whole, as opposed to specific private interests. A community would be comprised of a number of different stakeholders interested in the outcomes of wildlife conservation, such as government managers, politicians, First Nations, industrial interests, environmentalists, recreationists, and others. The influential role of diverse and often conflicting community interests in shaping conservation policies gives rise to the overarching question addressed by this research:

> Given the pressing need for new, more resilient approaches to wildlife conservation, how does stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems influence support for appropriate wildlife habitat and species intervention policies?

This research is based on the hypothesis that robust social support for wildlife conservation and restoration policies necessary to maintain ecological integrity and the resilience of wildlife species given rapidly changing climate is predicated on new approaches that challenge current beliefs and social norms. Such beliefs will be rooted in the knowledge, values, experience and situation of individuals. Specific lines of enquiry addressed include:

1) How effectively do British Columbia's current conservation designations meet ecosystem integrity requirements for wildlife in the study area?
2) What is the scope of potential climate change impacts on wildlife ecosystems in the study area?
3) What are stakeholders' current understandings, beliefs and attitudes about climate change, its predicted impact on wildlife ecosystems, and current conservation and restoration approaches? How are these perspectives influenced by personal values and demographic factors?
4) Does participation in a workshop that explores scenarios and impacts of climate change on wildlife ecosystems affect stakeholder beliefs and attitudes related to wildlife conservation and restoration strategies?
5) What factors enable or constrain conservation and restoration strategies from being implemented?

By pursuing these lines of enquiry, this study makes a range of important contributions to understanding of socio-ecological adaptation to environmental change at conceptual and stakeholder levels, and in local and provincial contexts. From a conceptual perspective, it elaborates on guiding theory associated with resilience, wild design and policy studies, particularly as it explores participatory approaches to the formulation of conservation policy. For stakeholders, it has strengthened understanding of the impacts of climate change on wildlife habitat in the study region and heightened their personal awareness of the values, beliefs and attitudes that shape their perspectives. At the same time, this research offers an in-depth account of the evolution of conservation policy in British Columbia, with a particular focus on both the history of conservation action in the Kootenay region as well as current and potential future wildlife habitat dynamics. The maps of both current and anticipated habitats for a range of important species in the study region and the methodologies underlying their creation should enable other researchers and policy makers to pursue their own lines of enquiry.

Above all, this study offers insights into the considerable challenges that society faces in adapting in the face of the uncertainty of climate change impacts. While the study focuses on the dynamics inherent in establishing conservation policy for resilient wildlife habitat in the study region, the importance of integrating social and natural concerns holds lessons for the wide range of dilemmas that climate change presents.

1.2.3 Core Concepts

Given my interests in the social dimensions of climate change impacts, I have relied on five areas of theory and practice in addressing the objectives of this research:

1) Resilience theory, that builds understanding of the dynamics of integrated socio-ecological processes (Gunderson & Holling, 2002);

2) Wild design, that offers a conservation design framework for integrating ecological integrity and conservation design practice to effect sustainable and resilient ecological systems into the future (Higgs & Hobbs, 2010; Higgs, 2003);

3) Policy sciences, that involve participants in mapping the social context, problem orientation, and in developing solution strategies (Cashore, Hoberg, Howlett, Rayner, & Wilson, 2001; Clark, 2002; Lasswell, 1970);

4) Habitat scenario modelling as a tool to address prediction and uncertainty coupled with dynamic change in ecosystems (Berkhout, Hertin, & Jordan, 2002; Gallopin, 2002; Peterson, Cumming, & Carpenter, 2003; Wang, Campbell, O'Neill, & Aitken, 2012; Wang, Hamann, Spittlehouse, & Murdock, 2012); and

5) Environmental motivation theory that builds understanding of the ways in which people engage with environmental challenges (Fishbein & Ajzen, 2010; Hines, Hungerford, & Tomera, 1987; Schultz 2001; Steg, De Groot, Dreijerink, Abrahamse, & Siero, 2011; Stern, 2000).

This section describes resilience, wild design, and policy science concepts that are influential in the research design. While environmental motivation theory is introduced here as a basis for the development of climate change scenarios in Chapter Four, these concepts are described in greater detail in Chapter Five where they have particular relevance. As habitat scenario modelling provides a framework for Chapter Four, it is noted here, but described in further detail in that chapter.

1.2.3.1 Resilience Theory:

A resilience-thinking approach has been advanced to integrate social and ecological systems management (Folke, 2006; Gunderson & Holling, 2002). This approach emphasizes non-linear dynamics, thresholds, uncertainty and surprise, and the interaction of changes that occur at multiple temporal and spatial scales (Folke, 2006). As Holling, Gunderson, and Ludwig (2002) point out, a common cause of failure in natural resource management policies is the disconnect between the complexity and resulting uncertainty in nature and the human tendency to presume a certainty of human control of nature. They reason that a sustainable policy approach needs to understand social and ecological systems as “evolutionary and adaptive” characterized by “complex systems behavior, discontinuous change, chaos and order, self-organization, [and] nonlinear systems behavior” (p. 14). Adaptation for resilience needs to integrate ecological, economic and institutional processes and develop an understanding of how the dynamics of these are linked at multiple scales. Extensive human activities on the land base have disrupted the composition, structural attributes, and functional processes of ecosystems, with the potential effect of reducing the system’s resilience to changing climate (Folke, et al., 2004).

Holling and Gunderson (2002) submit that ecosystems undergoing significant change are inherently unpredictable, and offer three broad strategies to address variability, including “to live passively with external variability by evolving appropriate adaptations”, “to control variability actively, minimizing its internal influences”, and “to anticipate, create, and manipulate variability” (p. 52). Holling, Carpenter, Brock, & Gunderson (2002) suggest that institutional policy decision mechanisms to address change need to take on a “participatory pluralistic” approach to address system complexity and uncertainty by “bridging differences between local knowledge and broader scale issues” (p. 412). A critical factor for sustaining resiliency is to understand how and why people react to the situation. They argue the need to “develop and implement integrated understanding, policies, and actions among scientists, economic and public interest groups, and citizens so that a self-correcting market for knowledge and action develops” (p.417). Socio-ecological resilience theory suggests that accelerating change with its attendant uncertainty and surprise requires active management using flexible adaptive approaches that integrate human activities with ecosystem dynamics (Yorque, et al., 2002). For example, for institutional and governance structures to be adaptive, they must be dynamic and flexible (Anderies, Walker, & Kinzig, 2006; Folke, Hahn, Olsson, & Norberg, 2005).

1.2.3.2 Wild Design:

Wild design is a concept advocated by Eric Higgs in his book *Nature by Design* (2003) that embraces resilience theory and attempts to reconcile the inherent tension between a biocentric perspective of nature as a self-governing entity unsullied by human impacts, and an anthropocentric view of human dominance over natural systems:

> Design is the intention and planning behind any action. Wild design refers to intentions and plans that recognize and support free-flowing ecological processes. Thus, there is a critical tension between unrestrained processes (wild) and human intervention (design) in wild design. We believe this tension is implicit in many of the challenges faced by contemporary protected area managers and that a comprehensive framework is needed to successfully adapt to changing conditions. (Higgs & Hobbs, 2010; p. 235)

With the global influence of the human footprint, in today's world even remote wilderness areas are subject to a variety of human impacts at multiple scales including the accelerating effects of climate change. The Wildlife Conservation Society has calculated that 83% of the land surface on earth is directly affected by human development (Sanderson et al., 2002). Conservation of ecosystems and biodiversity then is a product of human intention (Cole & Yung, 2010).

There is a need for careful integration of environment and politics in conservation design (Nygren & Rikoon, 2008). The human experience is thoroughly intertwined with nature through our reliance on the environment. People value and shape the environment according to needs and preferences, and the environment accordingly shapes culture and influences values (Bliss & Fischer, 2011; Ellis, 2011). Conservation objectives will inextricably be rooted in cultural values and behavioural customs. Perspectives on ecosystem conservation are based upon competing human values, preferences, and cognitive constructs about naturalness, biodiversity, wilderness, sustainable development, restoration, stewardship, and whether humans are a part of or separate from nature. Addressing climate change impacts will require a new understanding, which will be value-driven and controversial. This necessitates renegotiating current agreements, many of which remain tenuous (Swaffield, 2013).

Sustainable governance structures are necessary to the design and implementation of resilient wildlife ecosystem conservation policies. Understanding and engaging the values of interested actors are crucial to addressing competing interests and finding viable solutions.

Wild design provides an integrating framework for this. Higgs and Hobbs (2010) advocate that conservation and restoration interventions be based on principles that emphasize clear goals, afford careful reference to historical reference conditions, manage for ecological integrity based on resilient functioning of ecosystems, and provide public engagement which encourages direct involvement and participation. The wild design model adapted here from Higgs (2003) integrates ecological integrity, historical reference, and conservation design practice in determining appropriate socially and ecologically resilient conservation interventions (Figure 1.1). A critical

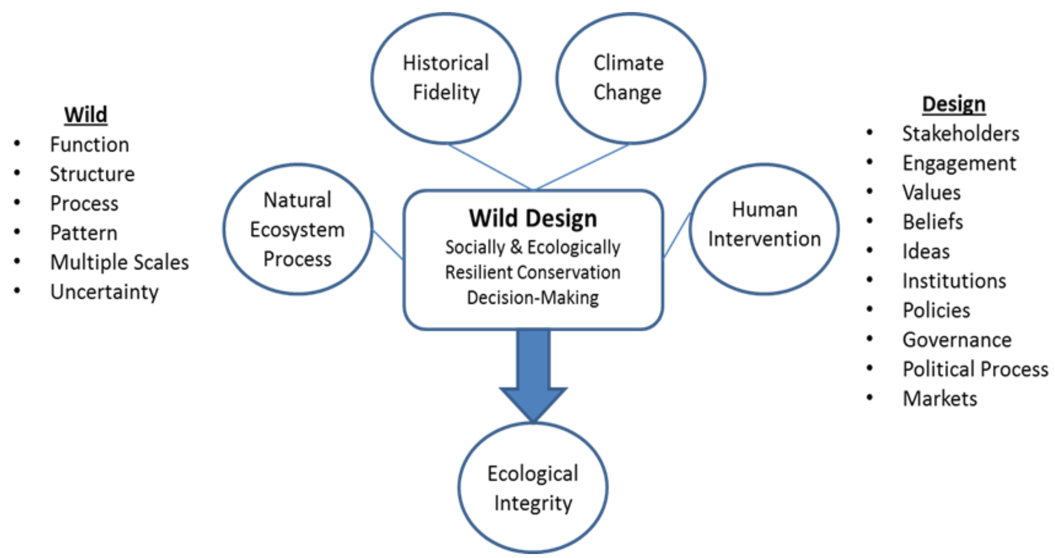

Figure 1. 1: Wild Design Approach to Conservation Policy Decision-Making[2] showing ecological integrity as a function of balance between natural ecosystem process and human intervention, and between historical understanding and addressing climate change dynamics

2 Adapted from Higgs (2003) and Higgs & Hobbs (2010).

consideration of this approach is the requirement to embrace the complexity and uncertainty of change trajectories based on reflections of historical conditions and deliberations of future possibilities.

The goal of a wild design approach should be ecological integrity. Chambers et al. (2013) have defined 'ecological integrity':

> … as the ability of an ecological system to support and maintain a community of organisms that has the species composition, diversity, and functional organization comparable to those of natural habitats. Areas of highest ecological integrity have unfragmented natural landscapes, biotic and abiotic components well within the natural range of variability, and few impacts from invasive species. These areas are resilient to change, often contain large intact blocks of land, and sustain healthy and connected populations of fish, wildlife, and plants." (p. 8).

However there is a need for a paradigm shift from protecting current spatial distribution and assemblages of species based on historic range of variability to addressing climate change with a new focus on maintaining functional ecological and evolutionary processes (Prober & Dunlop, 2011; Harris, Hobbs, Higgs, & Aronson, 2006). Maintaining habitat and corridor linkages will be critical to maintaining the viability of wild ranging wildlife populations. Landscape ecology is a useful scale for conservation analysis as suggested by Wiens (2013):

> …the sustainability of high-quality landscape elements may be contingent on the composition and configuration of the surrounding landscape. Consequently, managing the broader landscape mosaic is often necessary to sustain what is valued in a landscape. It is the particular heterogeneity of a landscape – the composition and arrangement of landscape elements – that can enhance the spatial resilience of a landscape…and provide a diversity of values to a diversity of organisms, including people." (p. 1049).

Adaptation goals need to incorporate how climate change impacts could be manifested at temporal and spatial scales across the landscape, and needs to account for uncertainty and resilience. Consideration of species compositional diversity and ecological functionality is critical to ecological integrity (Stein et al., 2013; Starzomski, 2013). Camacho, Doremus, McLachlan and Minteer (2010) have suggested that "static reserve systems will probably not be able to accommodate the biotic shifts projected to occur in coming decades" (p. 22). Changing climate conditions make it unlikely to be able to protect existing ecological systems and current understandings of what is natural. Adaptation should be an intentional process. Existing conservation practice may not ensure the functionality required to resiliently adapt to climate change. Intentional strategies will need to be flexible and dynamic enough to accommodate uncertainty, incorporate emerging knowledge, and be adaptive to changing conditions.

Higgs (2003) offers that fidelity to historical conditions "is a powerful force that inspires attentiveness, compels discipline, and projects… the panorama of possibilities ahead of us" (p. 177). The past connects to the future, and provides a reference that helps define what ecological integrity is. The value in historical fidelity is that it provides a necessary benchmark for understanding where ecosystems have come from, and a hedge against human hubris. It provides the cultural connection that people have to a place including their sense of belonging, their perceptions of concern for the natural world, and their access to ecosystem services. However, blind adherence to historical fidelity will be incompatible with ecological resilience and integrity, and can be expected to fail to deliver on conservation objectives.

Wild design offers a potential framework for integrating ecological integrity and conservation design practice to effect sustainable and resilient ecological systems into the future. The opportunity for wild design is to effect ecosystem resilience and integrity by integrating natural ecosystem processes with the realities of human activities on the landscape, and to do this through a focal practice that engages the community more broadly in processes that stimulate understanding and enables socially sustainable decision-making. Healey (1998) has suggested that both resolution of conflicts and the potential to build 'place making' benefit from collaborative approaches to planning. Framing new and broad understandings of the values at risk, and building consensus and ownership will be necessary to effect the changes in conservation policy approaches needed to address climate change impacts on wildlife ecosystems. Wild design principles are applied in this study as a framework for integration of ecosystem conservation. These concepts of social practice/engagement bring into focus the degree to which community engagement and understanding can influence future policy.

1.2.3.3 Policy Sciences:

Systematically balancing competing interests over the long term lies at the heart of appropriate wildlife conservation policy (Higgs & Hobbs, 2010). Clark (2002) defines policy as "a social process of authoritative decision making by which the members of a community clarify and secure their common interests" (p. 6).

Clark's approach to policy sciences integrates knowledge of the natural sciences that forms the basis for understanding conservation problems with social processes necessary to put conservation solutions into action (Rutherford, Gibeau, Clark, & Chamberlain, 2009). The social process addresses such questions as: who needs to participate, what are their perspectives, in what situations do they interact, what are their basic values, what strategies do they employ, and what outcomes and effects are achieved? Problem orientation involves clarifying goals, describing trends, analyzing conditions, projecting developments, and assessing alternatives. Clark emphasizes that "ultimate authority in society to make policy rests in the perspectives of living members of the community - their identification, demand, and expectations" (p. 6). Policy change is driven by pressure from social or special interests, for example environmentalism has successfully institutionalized important environmental concerns on the agenda of public policy processes influencing agenda-setting, problem orientation and epistemology (Torgerson, 1997 & 2005).

A trend toward deliberative democracy has characterized wildlife conservation policy in British Columbia and, in light of the complexity of interests to be addressed, will be of increasing significance in the future (Gregory & Failing, 2002; Gunton, Williams, & Finnigan, 2003). Post-modern theories of planning developed since the 1980s have institutionalized community collaborative planning processes, allowing connection of ideas, social learning, and coordinating consensus amongst diverse interests and values

(Fischler, 2000; Innes, 1996 & 1997). Planning processes which engage diverse interests in collaborative learning and constructive discourse allow complex and controversial issues in public land management policy to be addressed by improving understanding and seeking solutions that accommodate multiple interests (Daniels & Walker, 1996). Collaborative processes are seen to foster new knowledge, facilitate governance processes, encourage transparency and inclusiveness in decision-making, enhance trust, pool expertise and ideas, and can provide opportunities to bridge social and ecological interactions across multiple scales (Goldstein, 2009). In theory at least, decisions derived through democratic deliberation at the community level will enhance sustainable and resilient problem solving (Friedland, 2001; Paehlke, 1996). Brulle (2010) argues that broad scale mobilization needed to influence political and market institutions requires leadership and advocacy by civil society and participation by informed citizens; suggesting top-down approaches will fail to achieve universal understanding and commitment necessary to meet environmental challenges.

Land and resource governance mechanisms are reliant on scientific knowledge rooted in conservation biology, landscape ecology, and forestry, among others. Local stakeholders often have the advantage of local knowledge, but they can be sceptical of information provided by scientists (Beunen & Opdam, 2011). Holling, Carpenter, Brock, and Gunderson (2002) argue the importance of both external peer review of scientific information and institutional mechanisms where the public “gets to speak her piece and… gets to question any expert in a non-intimidating, mutually open, and supportive framework” (p. 417). They also note the need for “integrated understanding, policies and actions among scientists, economic and public interest groups, and citizens so that a self-correcting market for knowledge and action develops” (p.417). Science input needs to be scrutinized through peer review and deliberation by decision-makers, stakeholders and the public. Science information needs to be “properly generated, presented, and accountably used” to facilitate “discussion among competing interests by helping to define the range of available choice and focusing discussions on consequences of social choice" (Mills & Clark, 2001; p. 189). Sustainable decision-making processes develop integrated understanding based on deliberative processes that address scientific and local knowledge, and realistically address levels of uncertainty.

1.2.3.4 Habitat Scenario Projections:

Vulnerability assessment of climate change impacts on wildlife ecosystems relies on predictions of an uncertain future based on the best current understanding (Glick, Stein, & Edelson, 2011). Future scenarios are increasingly used by academics and conservation managers to evaluate potential consequences to global biodiversity and ecosystem services in such initiatives as the Millennium Ecosystem Assessment (2005) (Carpenter, Bennett, & Peterson, 2006), at the watershed or landscape level to aid decision making (Jankowski & Nyerges, 2001), to support social learning and participation processes in climate change impact assessment (Burkhalter, Gastil, & Kelshaw, 2002; Sheppard, 2005a & 2005b), and to predict potential habitat conditions for wildlife species (Schumaker, Ernst, White, Baker, & Haggerty, 2004). Scenarios are often used to support planning and decision-making (Bennett, et al., 2003; Carpenter, 2002; Mahmoud, et al., 2009; Peterson, Cumming, & Carpenter, 2003). Habitat scenario projection theory and its applications were an important part of this study. Ecosystem bioclimate models have been applied by numerous studies to predict potential impacts on ecosystems (Hamann & Wang, 2006; Wang, Campbell, O'Neill, & Aitken, 2012), tree species (Gray & Hamann, 2013), and mammals (Lawler, et al., 2009; Martinez-Meyer, Peterson, & Hargrove, 2004). Such an approach was used in this research to engage participants in this study in the potential magnitude, spatial extent, and uncertainty of future predictions as one of the key factors that may influence motivation to support conservation measures.

1.2.3.5 Environmental Motivation:

The interaction of factors[3] that shape peoples' motivation to engage in environmental action is another important theoretical construct that underpins this

[3] These factors and their interactions are described in greater detail in Chapter 4.

study. Fishbein and Ajzen (2010) and others (Allen, et al., 2009; Hines, Hungerford, & Tomera, 1987; Schultz, 2001; Steg, De Groot, Dreijerink, Abrahamse, & Siero, 2011; Stern, 2000) have suggested that environmental motivation is influenced by attitudes, which in turn are informed by social norms, beliefs and background factors. Background factors include individual personalities, values, attitudes and knowledge levels, as well as social factors such as education, age, gender, income, religion, race or ethnicity and culture (Fishbein & Ajzen, 2010). The following model (Figure 1.2) that has been adapted for this study from the work of these scholars, reinforces the importance of education

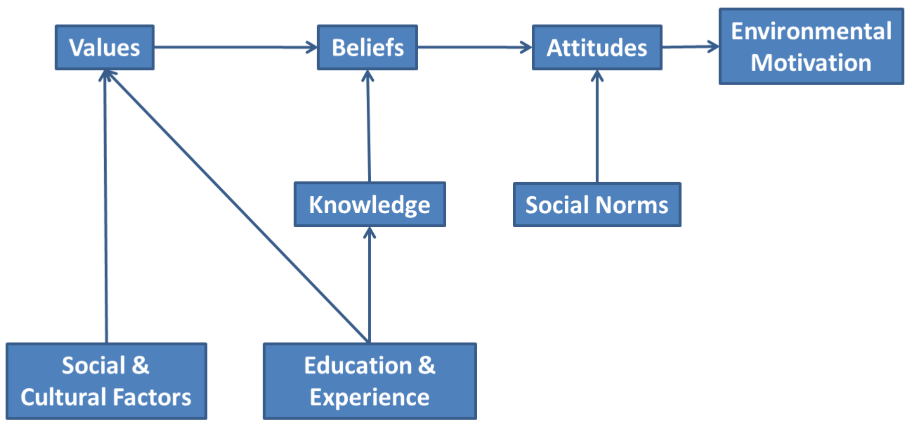

Figure 1. 2: Environmental Motivation Model[4] showing the relationship between motivation and values, beliefs and attitudes

and experience in shaping values, beliefs and attitudes that underlie motivation. While social and cultural factors are likely to be static, at least in the short term, the suggestion that new levels of understanding can influence motivation is central to this enquiry into how stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems influences support for appropriate wildlife habitat and species intervention policies.

[4] Adapted from Allen et al. (2009), Fishbein & Ajzen (2000), and Hines et al. (1987).

1.2.4 Overview of Research Methods

This study utilizes a mixed-methods approach that combines three complementary methods to address ways in which stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems influences support for appropriate wildlife habitat and species intervention policies. Methods include a historical analysis of conservation policies, spatial analysis and mapping of current and future wildlife habitat, and qualitative enquiry into stakeholder perspectives regarding approaches to assess options for more resilient wildlife management in the face of climate change.

This study begins with an overview of conservation policies and practices in British Columbia in general (Chapter Two) and in the Kootenay case study region in particular (Chapter Three) with specific reference to the conservation of six wildlife species (grizzly bear, fisher, lynx, mountain caribou, wolf and wolverine). This component of the research involved a comprehensive review of primary and secondary sources relating to conservation policies and practices over the past 40 years, with a focus on British Columbia. The study also draws on existing data and models to map a range of wildlife habitat and conservation measures in the Kootenay and Boundary Region study area.

From this background context, plausible future wildlife ecosystem climate change impact scenarios were projected for mountain caribou and wolverines (Chapter Four) as a basis for raising stakeholders' awareness of climate change impacts. Future habitat scenarios for key mammal species were developed based on climate change predictions (Wang, Hamann, Spittlehouse, & Murdock, 2012) applied to ecosystem and habitat change models (Roberts & Hamann, 2011; Wang, Campbell, O'Neill, & Aitken, 2012).

The assessment of conservation policies, current wildlife conservation dynamics in the study region, and scenarios of climate change impacts set out in Chapters Two to Four created a foundation for the focus in Chapter Five on stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems. To explore the ways in which stakeholder perspectives and emerging understanding of projected climate change impacts might influence support for appropriate wildlife habitat and species intervention policies, a survey was conducted that gathered both quantitative and qualitative data on values, beliefs and attitudes associated with wildlife conservation, a workshop was convened in which climate change scenarios offered a basis for discussion, and finally interviews were conducted with participants about their particular concerns relating to evolving conservation needs.

Detailed descriptions of methods involved in the various components are included in introductions to the relevant chapters.

1.3 THE STUDY AREA

The research is situated in the Kootenay Region of British Columbia, Canada. (Figure 1.3). This area is considered to be a key linkage zone in the Yellowstone to Yukon

Figure 1. 3: Map of Study Area: Kootenay Region is situated as a key linkage in the Yellowstone to Yukon ecoregional corridor

(Y2Y) ecoregional corridor (Y2Y Conservation Initiative, 2010). The area is geographically, historically, and in many ways culturally connected with the greater

Columbia River Basin, 15% of which is within Canada and the remainder in the United States. The selection of this study area is based on: 1) its importance as a transboundary wildlife habitat linkage between relatively more intact ecosystems in the northern portion of the Y2Y corridor and more developed portions to the south, and 2) because significant ecosystem shifts due to climate change are predicted for this region (Hamann and Wang, 2006; Utzig, 2012).

The Kootenay region of British Columbia features a range of land use, resource development and protected area systems. There are comprehensive strategic land use plans that were completed for the area in 2002 that have been guiding resource management and ecosystem conservation since then. Designated conservation measures cover ~ 65% of the total land area of the Kootenay region; these include parks and protected areas, conservation properties held in trust by government and non-government organizations, designations under the *Forest and Range Practices Act* (SBC 2002, c 69) (ie. Wildlife Habitat Areas, Ungulate Winter Range, Old Growth Management Areas), and Wildlife Management Areas designated under the *Wildlife Act* (RSBC 1996, c 488).

The Columbia Mountains are situated in the interior wet belt situated in an area of steep rugged topography and predominately narrow valleys (Parish, Coupe, & Lloyd, 1996). The area is drained by the Kootenay and Upper Columbia Rivers, which between the two systems cross the Canada-USA border four times. The area encompasses six biogeoclimatic zones, including Ponderosa Pine, Interior Douglas-fir, Montane Spruce, Interior Cedar - Hemlock, Engelmann Spruce - Subalpine Fir, and Alpine Tundra (Braumandl & Curran, 2002).

The study area is essentially the Canadian portion of the Cabinet-Purcell Mountain Conservation Project initiated by the Y2Y Conservation Initiative in 2006 to foster international conservation efforts aimed at ecological viability with a focus on corridor conservation and protection of habitat for wild ranging species including grizzly bears and mountain caribou (Y2Y Conservation Initiative, 2010). The selection of the study area is based on its importance as a trans-boundary wildlife habitat linkage between relatively more intact ecosystems in the northern portion of the Y2Y corridor and the more developed portion to the south.

The Y2Y corridor has been identified as critical to ensure regional connectivity for dispersal of large carnivores (Soule & Teborgh, 1999; Locke, 1998). This ecoregion is recognized for a full complement of large mammals (Laliberti & Ripple, 2004). Elk, Rocky Mountain bighorn sheep, mountain goats, mule deer, white-tailed deer, moose, and woodland caribou are among the large ungulate species. Some of the most threatened species in the region are carnivores, including populations of grizzly bears, gray wolves, wolverines, fishers and lynx. The region is also home to black bear, cougar, coyote, bobcat, and American marten. While populations for some of these species are stable, others are declining as a result of cumulative impacts from roads and other human uses (Nature Conservancy of Canada, 2004).

Murdock, Fraser and Pearce (2007) conducted an analysis of historical climate trends and predictions of future climate conditions in the Kootenay region. Future climate conditions were predicted from an ensemble of global climate models using a range of plausible greenhouse gas emission scenarios. This analysis projects a “most likely” climate change scenario with annual mean temperature warming 4.3 ^{o}C and annual precipitation increasing 7 % over the next century.

1.4 ETHICAL CONSIDERATIONS

Participatory aspects of my research were conducted in accordance with the Tri-Council Policy Statement: Ethical Conduct for Research involving Humans (Tri-Council, 2005) and under the terms of Ethics Approval 11-368, issued by the University of Victoria on September 7, 2011, renewed on August 12, 2012 and again on August 15, 2013 (Appendix 1).

Participants recruited for the stakeholder engagement component of this study included 28 community members with an interest in local wildlife conservation, resource management and/or land use, science domain experts, and resource management agency staff. All agreed to voluntary participation in a survey questionnaire, a workshop, and an interview process. Through these engagement activities, participants were asked to reflect on their understanding and experience related to climate change impacts on wildlife ecosystems, and on their motivation to support ecological conservation and restoration strategies and policies to mitigate such impacts. Participants were considered to be at minimal risk of possible harms beyond those normally encountered in their lives as professional experts or staff, or as members of the community.

Although invited, First Nations in the region did not participate in this study. As a result, this dissertation does not reflect on their important interests in the subject matter; further research on First Nation perspectives is critical to ensure effective approaches to wildlife conservation. However this does not negate the ability of the study to address other interests and knowledge of the broader community which did participate.

Further detail on participant selection, along with measures for protection of privacy are noted in Chapter Five.

1.5 SITUATING THE RESEARCHER

As noted, this study uses mixed methods to explore its central question. This approach reflects the inherent complexity in exploring ecosystem management as it balances scientific investigation with social dynamics. This aligns with Holling, Gunderson and Ludwig's (2002) call to integrate theories of ecology, economics and social dynamics in order to develop resource management policies supporting resilient and sustainable futures. This approach integrates a myriad of social and natural variables interacting to produce effects in a complex system. On one hand, projecting the need for new, more resilient approaches to wildlife conservation in the face of climate change necessitates an objective analysis of natural systems. On the other hand, evaluating stakeholder motivation to support appropriate habitat and species intervention policies is a subjective process grounded in careful listening, observation and interpretation of participants' situated realities and their influence on social systems. As Creswell (2009) and Stake (1995) note, qualitative enquiry is shaped by the ontology of the researcher, the questions asked, the methods selected, and the subjectivities that colour observations and conclusions. A good researcher is aware of personal values and beliefs, sensitive to ethical considerations, and committed to reciprocity of trust with those recruited to participate in the research (Marshall & Rossman, 1995).

Cresswell outlines four worldviews that shape qualitative or quantitative research approaches: postpositivism, constructivism, advocacy/participatory, and pragmatism (Cresswell, 2009). Of these, pragmatism with its emphasis on a worldview that "arises out of actions, situations, and consequences rather than antecedent conditions" and that focuses on understanding and finding solutions (Creswell, p. 10), best characterizes my stance and values. Pragmatism offers a compelling perspective for the inherently pluralistic theoretical and methodological study of environmental issues. As Light, Thompson and Higgs (2013) note,

> … it isn't the case that all theories of environmental values force a decision to use only one or another school of thought when morally assessing a given natural entity or deciding on ones duties to it in a given situation. So-called "pluralists," and some "pragmatists" in environmental ethics make a compelling case that under certain circumstances we should instead seek to find the greatest overlapping consensus of views, from a variety of approaches, on why any given thing in nature has value and then appreciate the array of values that should be operative in our decisions with respect to that thing. (p. 267)

Particularly at the level of practice and policy this pragmatic methodology asks us to set aside theoretical debates in environmental ethics and focus on morally responsible solutions to environmental problems which reflect the ends that are converged upon by a variety of stakeholders who have competing accounts of why things in the world are morally valuable.

My conviction that balancing an array of values and approaches is critical in both environmental policy and in my research has developed through my long involvement in this field. Prior to embarking on my doctoral program, my academic training was primarily in natural resources science. I hold a Bachelor of Agricultural Science, majoring in soil science (University of British Columbia, 1973) and a Master of Science (McMaster University, 1979) majoring in climatology. While my academic training imparted a positivist perspective on enquiry and research methods, my personal and professional experience incline me to value approaches to exploring issues that evaluate scientific evidence within social contexts. My career with the British Columbia government in various capacities between 1972 and 2007 including as director of the fish, wildlife and habitat conservation function in the Ministry of Environment (1999 to 2007), has instilled an appreciation of participatory approaches to the development and implementation of public policy. Conservation policies are socially constructed, and must involve many actors from the political and interest-based advocacy arenas to be effective.

My motivation to conduct this research emanates from concern for the resiliency of wildlife ecosystems and the efficacy of conservation policies. The research in itself explores conditions that support the protection of wildlife ecosystems and the roles of stakeholder engagement in the process. Given my pragmatic worldview, I am comfortable employing a mixed-methods approach to investigate the complex problems inherent in considering more effective approaches to wildlife conservation.

As a researcher focused on wildlife conservation policy in British Columbia, I cannot be considered an independent bystander. In my capacity with the Ministry of Environment before I retired in 2007, I was responsible for many aspects of formulating and implementing wildlife and habitat conservation policies, forest and range practices legislation, land and resource management planning processes, and the Mountain Caribou Recovery Implementation Plan, among other things. I was not, however, involved instrumentally in the Kootenay-Boundary Land Use Plan. Several of the respondents who participated in the stakeholder engagement phase of this research are well known to me as either former colleagues in government or as stakeholders representing interests to the government. These relationships have undoubtedly informed my research and analysis and must be acknowledged as an influence in the enquiry process.

Since retiring from the Ministry of Environment, I have continued to work as a resource management consultant[5], and currently I am appointed to the Managed Forest Council[6].

1.6 DISSERTATION OUTLINE

The remainder of this dissertation is structured to address my key question and lines of enquiry. The next chapter introduces contemporary contexts for wildlife conservation policy in British Columbia and Chapter Three offers an evaluation of wildlife ecosystem conservation implementation in the Kootenay Region of British Columbia. Chapter Four predicts wildlife ecosystem change through an analysis of climate change impact scenarios in the study area. Chapter Five evaluates stakeholder support for wildlife ecosystem intervention based on an understanding of likely futures. Finally, Chapter Six offers a synthesis of findings and focusses on implications for conservation practices that lead to resilient ecosystems. The dissertation concludes with a list of references and a number of appendices that offer details relating to ethics approvals, participant recruitment and research instruments. A list of acronyms is included in Appendix 12.

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5 Projects have included developing an implementation plan for mountain caribou recovery for the Ministry of Environment, advising the Oil and Gas Commission on wildlife habitat conservation, reviewing species at risk policy implementation for Fisheries and Oceans Canada, and conducting impact assessments for BC Hydro.

6 The Managed Forest Council was created under the *Private Managed Forest Land Act* ([SBC 2003] Chapter 80) as an independent public agency mandated to regulate and enforce forest practices standards on private managed forest land. I was first appointed to Council in 2004, and have been the Chair since 2012.

Chapter Two – Contemporary Contexts for Wildlife Conservation in British Columbia

2.1 INTRODUCTION

Significant effort and social capital has been invested in ecosystem conservation locally and globally since the publication of 'Silent Spring' by Rachel Carson (1962) marked the dawning of contemporary Western public awareness of environmental issues. Wildlife ecosystem protection in British Columbia has closely aligned with global level initiatives, often positioning this jurisdiction at the forefront of both domestic and international efforts due to the significant biological values at threat and the large-scale opportunities available for conservation. British Columbia's commitment to natural ecosystems, while balancing resource development and use, features a complex mix of principles, policies and tools directed at sustainable development.

This chapter outlines and critiques the evolution and implementation of current conservation policy frameworks in British Columbia as these hold profound implications for the study area. This detailed analysis provides a context for the discussion of specific wildlife conservation mechanisms in the Kootenay region in Chapter Three, and of policies that support more resilient approaches to conserving wildlife ecosystems in Chapter Five. To do this, Section Two offers an overview of contemporary global, national and regional biodiversity conservation frameworks, noting the influence of international protocols on Canadian conservation policy over the past four decades. Section Three explores the evolution of conservation policy and practice in the Province, tracing the impact of both land use regulations and biodiversity management policy on ecosystem conservation. Describing British Columbia's wildlife policy and practice context is an important starting point in this dissertation, as no single contemporary comprehensive analysis of these factors is available for reference purposes. This overview of ecosystem conservation policy, practice and current conditions on the land is of particular importance to an understanding of the line of enquiry regarding how effective British Columbia's current conservation designations are in meeting ecosystem integrity requirements for wildlife in the study area.

In preparing this overview, a broad range of government documents and task force reports have served as primary sources, along with a number of critiques of public policy available in the journal literature. I also draw on my experience as a public servant working on ecosystem conservation initiatives.

2.2 INTERNATIONAL AND NATIONAL CONTEXTS FOR BIODIVERSITY CONSERVATION

Institutional responsibility for wildlife in Canada has been shared by provincial and federal levels of government, although First Nations, land trusts, stewardship groups and other environmental organizations have and are playing increasingly significant roles. Under the Canadian Constitution (Department of Justice, 2013)[7], natural resources, including ownership and management of wildlife, are deemed a provincial responsibility. The province has a profound influence on ecosystems since 94% of land in British Columbia is provincial Crown land (Ministry of Forests, Lands and Natural Resource Operations (FLNRO), 2010). The federal role is focussed largely on fisheries, marine species and migratory birds; protection of species at risk; management of federal lands (eg. national parks, Indian Reserves, and national defence lands); issues related to First Nations land claims; and international protocols on biodiversity. Approximately 1% of land in British Columbia is under federal jurisdiction. The remaining 5% of land is privately owned, a large proportion of which resulted from the railway land grants on Vancouver Island and in the Peace River, Okanagan and Kootenay areas. First Nations have increasingly become significant policy actors in land and resource management as their rights and title, as embedded in the Canadian

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[7] The Canadian Constitution is embodied in the *Constitution Act* 1867 and the *Constitution Act 1982* as amended from time to time. A consolidation was published by the Canadian Department of Justice in 2013. Retrieved from http://laws-lois.justice.gc.ca/eng/Const/Const_index.html.

Constitution in 1982, are defined and understood. This holds particular implications for the conservation and use of fish and wildlife resources.

International calls for biodiversity conservation have been influential in shaping Canadian policy, beginning with the publication of *Our Common Future* (World Commission on Environment and Development (WCED), 1987), which led to the development of the United Nations Environment Program. The so-called ‘Brundtland Commission Report’ advocated sustainable limitations to economic development to ensure the needs of present and future generations. Among other things, the report recommended “that the total expanse of protected areas needs to be at least tripled if it is to constitute a representative sample of Earth's ecosystems” (p. 137) and that areas outside of protected areas be managed for the protection of biodiversity and conservation of species. The Brundtland Commission's suggestion that the world's protected areas (which at that point amounted to about 4%) should be tripled, was seized upon by the World Wildlife Fund Canada (WWF). The WWF launched its national endangered spaces campaign in 1989, arguing that each Canadian jurisdiction should develop an action plan for achieving the goal of 12% protected areas to represent Canada's major ecosystems (Hummel, 1989).

The subsequent *United Nations Convention on Biological Diversity,* signed at the 1992 Rio Earth Summit, echoed the call for establishment of protected areas to conserve biological diversity, along with the management and restoration of ecosystems, natural habitats and viable populations of species[8]. Canada was the first nation to ratify this convention in 1993. It was subsequently signed by 167 other countries[9]. Canada further

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8 Convention on Biological Diversity. Retrieved from https://www.cbd.int/convention/text/

9 Notably, the United States is not a party to the Convention, nor does it have a comprehensive national strategy on biodiversity conservation. Despite a lack of explicit national policy, conservation of biological diversity in the United States is incorporated in federal and state laws including the *Endangered Species Act (1973)*,

developed its response in its *Canadian Biodiversity Strategy*[10], endorsed by federal, provincial and territorial governments through the Canadian Council of Ministers of the Environment (Government of Canada, 1995). The *Ecosystems and Human Well-being: Biodiversity Synthesis* report (Millennium Ecosystem Assessment, 2005)[11] documented unprecedented global loss of biodiversity and called for establishing long-term goals for the conservation and sustainable use of biodiversity and ecosystem resources.

In October of 2010, the Council of Parties under the UN Convention on Biological Diversity developed a *Strategic Plan for Biodiversity 2011-2020*[12]*.* The so-called Aichi Biodiversity Targets outlined in the Strategic Plan state that:

> By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.(np).

To date, Canada is not a signatory to the Aichi Biodiversity Targets[13]. Indeed the country as a whole appears to be falling short on several key aspects of its commitments under the UN Convention and the national biodiversity strategy. A recent audit by the Canadian Commissioner of the Environment and Sustainable Development found that it is unclear how Canada intends to meet its biodiversity commitments (Commissioner of

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Marine Mammal Protection Act (1972), *Clean Water Act* (1972), and the *National Forest Management Act* (1976) (Blockstein, 1995).

[10] Federal, Provincial and Territorial Working Group on Biodiversity website. Retrieved from http://www.biodivcanada.ca/default.asp?lang=En&n=560ED58E-1.

[11] Millennium Ecosystem Assessment website. Retrieved from http://www.millenniumassessment.org/en/index.html.

[12] Convention on Biological Diversity website. Retrieved from http://www.cbd.int/sp/targets/.

[13] Convention on Biological Diversity website. https://www.cbd.int/countries/default.shtml?country=ca

the Environment and Sustainable Development, 2013)[14]. The findings of this audit note that:

1. there is no plan for implementing the UN Convention or the Canadian Biodiversity Strategy;

2. conservation planning, strategies and monitoring programs are inadequate or have been discontinued;

3. management of wildlife sanctuaries is inadequate to maintain ecological integrity; and

4. legal requirements for establishing recovery strategies, action plans and management plans under the *Species at Risk Act* have not been met.

Although the federal government committed to a national conservation plan in its 2011 Throne Speech, it has not yet been delivered. Federal government action to date has largely been comprised of two reports by the Canadian Parliamentary Standing Committee on Environment and Sustainable Development in 2012 and in 2014 regarding what the Environment Minister should consider in such a plan (Standing Committee on Environment and Sustainable Development, 2012 & 2014)[15], along with reiteration of the promise in the 2013 Throne Speech[16] to increase protected areas, and introduce stronger marine and coastal conservation measures.

The World Database on Protected Areas lists over 160,000 protected areas covering 13% of the terrestrial land base world-wide (Woodley et al., 2012). Canada's reported protected areas, at just 9.4% of its land base, fall considerably short of the Brundtland

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[14] Retrieved from http://www.oag-bvg.gc.ca/internet/English/parl_lp_e_901.html.

[15] Retrieved from http://www.parl.gc.ca/CommitteeBusiness/CommitteeHome.aspx?Cmte=ENVI&Language=E.

[16] Retrieved from http://www.speech.gc.ca/eng/full-speech

Commission target of 12%, let alone the 17% called for in the Aichi Biodiversity Targets.[17] However, this accounting is very conservative as it only includes protected areas such as national parks, national wildlife areas, and provincial parks and protected areas (Standing Committee on Environment and Sustainable Development, 2014). It does not include privately-owned protected lands or the significant contributions to biodiversity conservation afforded by legally defined designations such as wildlife management areas, wildlife habitat areas, ungulate winter range and old growth management areas as exist in British Columbia. Nor does the accounting of conservation benefits include contributions through specific 'ecosystem-based management' (EBM) (Lindenmayer & Franklin, 2002; Grumbine, 1994) approaches to integrated resource management. EBM is an integrated management approach that priorizes ecological objectives over resource development activities that could, in some situations, meet the definition of "other effective area-based conservation measures" as defined in the Aichi Biodiversity Target. While a comprehensive assessment of the percentage of protected areas in Canada is not available, these additional areas suggest that Canada could be aligned with international expectations.

Notably Aichi Biodiversity Target 11 establishes the need for conservation areas to be "effective", "ecologically representative", and "well-connected" (Woodley, et al., 2012). Woodley, et al. argue that such integrated management areas be limited to those that meet the IUCN definition for a protected area that Dudley (2008) defines as:

> …a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values. (p. 8)

However, where other areas "have clear nature conservation objectives, [are] clearly demarcated, and managed by a competent authority" they could be considered to "meet the intent of protected areas (Woodley, et al., 2012; p. 32). It will be argued in

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[17] British Columbia protected areas amount to nearly 14 million hectares or 14.4% of the province.

Chapter Three that some of the “other” conservation designations currently in place in British Columbia meet the Aichi Biodiversity Target 11 definition, and that there is a wider range of areas contributing to biodiversity conservation objectives that need to be considered as being important in ecosystem conservation design.

National land trusts such as the Nature Conservancy of Canada (NCC) and Ducks Unlimited Canada (DUC) have emerged as major actors in ecosystem conservation through significant investments in conservation land protection, through direct land acquisition and through arranging management agreements and legal covenants. For example, in 2007 NCC and the Government of Canada signed a funding agreement in regard to the establishment and management of the Natural Areas Conservation Fund[18]. This program was extended in 2014 bringing the federal government’s investment to $345 million[19]. NCC administers the program and has committed to matching the government’s contribution 2:1. In 2013-14 NCC invested $26.6 million in land acquisition and agreements[20], and in the same year, DUC invested $45.3 million in habitat conservation[21]. A significant source of funding for conservation in Canada results from the United States’ *North American Wetlands Conservation Act (1989)* that is administered through the US Fish and Wildlife Service. This program provides $20 to 25 million (USD)/year to carry out wetland conservation projects in Canada through partnerships notably with NCC and DU. Since the program began in 1990, $879.4 million

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[18] Environment Canada website. Retrieved from https://www.ec.gc.ca/financement-funding/sv-gs/search_results_e.cfm?action=details&id=331&start_row=1&all_records_details=fund&type_of_funder=Federal

[19] Nature Conservancy of Canada website. Retrieved from http://www.natureconservancyreport.ca/en/financials-governance/performance/

[20] Nature Conservancy of Canada Financial Statement – May 31, 2014 – Report downloaded from http://www.natureconservancy.ca/en/who-we-are/annual-reports/

[21] Ducks Unlimited Canada 2014 Annual Report. Retrieved from http://www.ducks.ca/who-we-are/annual-reports/2014-annual-report/

has been invested, resulting in the conservation of 6.6 million hectares of wetland habitat[22].

Just as the evolution of international and national values and protocols associated with ecosystem conservation has shaped public attitudes and public policy in Canada, complex if not comprehensive mechanisms have developed to support ecosystem conservation at provincial and regional levels. These are discussed in the next section.

2.3 WILDLIFE ECOSYSTEM CONSERVATION IN BRITISH COLUMBIA

Frameworks for wildlife ecosystem conservation in the Kootenay region study area are integrally tied to historic, contemporary, and emerging policy frameworks for land and resource management in British Columbia. Policies that dictate conservation of wildlife ecosystems in British Columbia are strongly embedded in broader provincial policies that integrate conservation with land and resource management. The current conservation framework is comprised of a number of layers, and includes parks, ecological reserves and protected areas, and private conservation lands owned by governments, land trusts, or individuals. As well, there are a number of specific conservation areas legally designated on Crown land, including wildlife management areas, wildlife habitat areas, ungulate winter ranges and old growth management areas[23]. Significant conservation benefit is also derived through measures effected through integrated approaches to resource development practices, particularly in forest management.

Development of these policies has involved broad discourse and required a degree of consensus amongst governments, First Nations, local communities, and conservation and industry stakeholders. As a result, a multitude of complex, overlapping and evolving

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[22] US Fish and Wildlife website. Retrieved from http://www.fws.gov/birdhabitat/Grants/NAWCA/Standard/Canada/index.shtm.

[23] These designations are defined and evaluated in the context of the Kootenay region in Chapter Three.

policy regimes address land and resource management across the province. These policy elements are summarized in Table 2.1, and discussed in detail in Section 3.2 below. The policy framework has been implemented mainly through a comprehensive

Table 2. 1: Conservation Policy Elements in British Columbia

Policy Element	Scale
Land use plans (resulting in protected areas strategy, & land and resource management guided by legal orders (under the *Land Act*) was well as non-binding policy objectives)	Regional -> Landscape
Protected area designations (Parks, Ecological Reserves, Conservation Areas, Wildlife Management Areas, etc.)	Regional -> Local
Special conservation designations (eg. Mountain Caribou Recovery Plan, Spotted Owl Recovery Plan, Grizzly Bear Conservation Strategy)	Regional -> Landscape
Wildlife Habitat Areas, Ungulate Winter Ranges, Old Growth Management Areas, General Wildlife Measures (legal designations under FRPA & OGAA)	Landscape
Wildlife Habitat Features (legal designations under FRPA & OGAA)	Local (stand-level)
Forest Stewardship Plan "Results & Strategies" for biodiversity conservation (enforceable under FRPA)	Landscape -> Local
Habitat conservation guidelines (broad suite of best practices guidelines for forestry, agriculture, mining, oil & gas development, urban development, recreation, commercial tourism, etc.)	Landscape -> Local
Specified conditions under permits & licenses (enforceable conditions under the *Mines Act*, *Petroleum & Natural Gas Act*, *Lands Act, Environmental Assessment Act*, etc. guided by policy guidelines)	Local
Land & conservation acquisition by government, land trusts & private entities	Landscape -> Local
Species at Risk Act (protects species at risk, residence & critical habitat)	Landscape -> Local
Conservation funding programs for land acquisition & stewardship (Habitat Conservation Trust Fund, Habitat Stewardship Program)	Landscape -> Local

system of land use planning processes (Frame, Gunton, & Day, 2004) and a number of important new legislative and policy initiatives. A system of strategic land use plans (SLUPs) was developed by the Province beginning in the early 1990s, with the last land use plan being approved in 2012 (Province of British Columbia, 2013). Among other things, these plans expanded the network of protected areas, and established detailed objectives for wildlife habitat conservation, which in many cases have been legally designated under the *Land Act* (RSBC 1996, c 245). Other key policy initiatives include:

1) new legislation regulating forest and range management, environmental assessments, oil and gas development, and professional reliance;
2) enactment of the federal *Species At Risk Act* (SARA) (SC 2002, c 29);
3) introduction of new ecosystem conservation guidelines directed at forest and range practices, mineral exploration, commercial recreation, agriculture, and urban development;
4) public and private investments in conservation land trusts and covenants; and
5) implementation of an array of new area-based wildlife ecosystem conservation designations under the *Forest and Range Practices Act* (FRPA) (SBC 2002, c 69) and the *Oil and Gas Activities Act* (OGA) (SBC 2008, c 36).

The following sections provide a detailed analysis of the evolution of key conservation policy and initiatives in the province over the past three decades.

2.3.1 Evolution of Land and Resource Management Policies Affecting Conservation in British Columbia

Land ownership is an important context for ecosystem management in British Columbia. Included in provincial Crown lands are provincial parks and protected areas that total 14.4% of the province, and land designated for forest harvesting as 'Provincial Forest' under Section 5 of the *Forest Act* (RSBC 1996, c 157). The Provincial Forest is 76.9% of the total land base, including the so-called Timber Harvesting Land Base (23%) in which timber harvesting is considered economically feasible (FLNRO, 2010) . Federal lands are comprised of national parks (0.6%), Indian Reserves (0.4%), and others including national defence lands, harbours and airports (0.1%) (FLNRO, 2010). Private land is owned under fee simple title, and includes land held by private interests and by governments and Crown agencies.

Many economic sectors rely on Crown land to support such activities as forestry, energy, utilities and pipelines, and mining, as well as agriculture, recreation and tourism

(FLNRO, 2010). Rights to access Crown land and natural resources are allocated to corporate entities and individuals by the provincial government through various permits and licenses, as specified in the *Forest Act* (RSBC 1996, c 157), the *Petroleum and Natural Gas Act* (RSBC 1996, c 361), the *Mines Act* (RSBC 1996, c 293), the *Land Act* (RSBC 1996, c 245), the *Water Act* (RSBC 1996, c 483), and the *Wildlife Act* (RSBC 1996, c 488). The primary forestry tenures allocated on the Provincial Forest include both area-based tree farm licenses and volume-based forest licenses. Other tenures include leases, licenses, rights-of-way, and permits for energy, utilities, mining, tourism, agriculture, recreation, and other uses – the total number of tenures issued under the *Land Act* between 2000 and 2009 was 34.4 million hectares (~ 36% of the landbase), while land grants during this same period comprised a further 65,736 hectares (~ 0.07%) (FLNRO, 2010).

The majority of private land is located in river valleys and riparian areas. These are most attractive for human settlement and are therefore the focus of most Crown grant applications. Generally, there is a higher percentage of private land in the south of the province; in population centres; and/or near transportation routes (FLNRO, 2010).

British Columbia has invested considerable effort in developing a comprehensive land and resource policy framework since the 1990s. Impetus for this arose from conflicts in the 1970s and 1980s about both the cumulative effects of resource extraction, especially forestry, and the government policies that supported these activities (Cashore, Hoberg, Howlett, Rayner, & Wilson, 2001; Wilson, 1998). Ideas about biodiversity conservation and sustainable development that were emerging at the global scale were influential in stimulating local discontent.

Due to expanding public concerns, international exposure and economic pressure, a number of developments occurred in quick succession that significantly changed British Columbia's approach to forest and range management. In 1989, the provincial government established the Forest Resources Commission which recommended a fundamental restructuring of land use planning, tenure reform, new investments in non-timber resource inventories, establishing enforceable forestry practices standards, and broad public involvement in forest planning and management (Forest Resources Commission, 1991).

In 1990, in response to the Forest Resources Commission recommendations, the Province initiated the Land and Resource Management Planning (LRMP) process to develop strategic land use plans at the sub-regional level which would consider all resource values, encourage public, stakeholder and First Nations participation, require inter-agency coordination, and seek consensus-based land and resource management decisions (Integrated Resource Planning Committee, 1993). In 1991, the New Democratic Party was elected with a strong mandate to reform land use and forestry policy and end the so-called “War of the Woods” (Cashore, Hoberg, Howlett, Rayner, & Wilson, 2001). In 1992, the Commission on Resources and Environment (CORE) was established by the government to conduct strategic land use planning in four of the more contentious areas of the province (Vancouver Island, Cariboo-Chilcotin, West Kootenay-Boundary, and East Kootenay areas), which initiated a new and innovative approach to collaborative planning (Day, Gunton, & Frame, 2003; Owen, 1998). Also in 1993, the Province supported the ground-breaking land use decision in Clayoquot Sound (Province of British Columbia, 1993b) and established the “Scientific Panel for Sustainable Forest Practices in Clayoquot Sound” to recommend sustainable forest practices (Clayoquot Sound Scientific Panel, 1995). Many of the new approaches to forest planning and practices that resulted from the CORE processes, the recommendations of Forest Resources Commission, and the Scientific Panel became incorporated into government’s evolving policies on land use and forest practices. As well, in 1995, the Province enacted the *Forest Practices Code Act* (RSBC 1996, c 159) (FPC) that regulated forest planning and practices. Another significant event was the creation of the ‘Corporate Resource Inventory Initiative’ by the Province in 1992, which was an $11 million annual investment in non-timber resource inventories.

The Forest Practices Code was short-lived as it was soon repealed and replaced by the so-called 'results-based' *Forest and Range Practices Act* (SBC 2002, c 69) (FRPA) by the BC Liberal government after it was elected in 2001. The forest industry was afforded a unique 'at-the-table' role in the development of the legislation and policies which implemented FRPA.

Strategic land use planning processes were intended to implement comprehensive land use plans for the entire province, using a consensus-seeking model with the objective to resolve land use conflict, generate economic certainty for resource-based industries, and implement measures to protect and manage the environment (Integrated Resource Planning Committee, 1993; Commission on Resources and Environment, 1995; Owen, 1998; Jackson, 2002; Jackson & Curry, 2002; Jackson & Curry, 2004; Gunton et al., 2003; Day, Gunton, & Frame, 2003; Halseth & Booth, 2003). Although the four CORE land use planning processes did realize significant agreement on land use strategies, full consensus was never achieved in any of the plans. In 1996 the provincial government dissolved the 1992 CORE structure and created a new Land Use Coordination Office (LUCO). It reported to a committee of deputy ministers from the various resource ministries at the time. LUCO morphed into the Integrated Land Management Bureau (ILMB) and was absorbed into the Ministry of Sustainable Resource Management after the election of the new Liberal government in 2001 (Thielmann & Tollefson, 2009).

These early land-use planning strategies were largely devoid of First Nations involvement due to their concerns that such participation could influence emerging understanding regarding Aboriginal rights and title. However beginning in the late 1990s a number of the LRMP processes initiated so-called 'government-to-government' consultation, resulting in agreements on land use decisions.

Following three decades of planning, using a number of delivery processes which have been estimated to have cost in the order of $100 million (ILMB, 2006a), over 90%

of the Crown land base has been addressed in 27 completed regional and subregional land use plans (Province of British Columbia, 2013; ILMB, 2006b). Regional and subregional plans resulted in the expansion of the protected area system and defined broad land use zones and strategies for integrating resource use, establishing environmental protection objectives and requirements, conducting socio-economic and environmental assessment analyses, and directing plan implementation and monitoring intentions across the balance of the Crown land base (ILMB, 2006a). In keeping with the initial intent that tactical and technical levels of planning would follow strategic regional or sub-regional scale plans, 102 landscape or watershed level plans have been completed (Province of British Columbia, 2013). However much of the province is not covered by this level of planning, as this program was curtailed in 2006 due to cutbacks in resource planning within government (ILMB, 2006a).

The changes affecting land use and resource development brought in by the Liberal government of the time as part of "New Era" campaign promises (2001)[24] were as profoundly significant to the policy regime as were the changes created by NDP government elected in 1990. Actions promised by the Liberals included, among other things:

- reducing regulations by one-third;
- encouraging private sector access to Crown land and resources;
- stimulating mineral exploration;
- reforming the Agricultural Land Commission;
- establishing a working forest land base to increase timber supply;
- replacing the Forest Practices Code with a reformed results-based regulatory regime;

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[24] Retrieved from https://www.poltext.org/sites/poltext.org/files/plateformes/bc2001lib_plt._27122008_141728.pdf.

- ‘scrapping’ Forest Renewal BC; and
- repealing the short-lived moratorium on grizzly bear hunting.

Another profound action of the Liberal Government was the Core Business Review undertaken in 2001. It reduced the operational budgets of resource ministries by 56% over the period from 1998 to 2011, leading to an approximate 30% loss in staff, many ministry reorganizations, and revamped and repriorized business operations (Archibald, Eastman, Ellis, & Nyberg, 2014).

The new government also formed politically-orientated task forces comprised of government Members of the Legislature to conduct land use policy reviews. On May 1, 2002 for example, the Results-Based Forest Practices Code Task Force unveiled a discussion paper entitled “A Results Based Forest and Range Practices Regime for British Columbia,” inviting the public to comment on reforms to the Forest Practices Code (Ministry of Forests, 2002). This discussion paper established the policy foundation for the new *Forest and Range Practices Act* (FRPA) implemented in 2004. And a significant effect of the BC Mining Task Force recommendations was the proclamation in 2002 of the so-called ‘two zone land use system for mineral exploration and mining’ through a change to the *Mineral Tenures Act* (RSBC 1996, c 292)[25]. This ensured all Crown Lands not in a designated park, ecological reserve or protected area were open to mineral exploration and mine development, subject to specific permitting and regulatory conditions, and for major projects, the *Environmental Assessment Act* (SBC 2002, c 43).

In 2006, the provincial government implemented a new policy direction designed to complete the legacy LRMPs in process and to limit initiation of new plans or amendment of existing plans (ILMB, 2006a). The policy direction was a clear shift from the community-based collaborative decision-making model championed by CORE (Commission on Resources and Environment, 1995) to a process that was more focussed

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[25] Ministry of Energy and Mines website. Retrieved from http://www.empr.gov.bc.ca/mining/exploration/pages/two_zone_system.aspx.

and tightly controlled: “New plans are government led, done collaboratively with First Nations, use stakeholders in advisory capacity, and have clear process, timelines and products” (ILMB, 2006a; p. 14). As well new plans were expected to reflect government’s interest in resolving land use issues with First Nations.

This streamlined process was accompanied by a 66% reduction in staffing levels in the resource ministries that facilitated land use planning processes (Thielmann & Tollefson, 2009). This has resulted in challenges finding the necessary resources for monitoring, review and amendments to address implementation issues or new conditions caused by natural disturbance, ongoing development pressures, emerging species at risk issues, or climate change.

Regardless of the evolving framework and reductions in staffing and budgets, SLUPs have been the significant mechanism for implementing the Protected Areas Strategy over the past 25 years, and they have set the direction for land use and resource management for public lands outside of protected areas by establishing strategic objectives and legal requirements. Government’s land use plan objectives are implemented through Higher Level Plan Orders (HPLO) under the *Land Act* (RSBC 1996, c 245) that provide legally mandated direction to forestry and natural gas/oil activities regulated under the *Forest and Range Practices Act* (SBC 2002, c 69) and the *Oil and Gas Activities Act* (SBC 2008, c 36). These processes have helped clarify government’s policy direction, promoted collaboration and common understanding at the community level, identified resource development opportunities, reduced conflict and market-based advocacy campaigns, and significantly improved conservation opportunities (Belsey et al., 2004; Frame, Gunton, & Day, 2004; Halseth & Booth, 2003; Integrated Land Management Bureau, 2006b; Jackson & Curry, 2002 & 2004; Joseph, 2004; Pierce Lefebvre Consulting, 2001).

2.3.2 Key Conservation Policy Elements

Integrated with land-use planning and the creation of protected areas are a range of policy tools for protecting the variety of wildlife present in diverse ecosystems across the province. British Columbia's approach to conserving biodiversity on the balance of the Crown land base outside of protected areas is an outcome of the development of the Forest Practices Code and is outlined in the *Biodiversity Guidebook* (Province of British Columbia, 1995a), the *Landscape Unit Planning Guide* (Province of British Columbia, 1999a), the *Identified Wildlife Management Strategy* (Province of British Columbia, 1999b), and the riparian conservation measures outlined in the *Riparian Management Area Guidebook* (Province of British Columbia, 1995b).

Integrated resource management has been a dominant policy paradigm guiding land and resource management in British Columbia since the 1980s. Ecosystem-based integrated management policies are being implemented on the matrix or so-called 'working forest'. They regulate forest practices by prescribing landscape patterns resembling natural disturbance, limits to cutblock size, green-up requirements, coarse woody debris retention, wildlife tree retention, and riparian zone protection. Ecosystem-based management is premised on an integrated resource management approach that emphasizes biodiversity conservation by employing resource development practices to mimic the natural function, structure and species composition of ecosystems (Lindenmeyer & Franklin, 2002; Voller & Harrison, 1998; Kohm & Franklin, 1997; Province of British Columbia, 1995a; Clayoquot Scientific Panel, 1995). This ecosystem conservation policy framework is largely predicated on a prevailing view of ecosystems that are more or less in dynamic equilibrium, with disturbance agents such as wildfire, insects and pathogens being the principal causes of change or variability in the landscape. The historical 'natural range of variability' has been the primary point of reference for implementing much of the conservation and restoration policies currently in effect (Parminter, 1998).

A primary mechanism for implementing such integrated management policies is through Forest Stewardship Plans mandated under the FRPA. Forest tenure holders must prepare these plans, which are required to outline results and strategies to meet the various objectives set by the provincial government. These plans are approved by government officials and are legally enforceable. Forestry operations must also comply with various regulatory practices requirements (eg. *Forest Planning and Practices Regulation* (B.C. Reg. 14/2004)).

The coarse-filter component of this approach specifies targets for the spatial distribution, age distribution, species composition, stand structure, and landscape connectivity of various ecological units[26]; and provides for a network of riparian systems critical to maintaining landscape connectivity and the ecological integrity of some of the highest biological diversity and wildlife habitats. The fine-filter component specifies species categorized as being at-risk or considered to be regionally important, and provides mechanisms to protect habitat considered critical to their survival (eg. Wildlife Habitat Areas, Wildlife Habitat Features and Ungulate Winter Range).

Strategic Land Use Plans constitute a significant delivery mechanism for implementing these measures since they engage stakeholders and resource management agencies in discourse about biodiversity and resource use objectives, negotiate trade-offs where values conflict, and in many cases specify implementation details. The mosaic of these diverse systems and their connectivity is critical to maintaining ecological integrity.

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[26] The *Biodiversity Guidebook* (1995) establishes targets for early seral, mature, and old forest to be achieved for each BEC varient for landscape units having high, intermediate and low biodiversity emphasis for each natural disturbance regime. The Landscape Unit Planning Guide (1999) provides the policies and procedures for implementing these targets through the landscape unit planning. Landscape units and biodiversity emphasis have been defined by across the province. *The Biodiversity Guidebook* set targets for the area within each biodiversity emphasis as follows: high (30 – 50%), intermediate (35 – 60%), low (10%).

The original intention under the FPC was a tiered planning framework, with strategic land use plans (CORE and LRMPS), augmented by tactical and technical planning at the landscape unit level. This planning framework then established objectives and legal requirements for operational forest management activities. Government's policies and procedures for implementing landscape unit planning was published in 1999 (Province of British Columbia, 1999b), with a priority of establishing old growth and wildlife tree retention targets, as well as legal objectives for other forest resource values where directed in approved SLUPs[27].

The Landscape Unit Planning Guide established a completion target of three years. The intent of these policy rules was to tightly constrain impacts from implementing biodiversity targets on timber supply. In the absence of direction from an approved SLUP to the contrary, the timber impact constraint to establishing old growth and wildlife tree retention was set at 4.1% of the allowable harvest, and was further controlled through direction that old growth representativeness could not be considered at scales finer than the Biogeoclimatic Ecosystem Classification variant level and that the target be first apportioned to the so-called 'non-contributing land base'[28]. In areas defined as having low emphasis biodiversity, only 1/3 of the old growth target was allowed unless the target could be met using the non-contributing land base[29]. These are significant policy constraints on meeting representative old growth

[27] Initially the targets for landscape and stand level biodiversity were established in the Forest Practice Code *Biodiversity Guidebook* (Province of British Columbia, 1995), and provided policy direction on old growth and wildlife tree retention, along with detailed guidance on spatial ecological design including patch size distribution, species representativeness and landscape connectivity.

[28] Areas of the Provincial Forest land base that are considered to be economically operable are spatially defined as timber harvesting land base (THLB). The remaining land is said to be "non-contributing".

[29] However where the old growth target was thus drawn down, a recruitment strategy was required to allow the full target to be met within 3 rotations or approximately 240 years.

biodiversity objectives. Initially the intent under the Forest Practice Code was to implement old growth representation at the BEC site level that would have enabled better protection of lower elevation, higher ecologically productive sites to be protected through OGMA designations. The policy was implemented to ensure the 4.1% timber supply impact limit was achieved.

Biodiversity management has also been linked with the protection of old growth areas. Under FRPA, all forest licensees are required to meet spatial old growth retention targets through landscape unit planning. After 15 years, this level of planning has been completed for less than 30% of the province, and thus legally designated spatially identified old growth management areas (OGMA) have been established for only a portion of the province (Province of British Columbia, 2013). Areas not subject to OGMA targets which have been spatially designated through a landscape unit plan are subject to a province-wide non-spatial old growth order[30] designated under the *Land Act* (RSBC 1996, c 245) in 2004. This non-spatial order was intended to both expedite the process of implementation of regional level biodiversity and old growth targets and to reduce government's planning costs. This order legally requires forest licensees to maintain old forest percentages by biogeoclimatic variant within each landscape unit. Where OGMAs have not been legally designated through spatially identified OGMAs, the provincial non-spatial order effects the spatial designation of old growth requirements in licensees' Forest Stewardship Plans and thus become legally enforceable.

The Forest Practices Board conducted an investigation in 2012 into implementation of old growth objectives under FRPA (Forest Practices Board, 2012). This report suggested that licensees:

[30] BC Provincial Land Use Planning and Objectives website. Retrieved from http://www2.gov.bc.ca/gov/content/employment-business/natural-resource-use/land-use/land-use-planning-and-objectives

> preferred non-legal OGMAs for two reasons: first, because they provide the assurance that licensees are complying with the non-spatial order without the need to undertake costly GIS analysis; and, second, because licensees may harvest in non-legal OGMAs without having to seek approvals, provided they continue to comply with the applicable non-spatial order. (p. 15)

The Board determined that "considerable financial and staff resources were committed to planning OGMAs", "ensuring that OGMA locations would not restrict access for timber harvesting in other parts of watersheds", and "were located in areas with multiple values such as important wildlife habitat, First Nations and other non-timber resources" (p. 16). However, the Board also questioned "whether the approach of managing non-legal OGMAs is sufficient to ensure the long-term integrity of the designated areas" (p. 22).

FRPA provides a number of further important planning and practices mechanisms to establish legally enforceable objectives and standards for fish, wildlife, biodiversity and riparian protection. Wildlife habitat areas (WHA) are designated to protect rare, endangered or regionally important species threatened by forest and range management[31], and ungulate winter range (UWR) designations are established to protect winter habitat requirements for ungulates[32]. FRPA provides the authority to designate orders for WHAs and UWRs, called general wildlife measures (GWM), that are legally enforceable. GWMs often restrict forest management activities unless the conservation objective of the WHA or UWR is not compromised. Such activities can be constrained by timing windows dictated by wildlife use of the area. Other practice standards include requiring timber harvesting to be carried out to resemble spatial and temporal patterns of natural disturbance[33]; and prescribing maximum size of harvested

[31] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html

[32] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/uwr/approved_uwr.html

[33] Forest Planning and Practices Regulation (B.C. Reg. 14/2004), Section 9

areas and adjacent area green-up, as well as wildlife tree and coarse woody debris retention[34]. A site-specific FRPA tool is wildlife tree retention (WTR) defined in FRPA as requiring retention of 7% of the total area of all cutblocks harvested by an agreement holder within a one-year period, and the minimum 3.5% tree retention for each individual cutblock. Another is the ability to designate wildlife habitat features (WHF) intended to protect sensitive localized features such as nests, dens, or species at risk residences. Although FRPA came into force in 2004, to date no WHFs have yet been designated. The Ministry of Environment website[35] suggests that "work to legally establish wildlife habitat features is ongoing"[36].

Understanding government's concerns about timber supply impacts, as calculated in the Forest Practice Code Timber Analysis (Province of British Columbia, 1996), is the key to understanding biodiversity management in British Columbia. This analysis projected that the new Forest Practices Code (FPC) would result in an impact on the timber supply of approximately 6% on the short-term timber harvest level on a provincially averaged basis. Implementing the new riparian protection standards was estimated to have a 2.1% impact on timber supply; stand and landscape biodiversity requirements were projected to have a 4.1% impact; the Identified Wildlife Management Strategy would have 1% impact (not including the so-called 'higher level plan' species); and watershed assessments would have 1% impact; totalling 8.2% of the allowable annual cut. However, a number of FPC provisions, such as riparian and biodiversity requirements, partial cutting and smaller cutblocks, along with better design and retention, were expected to reduce the impacts on timber supply resulting from visual retention

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[34] *Forest Planning and Practices Regulation* (B.C. Reg. 14/2004), Sections 64 – 68

[35] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/habitatfeatures.html

[36] Likewise, no temperature sensitive streams have been designated, as provided for under the *FRPA* (ie. Section 15 of the *Government Actions Regulation* (B.C. Reg. 582/2004)).

objectives in place by 2.2%, bringing the total impact of the FPC to 6.0%. Cabinet-level policy directed bureaucrats to implement the Code within these limits unless a cabinet-approved land use plan or Higher Level Plan Order specified otherwise. This policy was codified in the new *Forest and Range Practices Act* (SBC 2002, c 69) which directs that Wildlife Habitat Areas and Ungulate Winter Range, among other things, must "not unduly reduce the supply of timber from British Columbia's forests" and the "benefits derived… must outweigh any material adverse impact of the order on the delivered wood costs", nor cause "undue constraint on the ability of a holder of an agreement under the *Forest Act* or the *Range Act* that would be affected by the order to exercise the holder's rights under the agreement" (cf. Section 2 of the *Government Actions Regulation* (B.C. Reg. 582/2004)).

In the case of the Identified Wildlife Management Strategy, the Timber Supply Analysis predicted that protecting most species at risk would only result in a 1% impact on the Allowable Annual Cut given their rarity. However a number of individual species such as spotted owl, marbled murrelet, grizzly bear, caribou, and northern goshawk, were considered separately due to the significant amount of habitat required for their conservation. The political direction to staff at the time was to implement the Code within the 6% impact estimated in this analysis. Identified wildlife requiring greater than 1% of the Timber Harvesting Land Base required a separate management strategy and approval of the provincial cabinet. To date the government has developed recovery management strategies or higher level orders for spotted owl, grizzly bears, and mountain caribou, For example, the Kootenay-Boundary Higher Level Plan Order contained an explicit legal objective pertaining to the conservation of habitat for grizzly bears and mountain caribou.

The frequent criticism (Boyd, 2003; Cashore, Hoberg, Howlett, Rayner, & Wilson, 2001; Clogg & Carlsen, 2013; Forest Practices Board, 2004; McGonigle, 2000) that government has limited the implementation of the Forest Practices Code, and subsequently FRPA to a 6% impact is a mischaracterization of government's policy intent. Rather, the policy intent was to delegate bureaucrats the responsibility for implementing the new forest legislation and its associated environmental conservation policies to not exceed the level of impact projected by the Timber Supply Analysis. Implementing conservation targets in excess of the 6% target was considered to be a land use decision, requiring thorough stakeholder, public and First Nations consultation, a socio-economic assessment, and a subsequent decision by the provincial cabinet. Indeed many land use decisions across British Columbia have far exceeded the 6% timber supply impact limit.

The new *Oil and Gas Activities Act* (SBC 2008, c 36) specifies similar protection from oil and gas seismic lines, well sites and facilities, road right-of-way, and pipeline corridors for riparian areas, WHAs, UWRs, OGMAs, or WTR areas. This Act also specifies that:

> …oil and gas activities on an operating area outside of a wildlife habitat area be carried out at a time and in a manner that does not result in physical disturbance to high priority wildlife or their habitat, including disturbance during sensitive seasons and critical life-cycle stages[37].

The effect of this was to extend conservation designations applied to forest development activities to oil and gas development as well.

The federal *Species At Risk Act* (SARA) (S.C. 2002, c. 29) was proclaimed in 2003 to provide national level umbrella legislation to protect species at risk. This statute enables the assessment and listing of species at risk, directs the development of species recovery plans, and provides for legal protection of species and species residences for those aquatic and migratory bird species that come under direct federal responsibility. The act also establishes the authority of the Governor-in-Council (ie. the federal Cabinet) to apply protection to any wildlife species at risk which is the responsibility of a provincial government if the laws of the province are considered to not effectively

[37] *Environmental Protection and Management Regulation* (B.C. Reg. 200/2010), Section 6(b)

protect the species or its residences, or where Cabinet considers it necessary to protect critical habitat should the species face imminent threats to its survival or recovery. Critics of this legislation have claimed implementation of the Act has failed to list all species at risk, failed to designate critical habitat as required, has only been applied to federal jurisdiction, and has never implemented the 'safety net' provisions for species under provincial jurisdiction.[38] An internal audit completed by Environment Canada in 2012 found that only 43% of the recovery plans required to designate critical habitat have been completed (Environment Canada, 2012).

Given inter-jurisdictional responsibility for wildlife in Canada, the federal, provincial and territorial governments signed the 1996 Accord for the Protection of Species at Risk[39], and in 2005 the federal and British Columbia governments signed the Canada – British Columbia Agreement on Species at Risk[40]. In response, the British Columbia government introduced amendments to the provincial *Wildlife Act* (RSBC 1996, c 488) in 2004 to allow for the designation of species at risk. Ten years later the provincial government has not implemented the regulations necessary to bring these provisions into force. Therefore, despite there being 754 species listed as extirpated, endangered or threatened, and a further 757 considered to being of special concern by the BC Conservation Data Centre[41], the only provincially-mandated protections for species at risk are for activities under the *Forest and Range Practices Act* (SBC 2002, c 69) and the *Oil and Gas Activities Act* (SBC 2008, c 36) on Crown land and for four species designated

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[38] David Suzuki Foundation Website: Retrieved from http://www.davidsuzuki.org/issues/wildlife-habitat/science/endangered-species-legislation/canadas-species-at-risk-act/

[39] Environment Canada Website. Retrieved from http://www.registrelep.gc.ca/default.asp?lang=en&n=6B319869-1

[40] Legislative Library of British Columbia. Retrieved from http://www.llbc.leg.bc.ca/public/PubDocs/bcdocs/419585/aa_Canada-British_Columbia_agreement_on_species_at_risk_0805_e.pdf.

[41] Ministry of Environment website. http://www.speciesatrisk.bc.ca/.

under the *Wildlife Act* (Burrowing Owl, American White Pelican, Vancouver Island Marmot, and the Sea Otter).

British Columbia's *Wildlife Act* (RSBC 1996, c 488) regulates many aspects of wildlife management, including hunting and trapping activities and the protection of bird nests and eggs[42]. Using the *Wildlife Act* (RSBC 1996, c 488), the provincial government has established 28 wildlife management areas (WMA) ranging in size from 17 to 122,787 hectares to conserve habitat areas for regionally and internationally significant fish and wildlife species[43]. Although conservation objectives for the wildlife and habitat values are paramount in these areas, other compatible land uses may be permitted.

Biodiversity conservation has also been taken up by a number of private non-government organizations that are purchasing conservation lands, often in partnership with government. Between 2001 and 2003, for example, $91M was expended in land acquisitions[44]. Recently the Nature Conservancy of Canada purchased 55,000 hectares of ecologically important privately owned property in the Selkirk Mountains west of Kootenay Lake[45]. In 2004, the province established an $8 million trust to purchase private lands to support biodiversity conservation, with formal agreement from Nature Conservancy of Canada, Ducks Unlimited Canada, the Nature Trust of BC, the Land Conservancy of BC that they would match these funds with a further $24 million[46]. In 2000, the federal government established the Habitat Stewardship Program that

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[42] Migratory birds are protected under the federal *Migratory Birds Convention Act*. This legislation regulates hunting of migratory birds, and similarly protects those nests.

[43] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/fw/habitat/conservation-lands/wma/.

[44] Land Trust Alliance of British Columbia website. Retrieved from http://ltabc.ca/.

[45] Nature Conservancy of Canada website. http://www.natureconservancy.ca/en/where-we-work/british-columbia/featured-projects/darkwoods/.

[46] Province of British Columbia website. Retrieved from http://www2.news.gov.bc.ca/archive/2001-2005/2004srm0036-000815.htm.

allocates $2-3 million a year to community stewardship group projects in the British Columbia/Yukon Region to conserve and protect species at risk and their habitats on private lands, provincial Crown lands, aboriginal lands, or in aquatic and marine areas across Canada[47]. In British Columbia, about 40 land trust organization have worked to secure over 200,000 hectares (~ 0.21% of BC) of land for conservation and protection purposes through some 400 fee simple ownership and covenant arrangements[48]. A diverse range of values including significant biodiversity habitats and species, recreational, educational and research are represented in most ecoprovinces, with the exception of northern British Columbia (Hannah, 2006).

Major resource development projects of various types may be subject to environmental assessment under the *Canadian Environmental Assessment Act* (S.C. 2012, c. 19) or the provincial *Environmental Assessment Act* (SBC 2002, c 43). More modest projects are subject to a myriad of permitting and licensing review processes by federal, provincial and local government agencies. Such processes result in innumerable environmental impact mitigation and compensation requirements on a project-by-project basis. However there remains no comprehensive process to consider the cumulative effects of resource development on the land base or on biodiversity. In a recent review of cumulative effects across natural resource development in British Columbia the Forest Practices Board concluded that:

> … in BC, the current methods for cumulative effects assessment are largely ineffective in contributing to the management of those effects. Where proponents are required to conduct cumulative effects assessments to obtain approval for major projects, there are structural impediments that limit the utility of those assessments. More importantly, there is no requirement to assess the cumulative effects of the myriad of minor activities that are continually authorized. Because there is no requirement to do cumulative effect assessments on the totality of natural resource development, the overall effect remains largely unknown… there

[47] Environment Canada website. Retrieved from https://www.ec.gc.ca/hsp-pih/.

[48] Land Trust Alliance of British Columbia website. Retrieved from http://ltabc.ca/.

> is no decision maker in the context of cumulative effects. (Forest Practice Board, 2011; p. 12)

The above discussed policy initiatives have resulted in an impressive set of accomplishments across the province. More than 14% (or 13.5 million hectares) is now protected as park or conservancy areas in British Columbia[49], and through land use planning an additional 11 million hectares (~ 12%) has been zoned as special management areas[50] to protect environmental and cultural values. Old growth forest representation and stand retention targets have been established over the majority of the land base through a provincial non-spatial order[51] under the Land Act (RSBC 1996, c 245) or spatially through landscape planning processes. There have been approximately 55,000 old growth management areas designated, totalling approximately 3.9 million hectares (~ 4%) (Forest Practices Board, 2012). The Forest and Range Practice Act (SBC 2002, c 69) has established legally enforceable objectives and standards for fish, wildlife, biodiversity and riparian protection. Over 3.5 million hectares (~ 4%) have been designated as wildlife habitat areas to protect designated rare, endangered or regionally important species threatened by forest and range management[52], and a further 8.8 million hectares (~ 9%) has been designated as Ungulate Winter Range[53]. Species recovery plans further establish conservation requirements. For example the Mountain

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[49] Province of British Columbia website. Retrieved from http://www2.news.gov.bc.ca/news_releases_2005-2009/2008ENV0048-000650.htm#

[50] BC Spaces for Nature website. Retrieved from http://www.spacesfornature.org/greatspaces/smz.html

[51] BC Provincial Land Use Planning and Objectives website. Retrieved from http://www2.gov.bc.ca/gov/content/employment-business/natural-resource-use/land-use/land-use-planning-and-objectives/land-use-legal-direction-index.

[52] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html

[53] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/uwr/approved_uwr.html

Caribou Recovery Implementation Plan purports to protect 95% or 2.2 million hectares (~ 2%) of high suitability caribou habitat, and a management plan protects 363,000 hectares (~ 4%) for the northern spotted owl[54].

2.4 SUMMARY

This Chapter outlines the recent history of British Columbia's approach to wildlife conservation to contextualize, explain and justify the importance of the research questions addressed in this dissertation. While the federal level lacks a comprehensive national conservation plan and there are significant failures to adequately implement the *Species At Risk Act*, at the provincial level a complex array of conservation measures have been implemented through land use planning, resource management policies, and conservation land acquisitions. However, both federal and provincial legislation and practice historically have focussed on wildlife conservation strategies that assume that the environment itself is relatively stable. Comprehensive assessments of the efficacy of biodiversity conservation and the cumulative effects of resource development and human settlement are lacking.

Today there is recognition that the natural environment's response to climate change must be explicitly addressed when considering wildlife habitat and thresholds to survival. Conservation biologists and the environmental community recently have renewed a demand that up to 50% of the land base be conserved to meet biodiversity objectives in the context of climate change (Noss et al., 2012; Pojar, 2010). On one hand, British Columbia has shown notable leadership over the past three decades in its evolving, often tension-ridden, efforts to balance resource development with conservation and the protection of wildlife. On the other hand, it is evident that the long-standing goal of preserving and/or restoring ecosystems to a desired and accurate historic state is no longer viable in the face of changing climate conditions across the

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[54] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/sarco/index.html

province and well beyond. Wild fires, drought and mountain pine beetle infestation, attributed to climate change, provide evidence of widespread ecosystem transitions.

As noted in *Preparing for Climate Change: BC's Adaptation Strategy* (Ministry of Environment, 2010):

> Because of the historical and continuing rise in global GHGs [Green House Gas Emissions], the Earth will continue to warm for decades to come. We can expect more long-term warming, more extreme weather, changes to precipitation patterns, and rising sea levels. The Government of British Columbia will increasingly need to consider climate change as it continues to protect health and safety, maintain public infrastructure, manage natural resources, and achieve environmental, social and economic sustainability. (p. 1)

This *Strategy* goes on to note that:

> Preparing effectively for climate change will require decisions based on an understanding of future climate, not just the climate of the past. Smart investments that consider current climatic hazards and future climate risks will reduce long-term costs for infrastructure, and contribute to the maintenance and protection of societal goods and services. (p. 1)

Recent advancements in implementing wildlife conservation have been the result of notable and evolving social-political decision processes characterized by values-based conflict, negotiation and compromise. Accepting the realities of climate change implies recognition of significant new dimensions of political complexities and uncertainties compounding an already highly complex subject. Given that significant social capital has been invested to reach the oftentimes tenuous agreements currently in place, implementing new policy mechanisms will undoubtedly be contentious and will test community support, political decision-making, and scientific evidence. Given the complexity of change and change management across a wide range of urgent social and economic concerns, ways in which both land use and biodiversity management tools must be adapted at the provincial level are critical questions going forward. Subsequent chapters in this dissertation explore implementation of wildlife conservation (Chapter Three), the potential implications of climate change on ecosystems (Chapter Four), and community responses to future climate scenarios (Chapter Five) using the Kootenay area as a case study. The hope is that this study will yield insights and suggest possibilities that contribute to British Columbia's capacity to adapt its approach to wildlife conservation to explicitly acknowledge and address the scientific and political uncertainties and complexities that climate change adds to an already complex subject.

Chapter Three – Evaluation of Wildlife Conservation Implementation in the Kootenay Region of British Columbia

3.1 INTRODUCTION

Just as there have been remarkable advances in ecosystem conservation measures internationally, nationally and across the province, efforts to safeguard the unique and valued ecosystems of the Kootenay region have resulted in the preservation of key habitats for the significant species found in this mountainous refugium. And just as tensions are inherent in such activity across all jurisdictions, the conservation of eco-systems in the Kootenays has been shaped by conflicting values and perspectives. This area was selected for this research because it represents a discrete and rich case study for discussion of ways in which stakeholder engagement in a vulnerability assessment of climate change motivates support for appropriate wildlife habitat and species intervention policies, using the challenges of conserving mountain caribou as one particular focus.

The general study area is defined by boundaries established in the Kootenay-Boundary Land Use Plan (KBLUP) implemented by cabinet in 1995, as this offers an effective policy and data context. As the Kootenay-Boundary region encompasses the East and West Kootenay areas along with the Boundary area along the border, this overall area is referred to as the 'Kootenay region', the 'region', or the 'Kootenays' throughout the remainder of the dissertation. Within this overall context, the study pays particular attention to the West Kootenay area as this is the primary habitat for mountain caribou.

This chapter critiques the implementation of wildlife conservation in the Kootenays relative to new understandings of the ecological change dynamics. The chapter starts with an introduction of land use and resource development in the region. It goes on to describe an analysis focussing on current conservation of representative ecosystems and suitable habitat for mountain caribou, grizzly bears, lynx, fishers, wolverine and wolves. Finally, two proposals recently advocated by local environmental organizations are evaluated in the context of their potential contribution to ecosystem and wildlife species conservation.

3.2 LAND USE AND RESOURCE DEVELOPMENT IN THE REGION

British Columbia's Kootenay region is renowned for its spectacular beauty and the natural ecosystems that support its economy. The area is located in the southern half of the Yellowstone to Yukon (Y2Y) regional corridor in the Canadian Rocky Mountains ecoregion adjacent to Alberta, Montana, Idaho, and eastern Washington (Yellowstone to Yukon Conservation Initiative, 2010; Locke, 1998). It is home to wildlife ecosystems significant in a global context and is considered to be critical to maintaining connectivity for wildlife within the Y2Y corridor.

The rugged mountainous terrain creates a complex mosaic of biogeoclimatic conditions that impact settlement, resource development, and management of ecosystems in the region. Varied land uses include agriculture, commercial tourism, forestry, mining, hydro-electricity generation reservoirs, and public recreation. Figure 3.1 depicts the diverse land use categories in the study area. This map was derived from the Baseline Thematic Mapping model which classifies land use and ground cover primarily through the interpretation of Landsat 5 imagery, aerial photography, and forest cover inventory (ie. Vegetation Resource Inventory) (Ministry of Environment, Lands and Parks, 1995)[55].

The size distribution of land use categories is shown in Figure 3.2. According to this 2014 dataset, approximately 31% of the region is comprised of alpine, glaciers or barren surfaces, 67.2% is forest or rangeland, and 1.8% has been developed for agriculture, residential, urban, or mining. Of land classified as forested 33.3% is 'old forest', 48.4% is

[55] Data downloaded from the DataBC geographical data warehouse accessible at http://www.data.gov.bc.ca/dbc/geographic/index.page?

'young forest', 4.0% has been recently selectively logged, 12.8% has been clear-cut, and 1.6% has been 'recently burned'[56].

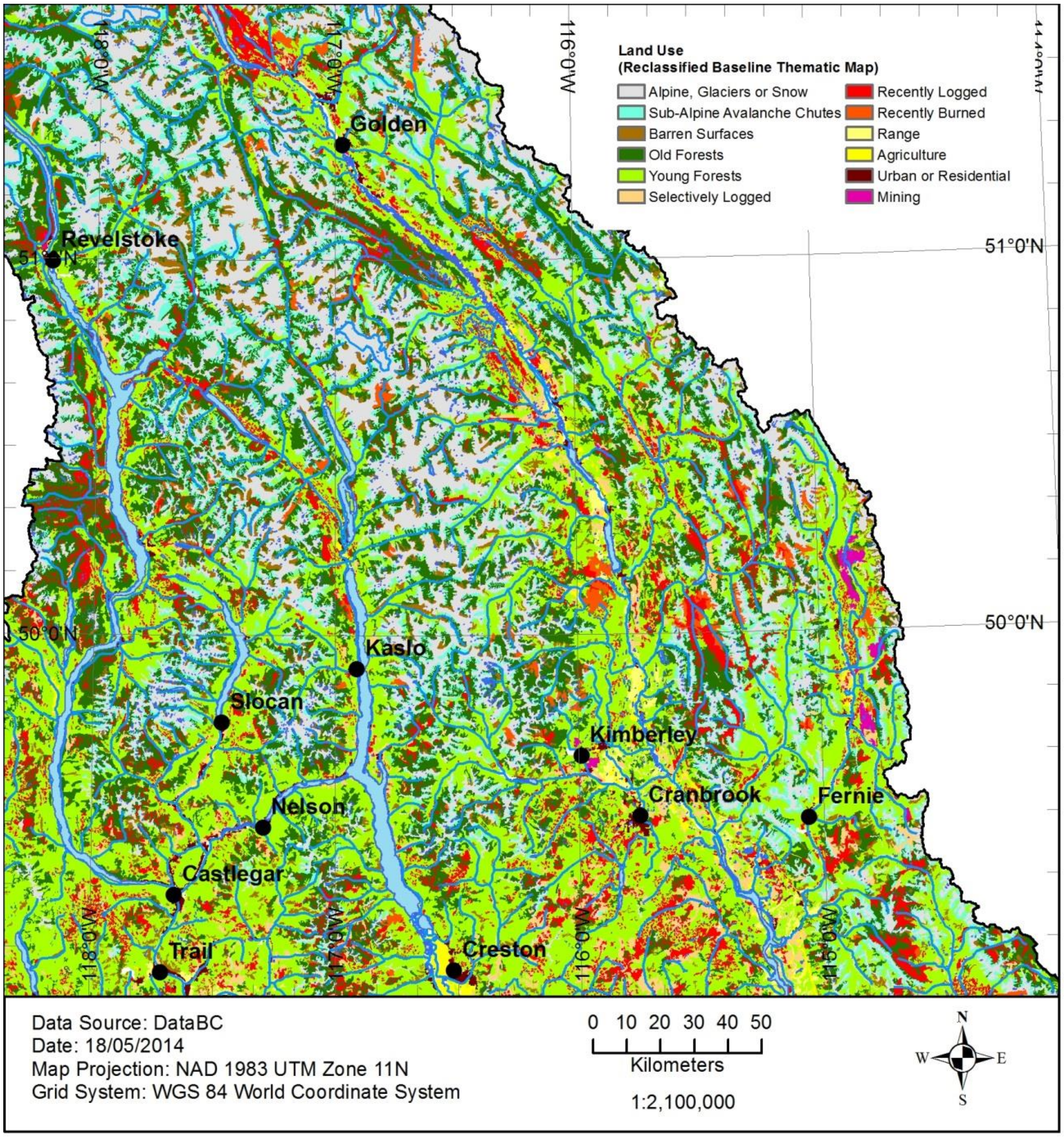

Figure 3. 1: Kootenay Region Land Use Categories

[56] Old forest was defined as >140 years old and > 6 metres in height; young forest as <140 years old and < 6 metres in height; recently clear-cut or selectively was harvested within the past 20 years; and recently burned as burned within the past 20 years and forest cover <15% (Ministry of Environment, Lands and Parks, 1995).

Aboriginal peoples, including the Ktunaxa and Interior Salish, have occupied the region since the last great ice age (CORE, 1994a; CORE, 1994b; Pryce, 1999). David Thompson of the Northwest Company surveyed much of the region in the early 1800s while exploring for new fur-trading territory (Affleck, 1976; Belyea, 1994). Prospectors descended on the region during the gold rush in the 1860s. The Canadian Pacific transcontinental railway bisected the region from Golden to Revelstoke in 1885. The area was subject to intensive prospecting for minerals leading to the discovery of rich

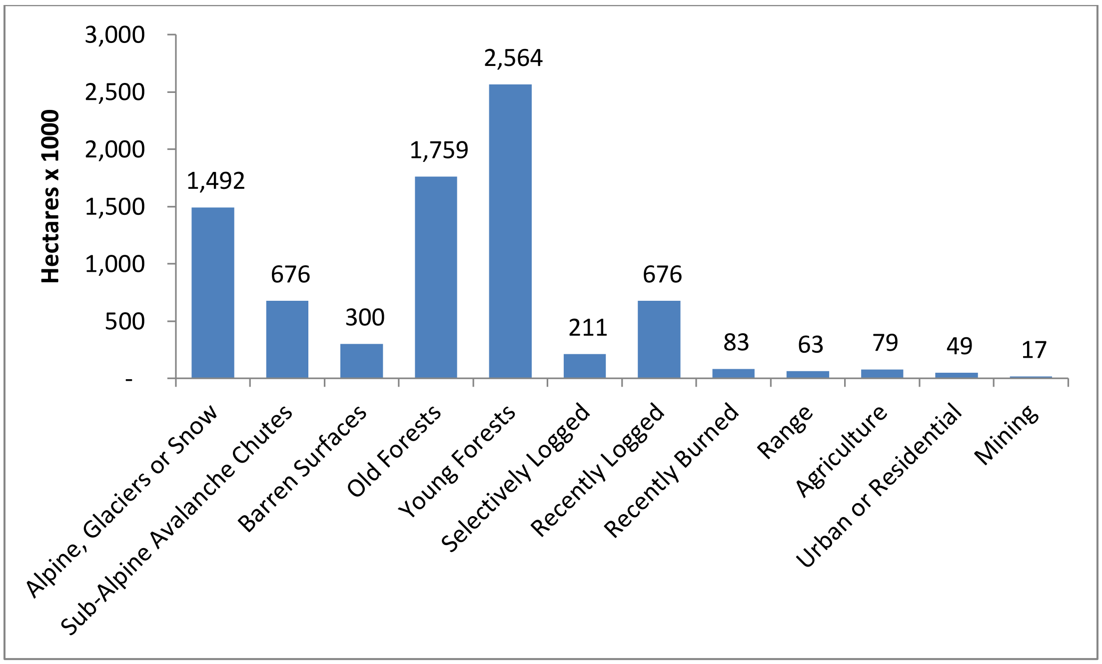

Figure 3. 2: Land Use Class Size Distribution, showing largest area of land is comprised of old and young forests, alpine areas or areas that have recently been logged

deposits of silver, gold, copper, lead and zinc late in the 19th Century. A regional transportation network was developed to support mineral exploitation, including a number of local rail lines and steamboats operating on Kootenay, Arrow and Slocan Lakes. The City of Nelson developed as the central supply centre, and a major smelter was built to process minerals from mines across the region. The Crowsnest Pass railway was constructed in the late 1890s to access rich coalfields in the south-east portion of the region (Gayton, 2002, Commission on Resources and Environment (CORE), 1994a; CORE, 1994b; Affleck, 1976). Gayton (2002) describes the environmental impacts of intensive mining exploration,

> …stream channels were blasted, sluiced, cribbed, straightened, and excavated. Small dams were built, forests were logged and burnt, huge quantities of overburden, processed ore, and smelter effluent were dumped into the lake. Miners would intentionally burn off whole mountainsides to better see the rock formations underneath the forest. Early photos of nearly every community in the Kootenays show burned, mine-scarred hillsides in the background. The lush vegetation growth in the West Kootenays covers many of the scars now, but one learns to pick out evidence of old mining activity. (p. 36)

The forest industry is now the biggest employer in the region (BC Stats, 2011). It developed initially to provide timber for the mining sector and railroad construction, and expanded significantly to serve growing construction markets in Canada and the United States. Mechanization extended the reach of logging activity through a network of roads that, by the 1970s, accessed forested areas in most major drainages across the region. Pulp mills were built in Castlegar in the West Kootenay area and Skookumchuck in the East Kootenays, and many sawmills served the region (Clayton, 2009; CORE, 1994a; CORE, 1994b). With the advent of pulpmills, new logging technologies including log skidders and feller-bunchers, and modernization of sawmills to process smaller logs, resulted in a shift from selective logging to clearcuts along with a substantial 49% increase in lumber production (Druska, 1998; cf. Clayton 2009, p. 161).

Important agricultural areas were settled in valley bottoms with rich soils and suitable climate conditions near Grand Forks, along Kootenay Lake, the Slocan Valley, near Creston and along the Rocky Mountain trench in the East Kootenays (CORE, 1994a; CORE, 1994b).

Since 1964 several hundred hydroelectric dams have been built on the Columbia River system under the auspices of the Columbia River Treaty, including eighteen on the British Columbia side of the border and over 470 in the United States[57.] Major Canadian

[57] Columbia Basin Trust website. Retrieved from www.cbt.org

projects include the Mica, Revelstoke and Keenleyside dams on the lower Columbia River; seven dams on the short reach of the Lower Kootenay River between Nelson and Castlegar; the Duncan dam on the River flowing into the northern end of Kootenay Lake; and the Seven Mile and Waneta dams on the Pend d'Oreille River. The Libby dam, located on the Upper Kootenay River in the United States, created the Lake Koocanusa reservoir that backs up into Canada. This network of reservoirs has disrupted human settlements, valuable wildlife habitat, and fish passage (Clayton, 2009; Loo, 2004).

> Long-time residents of the Kootenay, Arrow, and d'Oreille valleys were summarily expropriated and their properties were flooded by rising waters behind the new Libby, Keenleyside, and Seven Mile dams. Along the Kootenay south of Cranbrook, whole communities, like Flagstone and Dorr, disappeared completely under the waters of the Koocanusa reservoir. On the Columbia, Renata was flooded out by the Keenleyside dam, and Edgewood was forced to move to higher ground. Dozens of small farms along the Columbia also disappeared. The actual physical space lost to dams on the Kootenay and Columbia river systems is a small percentage of the landbase, but the ecological loss from the drowning of these productive bottomlands is enormous. (Gayton, 2002; p. 38)

Tourism and outdoor recreation are important economic drivers as people are drawn by the lakes and hiking in the summers and snow sports in the winter. Motorized backcountry access resulting from snowmobiles, ATVs, and heli- and cat-skiing activities have increasing potential to impact wildlife ecosystems (Ministry of Environment, 2006). These complex land uses are critical factors in planning for wildlife ecosystem conservation. Current land use includes extensive allocation of resource management activities on both public Crown land and privately owned land, particularly at lower elevations and in the southern one-third of the region.

Forestry operations and mineral exploration have undoubtedly had the most extensive impacts on land use and wildlife habitat, resulting in large areas particularly in the southern and low to mid elevation extents containing a network of access roads and areas disturbed by clear-cut and selective harvesting. Figure 3.3 presents road density as a proxy for land usage. Forest activity, mineral exploration, and human settlement areas are the land uses most associated with road densities greater than 10 m/ha. To create this figure, road density at a scale of 1 km^2 was calculated using the Spatial Analyst Line Density tool in ArcMap[58] based on the Digital Road Atlas dataset available from DataBC[59].

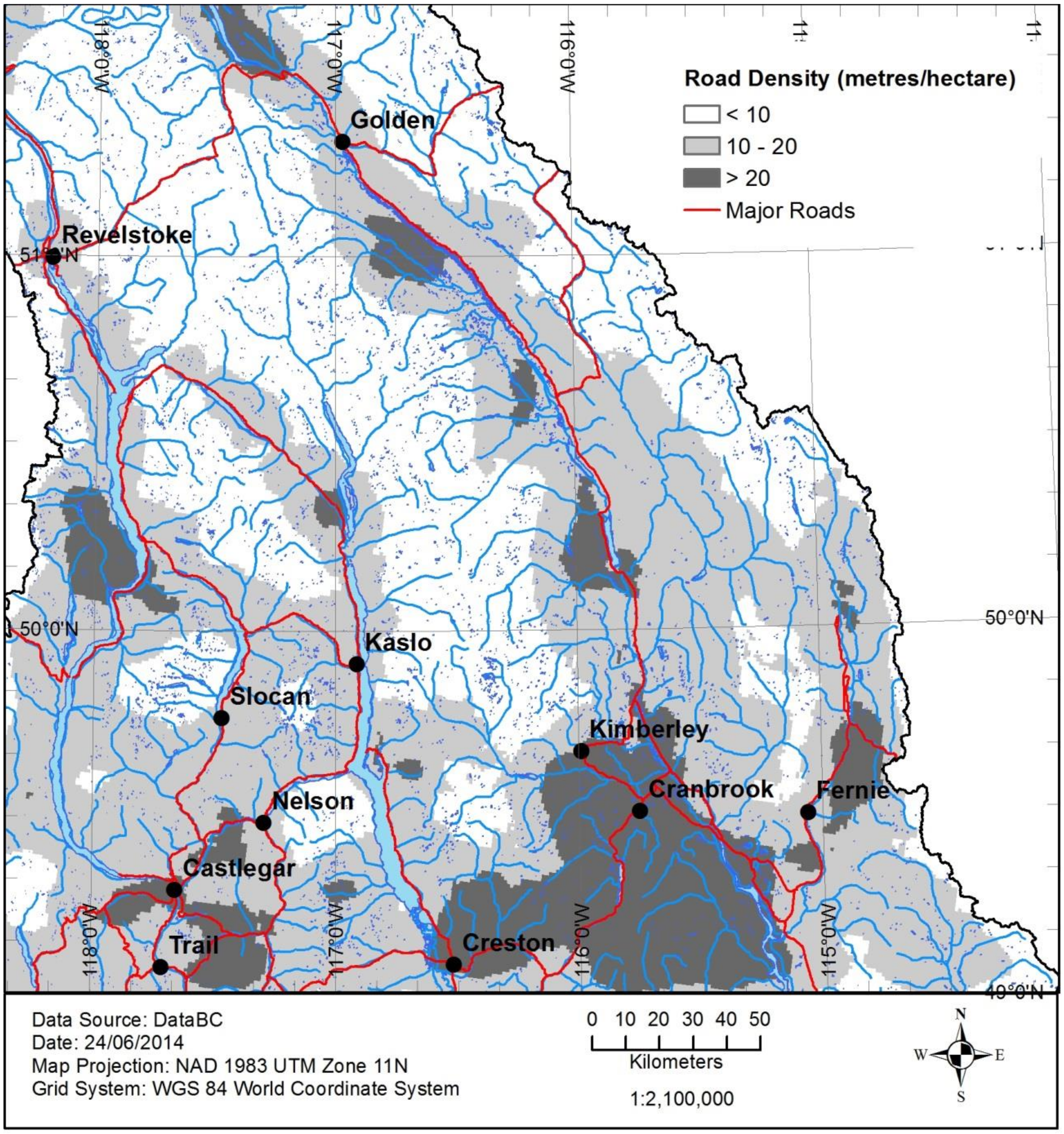

Figure 3. 3: Road Density (metres/hectare), showing areas of heavy, moderate and light road densities

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58 ArcGIS 10.2.2 for Desktop software from ESRI (http://www.esri.com/software/arcgis/arcgis-for-desktop)

59 DataBC website. Retrieved from http://www.data.gov.bc.ca/dbc/geographic/index.page?.

Not surprisingly, road density is similar to the density of forest harvesting areas presented in Figure 3.4. The Forest Harvest Density map was calculated based on the

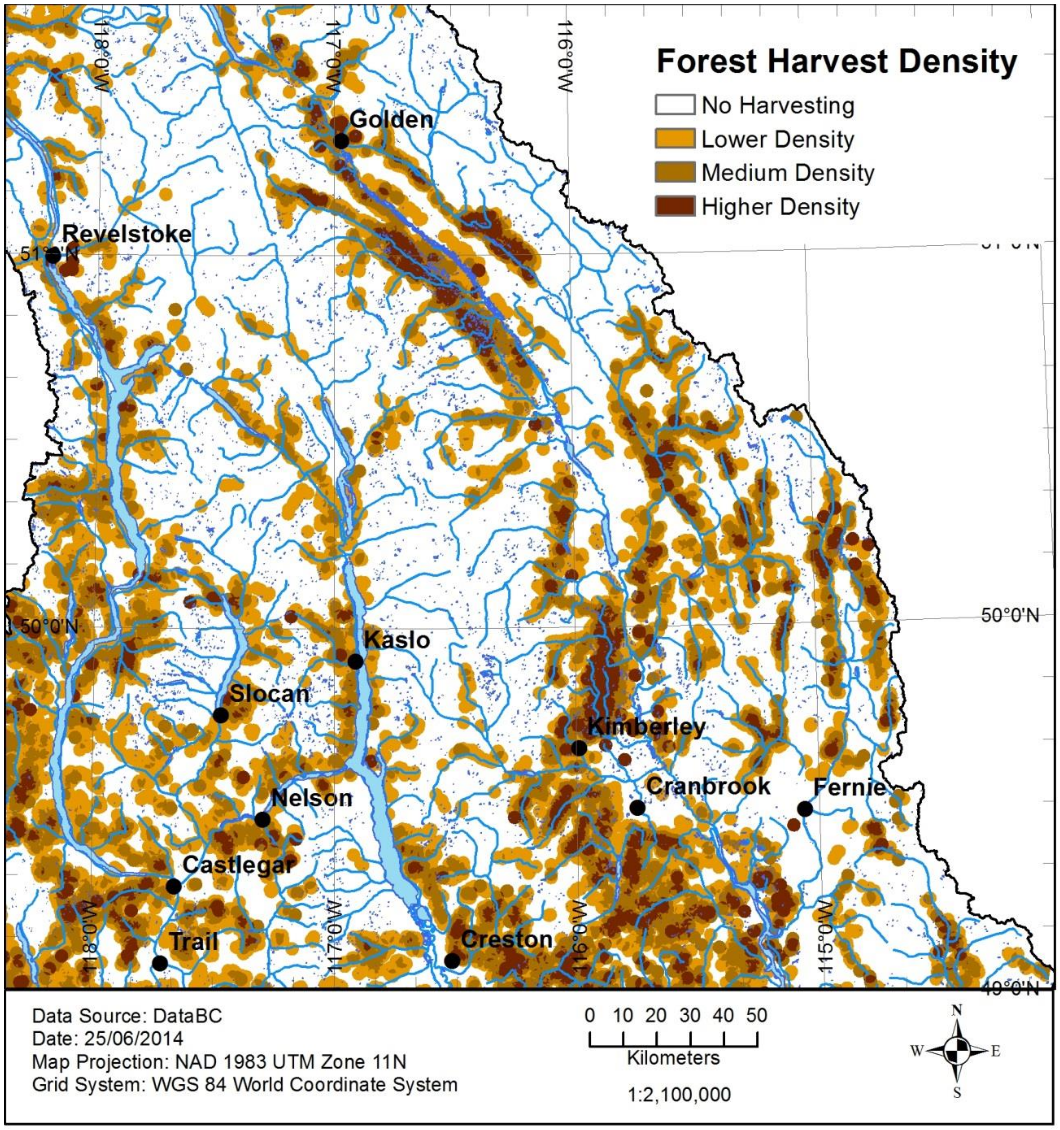

Figure 3. 4: Forest Harvesting Density (Quantile Density), showing areas of higher, medium, lower or no harvesting density

Forest Tenure Administration polygon file downloaded from DataBC[60], edited to focus primarily on commercial timber operations by removing the large tenure areas allocated to commercial cat- and heli-skiing operations for glading purposes. Each timber cutblock polygon was converted to a centroid point, and the spatial analyst point density tool in ArcMap was used to calculate a density function. This tool calculates the density of point features around each output raster.[61] The population density calculated was the 'area disturbed' in square meters, the output size was 100 m, radius 2000 m, and units are in square metres. Output size and radius values were selected through a process of trial and error. Selection of these values is justified based on 100 m being a reasonable raster size for mapping at a regional scale, and 2000 m set arbitrarily as the limit of direct influence of harvesting on wildlife habitat. This output was then classified into four quantile forest harvest density classes comprising 'No Harvesting', 'Lower Density', 'Medium Density', and 'Higher Density'.

Early land use conflict pitted resource developers against conservation activists in the Slocan Valley and the north arm of Kootenay Lake. Clayton (2009) makes reference to new arrivals to the West Kootenay who led community level discontent about the impacts resource development was having on the environment. These people included Quakers arriving in the early 1950s, and many young urban Canadians and American draft-dodgers arriving in the late 1960s to early 1970s (Clayton, 2009). In 1972, the New Democratic Party (NDP) formed a government, succeeding the Social Credit party that had held power for the previous 20 years. The outpouring of public support for preservation caught the ear of this government and led to the creation the Purcell Wilderness Conservancy in 1974 (Clayton, 2009) – the largest intact ecosystem in southern British Columbia. Creation of the Conservancy was contested by many other

[60] DataBC website. Retrieved from http://www.data.gov.bc.ca/dbc/geographic/index.page?.

[61] ArcGIS Resource Help Centre website. Retrieved from http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/How_Point_Density_works/009z00000013000000/.

locals who were dependent on logging for their livelihood. The argument for creation of the Conservancy was based on recreation values, as well as protection of fish and wildlife habitat. However, the NDP government was short-lived. It was replaced in 1975 by return of the Social Credit government that institutionalized policies sympathetic to resource development (Wilson, 1998). Over the next 15 years, land use planning occurred largely in response to specific conflicts among users of land-based resources (Forest Practice Board, 2008). Resulting plans were generally for watershed scale areas, and were conducted by government bureaucrats with public input.

The Valhalla Provincial Park was created in 1983 following a long campaign led by local conservationists motivated by their success in establishing the Purcell Wilderness Conservancy[62]. It was opposed by the forest industry and the BC Forest Service due to loss of timber access.

In 1992, after the NDP returned to power, the Commission on Resources and Environment (CORE) was established to prepare comprehensive regional land use plans for the Kootenays, among other regions, to "ensure the sustainability of a natural resource-based economy…and sustainability of…ecosystems", to "increase…meaningful public participation in land and resource management decisions" and to "address aboriginal concerns about land and resource use on [their] traditional territories" (CORE, 1994b; p.v).

The Kootenay-Boundary Land Use Plan (KBLUP) evolved from separate regional land use planning processes convened by CORE in the West Kootenay–Boundary and the East Kootenay areas (CORE, 1994a; CORE 1994b). The original intent was to resolve land use conflict by building consensus, based on the principles of community-level shared decision-making and interest-based negotiation (Owen, 1998). Land use negotiation tables were set up for each area, representing a full range of economic, social, and environmental values. Although significant progress was made, none of these tables

[62] http://www.spacesfornature.org/greatspaces/valhalla.html

were able to reach consensus on land use recommendations after a year and a half of intensive negotiations. As Gayton (2002) observes:

> The Kootenay-Boundary Land Use Plan, an outgrowth of the provincial Commission on Resources and the Environment (CORE) process…set the stage for an attempt at bioregionalism. The land use planning process brought together all the economic, environmental, and recreational sectors to work out zones of influence and reduce resource conflicts on Crown land, which makes up the vast majority of the Kootenay landbase. The sectoral representation around the planning table was daunting. Foresters, miners, ranchers, and guide-outfitters worked out details with parks advocates, environmentalists, small business people, fishers, and trappers. Going well beyond the usual B.C. stalemate of loggers with their jobs versus environmentalists with their old growth, the process produced a number of minor revelations and unexpected points of agreement. When they finished in 1998, the scarred veterans of the plan round-table had achieved a surprising degree of consensus and were prepared to soldier on with their innovative work. Officials were stunned by this unprecedented accord, so the Kootenay-Boundary Land Use Plan was hastily buttoned up and shuffled inside the safer confines of the government ministries. (p. 87)

Ultimately land use recommendations were provided to government by CORE for the two areas in the Kootenay region, based on the advice of planning tables and on an attempt to find balance among the various interests where total agreement was not achieved. In 1995, after much behind-the-scenes lobbying and negotiating by major sectors, the BC government announced the West Kootenay-Boundary Land Use Plan and the East Kootenay Land Use Plan (Government of British Columbia, 1995a, 1995b). These play significant roles in the establishment of new protected areas, and also introduced three integrated management zones with varying emphasis on conservation and resource development. These were labelled special resource management zones (SRMZ)[63], integrated resource management zones (IRMZ), and enhanced resource development zones (ERDZ), as noted in Figure 3.5.

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[63] The commitment of government to implementing "special" management zones was called into question by the environmental community following conclusion of many of the land use planning processes in the late 1990s (Cooperman, 1998). In response government set up a working group comprised of representatives from industry sectors, the environmental community, and government agencies. This group

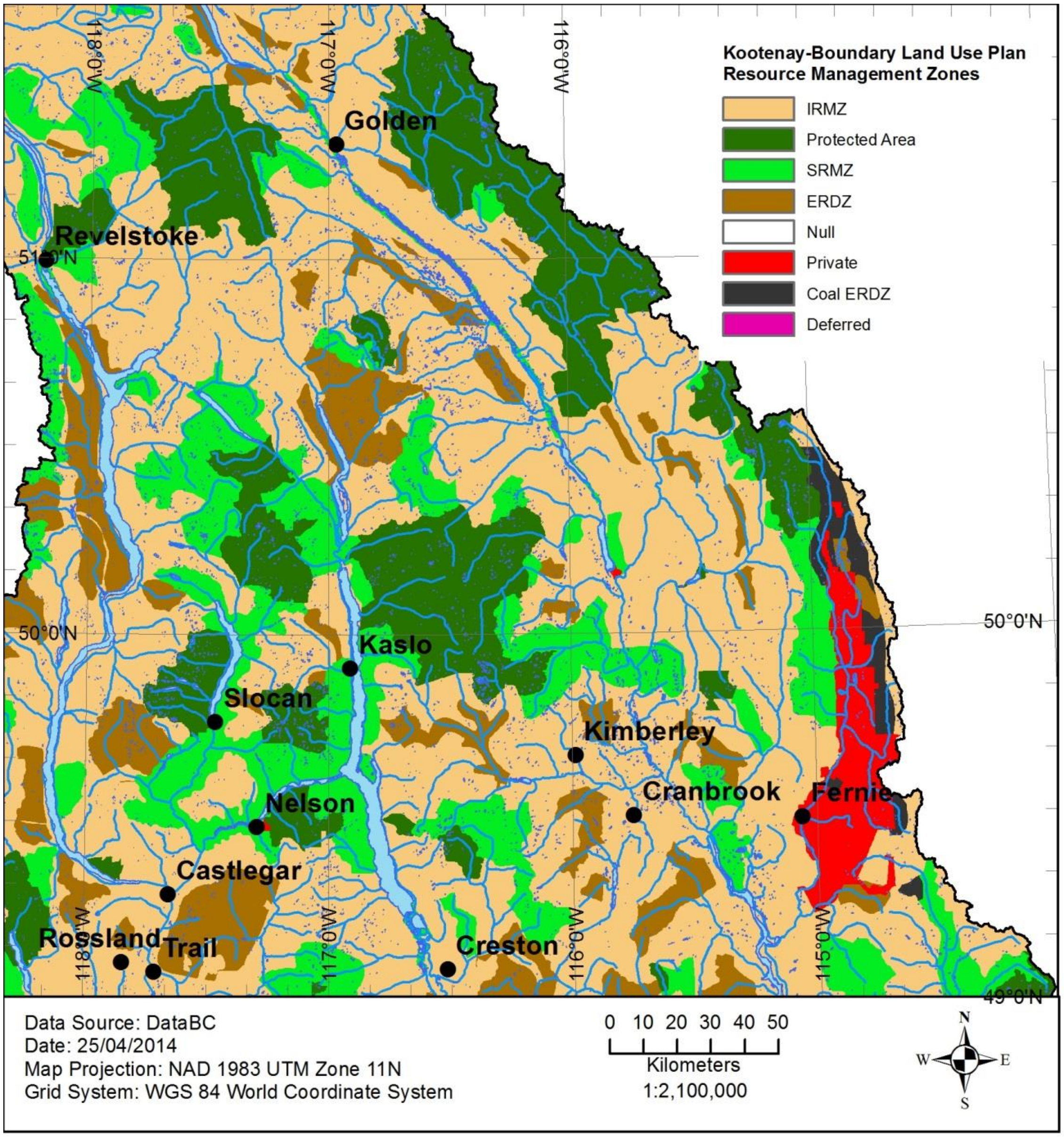

Figure 3. 5: Kootenay-Boundary Land Use Plan (1995) Resource Management Zones

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provided direction on implementing specific objectives and measures needed to meet the intent of land use plan negotiations (Province of British Columbia, 2001). In the case of the KBLUP, the designation was abandoned completely by the provincial government in favour of setting specific objectives on a landscape unit basis.

Although these zones were never formally implemented, they did provide significant direction to subsequent land use decisions. The original intent of special resource management zones was to protect “areas with high concentrations of regionally significant and sensitive resource values, such as critical fish and wildlife habitat, ecosystems that are under-represented in the region’s protected area system, important viewscapes, sensitive recreation areas and cultural heritage features” (Government of British Columbia, 1997; p. 6) while continuing to allow compatible resource development. The purpose of integrated resource management zones was “to balance environmental, economic and social benefits,” while lands designated as enhanced resource development zones were intended for “intensive resource development activities… regional economic development and community and work force stability” (Government of British Columbia, 1997; p. 7).

Specific objectives for each of these resource management categories were not included in the East and West Kootenay plans; this direction came later through the Kootenay Boundary Land Use Plan Implementation Strategy (Government of British Columbia, 1997) following further intensive consultations.

> To be overly definitive in a strategic level plan of the specific land uses/activities that can or cannot occur, or the particular resource management standards that should or should not apply, in each of these three zones is neither feasible nor desirable, given the geographic variability of resource qualities and attributes throughout the zones, and the goal to optimize opportunities for all resource values to the extent possible, within an integrated resource management philosophy. The general mapping scale and the low resolution of information separation at this broad scale makes it inappropriate to adopt specific and detailed management strategies by zone categories. Instead, the KBLUP Implementation Strategy addresses the need to present sufficiently prescriptive land and resource management guidance through regional objectives and strategies, spatially referenced resource management guidelines for individual resource values (see chapter 3), and by supplementing the regional guidance and guidelines with statements of specific objectives and strategies for individual resource values within resource management zones in the planning area (see appendices 1-7). (p. 6)

The 359-page Implementation Strategy did provide detailed strategies and guidelines for working toward broad economic, social and conservation land use objectives. However the resource management zones designated in the 1995 Kootenay-Boundary Land Use Plan and further defined in the implementation strategy were never legally implemented. These recommendations were replaced when specific elements of the land use plan were proclaimed in the Kootenay-Boundary Land Use Plan Higher Level Plan Order (HLPO) in 2000 under the Forest Practices Code Act[64]. The HLPO specified management objectives including:

- biodiversity emphasis and old and mature forest targets in designated landscape units;
- requirements for mountain caribou habitat conservation, green-up/patch, and protection of consumptive use streams;
- protection of grizzly bear habitat and connectivity corridors;
- restoration of fire-maintained ecosystems; and
- designation of visual scenic areas and enhanced timber resource development zones.

There was intense lobbying by industry interests (eg. forestry, mining, commercial recreation) and environmental interests about what the land use decision of 1995 meant. The land use zones were very broadly defined with little understanding of what they meant on the ground and how they would be implemented. Neither the 1997 implementation strategy nor the first HLPO brought in by the NDP government just prior to the 2001 provincial election resolved the lack of clarity or agreement. The forest industry had vigorously opposed the original land use plan as it impeded access to timber (P. Affleck, pers. comm.). A coalition that included the Association of Kootenay-

[64] The Kootenay Boundary 2002 Higher Level Plan Order, Kootenay-Boundary Land Use Plan Implementation Strategy, West Kootenay Land Use Plan, East Kootenay Land Use Plan, and associated variances, etc. are available at https://www.for.gov.bc.ca/tasb/slrp/plan50.html.

The 2000 version of the Higher Level Plan Order is no longer available on the government website.

Boundary Municipalities, IWA Canada, Canadian Women in Timber, the Interior Logging Association, the Interior Lumber Manufacturers Association, The Kootenay Wildlife Heritage Trust, Kootenay Livestock Association, the East Kootenay Wildlife Association, the Chamber of Mines of Eastern BC, the BC Chamber of Commerce, plus individual local politicians and business leaders, strongly advocated for the suspension of the HLPO until a socio-economic review was done[65,66,67,68]. The need for this review was supported by the Union of BC Municipalities[69]. This political backlash undoubtedly played into the 2001 election that resulted in a near sweep of BC Liberal MLAs into the legislature, including all the Kootenay ridings. Following the election, the four Kootenay area MLAs lobbied government ministers to amend the HLPO, resulting in a new plan that relaxed previous objectives protecting old and mature timber and legally established an Enhanced Timber Resource Development Zone that, among other things, relaxed green-up height standards[70]. The updated HLPO did settle some of the intense debate around KBLUP, and provided the direction needed by bureaucrats and industry to put the decisions on land use into effect. However, environmentalists then turned their attention to effecting further government actions on recovery strategies for mountain caribou, new protected areas in the Flathead Valley, protecting a wildlife corridor in the southern Canadian Rocky Mountains, opposition to the ski hill development at Jumbo

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[65] Hauka, D. Forestry rules hit hard in Kootenays. The Province, Vancouver, BC – Sept. 1, 2000

[66] Druska, K. Higher Level Plan one-sided: Coming land-use legislation for the Kootenay-Boundary region doesn't consider economic impact on forestry. The Vancouver Sun, Vancouver, BC – Sept. 6, 2000

[67] Warner, G. Local Liberal candidate blasts Land Use Plan. Daily Townsman, Cranbrook, BC – Jan. 10, 2001

[68] Warner, G. Local MLAs take aim at Land Use Plan. Daily Bulletin, Kimberly, BC – Aug. 17, 2001

[69] Kootenay-Boundary Land Use Plan: UBCM backs economic analysis. Journal of Commerce, Vancouver, BC – Sept. 27, 2000

[70] Warner, G. New higher level plan announced. Daily Bulletin, Kimberley, BC – Nov. 6, 2002

Glacier[71], and a significant park expansion in the Selkirk Mountains (Valhalla Wilderness Society, 2011).

Under the revised 2002 KBLUP HLPO, legally designated resource management zones and specific resource management objectives were then proclaimed for these zones. The effect of this was to make clear which management objectives applied to forest license operating areas. The revised HLPO:

1) delineated biodiversity emphasis assigned to landscape units;
2) defined old and mature forest targets by natural disturbance type and biogeoclimatic unit for biodiversity emphasis landscape units;
3) established forest cover targets and forest practices requirements to protect mountain caribou;
4) established green-up height standards;
5) established objectives for grizzly bear habitat and connectivity corridors;
6) established streamside management zones on streams licensed for human consumption;
7) relaxed green-up height standards in enhanced timber resource development zones;
8) prescribed ecological restoration measures in areas identified as fire-maintained ecosystems;
9) established scenic areas to conserve the quality of views from communities, major waterways and major highways; and
10) committed to a review of the HLPO in consultation with communities and forest licensees to ensure limits of the order on timber supply and costs.

Nine variances to this order have been approved to date, in order to address timber damaged by insect or fire, update ecological mapping, or manage mountain caribou conservation needs.

Subsequently, local environmentalists, led by Conservation Northwest, Wildsight, and ForestEthics, lobbied extensively for greater protection for mountain caribou based on

[71] Wildsight website. Retrieved from http://www.wildsight.ca/programs

their concern for the continued decline in populations; threatening to mount a market-based campaign similar to that which occurred on the central coast. In 2005, the provincial government convened an independent Mountain Caribou Science Team to recommend management actions which would be needed to recover populations throughout their range.[72] Ultimately the mountain caribou objective in the HLPO was replaced by the Mountain Caribou Recovery Implementation Plan (MCRIP) in 2007 based on recommendations of the Science Team.

The objectives in the KBLUP HLPO provide direction for forest and range management under the 2004 *Forest and Range Practices Act* (SBC 2002, c 69). For example, holders of major forest tenures must prepare Forest Stewardship Plans (FSP) for approval by delegated government officials. These plans must contain enforceable results and strategies to address objectives set by government, and are an important delivery mechanism intended for integrated management approaches to conservation implementation. The Forest Practices Board has conducted 23 audits of forest tenure holders operations in the Kootenay-Boundary region since 1995. These audits have found a high degree of compliance with the requirements under the *Forest and Range Practices Act* and the Kootenay-Boundary Higher Level Plan Order[73]. Subsequent to the analysis here, in August 2015 the Forest Practices Board published the results of an investigation which was highly critical of the effectiveness of Forest Stewardship Plans (Forest Practices Board, 2015). For example this investigation found, among other things, a high proportion of results and strategies in FSPs are not measurable or enforceable.

In addition to conservation outcomes resulting from the KBLUP process, a range of other land-use designations carry varied implications for ecosystem protection in the Kootenays. These include parks and protected areas, wildlife management areas,

[72] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/speciesconservation/mc/

[73] Forest Practices Board audit reports can be accessed at http://www.fpb.gov.bc.ca.

wildlife habitat areas, ungulate winter range, old growth management areas, and publicly and privately owned conservation properties.

Federal and provincial parks are generally fully reserved for wilderness preservation, ecosystem representation, and public recreation and are seen to provide a high degree of preservation for wildlife habitat. Ecological Reserves[74] are areas set aside to protect representative ecosystems and rare species of plants and animals. Resource extraction and activities considered to be incompatible with wildlife conservation are generally prohibited in parks and ecological reserves. An issue in fire disturbance-based ecosystems has been modern fire suppression, which is at odds with the non-interventionist paradigm that has predominated in parks management.

Wildlife Management Areas (WMA) are designated for the conservation and management of fish, wildlife and habitat, but other compatible land uses may be accommodated[75]. Wildlife Habitat Areas (WHA) are designated to protect critical habitats of Identified Wildlife (ie. species at risk and species designated as 'regionally important') from resource development activities[76]. Ungulate Winter Range (UWR) is designated to protect habitat necessary to meet the winter habitat conditions of an ungulate species[77].

Old Growth Management Areas (OGMA) have been spatially designated across the region to protect ecologically representative areas of natural forests with old-growth attributes (Province of British Columbia, 1995a; Province of Brtish Columbia, 1999a). OGMAs are normally identified during landscape unit planning or an operational

[74] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/bcparks/eco_reserve/

[75] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/fw/habitat/conservation-lands/wma/

[76] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html

[77] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/uwr/index.html

planning process. However in the study region, OGMAs were never legalized through a higher level plan order; rather the KBLUP HLPO legally specifies non-spatial mature and old growth retention requirements and the spatially designated OGMAs are considered to be areas recommended for conservation. Forest licensees are not required to follow direction provided by non-legal OGMAs when preparing FSPs, and may propose alternative areas that meet the requirements in the HLPO[78]. This remains a controversial topic in the region. Government and industry forest managers argue this facilitates operational efficiency and responsiveness to natural disturbance in maintaining old forest targets, while environmentalists believe this policy approach is resulting in a lack of conservation certainty and that where operational trade-offs occur these favour resource development rather than conservation objectives.

WHAs, UWR and OGMAs often prohibit resource development entirely, but can allow some limited resource development activity where this is not incompatible with their conservation objective, or the activity may actually enhance or restore ecological function (eg. commercial harvesting in NTD4).

In the Kootenays, a significant amount of privately owned land has been designated by owners for ecological conservation purposes. These conservation properties total over 115,000 hectares[79], held primarily by the Province, BC Hydro, Canadian Wildlife Service, Nature Conservancy of Canada, Teck Resources[80], The Land Conservancy, and Nature Trust. In addition, programs including the Habitat Conservation Trust

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[78] The Provincial Non-spatial Old Growth Order does not apply to the Kootenay region, this is superseded by old growth directive in the KBLUP HLPO.

[79] DataBC website. Retrieved from http://www.data.gov.bc.ca/dbc/geographic/index.page?.

[80] Recently purchased from Tembec Inc. (Teck Resources website. Retrieved from http://www.tecksustainability.com/sites/base/pages/story-detail/conserving-land-in-the-east-kootenays-109930).

Foundation[81] and Ducks Unlimited[82] expend significant funds in the region in support of fish, wildlife and ecosystem conservation, restoration and land acquisition.

This section has illustrated the complex range of competing land uses and the policies governing resource development and ecosystem conservation in the study area. These dynamics suggest that, going forward, resilient approaches to conservation must continue to reconcile tensions among land uses and take into consideration challenges inherent in shaping varied public values, attitudes and contemporary approaches to the conservation of wildlife ecosystems, while addressing the additional complexity associated with the implications and uncertainties of accelerating climate change. The following sections review in detail how conservation is implemented on the land base along with potential implications for wildlife conservation. The actual implications of climate change for wildlife ecosystems in the study area are explored in Chapter Four.

3.3 CONSERVATION DESIGNATION ANALYSIS

To further trace and critique current socio-ecological policy frameworks that impact conservation of wildlife ecosystems in the study area, spatial integration and analyses of varied data in a series of spatial maps that present the complex interplay of natural features and contemporary land use have been undertaken. The goal of this research and mapping is to assess the amount, distribution and effectiveness of conservation designations, with a focus on ecosystems generally, as well as on habitat for a number of key wide-ranging wildlife species.

3.3.1 Methodology

Spatial analyses were conducted using GIS software to review implementation of conservation designations in the Kootenays. Analyses compared designations that have been implemented through government legislation and policy or through ownership provisions that have designated lands for conservation purposes, with:

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[81] Habitat Conservation Trust Foundation website. Retrieved from www.hctf.ca.

[82] Ducks Unlimited Canada website. Retrieved from http://www.ducks.ca/national-news/2012/03/celebrating-partnerships-major-milestones/.

- recommendations from the Kootenay-Boundary Land Use Plan that were adopted by the Province in 1995,
- conservation priorities for the region established by the Nature Conservancy of Canada in the Canadian Rocky Mountains Ecoregional Assessment, and
- objectives established in the Mountain Caribou Recovery Implementation Plan and the Grizzly Bear Conservation Strategy.

Recent proposals for further conservation needs sponsored by the Valhalla Wilderness Society and by Wildsight/Conservation Northwest are also evaluated in this context.

The approach involved acquiring and overlaying data from diverse sources to assess known conservation measures being taken on public and private land. The integration of this broad range of data offers new perspectives and insights that support this study. Sources of data included spatial and contextual information from the DataBC[83] geographical data warehouse managed by the BC Ministry of Technology, Innovation and Citizens' Services, and spatial data and reports from the Canadian Rocky Mountains Ecoregional Assessment[84] (Nature Conservancy of Canada, 2004). Spatial data layers were also provided by the Yellowstone to Yukon (Y2Y) Conservation Initiative[85], the Valhalla Wilderness Society[86], and Wildsight[87]. The Mountain Caribou Recovery Science Team's Bayesian Belief Network models for mountain caribou early and late winter habitat suitability and the resultant suitability map were provided courtesy of S. Wilson (Chair, Mountain Caribou Science Team); and the Biogeoclimatic Ecosystem Classification (BEC) variant classification scheme used to model the Random Forest

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83 DataBC website. Retrieved from http://www.data.gov.bc.ca/dbc/geographic/index.page?.

84 Data provided courtesy of P. Iachetti, former Director, Conservation for the Nature Conservancy of Canada in Victoria, BC.

85 Data provided courtesy of W. Francis, Yellowstone To Yukon Conservation Initiative.

86 Data provided courtesy of C. Pettitt, Valhalla Wilderness Society.

87 Data provided courtesy of R. Nelson, Wildsight.

Model output was provided courtesy of G. Utzig. A detailed description of the data used in the analysis is listed in Appendix 2.

Analyses of spatial data were conducted using ArcMap GIS Version 10.2 software. Although spatial data were generally made available in an Albers Equal-area Conic projected coordinate system, data were re-projected as a Transvers Mercator projection (NAD 83 UTM Zone 11) prior to analysis and map presentation. Vector polygons were converted to 20, 50, 100 or 1000 metre raster grids for the purposes of the overlay analysis according to the table presented in Appendix 3. Selection of the grid resolution scale was dependent on the detail and resolution of the input data used in the analysis. Where the resolution of the input data was unknown, raster data produced from vector polygons were arbitrarily sampled and analyzed at 20 m in order to smooth class borders to minimize rounding errors during area calculations. Where an overlay map was produced as a product of maps of different grid scales, the coarsest of the datasets dictated the output grid size. Generally the mapping resolution exceeds the data resolution.

The overlay analyses were conducted using the Raster Calculator tool available in the Spatial Analyst Tools extension toolbox available in ArcMap. This assessment was conducted by spatially overlaying and comparing conservation designations to current land use, ecosystem representation (ie. biogeoclimatic ecological classification), land use objectives established in the Kootenay-Boundary Land Use Plan, habitat suitability for key species, and conservation priorities established for the region in the Canadian Rocky Mountains Ecoregional Assessment.

3.3.2 Conservation Designations in the Kootenay-Boundary Region

Given this study's focus on the amount, spatial distribution and effectiveness of conservation designations in the study area, an important first step was to establish the full range of protections that currently are in place on the land base as a result of the considerable work of government and conservation advocates over the past five decades. Spatial layers for the conservation designations that have been implemented in the region were downloaded from DataBC. These included vector polygon files for national parks, provincial parks, ecological reserves and protected areas, privately owned conservation properties, wildlife management areas, wildlife habitat areas, ungulate winter range, old growth management areas, high biodiversity emphasis landscape units, and grizzly bear connectivity corridors. The conservation overlay map is shown in Figure 3.6.

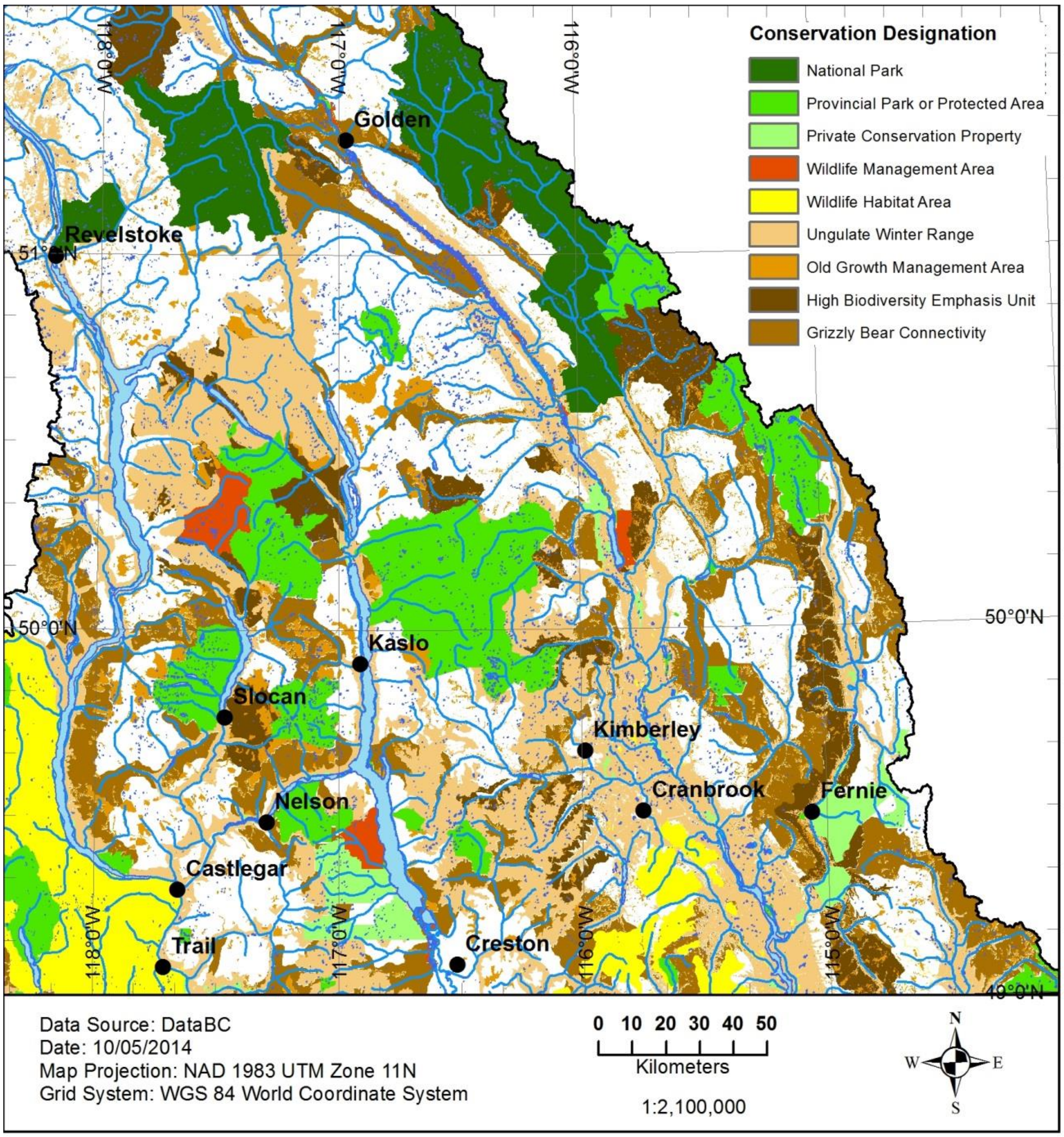


Figure 3. 6: Kootenay Region Ecological Conservation Designations

A total of 64.8% of the Kootenay region has been designated under one of the nine conservation designations considered in this analysis. The distribution of these designations is shown in Figure 3.7. The designations include:

1) parks, protected areas and ecological reserves, wildlife management areas designated under the *Wildlife Act*, and conservation properties usually owned by governments or land trusts where ecosystem preservation is the primary objective and other uses are significantly limited or prohibited;
2) designations under the *Forest and Range Practices Act* and the *Oil and Gas Activities Act* including wildlife habitat areas, ungulate winter range and old growth management areas where wildlife habitat or ecosystem diversity is the primary objective and resource development may either be prohibited or allowed under strict legal guidelines provided it is compatible or enhances conservation objectives; and
3) integrated resource management areas where resource development is permitted provided that conservation objectives established in the Kootenay-Boundary Higher Level Plan Order are met (eg. high biodiversity landscape units and grizzly bear connectivity corridors).

These nine designations have been grouped accordingly into these three categories for the purpose of the conservation overlay analysis in the next section.

In many areas, conservation designations overlap spatially for any one of a number of reasons. This most often occurs by design when policy dictates constraints that limit the impact on the timber harvesting land base from wildlife habitat areas, ungulate winter range, and old growth management areas by directing these zones to be delineated where possible into areas previously constrained by another designation. As well, many of the wildlife management areas involve private land owned by the provincial government, and so are also included in the conservation property spatial data layers available from DataBC. In the case of high biodiversity emphasis landscape units and grizzly bear connectivity corridors, overlap with other conservation designations is by

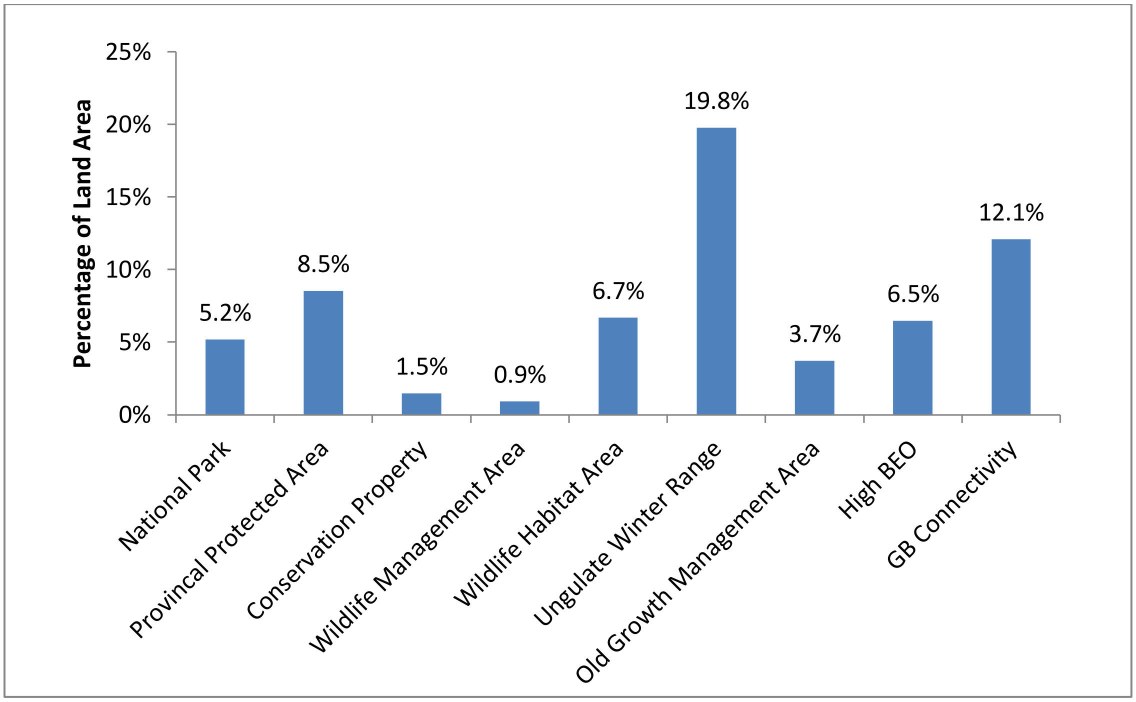


Figure 3. 7: Area (percent)of the Kootenay Region Designated for Conservation

design, as this contributes significantly to how the targets for those designations are achieved while minimizing impact on timber supply. So as to not double-count the contribution of overlapping designations for the purpose of the conservation analysis, such overlaps were resolved by attributing any overlapping portion to the designation with the highest conservation purpose. Accordingly, the following hierarchy was applied to resolving such overlaps: NP & PP > WMA > CP > WHA > UWR > OGMA > High BEO > GB CC[88]. For example, where a conservation property designation overlapped with a wildlife management area it was counted as a wildlife management area, or where an old growth management area overlaps with a wildlife habitat area it was counted as

[88] NP = national park, PP = provincial park, ecological reserve or protected area, WMA = wildlife management area, CP= conservation property, WHA = wildlife habitat area, UWR = ungulate winter range, OGMA = old growth management area, High BEO = high biodiversity emphasis landscape unit, GB CC = grizzly bear connectivity corridor.

wildlife habitat area. Table 3.1 summarizes conservation objectives, legal protection, number, and size and spatial distribution of each designation.

Prior to the Kootenay-Boundary land use plan decision in 1995, 9.1% of the region was designated as a park or protected area. The land use plan added seventeen new provincial protected areas totalling 383,182 hectares that increased this amount to approximately 13.8% of the land base (Government of British Columbia, 1997). Although a primary goal of new provincial park establishment through the Kootenay-Boundary Land Use Plan was to conserve significant and representative natural, cultural and recreational values, a variety of other uses are permitted or have been 'grand-parented' within parks (Province of British Columbia, 1999c). Park management plans have been prepared for each of the newly established parks and are available online at the BC Parks website . These management plans zone park use into a number of categories that include 'intensive recreation', 'natural environment', 'wilderness recreation', and 'wilderness conservation' areas. These designations dictate allowable uses depending on the specific objectives established for various zones in each park. The range of uses that may be allowed in an intensive recreation zone includes campground and associated facilities, mechanized access, and ski hills. Natural environment areas are zoned primarily for recreational access but with a greater emphasis on maintaining a largely undisturbed environment. Wilderness recreation and wilderness conservation zones are similar in that the objective is to protect remote undisturbed natural landscapes and provide backcountry recreation opportunities, the primary difference between the two zones is that access by aircraft is allowed in the former but not the latter. Parks Canada uses a similar zoning system for national parks, which includes 'special preservation', 'wilderness', 'natural environment', 'outdoor recreation', and 'parks services' zones.

Many provincial parks have such uses such as heli-skiing, guided mountaineering, guide-outfitting, heli-hiking, hunting and trapping permitted under British Columbia's Park Act, and occasionally have grand-parented uses such as livestock grazing or mineral tenures. Resource development such as commercial forestry or mining are generally

Table 3. 1: Purpose, Legal Protection, Size and Spatial Distribution of Conservation Designations

Designation	Conservation Purpose	Legal Protection	Number	Size Distribution (ha.)	Spatial Distribution
National Parks	• Protection of representative examples of Canada's natural landscapes	• *Canada National Parks Act*	4	Total = 429,864 Median = 132,646 Max = 138,250 Min = 26,322	• Large areas located mostly in mountainous areas in the northern 1/3 of the region
Provincial Parks & Protected Areas	• Protection of representative natural ecosystems and significant cultural features	• *Parks Act* • *Ecological Reserve Act* • *Protected Areas of British Columbia Act*	93	Total = 711,094 Median = 122 Max = 200,920 Min = < 1	• The 25 largest parks (ie. >1000 ha.) located mostly in mountainous areas in the middle of the region
Conservation Properties	• Protection of critical habitat for fish, wildlife and plants • Protection of significant cultural features	• Lands are owned by conservation trusts, federal and provincial government & Teck Resources Ltd. • Lands owned by the Canadian Wildlife Service are managed under the *Canada Wildlife Act*	57	Total = 121,676 Median = 183 Max = 54,880 Min = < 1	• Largest is the Darkwoods property (~55,000 ha.) owned by the Nature Conservancy located in the south Selkirk Mountains which was previously Managed Forest land; provides critical habitat for mountain caribou and grizzly bear • Teck Resources Ltd. recently purchased >7000 ha. in the Elk River valley to protect habitat for bighorn sheep, moose, wolverine, elk and grizzly bear • Many smaller parcels owned by Nature Conservancy of Canada, Nature Trust, Land Conservancy, Canadian Wildlife Service, and the BC Government are located in critical valley bottom riparian habitats

Wildlife Management Areas	• Wildlife sanctuaries • Critical habitat for endangered or threatened wildlife species	• *Wildlife Act*	5	Total = 75,967 Median = 14,829 Max = 14,829 Min = 6,900	• Designated in lower elevation high value critical wildlife habitats in the East and West Kootenay areas
Wildlife Habitat Areas	• Habitat necessary to meet the requirements of a species at risk or a species designated as 'Regionally Important Wildlife'	• *Forest and Range Practices Act* • *Oil and Gas Activities Act*	166	Total = 642,226 Median = 30 Max = 455,452 Min = < 1	• Primarily designations consist of smaller areas (<100 ha.) distributed across the region • Two large areas have been designated to protect grizzly bear habitat in the Grandby (~455,000 ha.) and Yahk (~93,000 ha.) areas
Ungulate Winter Range	• Habitat necessary to meet the winter requirements of a designated ungulate species	• *Forest and Range Practices Act* • *Oil and Gas Activities Act*	13	Total = 1,641,383 Median = 61,474 Max = 402,212 Min = 111	• Includes large designations in the East Kootenay and Boundary areas for deer, moose, elk, sheep, and goats (~971,000 ha.) • Further large areas designated in the West Kootenay area to protect mountain caribou as directed in the Mountain Caribou Recovery Implementation Plan (~549,000 ha.)
Old Growth Management Areas	• Areas containing or managed to attain specific structural old-growth forest attributes	• *Forest and Range Practices Act* • *Oil and Gas Activities Act*	12,511	Total = 308,352 Median = 4 Max = 8,015 Min = < 1	• Large number of small designations distributed across the region in old forested areas
High Biodiversity Landscape Units	• Areas delineated in HLPO to meet high biodiversity conservation old and mature forest targets	• Kootenay Boundary Higher Level Plan Order	35	Total = 538,065 Median = 10,925 Max = 50,488 Min = 5	• Located across the region primarily in areas which were designated as SRMZ in the KBLUP
Grizzly Bear Connectivity Corridors	• Areas delineated in the HLPO to maintain old and mature forests to provide grizzly bear habitat connectivity	• Kootenay Boundary Higher Level Plan Order	7	Total = 1,001,582 Median = 8,257 Max = 873,235 Min = 1,339	• Provides forest ecosystem connectivity across the region

prohibited in national and provincial parks; however tree removal can be permitted where required to address forest health or public safety issues, or for ecological restoration.

The region has a total of 98 national or provincial parks or protected areas, 29 of which are large (>1000 hectares) and remotely located wilderness areas. The 29 large ones are listed in Table 3.2. Park management plans, including an outline of the wildlife

Table 3. 2: List of Parks and Protected Areas Greater Than 1000 Hectares

Park Name	Park Class	Area (ha.)
Purcell Wilderness Conservancy	Provincial Park	200,920
Kootenay	National Park	138,250
Glacier	National Park	135,838
Yoho	National Park	129,454
Goat Range	Provincial Park	79,101
Height of the Rockies	Provincial Park	54,162
Valhalla	Provincial Park	49,828
Granby	Provincial Park	41,169
Gladstone	Provincial Park	39,501
Mount Assiniboine	Provincial Park	39,037
Kokanee Glacier	Provincial Park	31,905
Mount Revelstoke	National Park	26,322
Hamber	Provincial Park	25,135
West Arm	Provincial Park	25,088
Cummins Lakes	Provincial Park	21,827
Elk Lakes	Provincial Park	18,012
Bugaboo	Provincial Park	13,817
Kianuko	Provincial Park	11,658
Akamina-Kishinena	Provincial Park	10,752
St. Mary's	Provincial Park	9,327
Top of the World	Provincial Park	8,746
Syringa	Provincial Park	4,447
Lockhart Creek	Provincial Park	3,734
Gilnockie	Provincial Park	2,815
Goosegrass Creek	Ecological Reserve	2,701
Whiteswan Lake	Provincial Park	2,371
Purcell Wilderness Conservancy Corridor	Protected Area	2,036
Champion Lakes	Provincial Park	1,453
Stagleap	Provincial Park	1,203

ecosystem values, are available on the respective national and provincial parks websites[89,90].

The 57 conservation properties included in this analysis are held by a range of owners, including the Province, BC Hydro, Canadian Wildlife Service, Nature Conservancy of Canada, Teck Resources Ltd., The Land Conservancy, and Nature Trust. These fee-simple private lands are generally dedicated to conservation purposes and are primarily located in valley bottoms in the Rocky Mountain Trench, the Elk Valley, and on the Pend d'Oreille River. Conservation properties considered in this analysis range in size from < 1 hectare to a couple of large properties which are well over 10,000 hectares, with the majority being in the range between 100 to 1000 hectares (Figure 3.8).

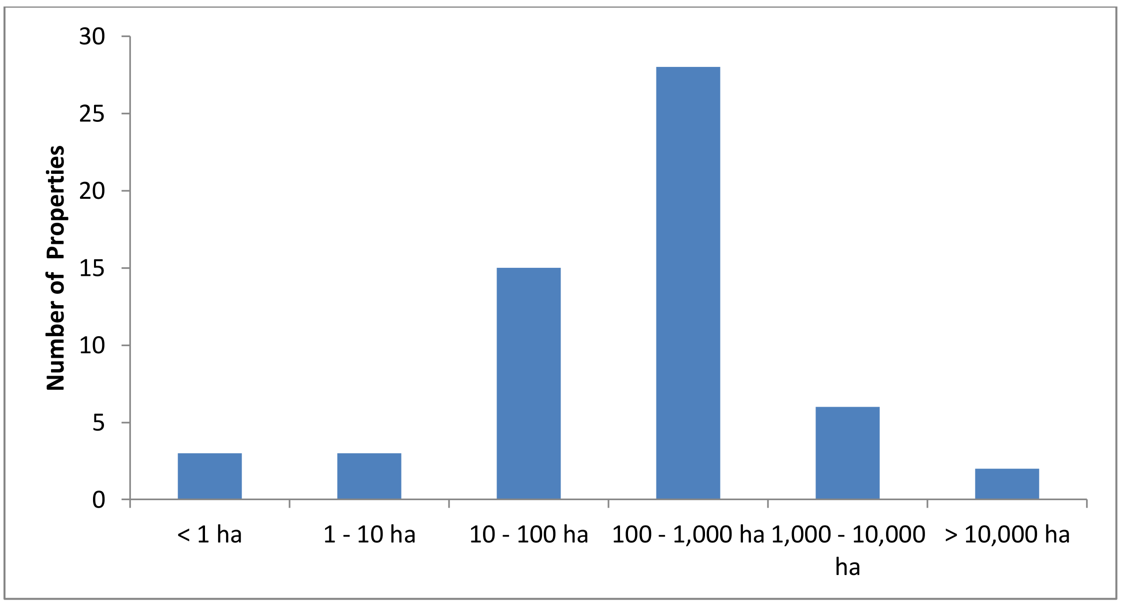


Figure 3. 8: Conservation Property Size Distribution

The Darkwoods property, located in the south Selkirk Mountains, which was previously privately-owned ‘Managed Forest’ land was purchased in 2008 by the Nature Conservancy since the area is considered to provide critical habitat for mountain

89 Parks Canada website. Retrieved from http://www.pc.gc.ca/eng/index.aspx.

90 BC Parks website. Retrieved from http://www.env.gov.bc.ca/bcparks/.

caribou, grizzly bear, wolves, cougars, lynx and moose. It is 55,000 hectares in size. More recently, in 2013, the large mining corporation, Teck Resources Ltd., purchased >7,000 ha. in the Elk River and Flathead River valleys to protect habitat for bighorn sheep, moose, wolverine, elk and grizzly bear. This company is working with the Nature Conservancy of Canada that owns ~ 8,900 hectares in the same area to coordinate conservation objectives. Many other smaller parcels owned by Nature Conservancy of Canada, Nature Trust, Land Conservancy, Canadian Wildlife Service, or the BC Government are located in critical valley bottom riparian habitats and wildlife corridor areas.

Five Wildlife Management Areas (WMA) have been designated[91], primarily in high value critical wildlife habitat including:

- the 16,969 hectare waterfowl wetland in the Columbia Valley;
- the 6,886 hectare Columbia Lake WMA protecting critical habitat for bighorn sheep and other ungulates;
- the 7,000 hectare Creston Valley Wildlife Management Area;
- the 14,757 hectare Midge Creek WMA considered to have critical habitat for mountain caribou, bears and other species located on the west shore of Kootenay Lake; and
- Hamling Lakes which protects 30,572 hectares of core mountain caribou habitat.

One hundred and ninety-one Wildlife Habitat Areas (WHA) have been designated on over 540,596 hectares[92], including two large WHAs that are 535,586 hectares in size for grizzly bear conservation. WHAs are designated to protect critical habitat elements for rare and endangered species and identified regionally important wildlife. Most of WHAs

[91] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/fw/habitat/conservation-lands/wma/.

[92] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/iwms/wha.html.

are quite small areas (see Figure 3.9) designed to protect critical habitat for a number of rare and endangered species, including badger, flammulated owls, Lewis's woodpecker, long-billed curlew, mountain caribou, Rocky Mountain tailed frog, western screech owl, Williamson's sapsucker, Gillette's checkerspot, the Douglas-fir/snowberry/balsamroot ecosystem, the ponderosa pine/black cottonwood/ snowberry ecosystem, and the antelope-brush/bluebunch wheatgrass ecosystem. A number of WHAs have been put in place to protect rare species considered to be 'data sensitive'. While these are spatially identified on maps, the species and the required general wildlife measure are not

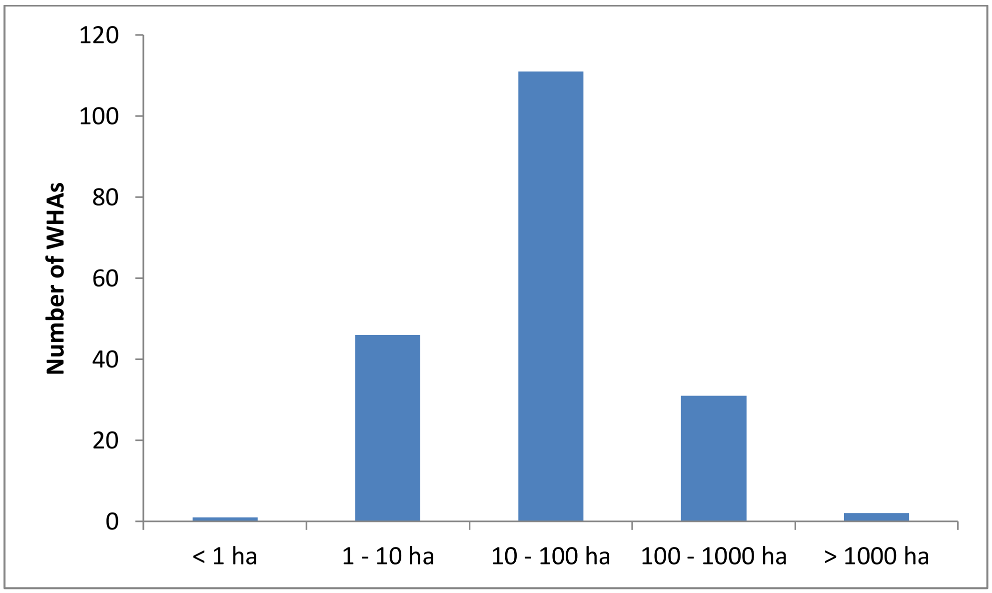


Figure 3. 9: Wildlife Habitat Area Size Distribution

publicly identified on the Ministry of Environment website due to concerns about the sensitivity of the species. Nonetheless, it is attendant on forest and range tenure holders who will have confidential access to the information to comply with the requirements of the general wildlife measure. Such measures are species- and location-specific, and prescribe a range of restrictions on forest and range practices necessary to protect the species. These restrictions range from prohibitions on forestry activities such as no timber harvesting or road building, to specific management prescriptions such as encouraging silviculture prescriptions that would optimize forage conditions or restricting road construction to maximize security cover. Prescriptions might also utilize timber harvesting as an ecological restoration tool, for example reducing stocking densities in Natural Disturbance Type 4. Often smaller WHAs consist of core patches of critical habitat where resource development is not allowed, surrounded by buffer areas that restrict development activities to uses compatible with protecting the habitat core. A further 101 WHAs are currently in the proposal stage totalling 8,559.2 hectares in size concentrated mainly in the Boundary area and the Flathead River valley (P. Holmes, pers. comm.).

Ungulate winter range (UWR) has been designated to protect habitat that is necessary to meet the winter requirements of an ungulate species[93]. In the Kootenay region a significant proportion of UWR (978,573 hectares) was designated to protect habitat as part of the Mountain Caribou Recovery Implementation Plan. General wildlife measures prescribed for caribou UWR generally restricts most timber harvesting and road construction, although mineral exploration activities and guided adventure tourism are generally exempt[94] (Table 3.3). Other UWR has been designated to protect a range

Table 3. 3: Designated Ungulate Winter Ranges in the Kootenay Region

UWR #	Species	Area (ha.)
U-4-001	Elk, Mule Deer, White-tailed Deer and Moose	277,387
U-4-006	White-tailed Deer, Mule Deer, Moose, Elk, Bighorn Sheep, Mountain Goat	402,212
U-4-008	White-tailed Deer, Mule Deer, Moose, Elk, Bighorn Sheep, Mountain Goat	217,379
U-4-010	Mountain Caribou	30,760
U-4-012	Mountain Caribou	61,474
U-4-013	Mountain Caribou	212,953
U-4-014	Mountain Caribou	276,944

[93] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/frpa/uwr/index.html.

[94] See UWR Orders U-4-010, U-4-012, U-4-013, U-4-014, and U-4-015.

of important species (1,115,983 hectares) including moose, white-tailed deer, mule deer, elk, bighorn sheep, and mountain goats. General wildlife measures for these designations generally prescribe minimum forest cover and age requirements necessary to provide sufficient winter forage and security habitat . Mineral exploration and development activities are exempt from these measures.

There have been 12,511 Old Growth Management Areas (OGMA) delineated in Kootenay-Boundary Region. Most OGMAs are quite small in size (ie. 71% are less than 10 hectares), however most of the area is in OGMAs greater than 100 hectares (ie. 34% of the OGMA area is in 431 OGMAs between 100 to 1,000 ha., while 28% of the area is in 37 OGMAs greater than 1,000 ha.) (Figure 3.10). A review of several of the major

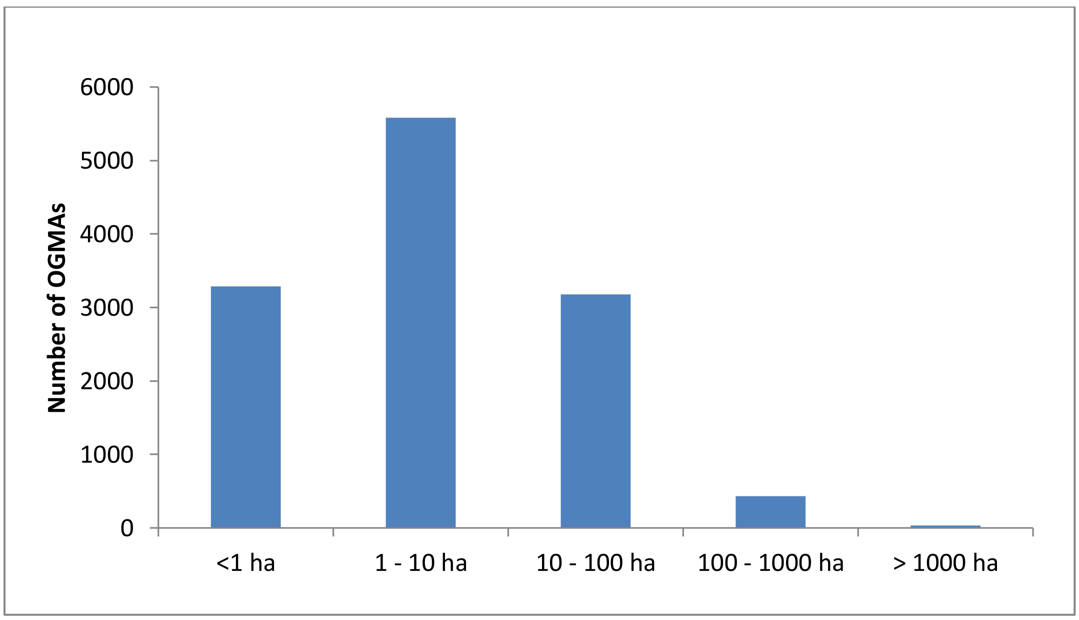


Figure 3. 10: Old Growth Management Area Size Distribution

forest licensees' Forest Stewardship Plans in the region (eg. Tolko Industries , Kalesnikoff Lumber , Downie Street Sawmills , Slocan Integral Forestry Cooperative , and BC Timber Sales) suggests that the non-legal spatially designated OGMAs are largely applied to meet the old growth requirements designated in the HLPO.

Grizzly bear habitat is protected through the KBLUP HLPO in designated 'Grizzly Bear Habitat and Connectivity Corridors' that maintain mature and/or old forests adjacent to such grizzly habitat features as avalanche tracks and denning sites. Although the fine-scale habitat features have not been spatially designated in the HPLO, the connectivity corridors themselves were legally designated on 12.1% of the land base (6.3% AT, 58.0% ESSF, 32.5% ICH, 3.1% IDF, 0.5% PP). This objective establishes a legal requirement for forest development activities. A detailed analysis of how this is effected on the ground would require an analysis of every Forest Stewardship Plan in the region and associated Site Plans. This has not been done.

The KBLUP HLPO defined both mature and old growth retention requirements for landscape units that were spatially designated in the order with high, intermediate and low Biodiversity Emphasis Options (BEO). Only landscape units designated with high biodiversity emphasis were evaluated as a significant contribution to conservation in this analysis. The following table[95] shows the mature and old growth retention targets for high biodiversity landscape units as a percentage of forest area within the biogeoclimatic unit of each landscape unit (Table 3.4). High BEO was designated on an incremental 6.5% of the land base. [Note: High BEO in KBLUP = 1,122,741 hectares or 13.6% compared to the 10% target in the Biodiversity Guidebook (Province of British Columbia, 1995a), however when accounting for overlaps the percentage is 6.5%].

The *Biodiversity Guidebook* defines low BEO as areas in which other "social and economic demands, such as timber supply, are the primary management objective… [although] the pattern of natural biodiversity will be significantly altered, and the risk of some native species will be relatively high" (p. 7). It notes that intermediate BEO is defined as "a trade-off between biodiversity conservation and timber production" (p. 7); and high BEO "gives a higher priority to biodiversity conservation…where biodiversity conservation is a high management priority" (p. 8).

[95] From the Kootenay-Boundary Higher Level Plan Order.

Table 3. 4: Mature and Old Growth Targets in High BEO Landscape Units in the Kootenay-Boundary Higher Level Plan Order (from KBHLPO, 2002)

	Seral Stage	
Biogeoclimatic Unit	**Mature + Old**	**Old**
NDT 1		
ICH	>51	>19
ESSF	>54	>28
NDT 2		
ICH	>46	>13
ESSF	>42	>13
NDT3		
MS	>39	>21
ESSF	>34	>21
ICH	>34	>21
NDT 4		
ICH	>51	>19
IDF	>51	>19
PP	>51	>19

As noted in Figure 3.3 (Section 3.2), road density and forest harvesting areas were used to assess the degree of development impact on each of the conservation designations. Average road density was calculated using a spatial join overlay of the conservation designation map layers with the DataBC Digital Road Atlas. Similarly the forest harvest area for each conservation designation was calculated using an intersect overlay of the designation layers with the Forest Tenure Administration layer. The results are shown in Table 3.5. Not unexpectedly, protected areas including parks, conservation properties and wildlife management area designations are negligibly impacted by roads and forestry development, whereas many of the other integrated management type conservation designations can have significant impacts from one or both activities.

Table 3. 5: Average Road Density and Total Area of Forest Harvesting in Conservation Designations

Conservation Designation	Size (hectares)	Road Density (metres/ hectare)	Area of Forest Harvested (hectares)	% of Designation Harvested
National Parks	429,864	0.00	3	0.0%
Provincial Parks & Protected Areas	711,094	0.07	1007	0.1%
Conservation Properties	121,676	1.55	497	0.4%
Wildlife Management Areas	75,967	0.03	450	0.6%
Wildlife Habitat Areas	642,226	0.93	113,929	17.7%
Ungulate Winter Range	1,641,383	27.58	134,375	8.2%
Old Growth Management Areas	308,352	10.98	11,367	3.7%
High Biodiversity Landscape Units	538,065	0.06	26,311	4.9%
Grizzly Bear Connectivity Corridors	1,001,582	0.01	100,290.2	10.0%

For WHAs and UWR, it is useful to compare how such impacts are distributed for specific species as shown in Table 3.6. There has been a significant amount of forest harvesting

Table 3. 6: Area of Forest Harvesting in Specific Wildlife Habitat Areas and Ungulate Winter Range

	Area Harvested (ha.)	Total Area (ha.)	% Harvested	% of Total Designation
Grizzly Bear WHA	113,385	553,292	20.5%	98.8%
All Other WHA	544	6,619	8.2%	1.2%
Mountain Caribou UWR	12,828	704,920	1.8%	42.5%
All Other UWR	121,547	953,106	12.8%	57.5%

(20.5%) within the two large WHAs established for grizzly bear conservation in the Boundary and southern Purcell areas. These comprise 98.8% of the WHAs in the region. Only 8.2% of the remaining WHAs have been harvested in the past 30 years. Approximately two-fifths of UWR in the region was designated to meet the objectives of the Mountain Caribou Recovery Implementation Plan, located in relatively undisturbed areas (1.8% harvested) consistent with the restrictive General Wildlife Measures that have been implemented. Large areas of UWR designated to conserve winter foraging habitat for elk, sheep and deer allow and even encourage forest harvesting creating the disturbance needed to restore foraging potential in the absence of natural wildfires.

There is a relatively minor forest harvest component in OGMAs, yet road density is relatively high at 10.98 m/ha. This should be considered consistent with these being relatively small areas located within forest operating areas to conserve old growth forests. High Biodiversity Landscape Units and Grizzly Bear Conservation Corridors are both so-called 'integrated management' zones and have forest harvesting impacts (ie. 4.9% and 10.0%, respectively), but interestingly have minimal road development impacts (ie. 0.06 m/ha. and 0.01 m/ha, respectively).

3.3.3 Ecological Representation within Conservation Designations

The numerous conservation designations across the study area offer protection to a range of ecosystem features. In order to assess the ecological representation within various conservation designations, the spatial raster layer for each of the nine conservation designations was overlaid with the Biogeoclimatic Ecosystem Classification (BEC) variants for the region to calculate the area of BEC variants in each conservation designation. The BEC variants downloaded from DataBC were reclassified using the classification scheme used by G. Utzig (Utzig, 2012) as outlined in detail in Chapter Four. The results are presented in Table 3.7.

National parks comprise 5.2% of the land base, primarily situated in alpine tundra (22.1%) and ESSF (69.5%) biogeoclimatic zones. Provincial parks have been designated on 8.5% of the land base, 31.0% of which is located in alpine tundra, 51.7% in ESSF, 16.7% in the ICH. Although an important goal of the Protected Area Strategy was ecosystem representation (Province of British Columbia, 1993a), this goal was not fully achieved (Figure 3.11). The Moist ESSF, Moist ICH and Dry IDF are particularly under-represented in parks and protected areas. Private conservation properties, which comprise only 1.5% of the land base, are more evenly distributed across biogeoclimatic zones (eg. 5.3% located in alpine tundra, 62.2% in the ESSF, 23.9% ICH, 8.3% IDF, and

Table 3. 7: Conservation Ecosystem Representation in the Kootenay-Boundary Region – Area (hectares) of BEC Variant in Each Conservation Designation)

	National Park	Provincial Protected Area	Conservation Property	Wildlife Management Area	Wildlife Habitat Area	Ungulate Winter Range	Old Growth Management Area	High Biodiversity Emphasis Units	Grizzly Bear Connectivity Corridors	Area Conserved in BEC Variant	% BEC Variant Conserved
AT	94,413	219,059	6,422	1,319	8,889	105,441	28,662	102,296	63,324	629,824	57.7%
Wet ESSF	37,546	6	0	0	0	71,619	8,881	17,652	4	135,708	33.2%
Moist ESSF	60,613	215,448	50,843	27,269	94,798	349,550	112,449	125,328	236,836	1,273,134	65.2%
Dry ESSF	147,409	143,723	14,682	2,158	84,586	65,492	52,109	138,471	229,192	877,823	67.4%
V Dry ESSF	51,946	5,822	7,580	3,558	51,990	251,036	23,740	30,338	113,690	539,698	77.7%
Wet ICH	31,175	5,168	-	3,870	7	94,209	19,440	25,191	19,152	198,211	45.7%
Moist ICH	4,519	95,564	20,843	13,960	182,795	185,440	50,344	59,630	249,978	863,073	65.4%
Dry ICH	-	17,000	6,070	5,882	110,326	135,697	6,909	1,107	46,142	329,133	71.7%
V Dry ICH	-	17	2,060	6,057	1,421	4,337	1,686	-	4,997	20,574	42.7%
Dry IDF	523	3,522	10,094	11,728	15,801	309,537	2,882	34,285	31,352	419,723	89.0%
PP	-	519	2,856	-	1,975	62,491	25	888	4,516	73,271	85.3%
TOTAL	428,144	705,848	121,449	75,800	552,588	1,634,849	307,126	535,186	999,181	5,360,170	64.8%

AT = Alpine Tundra

ESSF = Englemann Spruce – Subalpine Fir

ICH = Interior Cedar Hemlock

IDF = Interior Douglas Fir

PP = Ponderosa Pine

2.4% PP). Wildlife Management Areas designated under the Wildlife Act comprise only 0.9% of the land base, and are primarily located in the ESSF (43.5%), the ICH (39.3%), and the IDF (15.5%).

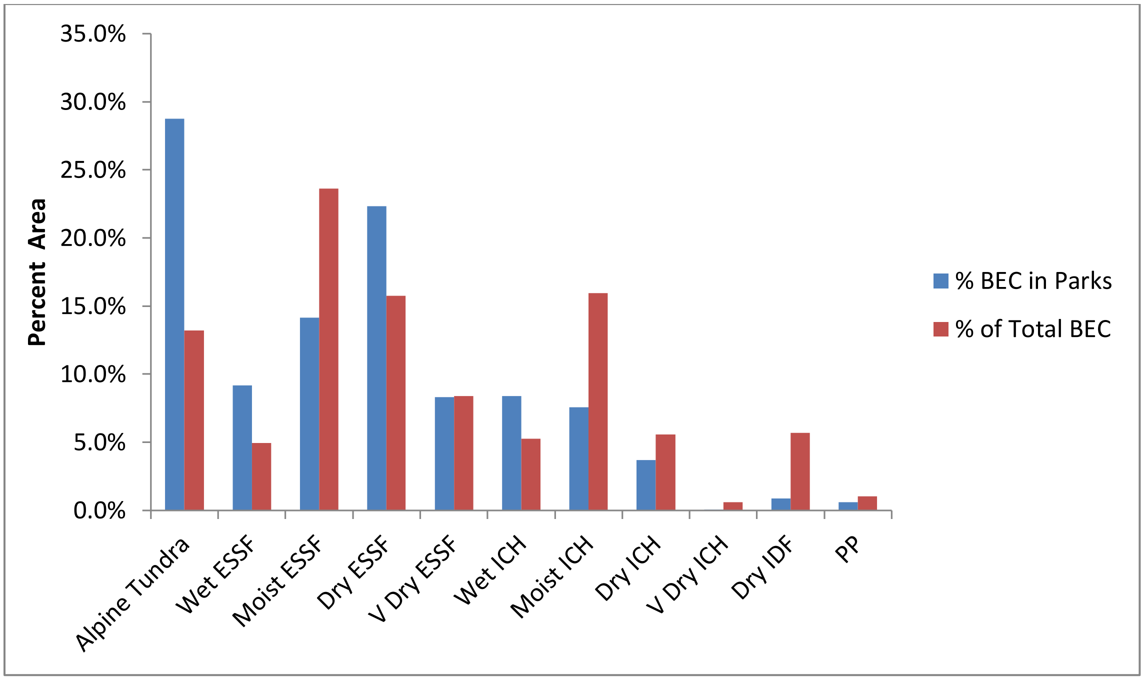


Figure 3. 11: Ecosystem Representation – showing the percent area of Parks compared to the percent area of the Kootenay Region in each Biogeoclimatic Ecosystem Classification

Wildlife conservation designations under FRPA (eg. WHAs, UWR and OGMAs) are located in:

- Alpine Tundra (AT): 5.7%
- the Englemann Spruce – Subalpine Fir (ESSF): 46.8%
- the Interior Cedar Hemlock (ICH) : 31.8%
- the Interior Douglas Fir (IDF): 13.2%, and
- the Ponderosa Pine (PP): 2.6%.

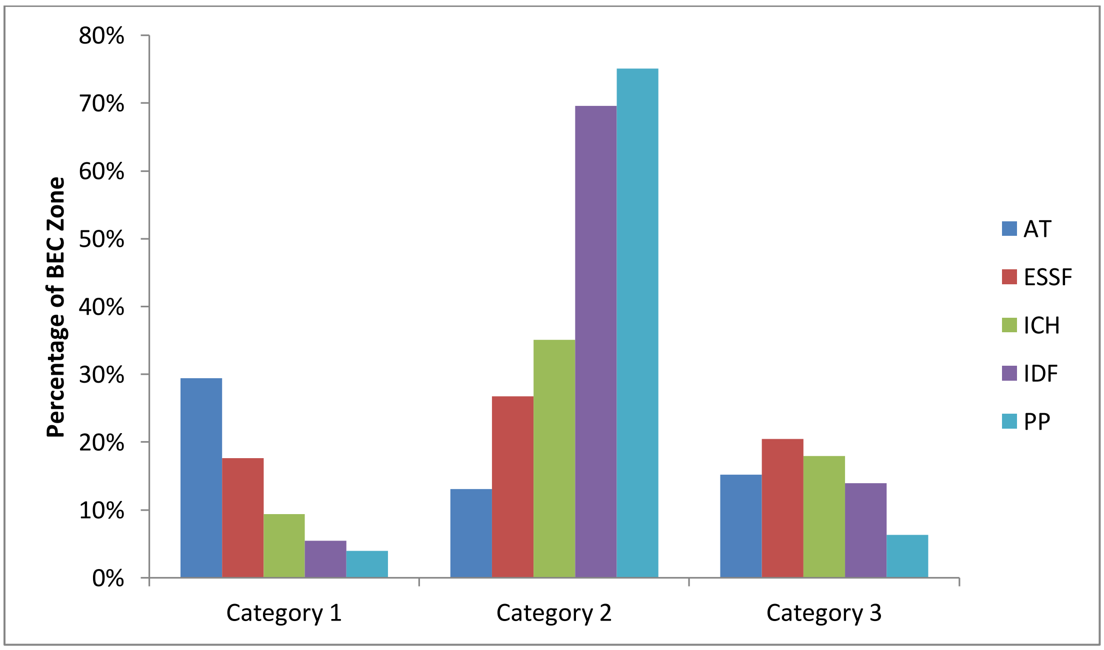
The distribution of FRPA designations better represent the amount and distribution of biogeoclimatic zones across the Kootenay region.

To illustrate the significance of conservation designation patterns on the landscape, the data has been simplified by grouping the nine categories of conservation designations into three categories. Category 1 designations are those where the primary objective is conservation, and other extractive uses are excluded. Category 1 includes parks, protected areas, conservation properties, and wildlife management areas. Category 2 designations are areas in which the primary objective is conservation although some extractive uses are allowed where conservation objectives can be met; these include wildlife habitat areas, ungulate winter range, and old growth management areas. Category 3 areas include landscape units designated as high biodiversity emphasis and grizzly bear connectivity corridors but allow industrial use with a strong legally-mandated emphasis on management practices that conserve and perhaps even restore conservation objectives.

The International Union for Conservation of Nature (IUCN) published guidelines for applying management categories to protected areas (Dudley, 2008). This categorization encompasses a diverse array of areas established around the world, from areas totally protected and that fully prohibit human interactions, to protected areas that include 'traditional' human cultural landscapes which affect high biodiversity.

Table 3.8 outlines IUCN conservation categories and compares these with conservation designations in British Columbia. For the purposes of this analysis, Category 1 conservation areas in the Kootenay region are argued to broadly equate to the IUCN Categories Ib or II, while Category 2 conservation areas mostly equate to IUCN Categories IV or VI. Areas within Category 3 in this analysis would not be considered to be 'protected areas' under the IUCN guidelines.

Figure 3.12 shows how each of these three conservation categories are represented ecologically. Category 1 comprises 16.1% of the region, Category 2 equals 30.2%, and Category 3 includes a further 18.6%. A common criticism is that areas protected consist of an over-representation of "rock and ice" while productive critical habitats located at lower elevation are under-represented. Indeed, 81.9% of Category 1 conservation areas are located at elevations > 1000 metres in either AT (24.1%) or ESSF (57.7%) biogeoclimatic zones. Only 18.1% of Category 1 conservation designations are located in the lower elevation zones (ie. ICH = 15.9%, IDF = 1.9%, and PP= 0.3%). Although Conservation Properties and Wildlife Management Areas represent a small proportion of Category 1 areas, they complement parks and protected areas in this category by being primarily located in low elevation areas providing critical habitat for migratory



Category 1 = NP, PP, CP & WMA
Category 2 = WHA, UWR & OGMA
Category 3 = High BEO & GB Connectivity Corridors

Figure 3. 12: Percentage of Biogeoclimatic Zones Designated as a Conservation Category

birds in valley-bottom riparian sites and other habitat critical for other species. However Category 2 and Category 3 conservation designations generally have more ecologically and elevationally representative distributions. Indeed many of the BEC zones at lower elevations are especially well represented by Category 2 conservation designations (eg. AT = 5.7%, ESSF = 46.8%, ICH = 31.8%, IDF = 13.2% and PP = 2.4%).

Table 3. 8: Comparison of Conservation Designations in British Columbia With IUCN Guidelines for Protected Areas Management Categories

IUCN Category	IUCN Category Description	Conservation Designations in British Columbia
Ia: Strict Nature Preserve	• Strictly protected areas to protect biodiversity or geological features • Human influenced strictly limited to protect conservation values	• Ecological Reserve
Ib: Wilderness Area	• Large unmodified areas without significant human habitation managed to protect natural conditions	• Backcountry area of many national and provincial parks
II: National Park	• Large natural areas to protect ecosystems and conserve species • Compatible scientific or recreational opportunities are permitted	• Most national and larger provincial parks
III: Natural Monument or Feature	• Small area to protect a site specific biological or geological feature	• Many smaller provincial and regional parks
IV: Habitat/Species Management Area	• Area established to protect species or habitats • Interventions reflect the species or habitat management objectives	• Wildlife Management Areas • Conservation lands owned by federal/provincial governments and conservation land trusts • Wildlife Habitat Areas and Ungulate Winter Range established with General Wildlife Measures which prohibit or significantly restrict resource development • Legally established Old Growth Management Areas
V: Protected Landscape or Seascape	• A protected area where human cultural interactions with nature resulted in significant ecological and cultural values	• Unknown
VI: Protected Area With Sustainable Use of Natural Resources	• A protected area where sustainable, non-industrial use of natural resources compatible with nature conservation is allowed	• Wildlife Habitat Areas and Ungulate Winter Range established with General Wildlife Measures which prescribe compatible resource use [however these areas may include industrial use such as timber harvest or road development where compatible with conservation objectives]

The predominant land use classifications in each of the conservation categories were evaluated by overlaying the reclassified Baseline Thematic Map with conservation designation layers. The results are shown in Figure 3.13 which shows the relative portion of each conservation category by land use type. Importantly a total of 69.6% of lands classified as remaining old forests are found in the three conservation categories (Cat. 1 = 18.9%, Cat. 2 = 35.0% & Cat. 3 = 15.7%). While Category 1 areas are significantly comprised of alpine and sub-alpine habitats and other barren areas as well as areas of both old and young forest types, both Category 2 and 3 areas are primarily forested including old, young and recently disturbed forests. Although areas classified as rangeland comprise only a small fraction of land use, 91.2% of have been designated in a conservation category, primarily as ungulate winter range.

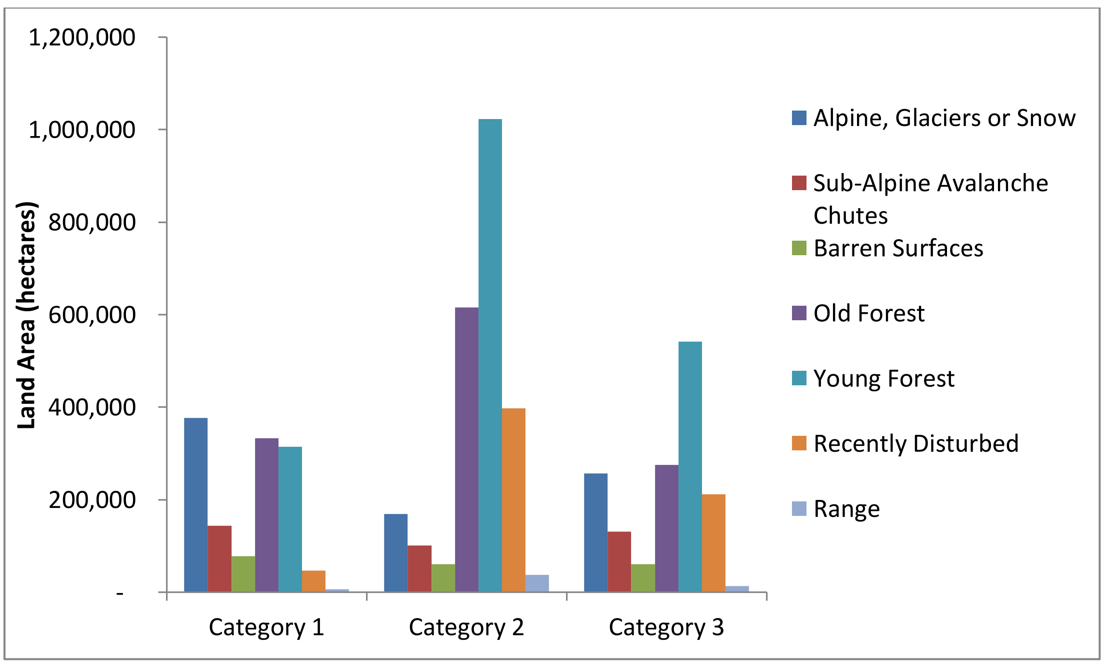


Figure 3. 13: Area (hectares) of Designated Conservation Categories in a Land Use Type

Figure 3.14 shows vegetative cover condition of forested BEC zones. Areas that have been recently disturbed included those that have been clearcut logged (70.3%), selectively logged (22.0%), and burned (7.7%). Young forest types predominate in lower

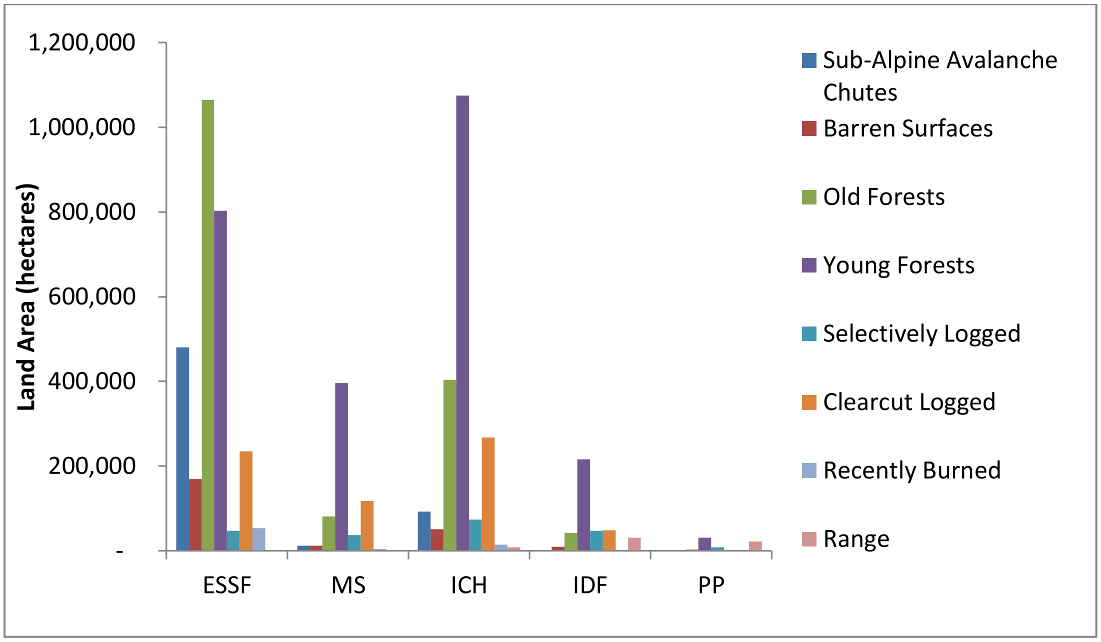


Figure 3. 14: Area (hectares) of Vegetation Cover Condition in Forested Biogeoclimatic Zones

elevation zones, resulting from historical fires and logging practices, whereas recent forest cover disturbance in the region is dominated by clearcut logging. Natural disturbance through wildfires has been suppressed through modern wildfire management programs since the 1950s. Young and recently disturbed forests comprise approximately one-quarter of Category 1 conservation areas, but over half of both Categories 2 and 3. Much of the remaining old growth forests are in the ESSF zone (66.8%) and the ICH (25.3%). As shown in Figure 3.14, the distribution of old forests is primarily in the ESSF, with young forests predominating the MS, ICH, IDF and the PP biogeoclimatic zones.

Each of the conservation designation elements needs to be considered as an important element contributing to habitat function and connectivity. Fully protected areas (ie. Category 1 designations) are not well distributed across lower elevation productive ecosystem types. Designations under FRPA (ie. Category 2) better represent such ecosystems, but significant portions of these areas have been recently disturbed primarily through logging practices and will require time to recover more natural ecosystem structure and function. Ungulate winter range especially provides a substantial area to the conservation land base, and provides critical connectivity between isolated Category 1 designations. Wildlife habitat areas tend to be a fine-filter approach focussed on protecting critical habitat for species at risk. The large new WHAs that have been designated in the Granby and southern Purcell areas are an exception in that they employ a coarse-filter approach to providing habitat for grizzly bears in an integrated management approach. Old Growth Management Areas were never legally designated as spatial entities under the land use plan, and their ongoing protection relies on their incorporation in forest licensees' Forest Stewardship Plans. Similarly, Category 3 designations that have been implemented under the authority of the Higher Level Plan Order and cover a substantial area of land are implemented through FSPs. The efficacy of these areas in providing a contribution to wildlife ecosystems, or the extent to which they meet the intended objectives in the land use plan needs to be evaluated. This was beyond the scope of this project. The provincial Forest and Range Evaluation program has not begun to evaluate the effectiveness of landscape biodiversity since this program was initiated in 2004[96], despite this being a primary deliverable under the results-based FRPA legislation, and despite criticism from the Forest Practices Board that suggested poor implementation of biodiversity measures at the landscape scale (Forest Practices Board, 2004; 2012).

3.3.4 Conservation Evaluation

As a method of evaluation the conservation designation framework being implemented through the Protected Areas Strategy, the Kootenay-Boundary Higher

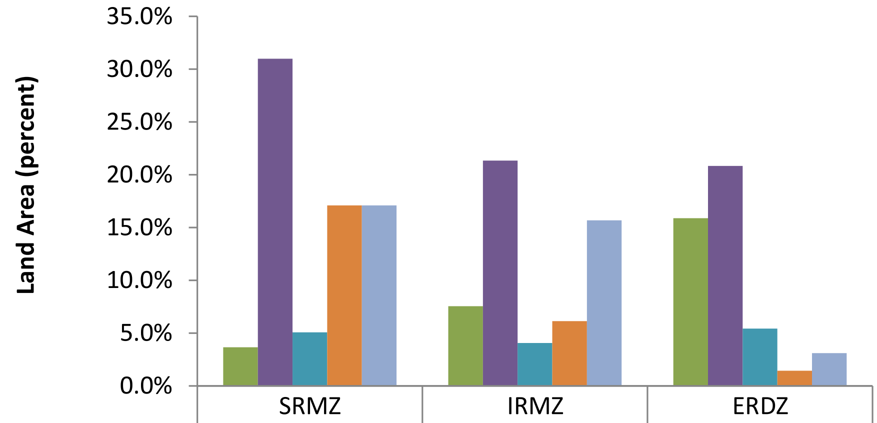
[96] Ministry of Forests, Lands and Natural Resource Operations website. Retrieved from http://www.for.gov.bc.ca/hfp/frep/.

Level Plan Order, and the *Forest and Range Practices Act* was compared to 1) the Kootenay-Boundary Land Use Plan that was approved by the provincial Cabinet in 1995, 2) conservation priorities recommended by the detailed conservation analysis in the Canadian Rocky Mountains Ecoregional Assessment in 2004, 3) the Mountain Caribou Recovery Implementation Plan, 4) conservation of wildlife habitat for selected wide-ranging carnivore species, 5) the Grizzly Bear Conservation Strategy, and finally 6) two new conservation proposals now being advocated by environmental groups in the region (eg. Wildsight and Valhalla Wilderness Society).

3.3.4.1 Kootenay-Boundary Land Use Plan

The 1995 Kootenay Boundary Land Use Plan (KBLUP) incorporated the results of intense community dialogue through the East and West Kootenay land use planning tables in the early 1990s. The land use zones in KBLUP were never officially implemented through legal designation. Nevertheless these guided ongoing planning that resulted in the Higher Level Plan Order implemented in 2000 that was subsequently revised in 2002. Given the extent of community and stakeholder input into this process, the extent to which this plan was actually implemented through designations on the ground was assessed through spatial overlay with the conservation designation layers using ArcMap.

A significant percentage of the land use zones designated under KBLUP were subsequently designated in a conservation category; 73.9% of SRMZ, 54.7% of IRMZ, and 46.6% of ERDZ were subsequently designated for conservation purposes under FRPA (ie. through WHAs, UWR or OGMAs) or the HLPO (ie. High BEO or Grizzly Bear Conservation Corridors) as shown in Figure 3.15.



	SRMZ	IRMZ	ERDZ
Wildlife Habitat Area	3.7%	7.5%	15.9%
Ungulate Winter Range	31.0%	21.3%	20.8%
Old Growth Management Area	5.1%	4.0%	5.4%
High BEO	17.1%	6.1%	1.4%
GB Connectivity Corridor	17.1%	15.7%	3.1%

Figure 3. 15: Area (percent) of KBLUP Land Use Zones in a Conservation Designation

Figure 3.16 shows those areas identified in the Kootenay Boundary Land Use Plan as SMRZ (ie. 20.1%) that were not effected under any conservation designation. Although the full target for special management zones designation under KBLUP was not fully achieved, it is argued here that this is offset at least partially by the significant conservation designations implemented within the integrated and enhanced resource development zones. This has allowed finer-scale enhancements to the conservation framework for the region.

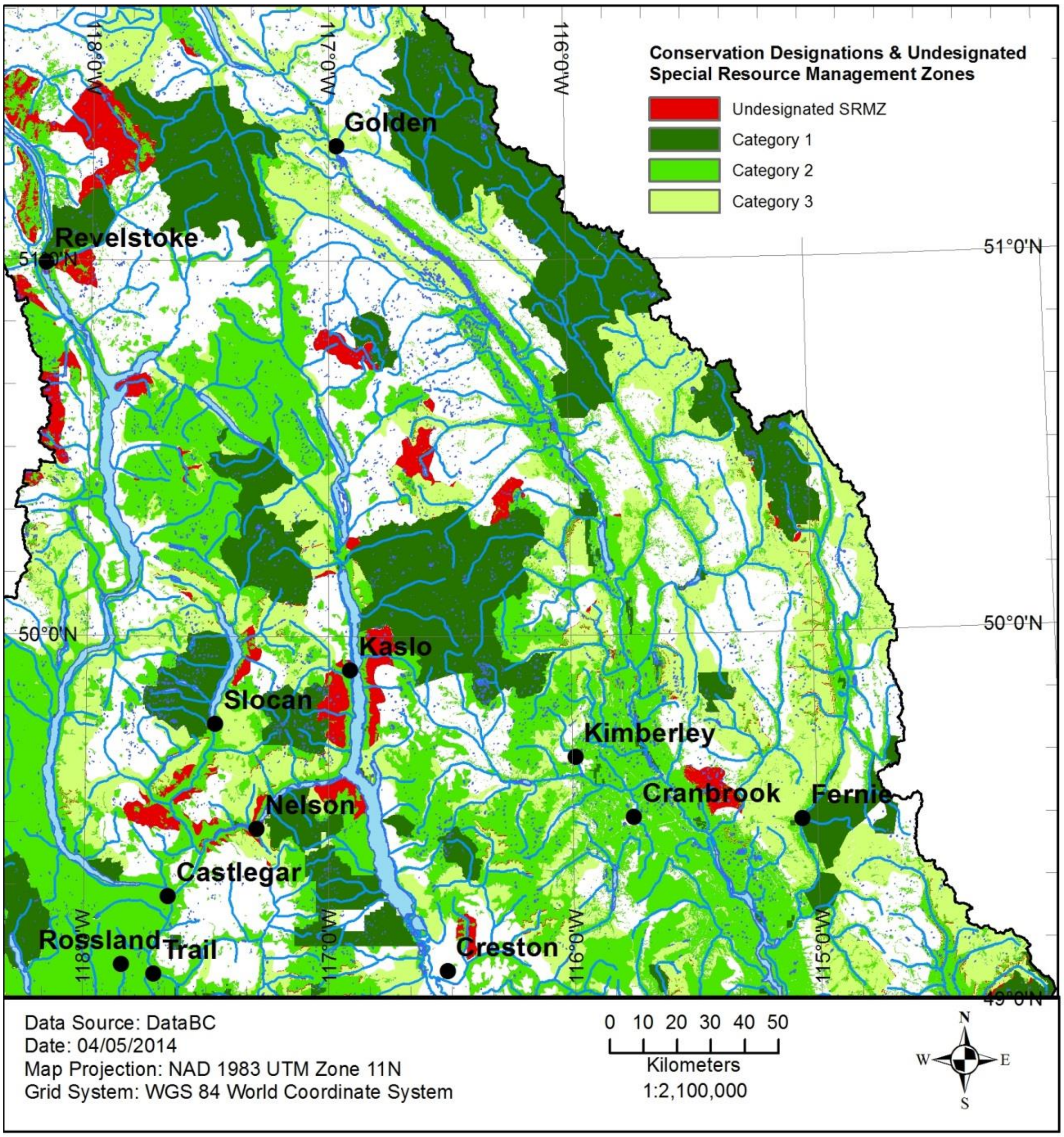


Figure 3. 16: Conservation Designations Overlay with Special Resource Management Zones, highlighting areas of SRMZ undesignated for conservation

3.3.4.2 Nature Conservancy of Canada's Ecoregional Assessment

The Nature Conservancy in the United States and its Canadian affiliate, the Nature Conservancy of Canada (NCC), have designed systematic conservation plans across North America to guide conservation actions that "conserve the diversity of species, communities and ecological systems in each ecoregion" (Groves et al., 2000; p. iii). Eight ecoregional assessments have been completed for British Columbia (Horn, 2011) including for the Canadian Rocky Mountains (CRM) Ecoregion which spans an area of approximately 27.1 million hectares extending across southeast British Columbia, southwest Alberta, northwest Montana, north Idaho and northeast Washington (Wood et al., 2004). The Canadian Rocky Mountains Ecoregional Assessment (Wood et al., 2004) has been used as a basis of evaluating the effectiveness of the current conservation designations in the Kootenay region.

The CRM Ecoregional Assessment (CRMEA) results from a science-based analysis that establishes a priorized network of conservation areas and stewardship strategies in the region to protect biodiversity. This network is based on coarse-scale ecological representation and fine-scale protection of imperiled and vulnerable species. The design of the CRM conservation areas was driven through data, modelling and expert analysis, and focused on establishing targets at the coarse-scale for terrestrial and aquatic ecosystems, and at the fine-scale for rare ecosystems and species, and wide-ranging focal species. A key component of CRM conservation design analysis focuses on providing habitat and connectivity to support large mammals in the region, with particular emphasis on wide-ranging carnivores including grizzly bears, gray wolves, wolverines, fishers and lynx (Wood et al., 2004). Over 100 scientists and experts from across the region participated in the CRM conservation design:

> The Nature Conservancy and Nature Conservancy of Canada convened a multi-jurisdictional team in March 2000 with the objective of employing a science-based approach to design a portfolio of conservation areas for the Canadian Rocky Mountains ecoregion. This assessment is not meant to serve as a protected areas strategy since it is recognized that conservation in this ecoregion will require a wide range of public/private conservation and stewardship strategies. The CRM ecoregional assessment represents a first step in this process by developing a network of conservation areas that with proper management would ensure the long-term persistence of the ecoregion's species, communities and ecological systems. (Wood et al., 2004, p. 13)

The Nature Conservancy of Canada generously provided spatial datasets from the CRMEA for the purpose of this research study.

Within the Kootenay component of the broader ecoregion, a total of 3.58 million hectares or 43.5% of the land base were identified in the CRMEA to conserve priority coarse-scale ecological systems and vulnerable fine-scale elements (see Figure 3.17). The NCC ecoregional assessment ranked priorities into four tiers:

1) higher conservation value and high vulnerability,
2) higher conservation value but lower vulnerability,
3) lower conservation value but higher vulnerability, and
4) areas with lower conservation priority and lower vulnerability.

Only Tiers 2 and 4 areas were identified within the study area (32.4% and 11.2% of the region, respectively). The CRMEA did not identify areas with the Kootenay Region considered to be subject to high vulnerability (ie. Tiers 1 and 3).

The Nature Conservancy considered its work to be preliminary, and emphasized that further conservation planning, qualitative assessments and feasibility studies would be required to update the CRM ecoregional conservation assessment:

> Conservation goals represent the end toward which we direct conservation efforts for targeted species, communities, and ecosystems. Goals provide the quantitative basis for identifying and prioritizing areas that contribute to the reserve network. Reserve design is appropriately dictated by target goals, thus creating a vision of landscape functionality at a regional scale. Establishing conservation goals is among the most difficult – and most important – scientific questions in biodiversity conservation (e.g., How much is enough? How many discrete populations and in what spatial distribution are needed for long-term viability?). There is no scientific consensus regarding how much is enough …these questions can't really be answered by theory, but require an empirical approach, target-by-target, and a commitment to monitoring and continual re-evaluation over the long-term. (Wood et al. 2014, p. 43)

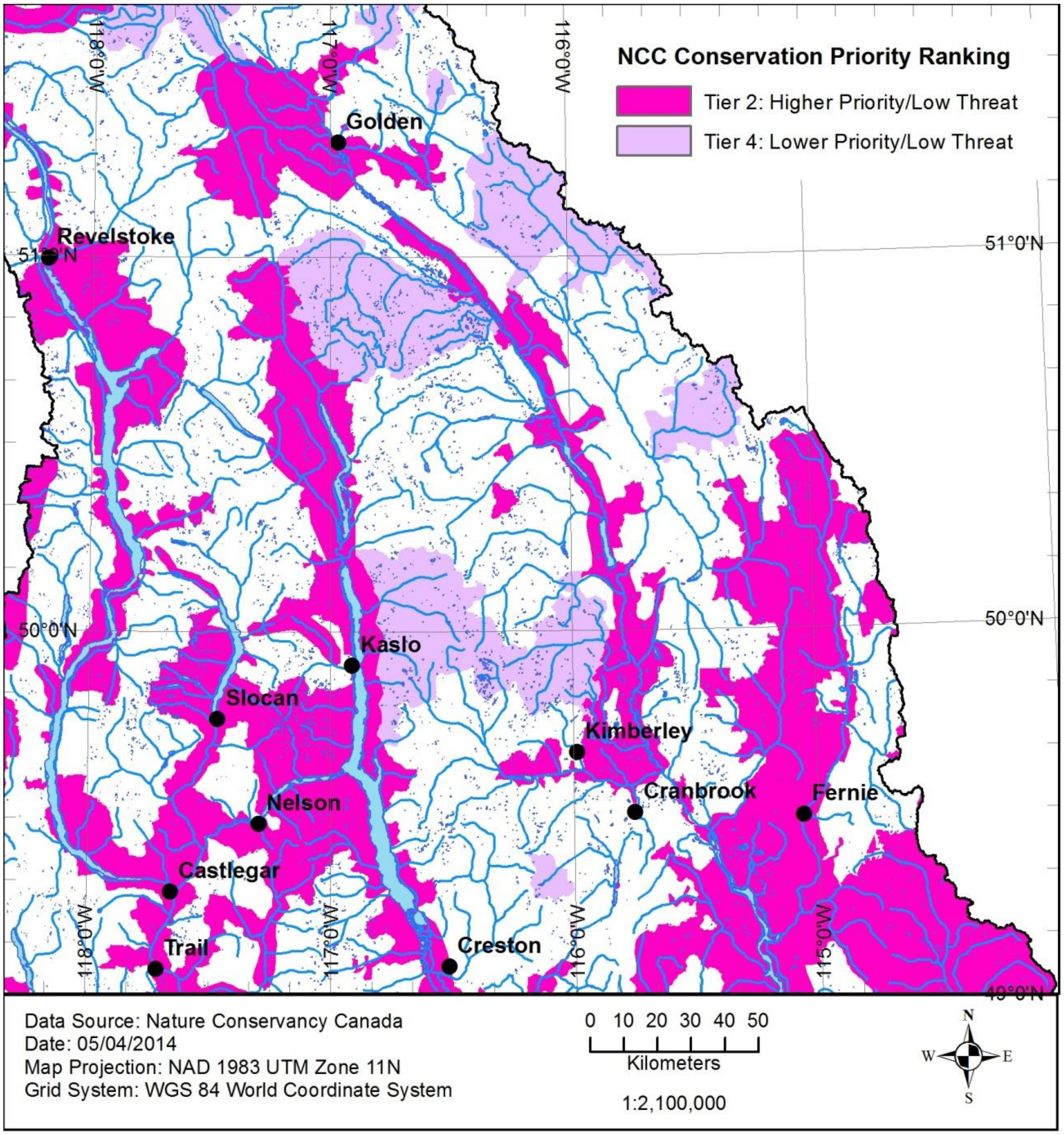


Figure 3. 17: Conservation Area Priority Rankings for the Kootenay Region of British Columbia [From the Canadian Rocky Mountains Ecoregional Assessment (Nature Conservancy of Canada, 2004)]

Although the CRMEA did not review potential implications of climate change on conservation design priorities, it did note that the plan addressed "major ecological gradients and variability…[which] are well represented across the portfolio of conservation areas, as evidenced by the high degree of representation of ecological systems and the ecological variables used to represent them (vegetation, elevation, landform, riverine characteristics, geologic substrate, etc.)…[which] should help buffer the conservation targets against the impacts of climate change." (Wood et al., 2014, p. 53). The report suggests that:

> Climate change was not addressed in the direct analysis of threats to conservation targets by conservation area. The team recognized that climate change could significantly impact biodiversity over time at some level in all of the conservation areas. Specific impacts to conservation targets at conservation areas are highly speculative at this point. While it was not possible for this team to address specifics related to biodiversity conservation and global climate change, regional research provide some clues as to expected impacts to some conservation targets. (Wood et al., 2014, p. 75)

and that:

> Global warming could accelerate a number of the threats to conservation targets within the portfolio, such as spreading of invasive species and increasing the risk of devastating wildfires. While the team designed the portfolio to ensure that it spans the full range of climatic gradients and that individual sites span the greatest possibly altitudinal range within contiguous natural areas, addressing specific impacts of global climate change was beyond the scope of this assessment. Further work is needed to guide conservation efforts in light of different climate change scenarios. For example, it would be useful to predict level of endangerment for certain species (especially in the alpine zone) and ecological systems based on certain global warming scenarios." (Wood et al., 2014, p. 78)

The Nature Conservancy of Canada viewed this assessment as a blueprint for conservation success, their goal being to conserve the entire portfolio of conservation areas. The CRMEA process represents the most comprehensive coarse- to fine-scale assessment of ecosystem conservation priorities for this region, and was used in this study as a benchmark to measure designations implemented through the current conservation policy framework.

The conservation designations evaluated in this analysis covered 69.1% of the area ranked by NCC as a conservation priority within the Kootenay Region (ie. 69.6% of Tier 2, and 67.6% of Tier 4) (see Table 3.9).

Table 3. 9: Area of Nature Conservation of Canada (NCC) Priority Targets Represented by a Current Conservation Designation

Scale = Hectares	NCC Tier2 (hectares)	NCC Tier 4 (hectares)	Total	% of NCC Priority (Tiers 2 & 4)
National Park	74,452	83,196	157,648	4.4
Provincial Protected Area	210,031	196,378	406,409	11.4
Conservation Property	54,274	-	54,274	1.5
Wildlife Management Area	44,128	-	44,128	1.2
Wildlife Habitat Area	161,921	-	161,921	4.5
Ungulate Winter Range	659,755	120,719	780,474	21.8
Old Growth Management Area	109,597	22,226	131,823	3.7
High Biodiversity Emphasis Unit	153,316	123,810	277,126	7.7
Grizzly Bear Connectivity Corridors	384,145	75,980	460,125	12.9
Total Designated	1,851,619	622,309	2,473,928	69.1
Total Priority Ranked	2,660,023	920,656	3,580,679	

Spatial overlay of conservation designations and NCC conservation rankings show a number of major gaps in current conservation designations (Figure 3.18). These include:

1) low elevation Tier 2 conservation priorities in the Flathead River Valley, the upper reaches of the Bull River, Blackfoot Creek, Thunder Creek and White River on the upper Kootenay drainage, a number of lower elevation zones in the lower Kootenay watershed, and the Akolkolex River basin in the lower Columbia watershed; and
2) the area identified by NCC as 'East-West Connectivity North' which connects the Duncan River Valley to the west with the Rocky Mountain Trench to the east which was ranked as Tier 4.

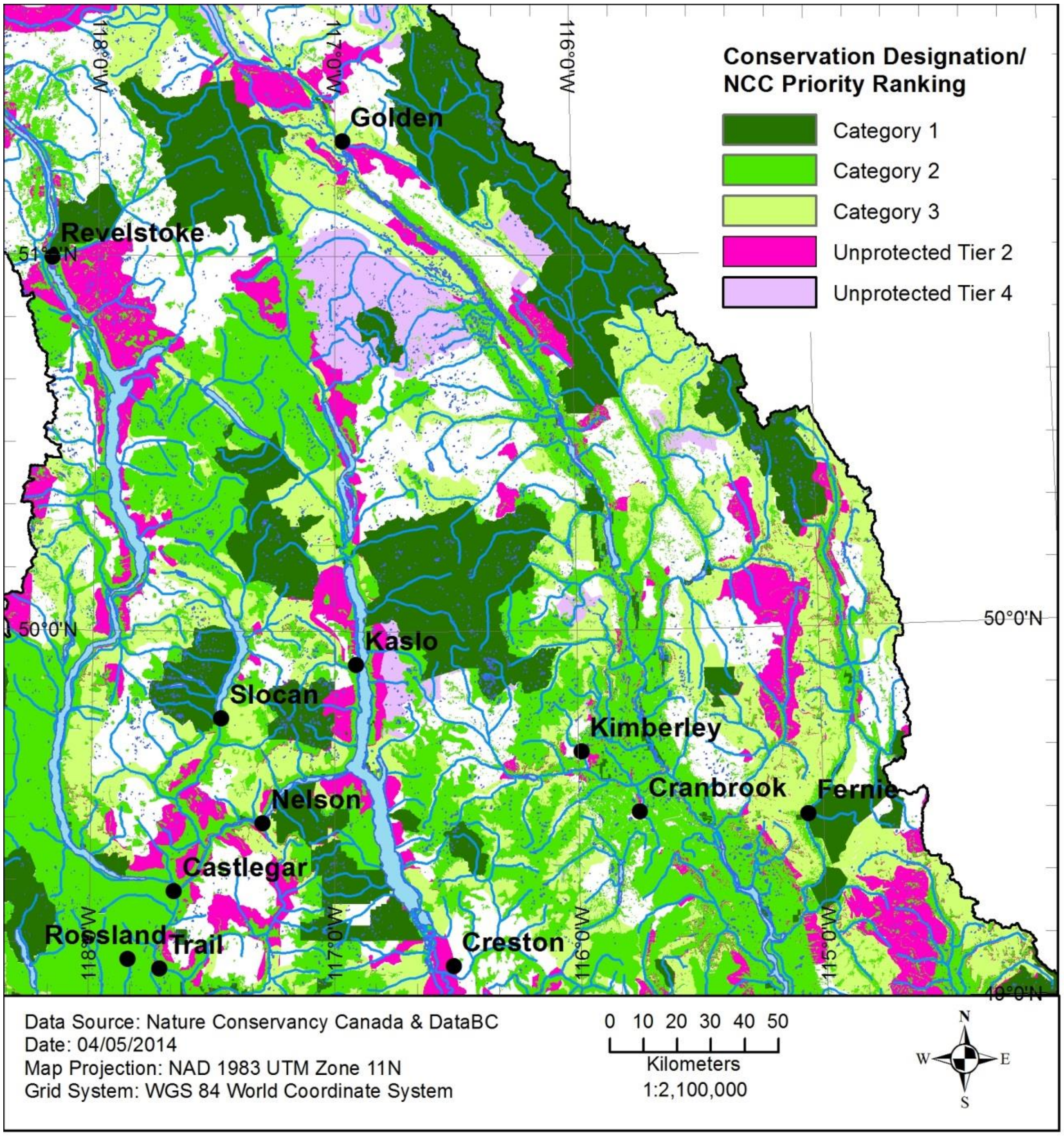


Figure 3. 18: Overlay of Nature Conservancy of Canada Conservation Priority Rankings with Conservation Designation Categories, showing areas which have not been protected

The CRM Ecoregional Assessment also identified 150 fine-scale target element occurrences in the region as conservation priorities. These were overlaid with the Category 1 and 2 conservation designations to evaluate the extent to which these have been protected (Table 3.10). Ninety-eight are located in one of these designations, and half of these (ie. 49) are located in ungulate winter range in the East Kootenay area. Given that this UWR consists of general wildlife measures allowing forest harvesting, it is reasonable to assume that only about one-third of the target elements identified in the Ecoregional Assessment have an explicit level of protection through a conservation designation. Only 13 WHAs have been established to protect the Target Elements identified in the CRMEA which is somewhat surprising given that the WHA is the policy mechanism designed to protect fine-filter critical habitat requirements for species at risk and regionally important species.

Table 3. 10: Number of Conservation of Target Elements Identified in the NCC Ecoregional Assessment

Conservation Designation	Number of Element Occurrences
National Parks	9
Provincial Parks	13
Conservation Property	3
Wildlife Management Area	5
Wildlife Habitat Area	13
Ungulate Winter Range	49
Old Growth Management Area	6
Total Identified	150

3.3.4.3 Mountain Caribou Recovery Implementation Plan

Given the significance of mountain caribou as a keystone species in the study area, this section addresses the extent to which suitable habitat for mountain caribou has been protected in the Kootenay Region. Conservation designations implemented in the study area are compared to the goals and strategies formulated as part of the Mountain Caribou Recovery Implementation Plan announced by the Province in 2007[97]. Spatial data used in this mapping analysis included mountain caribou habitat suitability, current

[97] Province of British Columbia, 2007. News Release and Backgrounder. Accessed at: http://www.env.gov.bc.ca/wld/speciesconservation/mc/index.html.

subpopulation locations, conservation designations, and Baseline Thematic Mapping land use classification.

Mountain caribou are considered an ecotype of the woodland caribou subspecies that range across the boreal and mountainous forests of Canada (Environment Canada, 2014). This unique ecotype is dependent on large tracts of old growth forests in the high snowfall mountainous region in the Interior Wet Belt extending from the Prince George area in the north, and south through the West Kootenay region and across the international boundary into northern Idaho (Stevenson et al., 2001; Wildlife Branch, 1999). Thirteen herd population units have been identified in British Columbia, five of which are located primarily within the West Kootenay area (Mountain Caribou Technical Advisory Committee, 2002) (Figure 3.19)[98]. Table 3.11 lists recent population census information for these five units and the corresponding nine sub-population units[99] (Mountain Caribou Technical Advisory Committee, 2002).

Mountain caribou are experiencing an accelerating decline throughout their range as a result of habitat loss, predation, and historical hunting (Environment Canada, 2014; Spalding, 2000). The two southern most population sub-units (ie. South Selkirks and Purcell South) have been shown to be geographically and genetically isolated relative to other units located further north (Mountain Caribou Technical Advisory Committee, 2002). The Purcell Central herd was considered to be extirpated in 2005 (Environment Canada, 2014). Mountain caribou in British Columbia have been classified as 'Threatened' under the Species At Risk Act (Environment Canada, 2014), and are 'Red-Listed' (meaning endangered or threatened) by the Province (Mountain Caribou Technical Advisory Committee, 2002).

[98] Data downloaded from the DataBC geographical data warehouse accessible at http://www.data.gov.bc.ca/dbc/geographic/index.page?

[99] The Monashee herd, which is peripherally located on the western boundary of the Kootenay region, is primarily located in the Okanagan region. The population estimate for this herd in 2006 was 4 caribou.

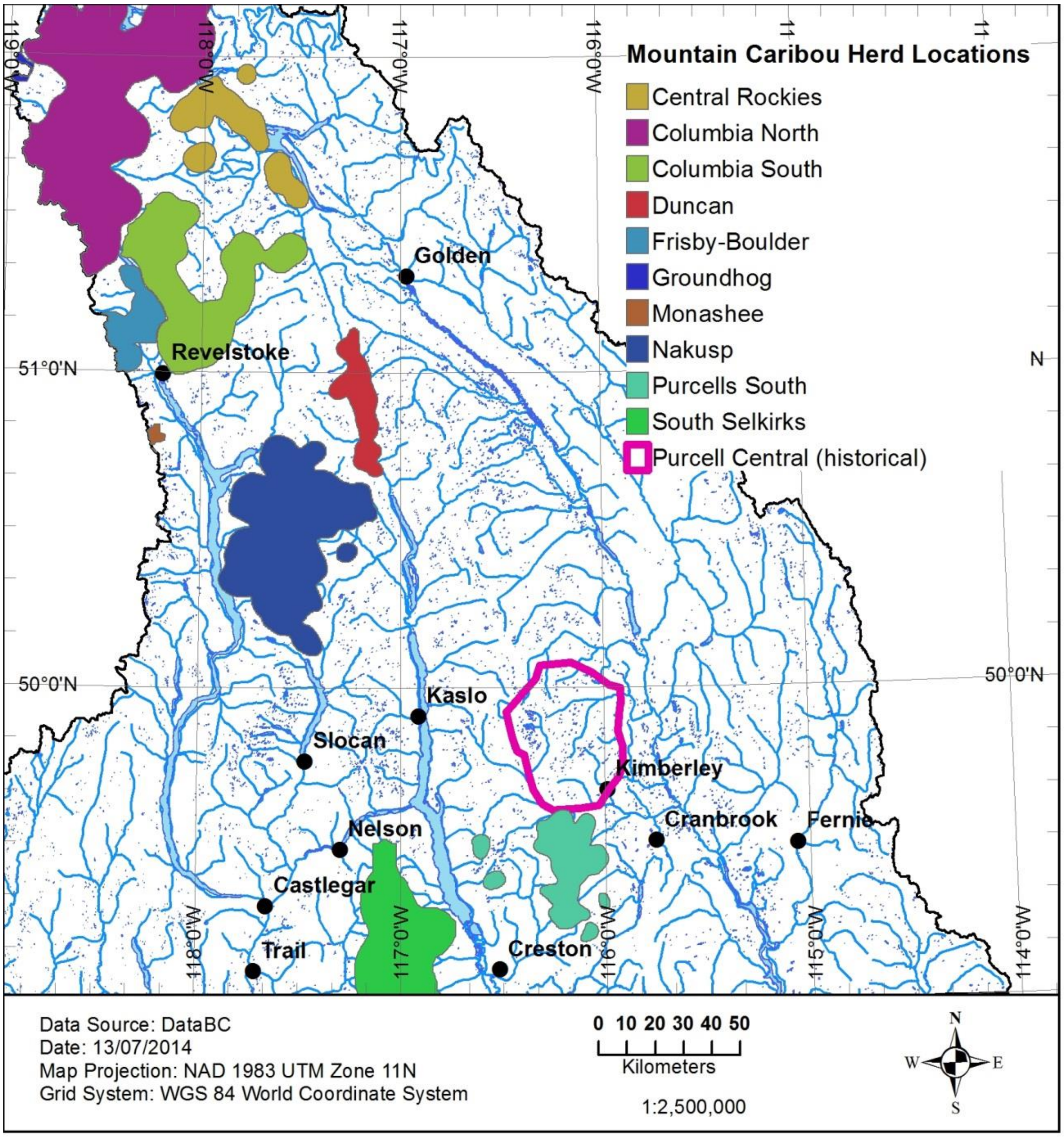


Figure 3. 19: Location of Mountain Caribou Herd Subpopulation Units in the Kootenay Region

Table 3. 11: Population Estimates and Trends for Mountain Caribou Herds Located in the Kootenay Region[100]

Population Unit	Provincial Recovery Objective[101]	Subpopulation Unit	2006 Population Estimate[102]	2014 Population Estimate[103]
Revelstoke - Shuswap	363	Columbia North	138	183
		Frisby-Boulder	19	13
		Columbia South	29	7
Kinbasket	0	Central Rockies	2	3
Central Kootenay	227	Duncan	9	2
		Nakusp	85	64
Southwest Kootenays	91	South Selkirks	37	22
Southeast Kootenays	159	Purcell Central	0	0
		Purcell South	20	19

At a broad scale, mountain caribou rely on lower elevation old growth forested habitats in the Interior Cedar-Hemlock and Engelmann Spruce – Subalpine Fir biogeoclimatic zones in early winter and during the spring where they forage on arboreal lichens on fallen trees and litterfall, and on shrubs and forbes accessible through the snowpack in tree wells and in windswept and solar exposed areas (Wittmer, et al., 2005a; Apps, McLellan, Kinley, & Flaa, 2001; Environment Canada, 2014). During late winter, as snowpack deepens, they migrate to higher elevations in the ESSF zone to forage for arboreal lichens within the forest canopy made accessible by walking on top

[100] Table only includes those herds that are primarily located within the Kootenay region (ie. Groundhog and Monashee herds in the Thompson and Okanagan regions are not included).

[101] From British Columbia Government's Mountain Caribou Recovery Implementation Plan. Retrieved from http://www.env.gov.bc.ca/wld/speciesconservation/mc/.

[102] Ibid.

[103] From Environment Canada's Woodland Caribou Recovery Strategy (Environment Canada, 2014).

of consolidated deep snowpack areas. In summer their habitat preference is closed canopy old growth forests in the lower elevation ESSF zone. A primary factor in habitat selection is avoiding predators such as wolves and cougars by keeping to either high elevation or closed canopy habitats, especially during calving and natal seasons (Wittmer, Sinclair, & McLellan, 2005b; Environment Canada, 2014).

The BC Government approved the Mountain Caribou Recovery Implementation Plan (MCRIP) in 2007[104]. It called for such recovery actions as:

> …protecting 2.2 million hectares, including 95% of high suitability Mountain Caribou habitat, from logging and road building; managing recreation to reduce human disturbance in Mountain Caribou habitat; managing predator and alternate prey populations to reduce predator densities in areas where predation is preventing Mountain Caribou recovery; [and] increasing Caribou subpopulations by transplanting animals from large to small herd areas.[105]

This recovery plan replaced prior legal objectives for mountain caribou conservation under the Kootenay-Boundary Higher Level Plan Order. Its goal is to recover the population to 2,500 animals from the current estimate of ~1,540 (Environment Canada, 2014). Specific targets for each population unit are established under the plan, as shown in Table 3.12 for the Kootenay region herds.

Actions to implement the MCRIP to date are broad-ranging, with considerable controversy and implications for land use. They include:

1) protecting approximately 2.2 million hectares of habitat from forestry activities through designation of new protected areas and ungulate winter range;
2) development of guidelines to manage impacts from mineral exploration and heli- and cat-skiing activities;

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[104] Ministry of Environment website. Retrieved from http://www.env.gov.bc.ca/wld/speciesconservation/mc/.

[105] Ibid.

3) closing approximately 1.0 million hectares of habitat from recreational snowmobile use;

4) entering into new stewardship agreements with recreational snowmobile clubs;

5) increasing enforcement;

6) implementing a moratorium on new commercial recreation tenures in caribou habitat, encouraging predator control through trapping and hunting;

7) piloting a sterilization program to assess whether this could effectively control wolf populations;

8) implementing enhanced moose hunting seasons as an alternate prey population control measure; and

9) transplanting 19 caribou captured in north-western British Columbia to the southern Purcell Mountains in the Kootenay region[106].

Caribou habitat conservation implementation in the Kootenay Region was assessed by comparing conservation designations implemented within caribou range in the region with habitat suitability mapped by the Mountain Caribou Recovery Science Team. This comparison was produced by overlaying the conservation layers for national parks, provincial parks and protected areas, portions of the NCC Darkwoods conservation property[107], the Midge Creek and Hamling Lakes wildlife management areas, and

[106] Mountain Caribou Recovery Implementation Plan Progress Board (2013), "Annual Report on Activities and Accomplishments of the Mountain Caribou Recovery". Accessed at: http://www.env.gov.bc.ca/wld/speciesconservation/mc/.

[107] The portions of the NCC Darkwoods property that continue to be Managed Forest under the Private Managed Forest Land Act were excluded. The remainder of the property that was excluded from Managed Forest in 2012 is intended to be managed for conservation objectives for mountain caribou as well as other species. NCC intends to continue forest harvesting on the Managed Forest portion. (http://www.natureconservancy.ca/en/where-we-work/british-columbia/featured-projects/darkwoods/dw_conservation_values.html).

caribou-specific ungulate winter range, with habitat suitability mapped for herd population units. These conservation layers are shown in Figure 3.20, and the habitat

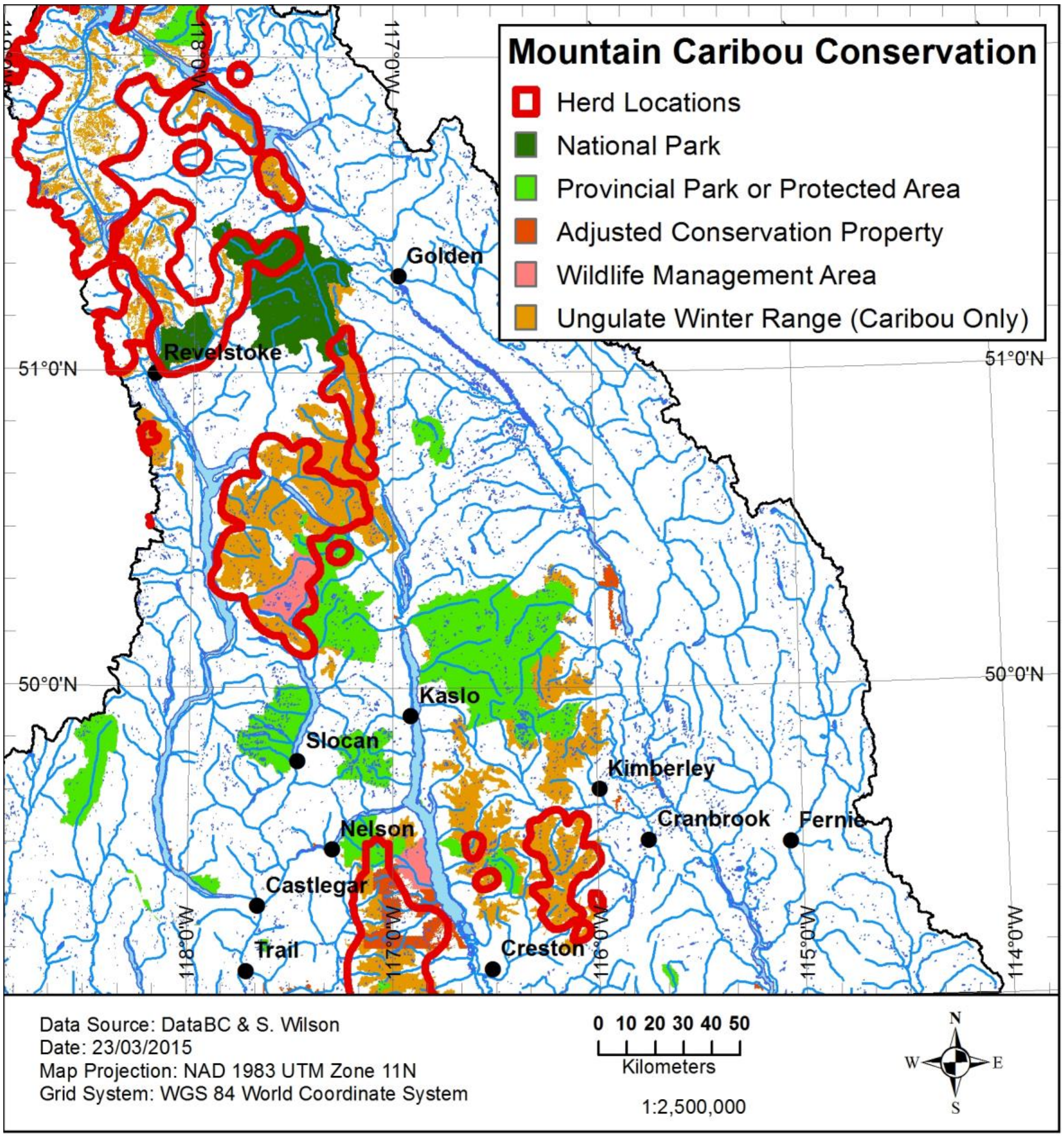

Figure 3. 20: Location of Conservation Designations Contributing to Mountain Caribou Recovery

suitability map is shown in Figure 3.21. The conservation designations analyzed were selected based on the criteria of having large areas of habitat conditions potentially

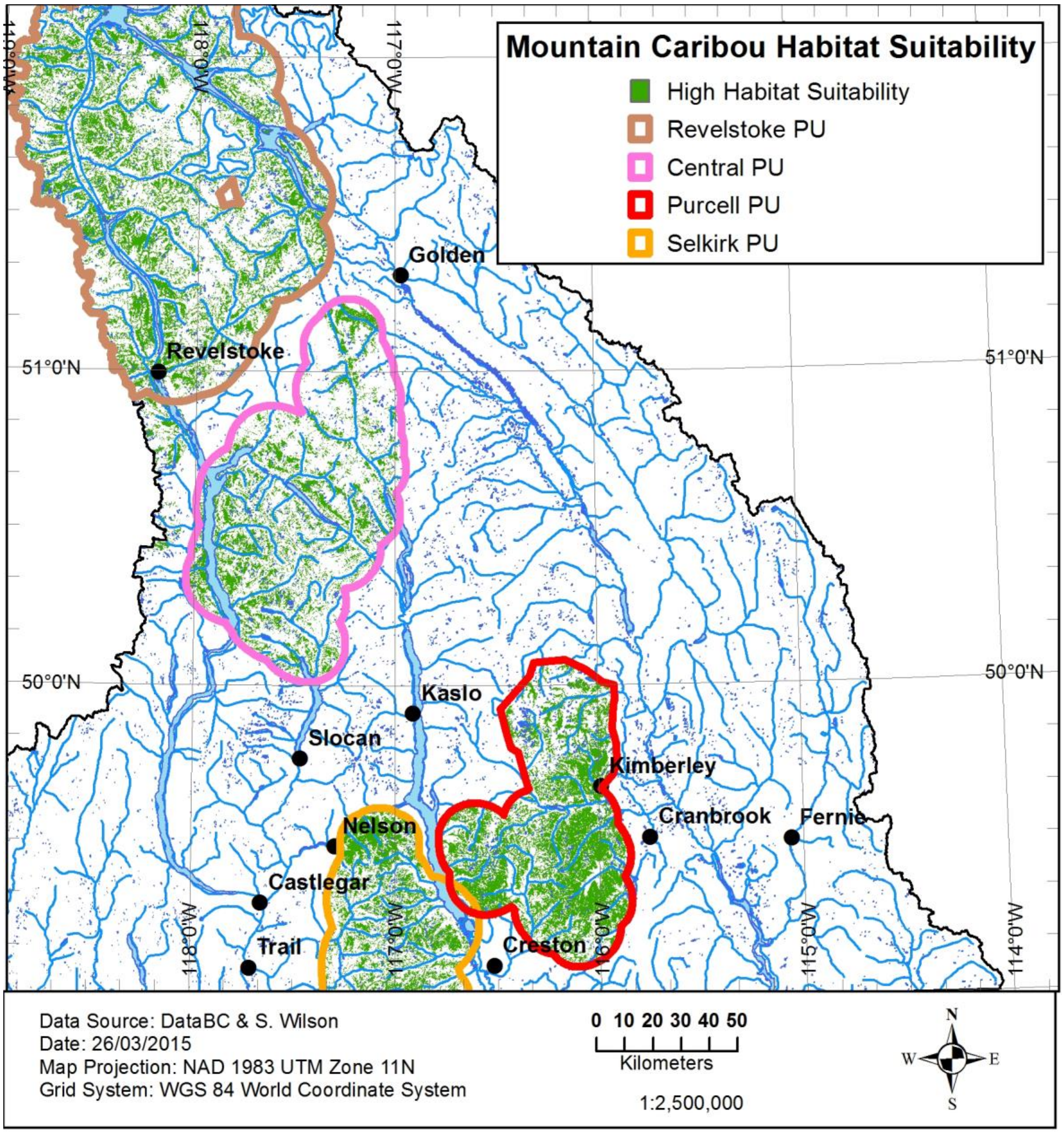

Figure 3. 21: Mountain Caribou Habitat Suitability in Buffered Population Units

suitable for caribou and having objectives compatible with mountain caribou conservation. The remaining conservation designations that are not noted in Figure 3.20, including non-caribou ungulate winter range, were judged to be too small or fragmented, or to have conservation objectives inconsistent with the habitat requirements of caribou (eg. allowing forest harvesting and road development).

The mountain caribou habitat suitability map presented in Figure 3.21 was produced based on the spatial data output from the Mountain Caribou Science Team Bayesian Belief Network model, which was provided courtesy of S. Wilson, who chaired the Science Team. The habitat model is described in McNay & McKinley (2007), McNay, et al., (2006a), and McNay, Marcot, Brumovsky, & Ellis (2006b). The model classifies caribou range into high, low, and null habitat suitability based on early and late winter forage availability and terrain accessibility and served as the basis for government's Mountain Caribou Recovery Implementation Plan. Although the area modelled by the Science Team included all of the area within the Interior Wet Belt from north of Prince George to the international boundary in the Kootenay region, the MCRIP focussed its recovery efforts only on current population unit locations (including the Purcell Central population unit that is considered recently extirpated). Herd population unit locations are noted in Figure 3.20.

Habitat suitability for the area specifically included in the recovery plan was extracted from the broader Science Team dataset based on an unpublished map made publically available during the media release regarding the plan (Figure 3.22). This map was developed by provincial government staff by buffering the full dataset used in the Science Team analysis to extract habitat suitability polygons specific to herd locations plus 10 km (S. Wilson & S. McNay, personal communication). However this buffered data subset was not was not available digitally. For the purpose of this analysis, a herd specific digital subset was re-created by extracting habitat suitability polygons from the Science Team's spatialized habitat suitability map based on herd location polygons with a 10 km buffer (see Figure 3.22). Although the extirpated Purcell Central herd is not included in the herd locations dataset, a new polygon representing this Population Unit was created by digitizing a polygon based on the area on the unpublished government map that included habitat suitability information for this subpopulation. The resulting extracted output seems to closely, but not exactly duplicate the government habitat

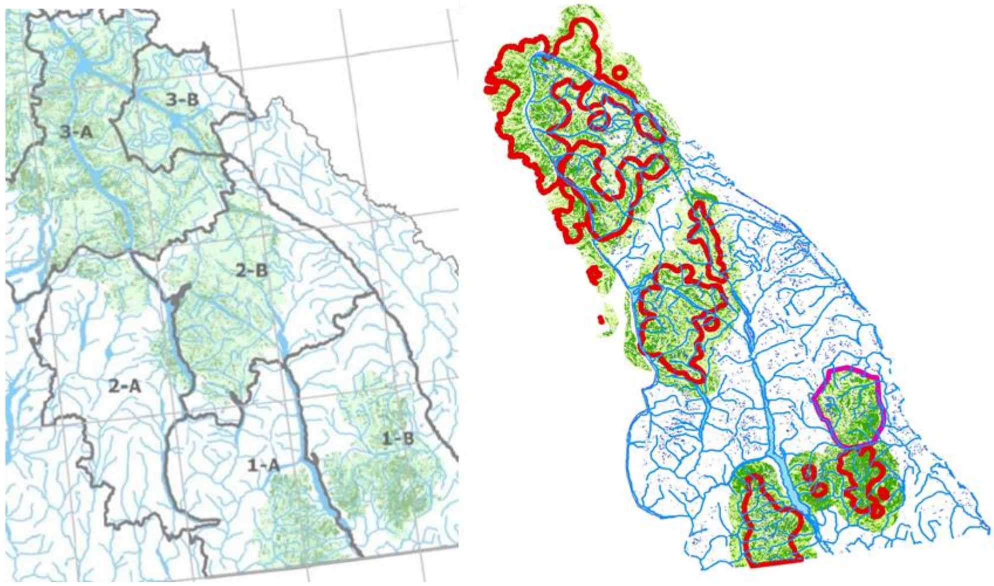

Figure 3. 22: Habitat Suitability Map Comparison - compares habitat suitability from government's unpublished habitat suitability map (left) with that used in the study based on the buffered Population Units (right) (Dark Green = High Habitat Suitability; Light Green = Low Habitat Suitability)

suitability map. The MCRIP target to protect 95% of high suitability habitat applies within the areas defined by these buffered population units.

Table 3.12 highlights areas of high habitat suitability in the region that have been included within a compatible conservation designation; as well as the amount of each designation comprised of old forests and young and recently disturbed forest. Across the range of Mountain Caribou within the Kootenay Region modelled by the Science Team, only 29.1% of high suitability caribou habitat has been included in a conservation designation; while within the four buffered population units 49.3% of high suitability has been conserved accordingly.

Land cover condition within conservation designations within mountain caribou population units was assessed from the Baseline Thematic Mapping (BTM) dataset within each buffered population unit (Figure 3.23). BTM land use classifications were

Table 3. 12: Area (hectares) of Mountain Caribou Habitat Within a Conservation Designation

	Within Region			Within Buffered Herd Location		
	High Suitability Habitat	Old Forest	Young & Disturbed Forest	High Suitability Habitat	Old Forest	Young & Disturbed Forest
National Park	41,779	48,054	14,833	34,492	39,286	12,033
Provincial Protected Area	157,882	140,554	124,891	52,926	50,159	39,730
Conservation Property	21,041	14,216	28,448	17,680	13,807	21,040
Wildlife Management Area	12,661	13,601	16,092	12,035	13,467	12,856
Ungulate Winter Range (Caribou Only)	318,256	330,779	173,274	297,699	309,615	164,242
Conserved Area	551,619	547,204	357,538	414,832	426,334	249,901
Total Area	1,897,455	1,759,421	3,533,461	841,981	750,705	788,002
Percent in Conservation Designation	29.1%	31.1%	10.1%	49.3%	56.8%	31.7%

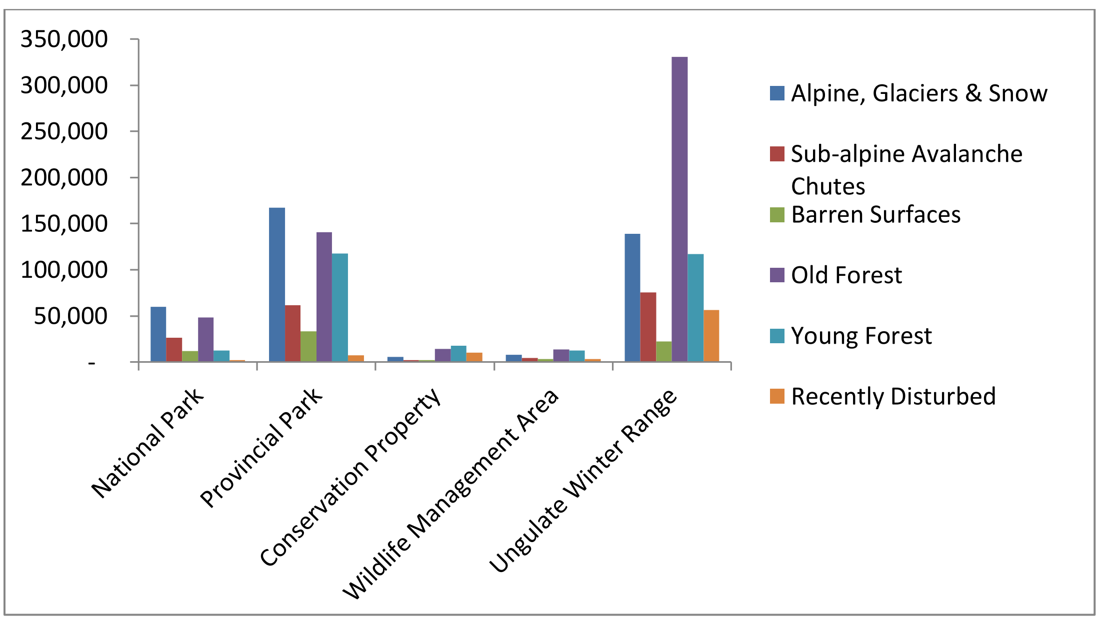

Figure 3. 23: Area (hectares) of Conservation Designations in Mountain Caribou Population Units within Land Use Classifications

reclassified into six classes which included 1) Alpine, Glaciers and Snow, 2) Sub-alpine Avalanche Chutes, 3) Barren Surfaces, 4) Old Forest, 5) Young Forest, and 6) Recently Disturbed. The 'Recently Disturbed' category includes areas that have been recently logged or burned. Within the area defined by population units, 56.8% of the forests defined as old growth have been protected in one of these five conservation designations. The primary land use categories that conservation designations are comprised of include old forest (41%), alpine (20%), young forest (17%), sub-alpine avalanche chutes (11.0%), barren surfaces (4%), and recently disturbed areas (7%).

Mountain Caribou are highly dependent on old growth habitats for forage and security cover and habitat disturbance has been shown to increase predation risk. Ungulate Winter Range recently designated to protect caribou habitat as a result of the MCRIP has contributed over 330,000 hectares of old growth forest, which is 73% of the old growth in all conservation areas in caribou range within the population units. National and provincial parks contribute 21% of the old growth within designated population units, conservation properties 3%, and wildlife management areas 3%. Significant portions of national and provincial parks are comprised of alpine, sub-alpine avalanche chutes, and rock (ie. 56% and 41%), respectively. Young and recently disturbed forests comprise the other major land use classification, including 10% of national parks, 26% of provincial parks, 48% of the Darkwoods property, 31% of wildlife management areas, and 24% of ungulate winter range.

BTM classifications in each population unit are shown in Figure 3.24. The South Selkirk and Purcell South herds are geographically isolated from each other and from populations residing in the northern part of the region by Kootenay Lake, including its west arm, and the rugged, marginally suitable habitat in the northern part of the Purcell Mountains. The Purcell Central and Purcell South subpopulation units are surrounded largely by unsuitable land use patterns where suitable old growth habitat is limited to isolated pockets. The Darkwoods property constitutes a critical component (31%) of the Selkirk population unit conservation designations comprising 30% of the old growth and

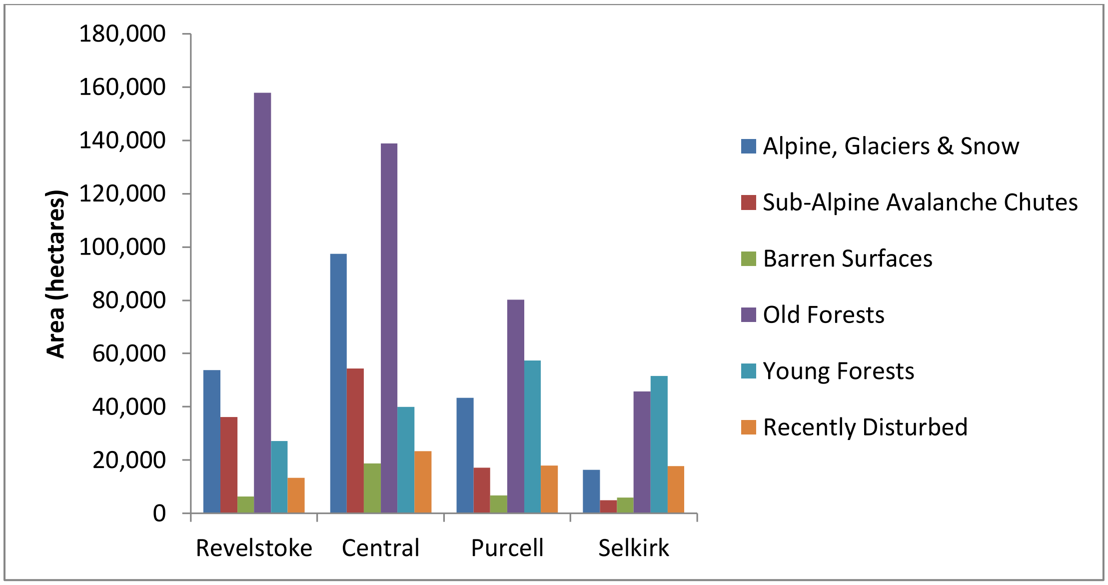

Figure 3. 24: Area (hectares) of Mountain Caribou Population Units in a Land Use Classification

is critically located in the core of this unit. A significant proportion of conservation designations within both the Selkirk and the Purcell population units are comprised of young and recently disturbed forests (ie. 49% and 34% of these designations, respectively) suggesting these units will require time to recover old growth attributes needed for caribou. Although the Duncan and Nakusp subpopulations are connected geographically to subpopulations to the north through Glacier National Park, they are essentially isolated, given the steep mountainous terrain and marginal habitat conditions and the Trans-Canada Highway that bisects the park from east to west.

Environment Canada finalized the recovery strategy under the *Species At Risk Act* (S.C. 2002, c. 29) for the Southern Mountain Population of Woodland Caribou in June 2014 (Environment Canada, 2014)[108]. The federal recovery strategy has spatially

[108] Under the Species At Risk Act critical habitat is only protected to the extent the habitat is on federal lands (eg. national parks), the species is an aquatic or migratory

identified critical habitat for mountain caribou in the Kootenay region, including high elevation late winter and summer habitats, low elevation early winter and spring habitats, as well as matrix habitat areas considered necessary for seasonal migration, spatial separation from predator species, and connectivity among subpopulations. The federal recovery strategy directs that 100% of these ranges be maintained with minimal disturbance. The recovery strategy also identifies significant additional habitat areas that to a significant extent are unprotected through existing conservation designations within which the goal is to "maintain predator densities consistent with performance indicators" (p. 66). Although detailed digital spatial files of critical habitat designated in the federal recovery strategy were not available for this study, a cursory review of the small scale maps of critical habitat in the recovery strategy indicates seasonal high and low elevation critical habitat has been protected through existing parks and protected areas and by ungulate winter range designated by the Provincial government under the *Forest and Range Practices Act* (Environment Canada, 2014).

Significant areas of high suitability and old growth habitat have been established in the region through mechanisms such as the Kootenay Boundary Land Use Plan and the Mountain Caribou Recovery Implementation Plan, although this falls considerably short of the goal to protect 95% of high suitability habitat within herd locations. Despite efforts, including habitat conservation and implementing closures and guidelines for commercial recreation and recreational snowmobiling, most of the herds in the region are continuing to decline in numbers primarily due to predation by wolves (Mountain Caribou Progress Board, 2013) [109]. A transplant project initiated in the Spring of 2012

bird species, or where the Canadian government considers the laws of the province do not adequately protect critical habitat.

[109] The Progress Board was set up by the Province in 2007 to monitor and report on the progress of implementing mountain caribou recovery. Membership on the Board includes forest industry, heli- and cat-ski industry, recreational snowmobiler associations, environmentalists, and government staff.

was largely unsuccessful, with only 3 of the 19 caribou surviving as reported in March 2013 (Mountain Caribou Progress Board, 2013). As noted in Table 3.12, the population recovery objectives are far from being achieved. It is worth noting that the Provincial Government had not approved an aerial wolf removal program as recommended by the Mountain Caribou Recover Science Team and by the Mountain Caribou Recovery Implementation Plan Progress Board until January 2015 when they announced a plan to cull up to 24 wolves in the South Selkirk Mountains, as well as an additional 160 to 180 in the Peace River Region[110].

3.3.4.4 Conservation of Habitat for Selected Wide-Ranging Carnivore Species

Habitat modelling available from the Canadian Rocky Mountains Ecoregional Assessment provided an opportunity to evaluate the extent to which suitable habitat for five wide-ranging carnivore species are protected within the conservation policy framework for the study area. Resource selection function data for these species were provided for the purpose of this study by the Nature Conservancy of Canada.

The source of the resource selection function data was the habitat modelling analysis conducted by Carroll (2001), Carroll, Noss, & Paquet (2001), and Carroll, Noss, Paquet and Schumaker (2003), and included data for grizzly bears, fisher, lynx, wolves and wolverines. Resource selection function is a measure of the relative probability that a habitat area will be used by an animal (Carroll, Noss, & Paquet, 2001). This methodology was based on spatially extrapolating a correlation developed between information available on species occurrences from available databases of sighting and trapping records, and biophysical information available from vegetation, satellite imagery, topography, climate, and metrics on human-related impacts (Carroll, Noss, & Paquet, 2001). Although Carroll, Noss, Paquet and Schumaker (2003) cautioned the level of unexplained variance in their results preclude use of this information for detailed

[110] Province of British Columbia website. Retrieved from http://www2.news.gov.bc.ca/news_releases_2013-2017/2015flnr0004-000035.htm.

conservation planning, they suggest the information does have broad-scale application for regional conservation planning purposes.

Carroll, Noss, & Paquet (2001) and Carroll, Noss, Paquet and Schumaker (2003) found that high quality habitats for grizzly bears, wolves and wolverines were strongly and negatively correlated with human population and road density, but fisher and lynx were not necessarily so. These studies broadly suggest that grizzly bears and wolves are opportunistic habitat generalists; fisher are associated with low- to mid-elevation forests; lynx are known to forage their primary prey species (snowshoe hares) in early seral habitats and den in mature forests; and wolverine require large home ranges largely isolated from human impact, are often associated with sub-alpine parkland forests, and usually den in areas with deep snowpack available late in spring. This suggests the need to consider a wide range of habitat requirements for multiple species in conservation planning (Carroll, Noss, & Paquet, 2001). Weaver, Paquet, & Ruggeiro (1996) documented the requirements needed by wolves, cougars and grizzly bears to sustain resilient populations at three scales, the individual (ie. foraging behaviour), population (ie. fecundity), and meta-population (ie. dispersal) scale. A common requirement for the resilience of wide-ranging large carnivores is large refugia to support foraging opportunities, an absence of human-caused mortality through hunting and collisions with highways and railroads, and functional connectivity corridors needed to support population colonization and genetic diversity (Weaver, Paquet, & Ruggeiro, 1996; Proctor, et al., 2012). Proctor, et al. (2012) suggest that the grizzly bear metapopulation in this region “is likely in a non-equilibrium state” due to mortality associated with human interactions (p. 25).

For this study, the resource selection function (RSF) probability spatial data for each of the five species obtained from the Nature Conservancy of Canada was classified into three habitat suitability classes (ie. high, medium and low), as delineated using the Jenks natural breaks function in ArcGIS (Jenks, 1967). The mapped results for each of the five species are shown in Figure 3.25. The Jenks natural breaks is a data clustering method

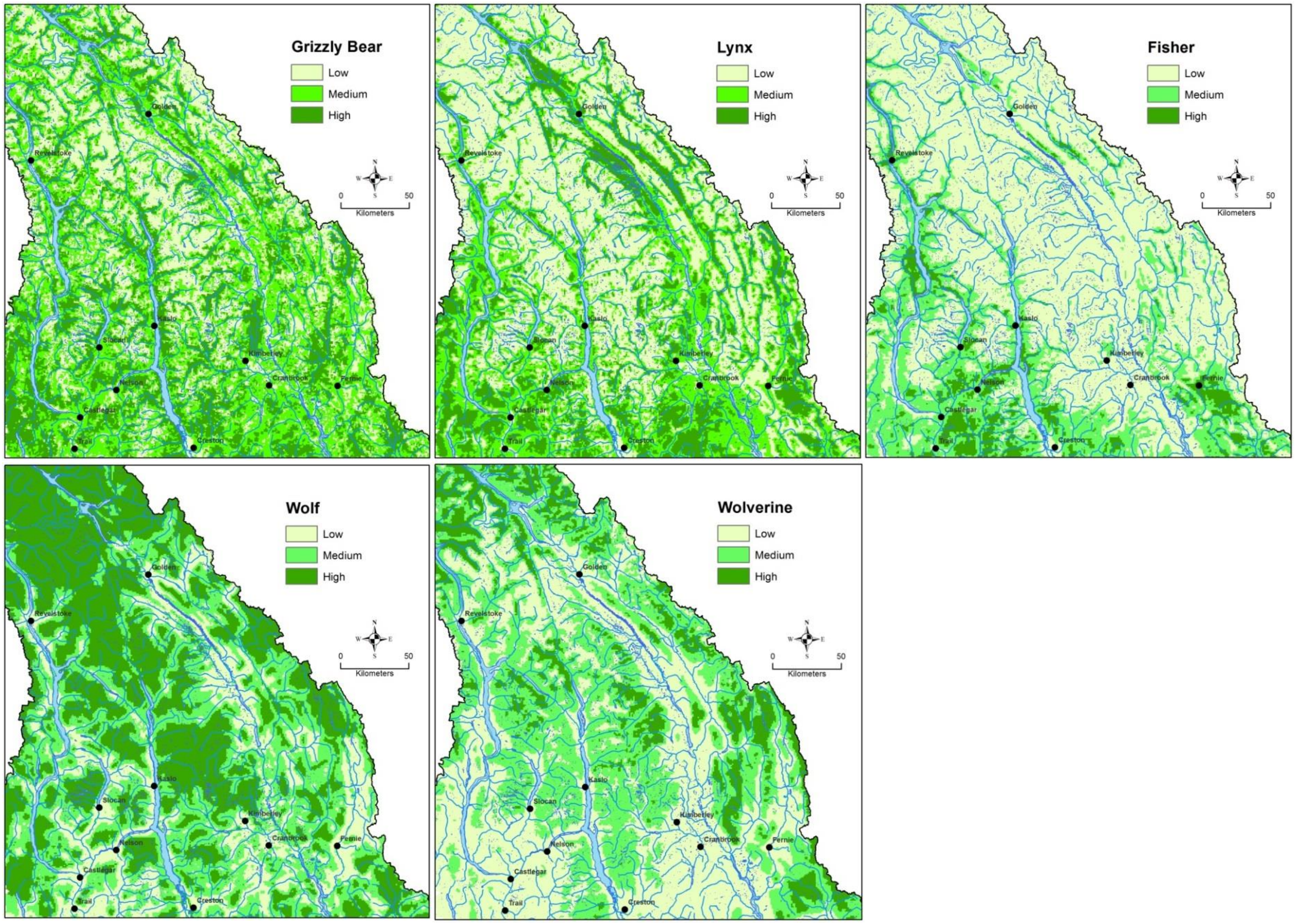

Figure 3. 25: Habitat Suitability Ratings (high, medium, low) Derived from Resource Selection Function for Selected Carnivores

which minimizes within class standard deviation, while maximizing the means of each class from other classes . The RSF suitability class for each of the species was overlaid with the maps of Biogeoclimatic Ecosystem Classification, Baseline Thematic Mapping land use classifications, and conservation designations, the results of which are shown in Figures 3.26 and 3.27 and Table 3.14, respectively.

Both high and medium grizzly bear habitat suitability classes seem to be well distributed across biogeoclimatic variants, which supports understanding of their broad use of habitat types in the region (Figure 3.26). Avalanche chutes, and old, young and recently disturbed forests are dominant land use types in high and medium habitat suitability classes for grizzly bears (Figure 3.27). High suitability classes for fisher and lynx are narrowly distributed in low- to mid-elevation forested land use types, especially younger and recently disturbed forests. The distribution of high and medium suitability classes for wolves appears across biogeoclimatic ecosystem classes and land use types, but away from areas of human activity. Wolverines are associated with mid to high elevation undisturbed habitats especially in the Englemann Spruce – Subalpine Fir zone.

Table 3.13 summarizes the extent of designation categories conserving high and medium habitat suitability classes for each of these five carnivore species. The total area of high and medium habitat suitability that have been conserved for grizzly bears is 68.6% and 67.9% respectively, for fisher 61.1% and 69.0%, for lynx 72.3% and 71.5%, for wolves 63.3% and 64.4%, and for wolverines 51.8% and 63.9%. Parks (12.9%), wildlife habitat areas (12.9%), ungulate winter range (15.1%) and grizzly bear connectivity corridors (16.7%) are significant contributions to the conservation of high suitability habitat for grizzly bears and wolves. Although this would appear to be adequate conservation of high suitability habitat for each of these species, except for perhaps wolverines; an analysis of the extent of habitat fragmentation was not conducted.

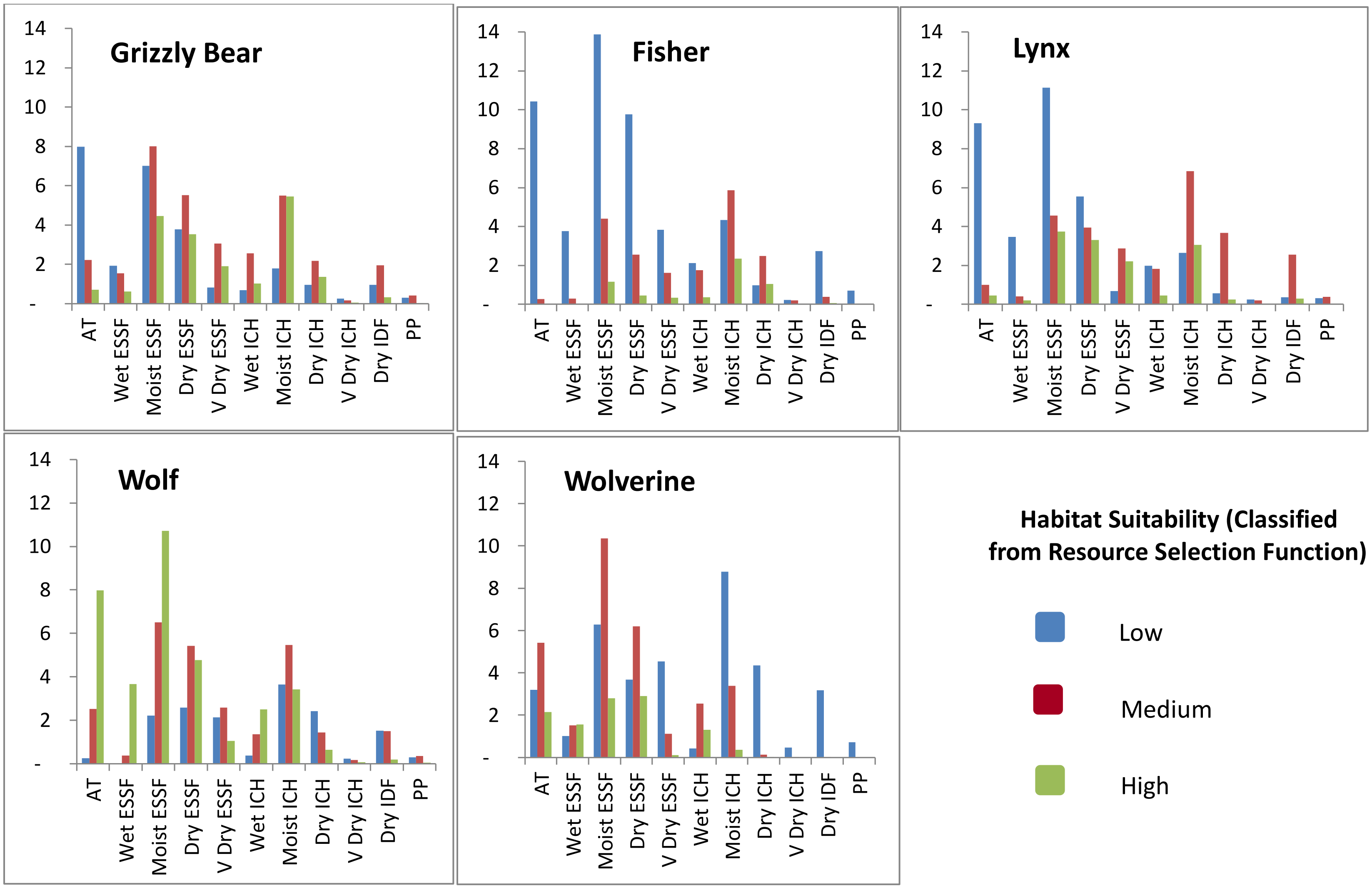

Figure 3. 26: Area (hectares x 10^5) of Habitat Suitability (high, medium & low) in Biogeoclimatic Variants for Selected Carnivores

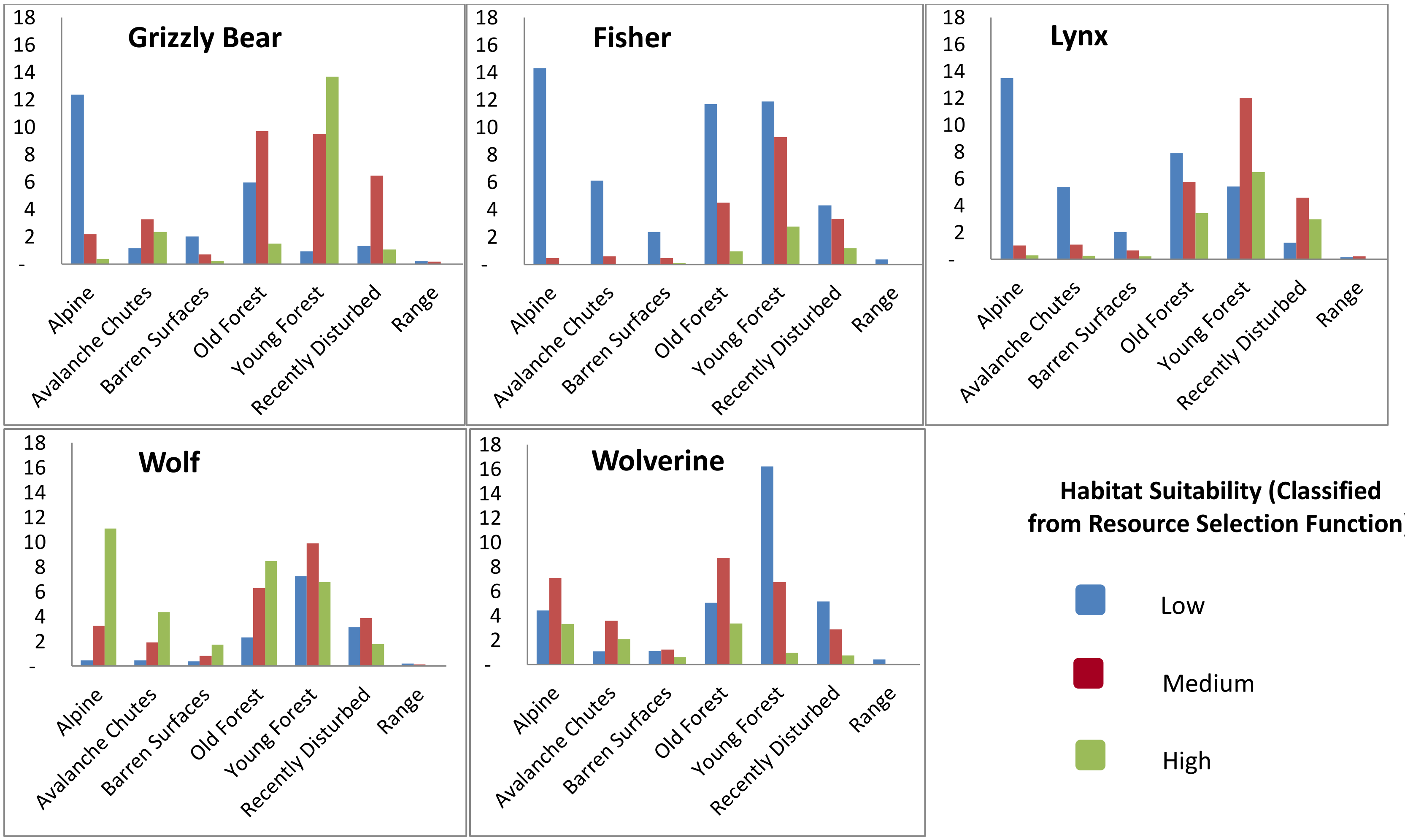

Figure 3. 27: Area (hectares x 10^5) of Habitat Suitability (high, medium & low) in Land Use Types for Selected Carnivores

Table 3. 13: Area (hectares) of Selected Carnivore High and Medium Habitat Suitability in Conservation Designations

	Grizzly Bear		Fisher		Lynx		Wolf		Wolverine	
	Medium	**High**	**Medium**	**High**	**Medium**	**High**	**Medium**	**High**	**Medium**	**High**
National Park	141,400	62,800	35,200	8,600	77,700	88,100	119,600	239,100	178,200	45,700
Provincial Park	224,900	189,800	112,200	21,100	179,200	104,200	80,900	612,500	412,100	126,800
Conservation Property	67,100	19,900	50,100	25,500	53,200	37,300	39,600	10,300	49,400	800
Wildlife Management Area	35,800	15,400	14,500	4,000	39,600	8,600	37,700	18,400	37,100	6,100
Wildlife Habitat Area	227,900	252,400	243,200	31,300	223,500	224,300	210,800	160,300	59,200	800
Ungulate Winter Range	814,700	294,300	394,500	139,500	829,900	209,200	587,000	507,700	471,100	138,000
Old Growth Management Area	151,800	64,600	95,400	17,200	99,900	50,700	128,700	120,500	158,400	35,500
High Biodiversity Emphasis	195,800	113,100	89,200	26,700	134,600	54,600	175,200	240,700	231,900	99,000
GB Corridor	399,400	325,900	337,300	87,200	388,100	233,900	405,700	319,900	371,400	127,200
Total	**2,258,800**	**1,338,200**	**1,371,600**	**361,100**	**2,025,700**	**1,010,900**	**1,785,200**	**2,229,400**	**1,968,800**	**579,900**
Percent of Suitability Class	**67.9%**	**68.6%**	**69.0%**	**61.1%**	**71.5%**	**72.3%**	**64.4%**	**63.3%**	**63.9%**	**51.8%**
Wildsight Park Proposal	23,300	20,400	30,200	8,100	29,900	9,900	25,700	21,400	26,300	18,700
Wildsight WMA Proposal	244,200	206,300	206,400	45,600	214,200	96,100	267,400	185,900	260,600	140,000
Valhalla Park Proposal*	21,700	17,400	6,200	200	16,500	2,200	10,400	56,100	37,800	3,800

* excluding areas currently designated as ungulate winter range or old growth management area

The two new WHAs designated in the Grandby and Yahk areas in particular protect critical areas of high suitability grizzly bear habitat that have been subjected to high densities of road development and timber harvesting. Both these areas are considered to be critical zones to international corridors for grizzly bears within the Cabinet Purcell Mountain Corridor project coordinated by the Y2Y Conservation Initiative (Proctor, et al., 2012; Yellowstone to Yukon Conservation Initiative, 2010). 3.3.4.5 Grizzly Bear Conservation Strategy

In 1995, the Government of British Columbia published the Grizzly Bear Conservation Strategy that, among other things, committed to maintain the diversity and abundance of grizzly bears and their habitats (Ministry of Environment, Lands & Parks, 1995). An objective stated in the subsequent Kootenay-Boundary Land Use Implementation Plan was to integrate implementation of land use zones with the strategic policy guidance outlined in the provincial Grizzly Bear Conservation Strategy. Accordingly the Implementation Plan identified Grizzly Bear Management Guidelines which included a classification of priority habitats which were derived from habitat suitability indices developed by Fuhr and Demarchi (1994) and a qualitative ranking based on a range of land use priorities. One intention of the Grizzly Bear Management Guidelines was to provide guidance to the formal implementation of land use designations such as new protected areas, wildlife habitat areas, biodiversity emphasis designations through landscape level planning, and identifying connectivity corridors (Ministry of Environment, Lands & Parks, 1995). Subsequently in 2002 the Kootenay Boundary Higher Level Plan Order specified legal objectives for grizzly bear habitat and connectivity corridors.

In order to map grizzly bear management priorities as a basis for evaluating conservation strategies (Figure 3.28), conservation designations were compared to priorities identified in the Kootenay-Boundary Land Use Implementation Plan (Government of British Columbia, 1997) as well as to grizzly bear habitat suitability maps derived from resource selection function maps developed by Carroll, Noss and Paquet

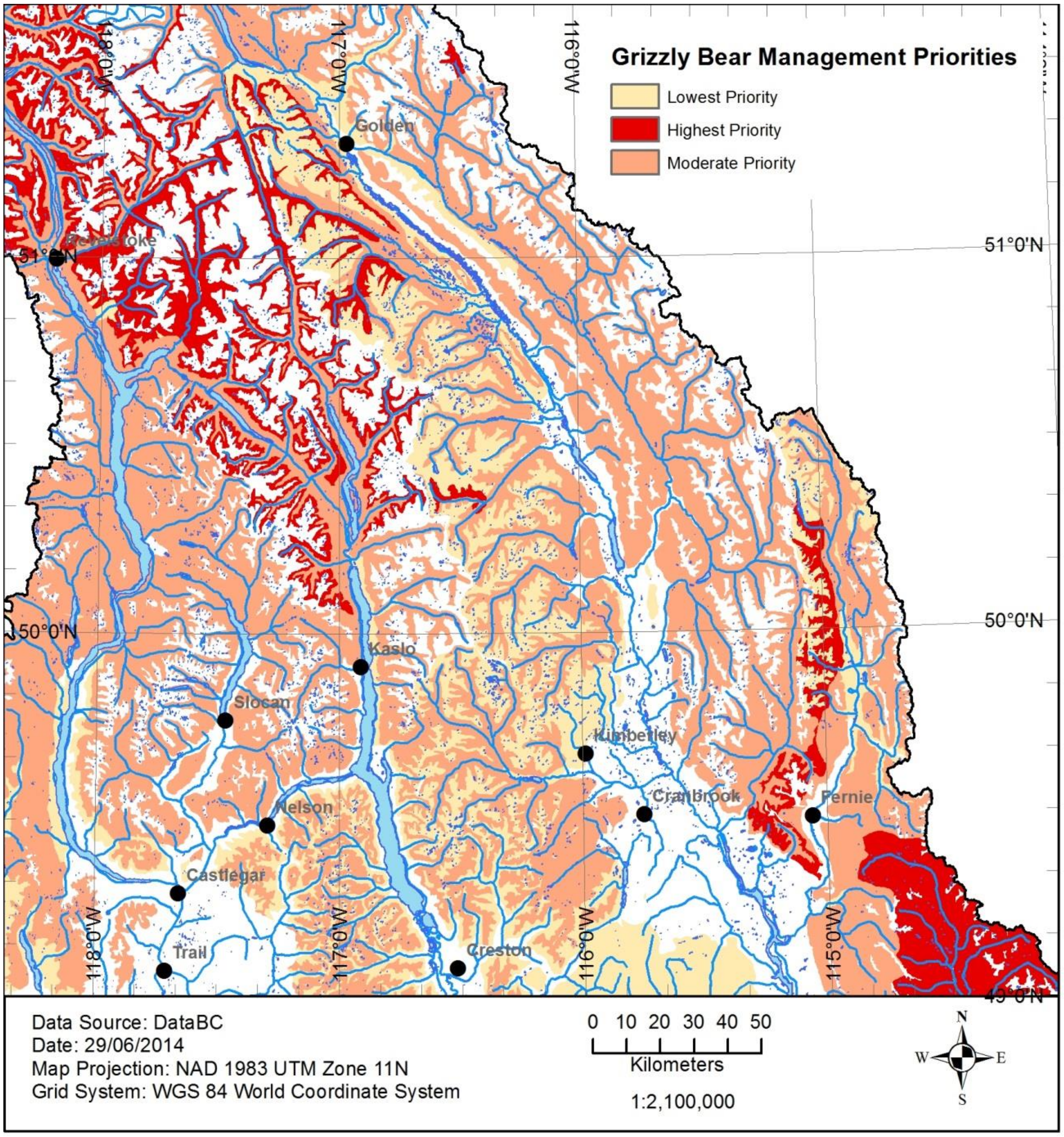

Figure 3. 28: Grizzly Bear Management Priorities Designated in the Kootenay-Boundary Land Use Plan

(2001). The conservation designation layer was overlaid with the spatial layer of grizzly bear management priorities from the 1997 Implementation Strategy. Conservation designations protect 56.6% of the highest priority grizzly bear management priority areas identified in the Implementation Plan, and 67% and 72% of the moderate and lowest priority areas, respectively. Conservation designations protect 68.6% of the high suitability, 67.9% of the medium suitability, and 57% of the low suitability grizzly bear habitat (Figure 3.29).

There seems to be little correlation between grizzly bear management priorities identified in the Grizzly Bear Management Guidelines and the habitat suitability maps derived from Carroll's resource selection function data. Indeed the RSF-based high and

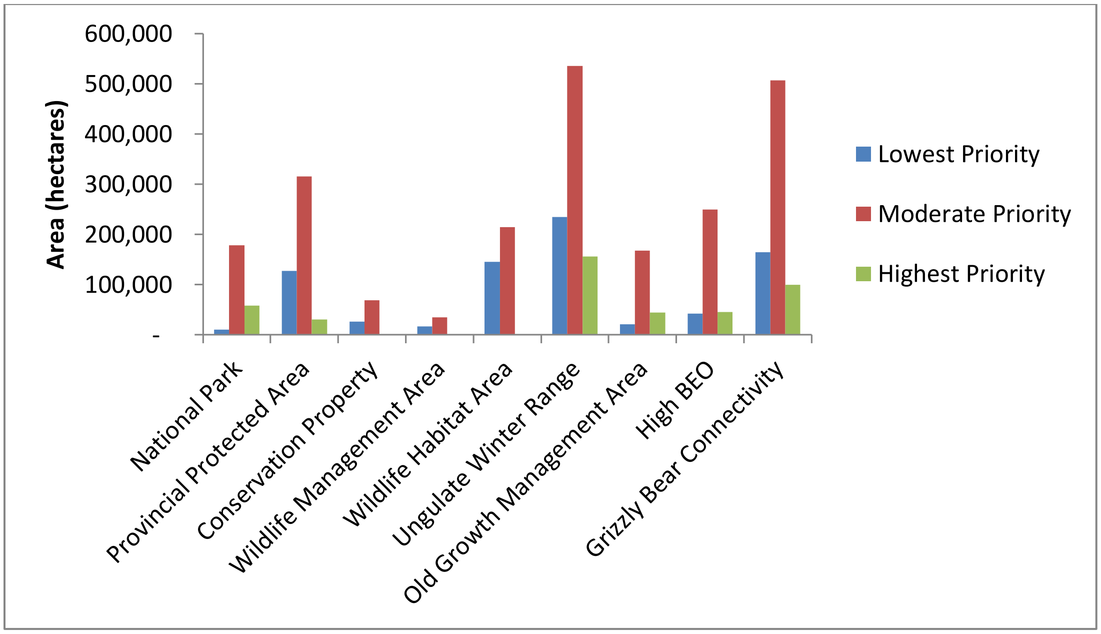

Figure 3. 29: Area (hectares) of Grizzly Bear Management Priorities in Designated Conservation Areas

medium habitat suitability areas most frequently overlap with the lowest grizzly bear management priority areas from the KBLUP-IS (Table 3.14). One explanation for this is in the differences in the two approaches (T. Hamilton, personal communication). Whereas Carroll, Noss and Paquet's (2001) resource selection function ranked habitat suitability based on a correlation between habitat use and factors such as habitat type and proximity to roads and human settlements; priority habitats identified in the Implementation Strategy excluded areas where there would be conflicts with other higher priority land uses such as forestry. It is interesting to note the recent designation of the large Grizzly bear WHA in the Yahk area is located where the RSF habitat suitability rating is high, but the Implementation Strategy ranks this area as low priority.

Table 3. 14: Comparison of Grizzly Bear Management Priorities (Kootenay-Boundary Land Use Plan Implementation Strategy) with Grizzly Bear Habitat Suitability Ratings (Based on the Carroll et al., 2001 Resource Selection Function Model)

	KBLUP-IS Grizzly Management Priorities		
Habitat Suitability (Carrol's RSF)	**Highest**	**Moderate**	**Lowest**
High	20.7%	12.2%	67.1%
Medium	16.7%	15.5%	67.7%
Low	27.7%	16.4%	55.8%

3.3.4.6 Evaluation of Proposals for Expanded Conservation Designations

Two prominent environmental groups operating in the Kootenay-Boundary region, Wildsight and the Valhalla Wilderness Society, have developed separate conservation proposals in the East Kootenay and West Kootenay areas respectively that call for new protected areas and are mapped in Figure 3.30. Each of these proposals were compared to existing conservation designations as well as wildlife resource values in the area. The results of the comparison with carnivore species habitat suitability is presented in Table 3.14 shown in Section 3.4.4.

Wildsight is an environmental advocacy group with interests located primarily in the East Kootenay region. Its conservation priorities include grizzly bear conservation in the Purcell Range and proposals for park expansion and a new wildlife management area in the southern Rockies to provide for wildlife connectivity[111]. Wildsight provided spatial data for their southern Rockies proposal that allows comparison with current conservation designations. Its proposal includes extending the area currently designated

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[111] Wildsight website. Retrieved from http://www.wildsight.ca/programs.

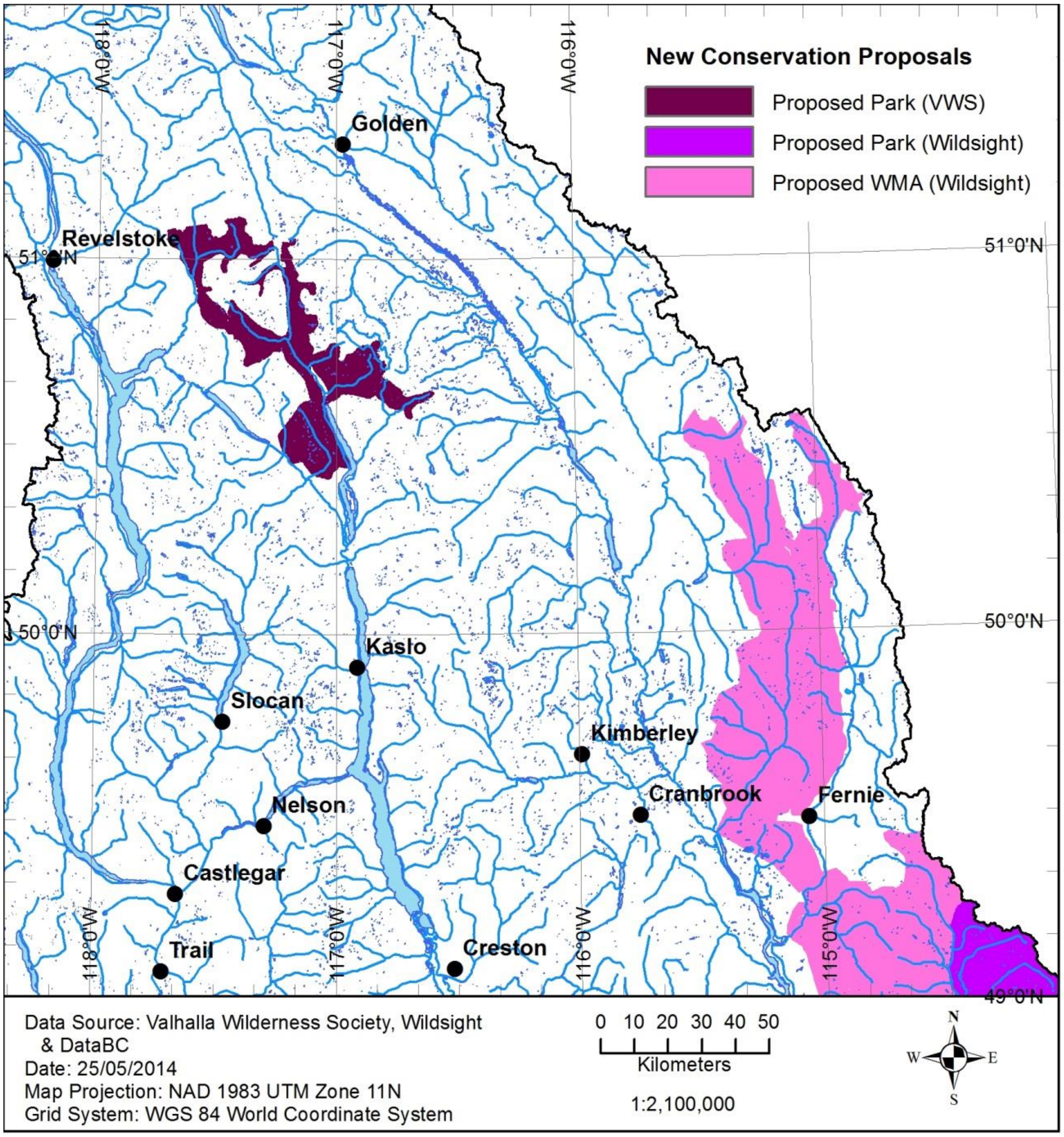

Figure 3. 30: Wildsight and Valhalla Wilderness Society (VWS) Conservation Proposals in the Kootenay Region

as Akamina-Kishinena Provincial Park by approximately 51,000 hectares as an expansion of the Waterton-Glacier International Peace Park. Of this additional area proposed, 98% is currently designated as ungulate winter range, old growth management area or grizzly bear connectivity corridor. Its proposal also includes establishing a 560,000 hectare wildlife management area that would extend from the US border to the Height of the

Rockies and Elk Lakes Provincial Parks, 358,383 ha of which is currently designated grizzly bear connectivity corridor, high biodiversity emphasis, ungulate winter range or old growth management area. The park and wildlife management proposals would add significant areas of high suitability habitat particularly for wolves and grizzly bears, and would provide habitat connectivity between the northern and southern mountain park system on the west slope of the Rocky Mountains, incrementally adding 202,632 hectares or 32.6% to the area protected. At the same time, park and wildlife management area status would incrementally improve on current designations comprised primarily of ungulate winter range, high biodiversity emphasis landscape units and grizzly bear connectivity corridors where varying degrees of resource development is now permitted.

Valhalla Wilderness Society is an environmental group based in New Denver, British Columbia that is involved in advocacy to resolve a number of conservation issues across the province. This group has been especially critical of the provincial government's mountain caribou recovery plan for its failure to protect sufficient habitat (Valhalla Wilderness Society, 2007). In 2011, the Society submitted a proposal to the Province for a 146,914 hectare park (Vahalla Wilderness Society, 2011) centred primarily on the Duncan and Incomappleux river drainages. The spatial data of the proposed areas for designation was provided by the Vahalla Wilderness Society. Of the area proposed, 55.3% is currently designated as either an ungulate winter range for mountain caribou or an old growth management area. The Valhalla proposal would provide protection for an incremental 65,629 hectares in three primarily undeveloped watersheds, the Incomappleux, the Upper Howser and Giegerich/East Creek. However comparison with the Mountain Caribou Science Team habitat suitability maps shows that these three watersheds would protect an incremental 8,619 hectares or only 1% of high suitability caribou habitat within the buffered population units. The most significant contribution of this proposal to wildlife habitat would be the incremental conservation of 56,100 hectares of high suitability wolf habitat and 17,859 hectares of undeveloped old forest.

3.4 SUMMARY

There have been impressive accomplishments, beginning with the Kootenay-Boundary Land Use Plan and subsequent policies implemented by the Province of British Columbia, which provide significant levels of wildlife ecosystem conservation at the site, landscape and regional level in the study region.

One challenge in devising new approaches to wildlife conservation is the common perception that equates conservation only with the creation of parks. Parks frequently allow other uses, are often established with goals other than just ecological conservation, and much of their spatial distribution is concentrated in higher elevation areas. However, other designations including Wildlife Habitat Areas, Ungulate Winter Range, and Old Growth Management Areas offer more flexible approaches. Their advantage is that they allow resource development to varying degrees, but also provide a significant contribution to better representation of ecosystem types, restricting non-compatible resource development, establishing legally enforceable conservation targets and management requirements, and providing opportunities to restore disturbance on the landscape given the advent of modern fire suppression programs. Their use in protecting large areas of critical wildlife habitat by creating landscape and regional connectivity across the region promises a particular benefit. On the other hand, no mechanisms have been put into place which would allow an assessment of the efficacy of integrated management approaches to conservation management.

Current and historical land uses permeate the region, with only very small areas of lower elevation ecosystems remaining undisturbed by extensive human use. Private conservation properties owned by conservation land trusts and the provincial government protect key low elevation wildlife habitat areas, which have been identified as conservation priorities in the Nature Conservancy of Canada's (NCC) Canadian Rocky Mountains Ecoregional Assessment (CRMEA) (Nature Conservancy of Canada, 2004). However significant gaps exist. Land ownership in these identified areas include privately owned land and provincial crown land with an extensive resource allocation and development history. The ‘East-West Connectivity North’ unit identified by NCC is heavily impacted by timber harvesting along its north-eastern quadrant where this unit overlaps with Tree Farm License # 14 within the Bobbie Burns drainage. An east-west grizzly bear connectivity corridor has been designated in the Spillamacheen, which is the next drainage north of Bobbie Burns.

The Valhalla Wilderness Society has proposed a corridor linkage on the southern boundary of NCC’s proposal that would provide important habitat linkages between the Upper Duncan drainage and Bugaboo Provincial Park including the Giegerich, East Creek, and the upper Howser drainages. This would connect a number of OGMAs that provide discontinuous habitat contributing to this linkage zone along the southern half of the East Creek drainage and the upper Howser. These drainages consist primarily of old growth forests with no timber harvesting. The controversial Glacier-Howser hydropower and the Jumbo Glacier ski resort proposals are located in the vicinity to the south of the CRMEA linkage and Valhalla park proposals. The portion of the unit east of the park in the upper Bugaboo drainage is moderately impacted by timber harvesting, contains the access road to the park and a commercial resort, and conservation is limited to a number of identified OGMAs. The lower reaches of the Templeton and Dunbar drainages are within UWR. The Incommappleaux River area has been identified by the Valhalla Wilderness Society as a significant area that would conserve an additional 65,629 hectares not currently conserved through any of the current designations. The Valhalla proposal areas, not otherwise currently designated, would protect areas that are currently relatively unroaded and would conserve areas high habitat suitability for wolves and grizzly bear, and medium suitability for both caribou and wolverines. Other areas proposed by the Vahalla Wilderness Society in the Incomappleux River, East and Giegerich Creeks, and the upper Howser drainages would conserve small pockets of high suitability old growth habitat for mountain caribou. Protecting the Incomappleux drainage would improve connectivity between the Nakusp and Duncans herds with the Columbia South herd to the north.

The Wildlife Management Area proposed by Wildsight has the potential to add new conservation areas that would also provide important habitat connectivity and protect large areas of high capability for grizzly bears, lynx, wolverine and wolf, and smaller areas of high and medium capability habitat for fisher.

Caribou numbers are rapidly and significantly declining primarily as a result of wolf predation and are unlikely to recover to the population targets established in the Mountain Caribou Recovery Implementation Plan without an effective predator management program being implemented in concert with reintroductions based on translocation or captive breeding. The large areas designated as ungulate winter range for the conservation of mountain caribou habitat provides important habitat conservation for a range of other species including grizzly bears, wolves and wolverines.

The two large wildlife habitat areas designated in the Arrow-Boundary district (WHA 8-373) and in the Yahk area (WHA 4-180) establish general wildlife measures on 536,315 ha and 92,835 ha, respectively by requiring protection of grizzly bear security and foraging habitat from road construction and forest management activities. Both of these areas have some of the highest densities of roads and forest harvesting in the region. Proctor, et al. (2012) found that the Purcell South Yahk population is declining at 3.9% annually due to habitat fragmentation and is unlikely to be viable over the long-term without habitat connectivity or population management measures being implemented. Within WHA 8-373, a number of core grizzly bear wildlife habitat areas which only amount to 5,036 ha have been designated which preclude both roads and forestry activities. A monitoring program needs be initiated to evaluate the effectiveness of these large buffer areas in supporting resilient populations of grizzly bears in the future.

In 2013, the Nature Conservancy of Canada added the Frog Bear Conservation Corridor through purchase of 150 hectares of land and a conservation covenant that provides connectivity between grizzly bears in the Selkirk and Purcell Mountains[112]. Ongoing monitoring will be needed to evaluate how effective these designations are in the conservation of grizzly bears in the region.

Category 2 and 3 conservation designations permit varying degrees of industrial resource management activities. Wildlife habitat areas and ungulate winter range are guided by general wildlife measures that are legally enforceable under the *Forest and Range Practices Act* and the *Oil and Gas Activities Act*. High biodiversity emphasis landscape units and grizzly bear connectivity corridors establish targets for old and mature forest stands that are legally enforceable under the Kootenay-Boundary Higher Level Plan Order. Ensuring compliance with such measures and targets is the obligation of the Ministry of Forests, Land and Natural Resource Operations. It is not apparent from reviewing a number of Forest Licensee Forest Stewardship Plans what measures are in place to ensure compliance with these requirements.

This conservation analysis has shown significant gaps in implementing conservation measures on the ground including:

1. ~20% of special management zones identified in the original Kootenay Boundary Land Use Plan not designated,
2. ~ 30% of the coarse-filter conservation priorities and 2/3 of the fine-filter target occurrences identified in the Nature Conservancy in the Canadian Rocky Mountains Ecoregional Assessment not designated,
3. only 49% of high suitability mountain caribou habitat protected, compared to the 95% target established in the Mountain Caribou Recovery Implementation Plan,

[112] Nature Conservancy of Canada website. Retrieved from http://www.natureconservancy.ca/en/where-we-work/british-columbia/featured-projects/frog-bear/.

4. a lack of suitable connecting habitat has particularly isolated the Selkirk and Purcell mountain caribou herds, and
5. protection of high suitability and connectivity habitat for other species, particularly for grizzly bears and wolverines.

The analysis also shows a relatively poor representation of lower elevation ecosystems in Category 1 conservation designations, and a lack of systematic evaluation of the effectiveness of Category 2 and 3 designations that comprise the majority of conservation implemented for such ecosystems. The effectiveness of Category 3 designations which are reliant on integrated delivery mechanisms through forest licensees' government-approved Forest Stewardship Plans is especially called into question in light of recent findings of the Forest Practice Board (2015) indicating a lack of consistency, measurability and accountability of such plans.

The Ministry's Forest and Range Evaluation Program is mandated to evaluate the effectiveness of forest and range practices in meeting these management objectives. To date FREP has not conducted a systematic review of the effectiveness of these conservation measures, although a methods guide to evaluate the effectiveness of wildlife conservation mechanisms has recently been published (Paige, Darling, & Pickard, 2014). No systematic review of the effectiveness of these measures in meeting their intended objectives has been conducted.

Given the investment in planning, the on-going economic implications of such constraints, and the global significance of wildlife in this region this would seem to be an obvious priority. With the demise of ongoing government-mandated planning at strategic or landscape scale, complexity of land uses and conservation policy gaps identified here, there is a clear need for a systematic review towards responsive strategies to protect wildlife in the face of both current developmental pressures and future climate change impacts.

Chapter Four – Predicting Wildlife Ecosystem Change: An Analysis of Climate Change Impact Scenarios

4.1 INTRODUCTION

There is increasingly widespread concern about impacts on the natural environment from recently observed and predicted changes in climate attributed to anthropogenic emissions of greenhouse gases, primarily carbon dioxide.

> It is now clear that climate change is the major new threat that will confront biodiversity this century, and that if greenhouse gas emissions run unchecked until 2050 or beyond, the long-term consequences for biodiversity will be disastrous. (Lovejoy & Hannah, 2005, p. xiv)

The Intergovernmental Panel on Climate Change (IPCC) has concluded that "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC, 2007a, p. 30). Increased atmospheric concentrations of CO_2 from the combustion of fossil fuels, deforestation and agricultural land use are estimated to be responsible for a global average temperature increase of 0.7^{o} Celsius over the past 100 years, with increases of between 1.8^{o} to 4.0^{o} C estimated by the end of the century depending on assumptions on different rates of future industrial atmospheric emissions (IPCC, 2007a).

The IPCC further concludes that "natural systems across the planet are being affected by regional climate changes, particularly temperature increases" (IPCC, 2007b, p. 8), and that the "resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g., flooding, drought, wildfire, insects, ocean acidification), and other global change drivers (e.g., land use change, pollution, over-exploitation of resources)" (IPCC, 2007b, p. 11). Major changes are projected for ecosystem structure and function, species' ecological interactions, and species' geographical ranges. Approximately 20-30% of plant and animal species are considered to be at risk of extinction from these impacts (IPCC, 2007b).

Changing climatic conditions can be expected to affect ecosystems through complex alterations to the abiotic environment, biotic relationships and disturbance dynamics. Such changes have significant potential to affect habitat and resource availability, shift the range and distribution of species, impact population demographics, and disrupt community interactions, among other things. Species will adapt and evolve to changing environmental conditions, disperse and migrate to suitable environments, or go extinct (Hewitt & Nichols, 2005). Recent changes in climate have been observed to affect species populations and life history traits, result in shifts in geographic range, alter species composition of communities, and have resulted in changes in the structure and functioning of ecosystems (McCarty, 2001). Observed changes in recent decades have been linked to population declines, and both local extirpation and global extinction of species (Parmesan, 2006; Walther et al., 2002; McCarty, 2001; Hughes, 2000). Considering that the strong scientific consensus is that global temperatures will increase by many times this recent rate of warming, perhaps to a degree unprecedented in perhaps the past two million years (Barnosky, Hadly, & Bell, 2003; Morrison, Marcot, & Mannan, 2006), the future implications of climate change on ecosystems and species is very significant.

Quite apart from the need to mitigate global warming by controlling and reducing greenhouse gas emissions into the atmosphere, there is a clear need to develop adaptation strategies at the ecosystem and species level. Such strategies should be based on an understanding of ecosystem dynamics in order to manage impacts, to the extent that may be practical or even possible. In British Columbia, climate change is predicted to have significant ecological effects over the next century (Spittlehouse, 2008; Murdock, Fraser, & Pearce, 2007; Hamann & Wang, 2006). As this jurisdiction has become the North American refugium for multi-species mega-fauna since European colonization (Laliberte & Ripple, 2004), British Columbia has a global-scale responsibility to conserve large mammal wildlife diversity. A number of incremental conservation and restoration intervention measures have been proposed to mitigate climate change impacts on wildlife ecosystems (Mawdsley, O'Malley, & Ojima, 2009; Heller & Zavaleta, 2009; Gayton, 2008; Morrison et al., 2006; Inkley et al., 2004; Noss, 2001). Recommended measures include:

- substantial efforts at protecting habitat from further loss and fragmentation from resource development;
- implementing connectivity on the landscape to enable species migration;
- employing habitat restoration to repair damaged critical habitat areas and to re-establish natural ecosystem disturbance processes; and
- direct interventions such as augmenting populations through translocation or controlling population dynamics through animal culls.

Since implementing interventions to mitigate the impacts of climate change will be controversial and expensive, and since their efficacy is highly uncertain, better understanding of ways in which public policy can evolve to support interventions is central to the overall research question for this dissertation.

Scenarios based on climate change predictions offer a means of assessing the vulnerability of ecosystems as a basis for gauging stakeholder support for interventions. Towards this end, the research presented in this chapter addresses two questions:

1) What is the potential scope of climate change impacts on wildlife ecosystems in the Kootenay Region?
2) How can spatialized wildlife ecosystem scenarios inform conservation decision-making and what are the limitations?

To project the scope of potential implications of climate change for wildlife, future habitat suitability models for two wildlife species (mountain caribou and wolverine) were developed, based on scenarios of climate change. Future habitat availability was assessed for four additional species (grizzly bear, fisher, lynx and wolves) based on a bioclimate ecosystem change model. These modelled climate change and habitat suitability scenarios were then presented to study participants in a workshop (see Chapter Five) designed to assess factors affecting stakeholder support for conservation.

4.2 MODELLING CLIMATE CHANGE IMPACTS ON ECOSYSTEMS AND WILDLIFE

As the current rate of temperature warming predicted over the next century far exceeds anything experienced over the past 100,000 years (Overpeck, Cole, & Bartlein, 2005), an extensive literature relating to both cause and effect has come together in the past two decades. This study's particular focus within this broad discourse has been the anticipated impacts on ecosystems in western North America and, more specifically, on current projections for change in the study area.

4.2.1 Climate Change Impacts Research

Given that climate is the major factor controlling global patterns of vegetation and animal species distribution (IPCC, 2002), such changes can be expected to affect ecosystems and therefore wildlife in significant ways. Climate encompasses the energy and moisture regime in an area, and is characterized by solar radiation, diurnal and seasonal temperatures, precipitation type and quantity, humidity, day length, available soil moisture, and wind regime all of which can affect living organisms. Organisms exist in all of earth's very diverse climates, including desert, tropical rainforest, grassland, temperate rainforest, cold boreal forest, alpine and tundra biomes. Species have adapted to survive, forage and reproduce in these environments. Such adaptations include specialized morphology, physiology and life history characteristics including seasonal phenologies, reproductive strategies, resource utilization and defence mechanisms, migration and dispersal capabilities, and complex trophic and community interactions (Morrison, Marcot, & Mannan, 2006).

Understanding how ecosystems and species will respond to changing climatic conditions requires a perspective that views ecosystems as dynamic, non-linear, and evolutionary. Climate change will affect species abundance, range and distribution, behaviour, phenology, and genetic adaptation (Root & Schneider, 2002). The distribution, abundance, and dynamics of a population in a landscape are influenced by species attributes, habitat attributes, and other factors (Morrison, Marcot, & Mannan, 2006). Critical species attributes to consider include movement and dispersal patterns, habitat specialization, metapopulation dynamics, and population genetics. Habitat attributes include quality, size, spacing, connectivity, and fragmentation of habitat patches and the resulting availability and distribution of food, water, and cover. Other factors include a host of environmental conditions such as influences from other species (eg. competition, predation and mutualism), environmental stochasticity, and human disturbance. Species will respond to changing environmental conditions according to their individual tolerances to those changes as well as the tolerances of other species on whose survival they may depend, and significant change could result in significant restructuring of ecological communities (Morrison, Marcot, & Mannan, 2006; Inkley et al., 2004). The faster the rate of climatic change, the higher the probability of substantial disruption of ecosystem structure and function and surprise within natural ecosystems, and the greater risk of serious ecosystem degradation (Markham, 1996).

There is significant evidence that ecosystems are responding to recent global warming. Based on a review of 44 published studies, which included 59 plants, 47 invertebrates, 29 amphibians and reptiles, 388 birds, and 10 mammal species, the IPCC (2002) concluded ~80% showed change in the biological parameter measured (eg. start and end of breeding season, shifts in migration patterns, shifts in species distributions, and changes in body size) in a manner expected with global warming. Parmesan (2006) concludes that about half of the 1600 species included in her review exhibited significant phenological and distributional changes in the past 20 to 140 years as a direct result of climate change. Walther et al. (2002), McCarty (2001), and Hughes (2000) have documented evidence of phenology effects, range shifts, and changes in community dynamics in response to changes in climate in the 20th century.

The International Union for Conservation of Nature (IUCN) conducted assessments of species susceptibility to climate change and found 35% of world’s birds and 52% of amphibians are susceptible to climate change impacts (Foden et al., 2008). It observed that species with generalized and unspecialized habitat requirements are likely to be able to tolerate a greater level of climatic and ecosystem change than specialized species. Species may be more susceptible to habitat conditions during sensitive life stages (eg. egg-laying or natal stages). The physiology and ecology of many species is tightly coupled to very specific ranges of climatic variables, and those with narrow tolerance ranges are particularly vulnerable to climate change. Even species with broad environmental tolerances and unspecialized habitat requirements may already be close to thresholds beyond which ecological or physiological function quickly breaks down. Foden et al. (2008) in their IUCN report outline a number of the potential effects on species from climate change including phenological desynchronization, uncoupling of species interactions (trophic relationships, pollination, mutualism, community dynamics), loss of habitat, increased physiological stress, susceptibility to disease, pestilence and competition, changes to species range and distribution, and impacts on population demography and genetic diversity. Hughes (2000) categorizes such effects of climate change on species into effects on physiology (photosynthesis, respiration, growth, etc.), effects on phenology (timing of biological phenomena), effects on distribution, and adaptation. These species-level effects in turn are expected to interact to produce potentially complex change at both the species and ecosystem community level resulting in possible changes to community structure and composition (Hughes, 2000).

In the Northern Hemisphere it can generally be expected that the geographic range of plant and animal species will shift northward in latitude and upwards in elevation in response to predicted climate changes. A 3^{o}C change in mean annual temperature corresponds to a shift in isotherms of approximately 300–400 km in latitude or 500 m in elevation (Hughes, 2000). Such range shifts of plants are likely to depend on availability of suitable soil conditions and dispersal mechanisms, and similarly range shifts of wildlife will depend on availability of suitable habitat, habitat connectivity, dispersal capability, and competitive and trophic interactions (Inkley et al., 2004). Shifts in geographical distributions of species have been observed both in the present and the past (Martinez-Meyer, Peterson, & Hargrove, 2004). Particularly dramatic climate change has occurred since the Last Glacial Maximum (ie. 18,000 years before present), with numerous species moving hundreds of kilometres as climates warmed (Lyons, 2003). A meta-analysis of range boundary changes in the Northern Hemisphere by Parmesan and Yohe (2003) estimates that northern and upper elevational boundaries have moved on average 6.1 km per decade northward and 6.1 m per decade upward in elevation over approximately the past one hundred years. For example, upward movement of treelines has been observed in Canadian Rocky Mountains, where temperatures have risen by 1.5^{o}C (Luckman & Kavanagh 2000).

Hutchison defines the ecological niche of a species as the range of environmental and biotic conditions within which its populations can persist (Hutchison, 1957, cf. Martinez-Meyer, Peterson, & Hargrove, 2004) and projects that in the face of environmental change, species will either tolerate or adapt to changing conditions, move to track niches spatially, or otherwise face extinction. Martinez-Meyer, Peterson and Hargrove (2004) model ecological niches for 23 mammal species, and predict geographical distributions shifts since the Last Glacial Maximum across the conterminous US states. The results of this study thus indicate that many species have not changed in their ecological niche characteristics over the past 18,000 years. They conclude,

> Ecological niches represent long-term stable constraints on the distributional potential of species; indeed, this study suggests that mammal species have tracked consistent climate profiles throughout the drastic climate change events that marked the end of the Pleistocene glaciations. Many current modelling efforts focusing on anticipating climate change effects on species' potential geographical distributions will be bolstered by this result — in essence, the first longitudinal demonstration of niche conservatism. (p. 305).

McDonald and Brown (1992) developed a quantitative model to estimate extinctions of 14 small boreal mammal species among nineteen isolated mountain ranges in the Great Basin. Their model predicts that global warming of 3^{o}C will result in the loss of 9-62% of the species inhabiting each mountain range and the extinction of 3 of 14 species through the region, suggesting that environmental change could seriously threaten the survival of species that are restricted to isolated “habitat islands” (ie. mountain tops or biological reserves). Guralnick (2006) reviewed niche utilization of 21 mammal species from a variety of taxonomic orders, and concludes that populations appear to occupy niche environments close to temperature conditions similar to those at the core of their range. He suggests that recolonization during climate changes may be limited to regions similar to the range core and adaptation to new conditions may not occur quickly so that new conditions cannot be exploited.

Peterson, et al. (2002) apply ecological niche models developed for 1,870 faunal species occurring in Mexico to predict future species ranges based on predicted environmental change. They identify three main assumptions of future species range occupancy:

- universal dispersal – where species will occupy all of their potential future range;
- contiguous dispersal – species will only occupy areas adjacent to their current range; and
- no dispersal – species will only occupy their future range where it overlaps with their current range.

Their results indicate relatively few species extinctions and drastic range reductions; however a greater than 40% species turnover in some local communities is predicted, suggesting that severe local ecological perturbations may result. They conclude that, “although only limited numbers of species will face entirely unsuitable conditions for persistence, others will experience drastic reductions and fragmentation of distributional areas, or extend their distributions, creating new natural communities with unknown properties” (Peterson, et al., 2002, p. 628). No significant differences were found in this study between taxonomic groups (mammals, birds, and butterflies) in expected severity of effects on species’ distributional areas.

Peterson (2003) applies the ecological niche mapping approach to predict the influence of topography on bird species distributions in the montane and Great Plains regions of central and western North America. This study found that bird distributions were significantly more influenced by climate change for plains species than montane species, and concludes that this results from the difference in the area changed by a comparable change in temperature in montane versus plains topography. A change in temperature in montane regions is realized over much shorter distances in mountainous topography as compared to flat terrain due to adiabatic cooling with increasing elevation. In other words, plains species need to disperse further in areas of flat topography to maintain the same regime given a change in temperature.

The responses of individual organisms begin the cascade of ecological processes that are manifest as changes across landscapes, biomes, and globally (Hansen, et al., 2001). Hansen and Dale (2001) suggest substantial change in species and communities. Forested area in the conterminous United States is projected to decrease by an average 11%, with lost forest replaced by savannah and arid woodland biome types. Several community types are projected to decrease significantly, including alpine habitats, sagebrush, and subalpine forests. In the western US western hemlock are projected to decrease west of the Cascade Mountains and expand into mountain ranges in the interior. Ponderosa pine is predicted to expand in this area as well. The potential habitats for most eastern species are projected to move northward by 100-530 km. While the ranges of many taxa in the West shift northward, topographic complexity results in some conifer species associated with mesic climates shifting south and east along the Rocky Mountains. The complex topography in the West results in many current tree populations being disjunct. Potential species richness is projected to increase for trees, reptiles, and amphibians, particularly in the coldest portions of the US; while potential bird and mammal species richness is projected to decrease in the southern US, but increase to the north (Currie, 2001). The pace of climate change is likely to exceed the natural dispersal rates of several species (Hansen & Dale, 2001). Thus, these species are not expected to reach newly suitable habitats without human intervention. Rapidly dispersing weedy species may dominate these new habitats, leading to entirely new community types. Actual patterns of dispersal are likely to be influenced by factors that interact with climate, including disturbance regimes and human land use.

Concurrent with the growing research on climate change impacts in the western US, researchers in British Columbia have focussed on dynamics observed and predicted across the province. Hebda (1998 & 1997) outlines potential ecosystem changes which could result from predicted levels of climate change in British Columbia, including:

- coastal Douglas fir dominated stands expanding at the cost of Western hemlock forests;
- expansion of Sitka spruce into western hemlock;
- mountain hemlock zone shrinking as western hemlock expands up slope;
- interior steppe and pine savannah vegetation expanding up slope and northward displacing Interior Douglas-fir ecosystems northward and up slope; and
- merging of montane spruce and Engelmann spruce - subalpine fir vegetation.

Central interior zones may expect expansion of steppe vegetation and interior Douglas fir dominated stands at the expense of lodgepole pine and spruce. Further north, white spruce and lodgepole pine are likely to predominate whereas black spruce will become less abundant, and forest will invade alpine and arctic tundra and shrub tundra communities. However Noss (2001) suggests that mature trees will lag behind changes in climate for as much as several centuries.

Bunnell and Squires (2005) found pronounced changes in arrival and departure dates among several species of birds examined for British Columbia. Analysis shows that most species analyzed were arriving 3.8 to 7.6 days earlier per decade. They were also able to show northward expansion in several species.

Hamann and Wang (2006) developed an ecosystem-based climate envelope modeling approach to assess the potential climate change impact on forest ecosystems in British Columbia. This modelling approach predicts the potential for significant ecosystem change in BC by the end of the century, forecasting considerable expansion of the climatic envelope for bunchgrass, interior cedar hemlock, interior Douglas fir, and ponderosa pine climate regions throughout the interior plateau replacing the current climate space of sub-boreal and boreal ecosystems. Ecosystems in mountainous areas shift out of their current climatic envelope within 50 years. Coastal Douglas fir, a species with a limited range in south-western British Columbia and threatened by forestry and human development, is expected to significantly expand on the British Columbia coast. All ecosystem zones move significantly upwards in elevation, and most all move northwards. Actual ecosystem shifts will depend on individual species reproductive and dispersal capabilities, community successional dynamics, trophic interactions, and disturbance regime. None-the-less, it seems clear that ecosystems will experience significant changes in the next century as a result of warming temperatures.

Conclusions based on these studies include that there is irrefutable evidence of climate change occurring, and that significant, complex and largely unpredictable changes to wildlife ecosystems to be expected. The challenges of modelling such change is discussed in the next section.

4.2.2 Limitations to Modelling Climate Change Impacts on Wildlife Species Distribution

While the researchers have projected a range of impacts resulting from climate change across the province, implications of potential ecosystem change on faunal distribution in British Columbia have not been assessed extensively. However, the review prepared by Thuiller, et al. (2006) on the vulnerability of mammal populations to predicted climate change in Africa, using a climate-ecosystem modelling approach similar to Hamann and Wang's (2005) analysis, offers a useful guideline. Assuming no species dispersal, between 25% to 40% of species are projected to fall within critically endangered or extinct categories by 2080 and, assuming unlimited species dispersal, this range would be approximately 10–20%. They also found contrasting spatial latitudinal patterns of richness loss and a westward range shift of species around the species-rich equatorial zone in central Africa, and an eastward shift in southern Africa, mainly because of latitudinal aridity gradients. They conclude that the effects of global climate change on wildlife communities may be most noticeable, not as a loss of species from their current ranges, but instead as a fundamental change in community composition.

Ecological niche modelling has been criticized by Barnard and Thuiller (2008), Davis, et al. (1998), and others. Bernard and Thuiller (2008) argue that realized niches, while easily modelled, are not easy to project into the future or in space since they do not represent the full environmental capabilities of species that should be closer to the fundamental niche. Davis, et al. (1998) suggest that distributions of species also reflect the influence of interactions with other species, so predictions based on climate envelopes may be very misleading if the interactions between species are altered by climate change. They argue models incorporating dispersal and species interactions will be required for adequate predictions of the consequences of global warming. The variation in range shift between species, and community and population dynamics is likely to result in novel community structures that may not have any contemporary analog. Schmitz, Post, Burns and Johnston (2003) criticize range distribution modelling of climate-driven ecosystem change as it does not consider implications of trophic interactions. They argue that such modelling approaches will often provide conservative estimates of climate change effects on ecosystems because they do not consider the interplay and feedback among higher trophic levels in ecosystems, which may have a large effect on plant species composition and ecosystem productivity. They criticize the range distribution modelling approach because it assumes ecosystems are driven by dominant plant life forms, ignoring the effects of animal species at higher trophic levels (ie. herbivores and carnivores) on ecosystem structure and function. Top-down and bottom-up trophic effects can rapidly result in ecosystem restructuring as a result of changing climatic conditions (Post, Peterson, Stenseth, & McLaren, 1999). The assumption that animal species will distribute themselves geographically by passively following the range shifts of plants in their habitats is not evident with most mammal species during the last episode of rapid climatic warming at the Pleistocene–Holocene transition where extinctions were widespread (Schmitz, Post, Burns, & Johnston, 2003).

Species distribution models need to incorporate the effects of competition, facilitation, pollination, herbivory, predation, parasitism and symbiosis in order to anticipate species niche potential and distribution following climate change (Guisan & Thuiller, 2005). Animal species with high reproduction rates, which can disperse over long distances, rapidly colonize new habitats, and readily use new forage or prey species, tolerate humans, and survive in a broad range of physical conditions, will be most successful in finding and using new niches, while survival, distribution, and abundance of plant species will depend on good health and access to appropriate soil types, migratory pathways, pollinator species, and asexual and sexual reproduction (Gray, 2005).

Peterson (2003) argues that these concerns raised that niche models are limited by confounding effects of species' interactions was not evident in their results and other studies which show the ability to predict species shifts and longer term phenomena (eg. Pleistocene-to-recent comparisons, and phylogenetic comparisons). Bioclimate envelope models have been used to predict potential range shifts that species could experience with changing climate conditions (Hannah, et al., 2008; Hannah, Midgeley, Hughes, & Bomhard, 2005; Hannah, et al., 2002a; Hannah, Midgley, & Millar, 2002b). By applying climate envelope correlation analysis, Currie (2001) predicts the richness of vertebrate ectotherms will increase over most of the conterminous United States. Mammal and bird richness are predicted to decrease in much of the southern US and to increase in cool, mountainous areas. Green, et al. (2008) were able to demonstrate that a climate envelope model was able to predict population trends of 42 bird species in the United Kingdom in response to climate trends. A study by Lawler, White, Neilson and Blaustein (2006) investigating bioclimate modelling predictions of 100 mammal species range response to climate change found a bioclimate modelling approach correctly predicted >99% of current absences and 86% of current presences. Lawler, et al. (2009b) used a random forest bioclimate modelling approach correlating climate parameters to species distributions which found the impact that climate projections based on a relatively low greenhouse-gas emissions scenario results in the local loss of a least 10% of the vertebrate fauna over much of North and South America. These studies conclude that despite limitations of the bioclimate modelling approach, there will be substantial changes in the distribution ranges of vertebrate fauna due to climate change over the next century which will profoundly alter ecosystem functioning.

4.3 ASSESSING POTENTIAL CLIMATE CHANGE IMPACTS ON WILDLIFE ECOSYSTEMS IN THE KOOTENAY REGION

In order to assess the potential scope of climate change impacts in the Kootenay Region as a basis for formulating spatialized wildlife ecosystem scenarios for the study area, the ClimateWNA[113] software model was used to evaluate shifts in biologically relevant climatic parameters (Mbogga, Hamann, & Wang, 2009; Wang, Hamann, Spittlehouse, & Aitken, 2006; Wang, Hamann, Spittlehouse, & Murdock, 2012a), and as input to bioclimate and habitat suitability models. Historical climate trends in the study area are described in Section 4.3.1. These were assessed by reviewing observational records at climate stations operated by Environmental Canada[114], and spatial projections of historical and predictions of future climate trends using the ClimateWNA model. In Section 4.3.2 the ClimateWNA model is used to spatially predict seasonal biologically relevant climate parameters for the 2020, 2050, 2080 time periods for four emissions modelling scenarios.

The Random Forest bioclimate model developed at the University of Alberta (Mbogga, Wang, & Hamann, 2010; Roberts, 2013) was used to predict future biogeoclimatic conditions in the Kootenay region. Future projections of habitat suitability in the West Kootenay region for mountain caribou and wolverine are described in Sections 4.3.4 and 4.3.5 based on the A1B future scenario for 2080. Mountain caribou habitat suitability was projected, based on adjusting ecological parameters in the Bayesian Belief Network (BBN) mountain caribou habitat suitability

[113] Climate WNA software is available at: http://cfcg.forestry.ubc.ca/projects/climate-data/climatebcwna/.

[114] Climatic data was downloaded from Environment Canada. Retrieved from http://climate.weather.gc.ca/

model described in McNay and McKinley (2007), using the output from the reclassified Random Forest output. The BBN model had been used as the basis of the habitat suitability mapping developed by the Mountain Caribou Recovery Science Team for the Mountain Caribou Recovery Implementation Plan (MCRIP). Spatial 100 m grid resolution habitat suitability output from this model and copies of the Netica Bayesian Belief Network[115] models for early winter and late winter were provided for use in this study courtesy of Dr. Steve Wilson who chaired the Science Team. Wolverine habitat suitability was modelled following Copeland, et al. (2010) based on projections for late spring snowpack and August maximum temperature from ClimateWNA. Future habitat availability for 5 mammal species (grizzly bear, fisher, lynx, wolf and wolverine) is inferred in Section 4.3.6 by comparing resource selection function data for these species from Chapter Three with shifting bioclimate ecological zones.

4.3.1 Historical Climate Trends

As a starting point for assessing the potential scope of climate change impacts in the Kootenay Region, the nature of historic climate dynamics were analyzed to identify influential patterns. Murdock, Fraser and Pearce (2007) conducted an analysis of historical and projected future climate trends across the Columbia Basin. They found annual mean temperature basin-wide increased by 1.4 ^{o}C and annual precipitation increased 26% over the 90-year period from 1913 to 2002. Future climate conditions were predicted from an ensemble of global climate models using a range of plausible greenhouse gas emission scenarios. Their analysis projects a 'most likely' climate change scenario with annual mean temperature warming trends for the 2020, 2050, and 2080 normal periods of 1.3 ^{o}C, 2.6 ^{o}C, and 4.3 ^{o}C, respectively, and increased annual precipitation for the same periods of 2%, 3%, and 7%, respectively. However their analysis projects summers for the region to be 5 – 16 % drier by the 2050s.

[115] Norsys Software Corp. Retrieved from https://www.norsys.com/netica.html.

Seasonal historic and projected future trends were compared at the Kaslo climate station location as a basis for understanding the implications of climate trends on wildlife ecosystems in the study and to assess application of the ClimateWNA model. This station has had a continuous observation record from 1913 to 2006. Kaslo is centrally located in the centre of the study area on the northern arm of Kootenay Lake. This station was used to evaluate long-term climate trends as a comparison with projections of climate change to the end of the 21st century. Trend analysis over the period record was calculated using linear regression. Since 1913, annual mean temperature at Kaslo has increased approximately 1.5 °C, and annual precipitation has increased by 34%. Seasonal mean temperature and monthly mean precipitation trends are presented Table 4.1, and in Figures 4.1 and 4.2, respectively. There is significant

Table 4. 1: Kaslo Climate Station Temperature and Precipitation Trends Over 1913-2006 Period of Record

Parameter	Change Over 1913-2006 Record	Standard Deviation	Trend (per decade)
Winter Tmean	2.0 °C	1.5 °C	0.22 °C
Spring Tmean	1.6 °C	1.2 °C	0.17 °C
Summer Tmean	1.3 °C	0.9 °C	0.14 °C
Autumn Tmean	0.8 °C	0.9 °C	0.09 °C
Annual Extreme Tmax	1.8 °C	1.9 °C	0.19 °C
Annual Extreme Tmin	2.5 °C	4.0 °C	0.27 °C
Winter Monthly PPT	18 mm	26.3 mm	2.3%
Spring Monthly PPT	34 mm	16.1 mm	11.1%
Summer Monthly PPT	24 mm	16.8 mm	7.1%
Autumn Monthly PPT	25 mm	23.1 mm	4.8%
Annual Days > 0 mm PPT	68 days	31.1 days	6.4%
Annual Days > 25 mm PPT	0.7 days	1.5 days	4.2%

year-to-year variation in seasonal temperatures and precipitation amounts, however the data shows the climate has become warmer and wetter in each of the four seasons over the period of record. The warming trend is most pronounced in winter with mean temperature having increased 2.0 °C or an average 0. 22 °C/decade. Mean temperatures

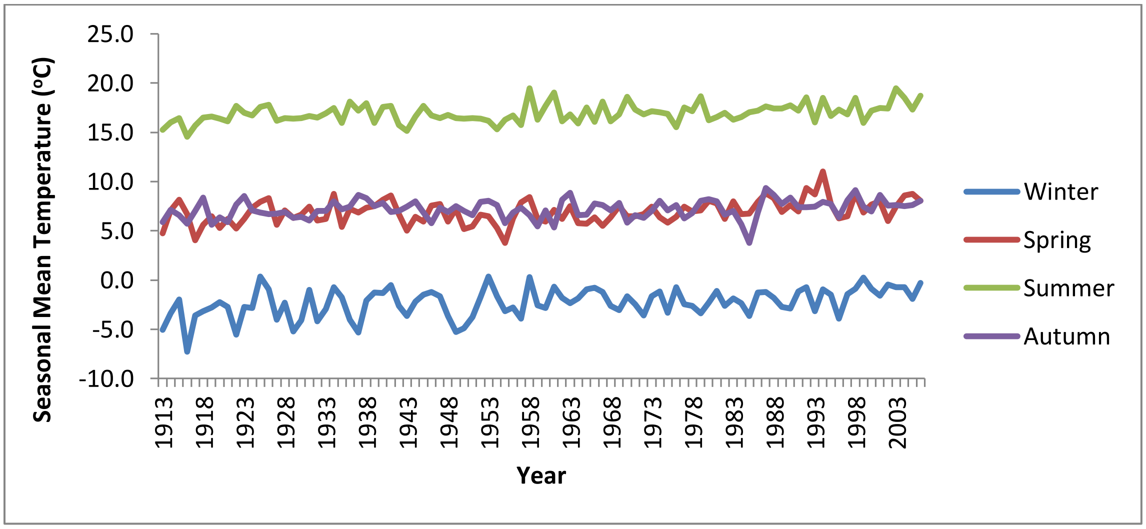

Figure 4. 1: Kaslo Climate Seasonal Mean Temperature Trends (°C) – 1913-2006

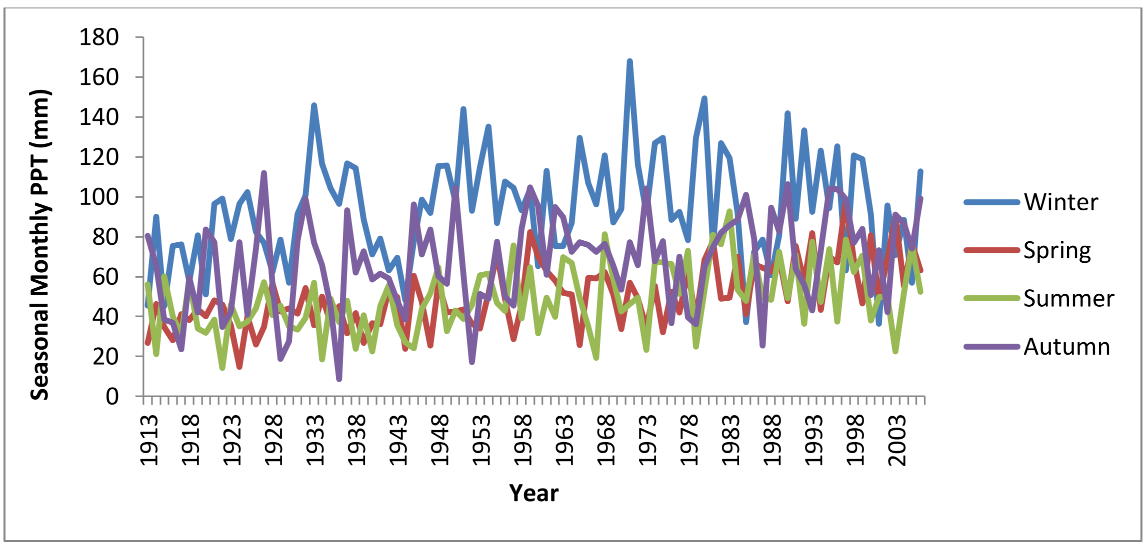

Figure 4. 2: Kaslo Climate Station Seasonal Monthly Precipitation Trends (mm) – 1913-2006

have increased 1.6 °C in spring, 1.3 °C in summer, and 0.8 °C in autumn. The annual extreme maximum temperature has increased by 1.8 °C and the annual extreme minimum temperature has increased by 2.5 °C. Seasonal means of monthly precipitation have increased 21% in winter, 103% in spring, 66% in summer, and 45% in autumn. The number of days with precipitation has increased annually by 59% or 68 days, and the annual number of days with precipitation amounts greater than 25 mm has increased by 39%. Observed long-term trends in temperature and precipitation are masked by the inter-annual variability. The standard deviation of each of the climate parameters examined shows that the year to year variation in seasonal temperature and precipitation are similar in scale as the change over the period of record.

4.3.2 ClimateWNA Climate Projections

A key element in assessing climate change impacts on wildlife is projecting anticipated conditions across the region. For the purposes of this study the three future normal periods (ie. 2020s, 2050s and 2080s) available in the ClimateWNA model were applied.

The bioclimate ecological projections and the habitat suitability mapping used in this study are grounded on predictions of climate change based on the CGM3 AR4 model of the A1B future emissions scenario (IPCC, 2000) using the ClimateWNA software. The applicability of this model was assessed by comparing its output to observations at the Kaslo climate station and by comparing the results of future climate projections from this model to the CGM3 A2, HadCM3 B1, and the HadGEM1 A1B AR4 model and emission scenarios. Murdock and Spittlehouse (2011) have recommended this combination of models as suitable to bound and compare future climate change scenarios for illustrative purposes.

The ClimateWNA software used for the modelling in this study produces high spatial resolution estimates of historic and predicted future temperature and precipitation and a number of derived climate variables based on inputs consisting of latitude, longitude and elevation (Hamann & Wang, 2005; Mbogga, Hamann, & Wang, 2009; Wang, Hamann, Spittlehouse, & Aitken, 2006; Wang, Hamann, Spittlehouse, & Murdock, 2012a). The software to run this model is freely available through the University of British Columbia’s Centre for Forest Conservation Genetics. Version 4.6 uses the PRISM baseline climate layers which predict monthly temperature and precipitation for the

1961-90 normal period (Daly, Gibson, Taylor, Johnson, & Pasteris, 2002). PRISM (Parameter-Elevation Regressions on Independent Slopes Model) is a statistical regression spatial interpolation model at 4 km grid, and is based on an interpolation of weather station data, a digital elevation model, and expert climatological knowledge of rain shadow, coastal, orographic, and temperature inversion effects. ClimateWNA uses bi-linear interpolation and elevation adjustment to downscale this information for applications in mountainous areas (Wang, Hamann, Spittlehouse, & Murdock, 2012a).

Historical data for the period from 1901 to 2002 are calculated based on Mitchell and Jones (2005) historical climatic data, which are at 50 km grid resolution (Mbogga, Hamann, & Wang, 2009). The 1961-90 monthly averages from this dataset were subtracted from each year to calculate an anomaly surface for temperature and precipitation for each month and year. These anomalies were then downscaled through bi-linear interpolation and compared to the PRISM climatic normals.

Future monthly temperature and precipitation anomaly surfaces are similarly calculated at 4 km resolution, based on General Circulation Models from the Intergovernmental Panel on Climate Change Fourth Assessment (Solomon, et al., 2007) compared to the PRISM 1961-90 normals. ClimateWNA Version 4.6 includes 3 emission scenarios (ie. A1B, A2, B1) for 12 of the IPCC General Circulation Models available. The model uses a bilinear interpolation and elevation adjustment to downscale the baseline climate data to specific geographical coordinates and elevations of interest. The model software includes a capability to import geographical coordinates and elevational grids extracted from a digital terrain map, producing an Excel spreadsheet of the climate parameters of interest that can then be exported into GIS software.

To test application of the ClimateWNA Version 4.6 model in the study area, the predicted monthly mean temperature and precipitation normals from the model were compared to those observed at six climate stations which span the Kootenay region (ie. Castlegar, Cranbrook, Creston, Golden, Kaslo and Revelstoke) for the 1961-90 normal period. The model output was generated at the geographic coordinates and elevation of each of these climate stations. The results of this comparison are shown in Figure 4.3. Linear regression of these comparisons suggests the model accurately predicts both monthly temperature and precipitation where a climate station is located since results are well correlated with observed values. The model underestimates monthly mean temperature by 0.88 °C with an r^2 = 0.994 and a mean absolute error of 0.93 °C. The model accurately estimates monthly precipitation with an r^2 = 0.966 and a mean absolute error of 3.4 mm. It should be noted that these results need to be considered in the context of the rugged topography of the region as this would have complex effects including hillslope shading, cold air pooling at valley bottom locations, and orographic influences on precipitation patterns. An independent test of how accurately the model predicts temperature and precipitation at locations between climate stations is not

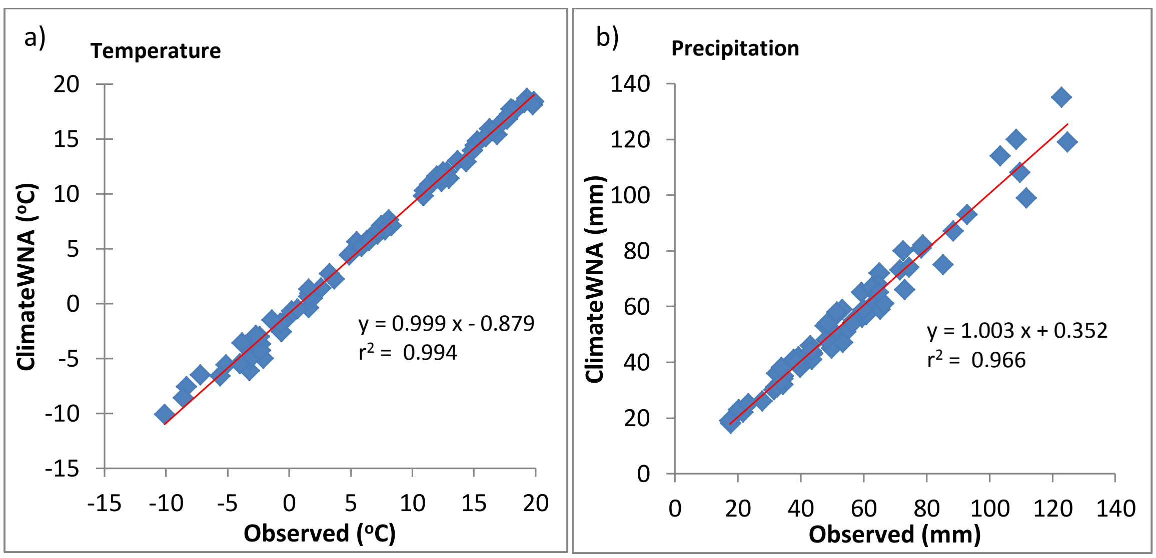

Figure 4. 3: ClimateWNA Predictions of a) Monthly Mean Temperature and b) Monthly Precipitation compared with Observations at the Castlegar, Cranbrook, Creston, Golden, Kaslo and Revelstoke Climate Stations for the 1961-90 Normal Period (Regression line shown in red)

available. Most climate stations are located in valley bottom areas at lower elevations. Testing the interpolation and elevational adjustment functions in the model would require evaluating its predictive capability against an independent set of climate stations located across elevational and topographic transects, data for which are not available and beyond the scope of this study.

The ClimateWNA model was applied to predict seasonal mean temperature and monthly mean precipitation at Kaslo (49°54'N; 116°56'W; elevation = 600 m) for the three future normal periods (2020s, 2050s and 2080s)[116] using the four different GCM models which were plotted as trends from the 1970s normal period in Figures 4.4 and 4.5, respectively, and mean temperature and monthly precipitation trends from the 1970s normal period to the 2080s period are tabulated in Table 4.2. The median results across all four models predicts an increase in mean annual temperature of 3.5 °C and a 3.8% increase in annual precipitation between the 1970s and 2080s. The HadGEM1 A1B model scenario predicts significantly higher temperature and lower precipitation in the summer than the other three models, the highest temperature across all four seasons, and significantly higher precipitation in the spring. The HadCM3 B1model scenario predicts colder temperature and higher precipitation in the winter. The CGM2 A1B and A2 model scenarios for temperature tend to bracket the median for all four model results, with the former being 0.9°C cooler than the latter on average across all seasons. The variance between the models was measured by the standard deviation of the different model results for each season. The standard deviation is 1/3 of the median temperature results between models averaged across all four seasons; however for precipitation the standard deviation between model results is 100% of the median indicating a high degree of variability between models. For comparison purposes the linear observed trend over the period of record at the Kaslo climate station was projected forward to the 2080s period, and is presented as well in Table 2. All four models predict higher temperatures trends than those observed across all four seasons,

[116] Note: By convention 1970s = '1961-1990 normal', 2020s = '2011-2040 normal', 2050s = '2041-2070 normal', 2080s = '2071-2100 normal'

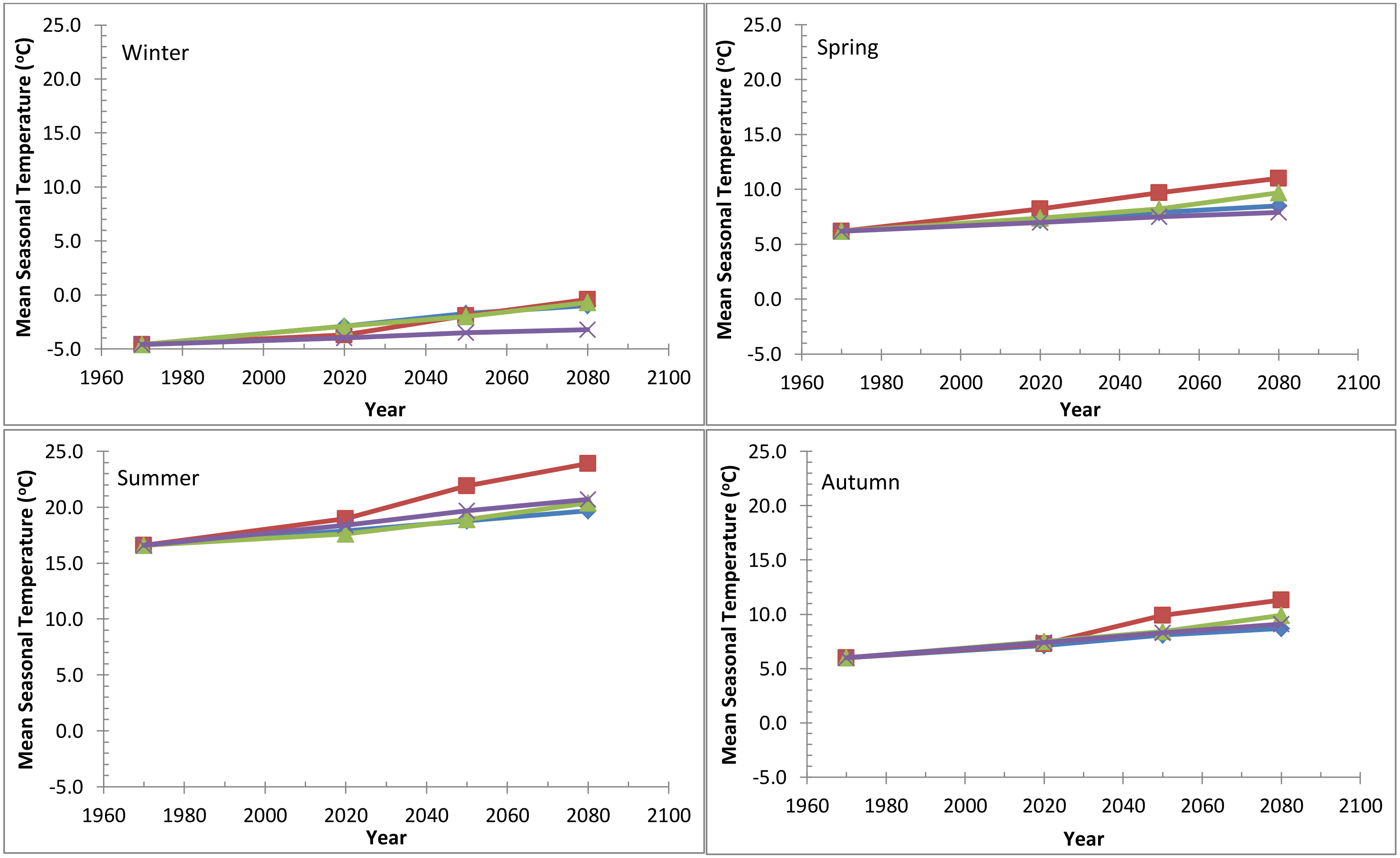

Figure 4. 4: Projected Trends in Mean Seasonal Temperature (°C) at Kaslo Predicted by ClimateWNA for 1970s Normal and Four IPCC AR4 Climate Scenario Normals for 2020s, 2050s and 2080s* (ie. CGM3 A1B; HadGEM1 A1B; CGM3 A2; and HadCM3 B1)

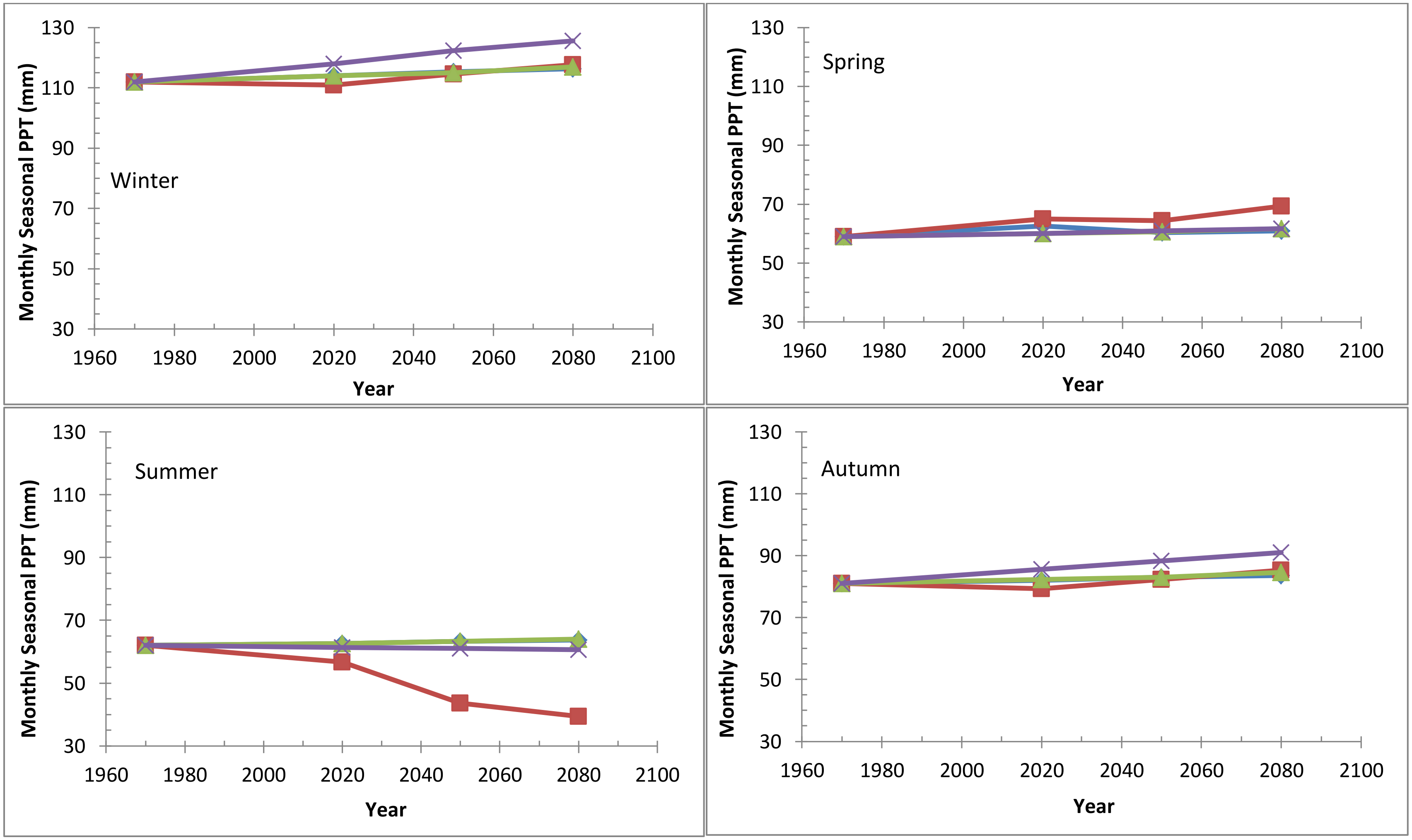

Figure 4. 5: Projected Trends in Monthly Seasonal Precipitation (mm) at Kaslo Based on Climate WNA Model Projections for Four IPCC Emission Scenarios (ie. CGM3 A1B; HadGEM1 A1B; CGM3 A2; and HadCM3 B1)

Table 4. 2: Projected Change in Mean Seasonal Temperature (^{o}C) and Monthly Seasonal Precipitation (mm) Between the 1970s and 2080s Normal Periods as Predicted by ClimateWNA for Four IPCC AR4 Climate Scenario Normals

	Tmean Change (°C) Per Decade						
Season	CGM3 A1B	HadGEM1 A1B	CGM3 A2	HadCM3 B1	Median	Standard Deviation	1913 – 2006 Trend
Winter	0.33	0.38	0.35	0.13	0.34	0.10	0.22
Spring	0.21	0.44	0.32	0.15	0.26	0.11	0.17
Summer	0.28	0.66	0.35	0.37	0.36	0.15	0.14
Autumn	0.25	0.48	0.35	0.28	0.32	0.09	0.09
Annual	0.27	0.49	0.34	0.23	0.30	0.10	0.16
	Monthly Precipitation Change (%) Per Decade						
	CGM3 A1B	HadGEM1 A1B	CGM3 A2	HadCM3 B1	Median	Standard Deviation	1913 – 2006 Trend
Winter	0.4	0.5	0.4	1.1	0.4	0.3	2.3
Spring	0.3	1.6	0.4	0.4	0.4	0.5	11.1
Summer	0.2	-3.3	0.3	-0.2	0.0	1.5	7.1
Autumn	0.3	0.5	0.4	1.1	0.4	0.3	4.8
Annual	0.3	-0.1	0.4	0.7	0.3	0.3	5.5

except for the HadCM3 B1 model scenario in winter and spring. However none of the models predict that precipitation will increase at the rate observed over the past 93 years at the Kaslo climate station. These results are consistent with Murdock, Fraser and Pearce (2007) who found that over the past century across the Columbia Basin observed mean annual temperature has increased 1.5 ^{o}C and precipitation has increased 115 mm or approximately 30%, and using an ensemble of 22 climate prediction model scenarios that mean temperature is predicted to rise 3.3 to 5.0 ^{o}C (ie. 0.30 to 0.45 ^{o}C/decade) and annual precipitation increases of 4.2 to 8.7% (ie. 0.4 to 0.8 percent/decade) by the 2080s. Utzig (2011) applied eight GCM model/emission scenarios to backcast the 1961 - 1990 normal period and compared these to observed data for the same period for the west Kootenay region. His analysis found that on average the general circulation models analyzed underestimated seasonal temperatures by 1 – 2 ^{o}C except for summer, and underestimated seasonal precipitation by 16 – 21% for spring, summer and autumn and about 37% for winter.

The CGM3 A1B scenario was selected to forecast future changes in climate, ecosystems and wildlife habitat based on its 'mid-range' performance in being able to hindcast the 1961 – 90 seasonal temperature and precipitation normals in comparison to other GCM model/scenario combinations. The A1B emission scenario is described by IPCC (2000) as resulting from a "future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies" (p. 4). The A1 family of emission scenarios are differentiated by their technological emphasis, (ie. A1F1 is fossil fuel intensive, A1T emphasizes a transition to new non-fossil energy sources, and A1B assumes a balance between energy sources). Other emission scenarios proposed by IPCC (2000) include A2 which emphasizes slower and regionalized economic growth and continuous population growth, and B1 and B2 scenarios which both emphasize significant changes which would reduce greenhouse gas emissions. Using the A1B emission scenario to estimate potential impacts on ecosystems should be considered a conservative and perhaps optimistic approach, given the assumptions of a balanced transition reducing reliance on fossil fuels, as well as recent failures to introduce international greenhouse gas reduction agreements and evidence which shows that current emissions are increasing at a rate even greater than the A1F1 emissions scenario (IPCC, 2014).

Use of only one mid-range scenario is justified on the basis that this research was intended to introduce how climate change may potentially affect wildlife ecosystems, and outline the extent of uncertainty which results from the potential range of future scenarios as well as from the modelling itself.

4.3.3 Bioclimate Modelling Results

Both historic and projected climate modelling set the stage for projecting bioclimate models as a basis for evaluating the impact of future climate change scenarios on ecosystems and wildlife species. A particular focus was on developing scenarios of the potential for climate change to impact habitat suitability for a number of species for which appropriate data were available. The Climate WNA model allowed a comparison of current and future scenarios for a number of biologically relevant climatic parameters, ecosystem bioclimatic envelopes, and potential impacts on habitat suitability.

In addition to facilitating this analysis of historic and anticipated climate change in the study region, ClimateWNA v.4.6 facilitated the creation of climate parameter maps. This utility calculates of a number of relevant climatic parameters spatially for past and future time periods. This is accomplished by inputting an Excel .csv (comma separated value) file containing elevation and geographical coordinates. For this purpose the 1:50,000 scale digital data were downloaded from the Natural Resources Canada GeoBase data portal[117] for the Kootenay region. This raster digital elevation data were then imported into ArcGIS software that was used to extract digital elevation points on a 1 km grid that was exported for input into the ClimateWNA software. The ClimateWNA software outputs a .csv file containing the georeferenced climate parameters that were imported to ArcGIS to then produce the raster climate parameter maps.

Results from the University of Alberta's Random Forest ecological zone bioclimate model for the Kootenay Region were obtained from Dr. David Roberts. The dataset provided included 1 km grid spatialized output of predicted current ecosystem zones, and future bioclimate envelopes for 2020, 2050 and 2080 based on the CGM3 B1 and

[117] Natural Resources Canada website. Retrieved from http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/$categories?scheme=urn%3Aiso%3Aseries&q=GeoBase

CGM3 A1B emission scenarios (IPCC, 2000). The bioclimate ecological zones were reclassified according to the methodology described in Utzig (2012).

Random Forest is a classification tree analysis technique that was used by Roberts (2013), Mbogga et al. (2010), Roberts and Hamann (2012), Gray and Hamann (2013) and Wang, Campbell, O'Neill and Aitken (2012b) to predict ecosystem classes as the dependent variable and a number of biologically relevant climatic parameters as independent variables. Roberts and Hamann (2012) conclude that ecosystem-based methods are useful as effective decision-making tools for climate-informed conservation and resource management applications. They found that Random Forest was consistently the best ecosystem-based method they evaluated, and concluded it was a useful tool to model tree species distribution. Wang, Campbell, O'Neill and Aitken (2012b) suggest that "that when the results of climate envelope model projections are appropriately conveyed and used with their limitations in mind, they can provide a powerful framework for evaluating and illustrating potential climate change impacts and guiding land-use planning" (p. 129).

The ecological zone bioclimate modelling results supplied by Dr. Roberts used ten predictor climatic variables as independent variables, including:

- mean annual temperature,
- mean annual precipitation,
- mean temperature of the warmest month,
- mean temperature of the coldest month,
- difference between January and July temperature as a measure of continentality,
- growing season (May to September) precipitation,
- frost-free days,
- growing degree days above 5^{o}C,
- annual climate moisture index, and
- summer climate moisture index (Roberts, 2013).

The climatic input parameters were calculated using ClimateWNA inputs for the 1961-1990 normal period and the CGM3 A1B emission scenario for 2071-2100. The model was based on 770 mapped ecosystem classes covering western North America based on six sources for the dependent variable: the Biogeoclimatic Ecosystem Classification for British Columbia (Pojar, Klinka, & Meidinger, 1987), Natural Regions and Sub-Regions of Alberta (Government of Alberta, 2004), the Ecoregions of the Continental United States (Omernik, 2003), Ecosystems of Alaska (Joint Federal-State Land Use Planning Commission for Alaska, 1991), the National Ecological Framework (Govt. of Canada, 1999), and Potential Natural Vegetation Maps for California and Arizona (Kuchler, 1993 & 1996). Output from the model is a spatially georeferenced 1 km grid predicting ecosystem class at the variant/sub-variant level based on the ClimateWNA input scenario. Utzig (2012) developed a scheme that converted and generalized the British Columbia, Alberta, Alaska, and western USA ecosystem classifications to a common system based on the Biogeoclimatic Ecosystem Classification widely used in British Columbia (Meidinger & Pojar, 1991). Only these first four sources of ecosystem classes as listed above applied to ecosystems predicted in the Kootenay region. A version of Utzig's generalized classification[118] was adapted for the purpose of this study, and is presented in Appendix 4. The resulting generalized ecosystem subzones used to evaluate bioclimate shifts in the Kootenay region are:

- Alpine Tundra (AT)
- Wet Engelmann Spruce – Subalpine Fir (Wet ESSF)
- Moist Engelmann Spruce – Subalpine Fir (Moist ESSF)
- Dry Engelmann Spruce – Subalpine Fir (Dry ESSF)
- Coastal Western Hemlock (CWH)
- Coastal Transition (Ctrans)

[118] This generalized classification scheme was provided courtesy of Greg Utzig and are described in Utzig (2012).

- Dry Montane – Sub-boreal Spruce (MSD)
- Wet Montane – Sub-boreal Spruce (MSW)
- Wet Interior Cedar – Hemlock (Wet ICH)
- Moist Interior Cedar – Hemlock (Moist ICH)
- Dry Interior Cedar – Hemlock (Dry ICH)
- Very Dry Interior Cedar – Hemlock (V Dry ICH)
- Wet Interior Douglas Fir (Wet IDF)
- Moist Interior Douglas Fir (Moist IDF)
- Dry Interior Douglas Fir (Dry IDF)
- Ponderosa Pine (PP)
- Grassland (GRA)

For comparison purposes the currently mapped Biogeoclimatic Ecosystem Classification variant units were obtained from DataBC (Version 8) (Meidinger & Pojar, 1991), polygon units were sampled at 1 km grid, and reclassified according to Utzig's classification scheme as amended for this project. Figure 4.6 shows the mapped generalized ecosystem subzones for a) currently mapped (ie. Current BEC Subzones), b) those predicted by the model for the 1961 – 1990 normal period (ie. Modelled BEC Subzones), and d) those predicted by the model for the 2070 – 2100 normal period (ie. Predicted BEC Subzones). The current BEC mapping was compared to the 1970s modelled results at the zone level overlaying these maps in ArcGIS (Figure 4.6c).

This overlay comparison shows the Random Forest model correctly classified BEC zone units for 64% of the area . As a percentage of the total study area, the model correctly predicts:

- 52% of the AT zone, but classifies 48% of that zone as ESSF;
- 68% of the ESSF, but classifies 11% as AT, 10% as MS and 10% as ICH;

- 62% of the ICH, but classifies 25% as ESSF, 6% as MS and 5% as IDF;
- 64% of the IDF, but classifies 9% as MS, 6% as ICH & 17% as PP; and
- 89% of the PP, but classifies 10% as IDF.

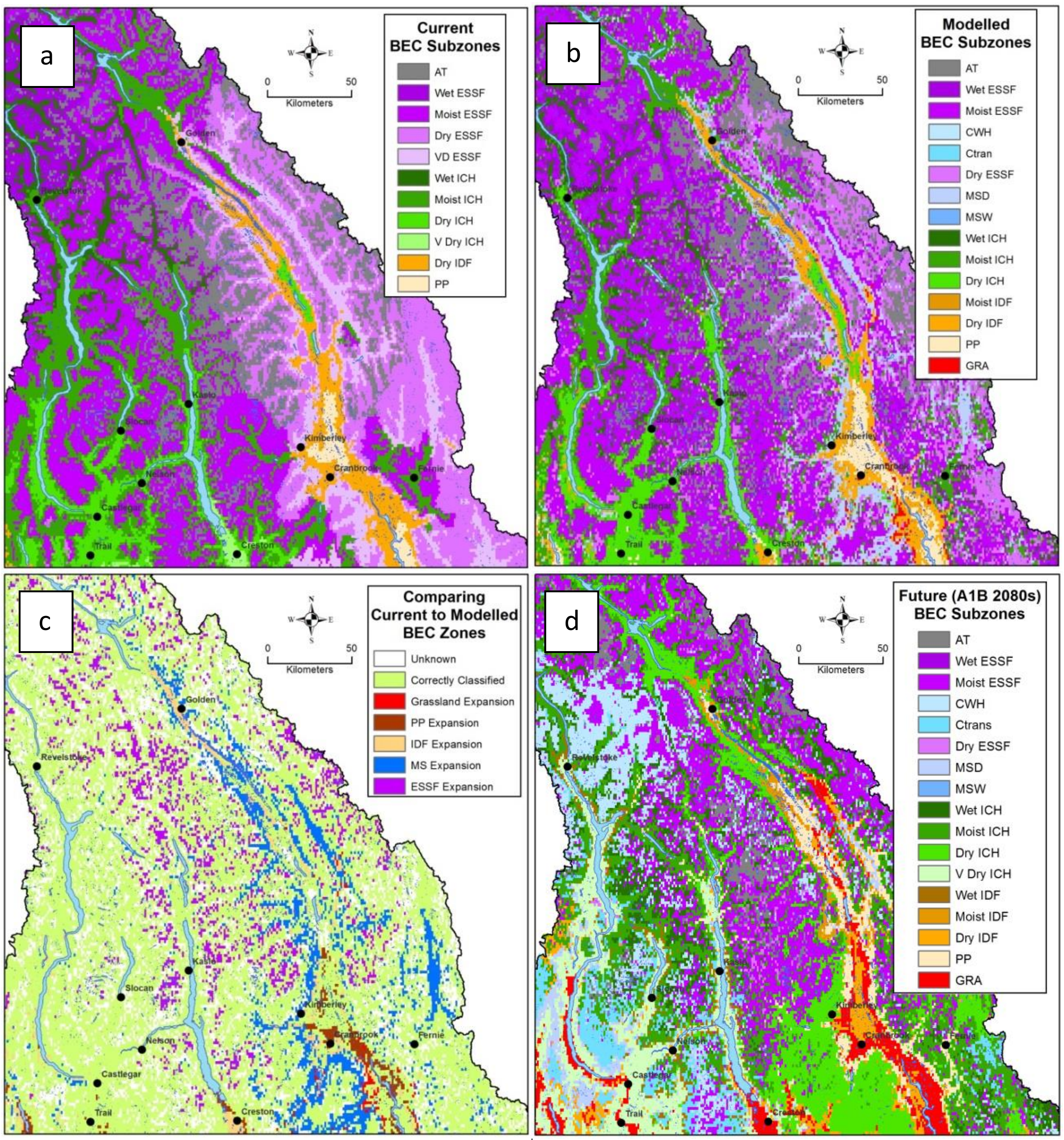

Figure 4. 6: Scenario Comparisons of BEC Subzones in the Kootenay Region: a) Currently Mapped, b) Modelled for 1970s, c) Comparison of Currently Mapped to 1970s Modelled, and d) Modelled for 2080s

Some of these differences can be interpreted as being consistent with recent warming trends in the region. For example, the model is predicting the current bioclimate envelope, whereas the BEC classification represents climate ecosystem interactions that developed through time and would represent a lag in time. A number of differences between the current BEC zone classification and that predicted by the RF 1961 -1990 model which could be argued as being consistent with recently observed climate changes, and are noted in Figure 4.6c. The RF 1961 -1990 model predicts:

- a small area of grasslands in the Ponderosa Pine zone in Rocky Mountain Trench,
- a larger area of Ponderosa Pine in the Boundary and Rocky Mountain Trench areas currently classified as Interior Douglas Fir,
- a larger area of Interior Douglas Fir in the Rocky Mountain Trench north of Golden into the Interior Cedar Hemlock Zone,
- occurrence of dry montane/sub-boreal spruce forest in areas classified as Englemann-Spruce Subalpine Fir, and
- occurrence of the Englemann-Spruce Subalpine Fir zone at higher elevations into the Alpine Tundra.

The effect of potential climate change on the ecological representation of areas designated in conservation categories was assessed by overlaying the modelled climate change biogeoclimatic ecosystem classification maps for the current normal period and for the A1F 2080 emission scenario with conservation designations from Chapter Three shown in Figure 4.7. This assessment suggests reductions in conservation areas of 52% in Alpine, 60% in ESSF, 48% in the Sub-boreal, and 31% in the IDF. Areas designated in the ICH would increase by 84%, and areas represented by grassland and non-analogous coastal-type ecosystems would increase very significantly, respectively.

The scenario forecasts of climate parameters and ecological response are credibly consistent with recent trends. Such forecasts are subject to large degrees of uncertainty associated with understanding future greenhouse gas emission scenarios, the ability of global climate models and downscaling routines to reasonably emulate local climatic conditions, and the substantial limitations of simple bioclimate models that ignore complex ecological dynamics. However this analysis demonstrates potential for very real

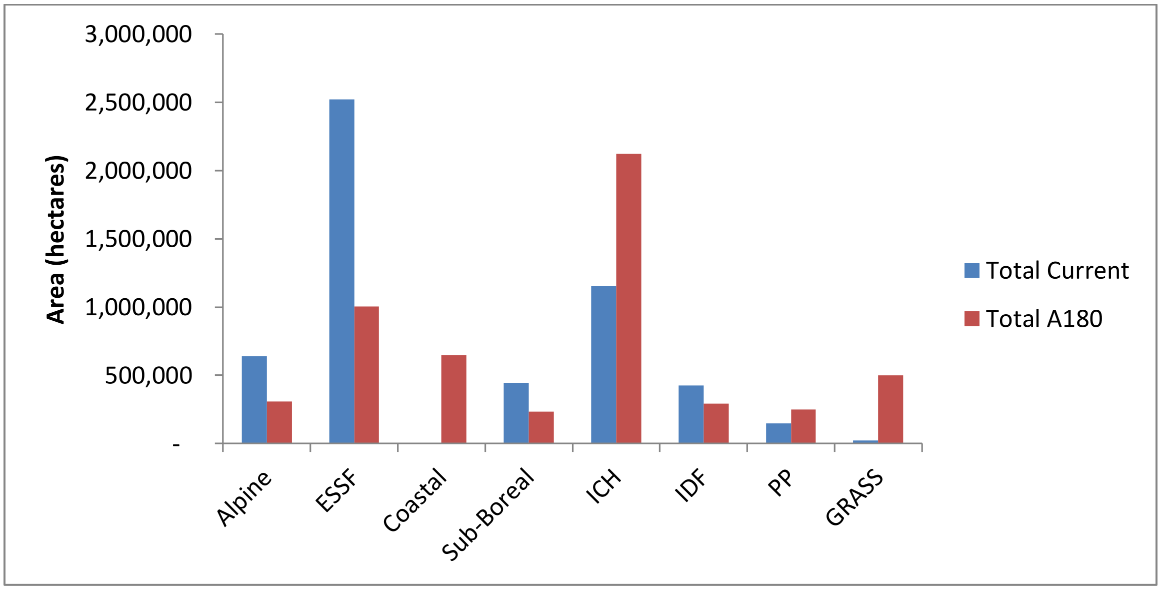

Figure 4. 7: Scenario Comparison of the Current Area (hectares) of Biogeoclimatic Zones Designated for Conservation with Projection for 2080s

and significant ecological impacts with the study area resulting from the trajectories forecasted for climate change.

This dissertation makes the argument that prudent wildlife ecosystem management needs to accommodate both the dimensions of potential change and the uncertainties associated with such forecasts. The following three sections therefore explore some potential dimensions of climate change on wildlife habitat for a number of species through the opportunity provided by data and information available on species and habitat responses to climate.

4.3.4 Mountain Caribou Habitat Suitability Scenarios

The Mountain Caribou Recovery Science Team produced maps for early and late winter mountain caribou habitat suitability across the extent of their range in British

Columbia. The availability of this data has provided a relatively simple opportunity to consider a potential scenario for impacts from future climate change on mountain caribou habitat availability. The Bayesian Belief Network (BBN) model used by the Science Team to produce these maps is described by McNay and McKinley (2007). Copies of the shape files for these maps and a copy of the Netica™ BBN model were provided for this study by Dr. Steve Wilson, who chaired the Science Team. This information was used in conjunction with University of Alberta Random Forest model results to evaluate potential implications of climate change on mountain caribou habitat suitability. This approach consisted of adjusting habitat suitability ratings from the Science Team BBN model based on an assumption of a linear response between climate parameters, and ecosystem and caribou response. It is important to emphasize that a real world response will undoubtedly be significantly more complex than the scenario modelled here.

The habitat suitability model developed by the Science Team was constructed on the Netica software platform[119], and consists of a set of nodes representing environmental correlates, disturbance factors, and response conditions linked by probabilities (McNay, et al., 2006). The model was developed through a combination of previously conducted studies on mountain caribou with expert opinion. The version of the Science Team model used in this study correlated a seasonal forage usefulness parameter with BEC zone, moisture regime, snowfall, tree species, forest age, terrain steepness, and land cover permeability (McNay & McKinley, 2007). Intermediate correlates were calculated for seasonal available forage and movement cost.

The probability tables from the Science Team early and late winter models for seasonal available forage were used to model future habitat suitability in this study. In the Science Team model habitat suitability was considered high when forage availability

[119] Norsys Software Corp. https://www.norsys.com/netica.html

was >0.72 kg/ha., low between 0.18 and 0.72 kg/ha., and null when <0.18 kg/ha. Evaluation of the seasonal available forage probability tables in the Science Team BBN model shows a >50% probability of high suitability late winter habitat results when BEC zone = ESSF or AT, and forest age is >140 years or the tree species are predominantly subalpine fir, whitebark pine, Douglas fir, and spruce. A >50% of low suitability late winter habitat generally results in forests >140 years, or where forest age is between 81 and 140 years, and tree species are predominantly subalpine fir, whitebark pine, Douglas fir, and spruce. A >50% probability of high suitability early winter habitat results when forest age >140 years, or when forest age >80 years and BEC subzone= Wet ESSF, Moist ESSF, Wet ICH or Moist ICH, or when BEC subzone = Dry ESSF or Dry ICH and tree species include a combination of subalpine fir and whitebark pine >70%. A >50% of low suitability early winter habitat generally results in the Dry ESSF and Dry ICH zones. Following this information derived from the Science Team BBN model, for the purpose of evaluating climate change impacts on habitat suitability in this study, natural disturbance regime was used to estimate potential early and late winter habitat suitability classes following the logic outlined in Table 4.3.

Table 4. 3: Mountain Caribou Habitat Suitability Classified Based on Natural Disturbance Type

Natural Disturbance Type	Description	Early or Late Winter Suitability Class
NDT 1	250 year mean fire return interval, and includes Wet ESSF and Wet ICH subzones	High
NDT 2	200 year mean fire return interval, and includes Moist ESSF and Moist ICH subzones	High
NDT 3	100 to 150 year mean fire return interval, and includes Dry ESSF and Dry ICH subzones	Low
NDT 4	5 to 50 year mean fire return interval	Null
NDT 5	Alpine tundra and subalpine parkland	High

Natural disturbance regime was selected as a predictor variable for early and late winter suitability class as this parameter can be correlated with forest age and BEC subzones, and natural disturbance type can be inferred from the BEC subzones predicted by the University of Alberta Random Forest model. Habitat suitability was calculated by modifying or reclassifying the Science Team habitat capability map according to natural disturbance type. Natural disturbance type was classified from the BEC subzones according to the Biodiversity Guidebook (Province of British Columbia, 1995). Accordingly Table 4.4 was used to equate the Science Team habitat suitability to habitat suitability ratings based on natural disturbance types derived from BEC subzones from the Random Forest model for the 1970s and 2080s. Maps showing a) habitat suitability from the Science Team BBN model, b) derived habitat suitability based on the 1970s climate scenario, c) a comparison of habitat suitability from the Science Team BBN model and the 1970s derived map, and d) derived habitat suitability based on the 2080s climate scenario are shown in Figure 4.8.

Table 4. 4: Mountain Caribou Habitat Suitability Ratings Based on Natural Disturbance Type Model

Natural Disturbance Type	Science Team Habitat Suitability Rating	Adjusted Habitat Suitability Rating
NDT 1, NDT 2 or NDT5	High	High
	Low	Low
	Null	Null
NDT 3	High	Low
	Low	Low
	Null	Null
NDT 4	High	Null
	Low	Null
	Null	Null

The 1970s model compares to the Science Team model for high suitability 86% of the area, with 12% classified as low suitability and 1% classified as null, and for low suitability 99% of the area, with 1% classified as null (Table 4.5). Disagreement between the two models is most prevalent in the South and Central Purcell mountain caribou population units. Given this area has experienced a significant decline in caribou

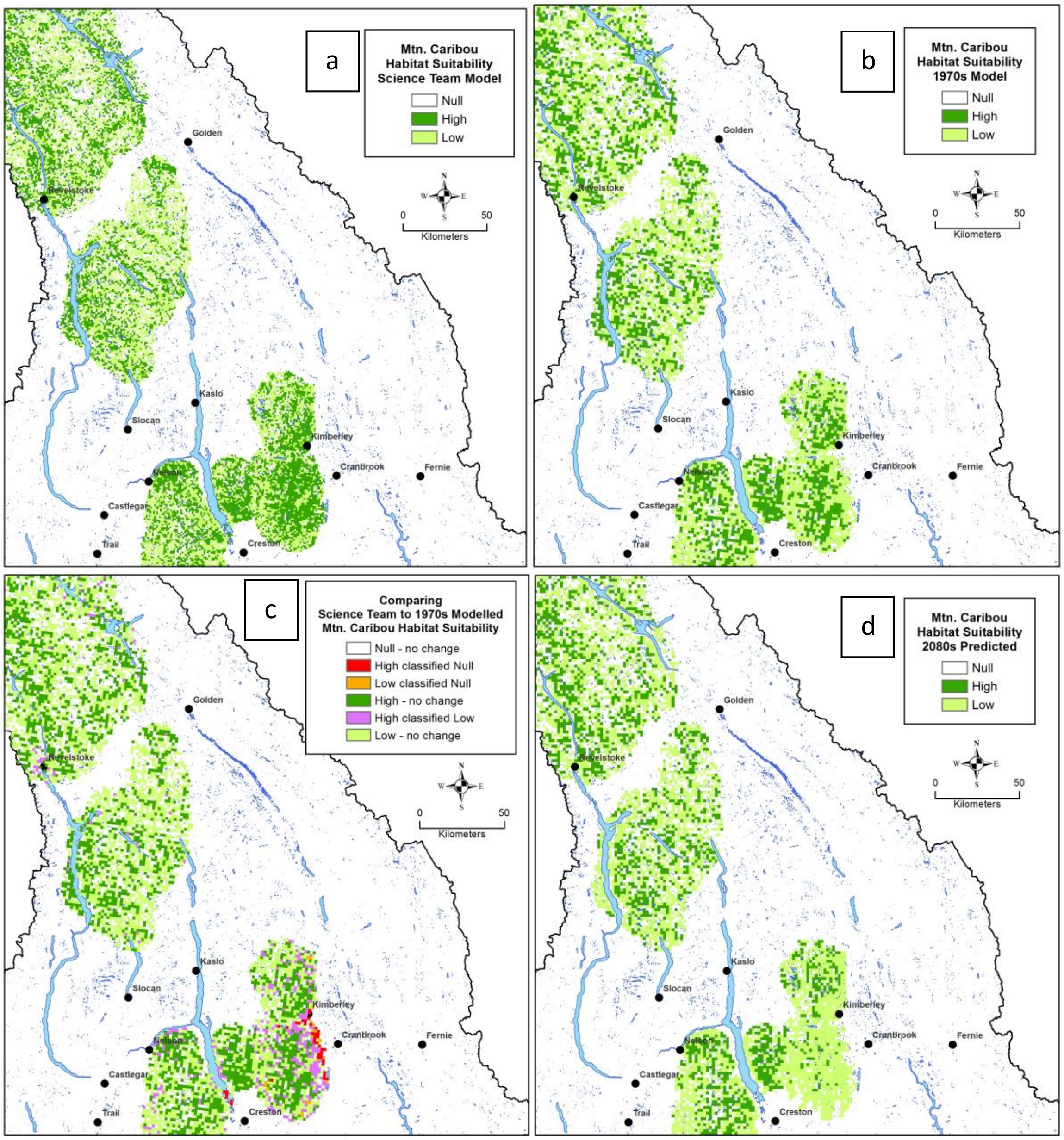

Figure 4. 8: Scenario Comparisons of Mountain Caribou Habitat Suitability: a) Science Team Model, b) 1970s Model, c) comparison of Science Team Model with 1970s Model, and d) 2080s Scenario

Table 4. 5: Mountain Caribou Model Comparisons (Area in each category in hectares): a) 1970s Model Compared to Science Team Model, b) 2080s Compared to the 1970s

Model Comparison	1970s Model Compared to Science Team Model		2080s Model Compared to 1970s Model	
	Hectares	Percent of Suitability Class	Hectares	Percentage of Suitability Class
Null	762,671	100	776,254	99
Null to Low	0	0	4,046	1
Low	990,114	99	1,036,932	95
Low to Null	5,491	1	24,854	2
Low to High	0	0	30,634	3
High	720,766	86	540,430	75
High to Null	12,138	1	2,601	0
High to Low	102,306	12	177,735	25

population, one hypothesis that could be argued from this result is perhaps recent climate trends have already impacted habitat suitability in that area.

Comparison of the 1970s and 2080s modelled scenarios predicts a 25% loss of high suitability mountain caribou habitat resulting from climate change impacts. This loss is most prevalent in the southern Purcell area, mid-elevation areas in the Arrow Lakes drainage in the western part of the habitat range, and to a more limited degree in the south Selkirk area, resulting from the predicted transition in these areas to the drier ecosystem types predicted by the bioclimate modelling results outlined in Section 3.3 above, which would be expected to affect foraging opportunity.

The approach used here to model potential future impacts on mountain caribou habitat suitability must be viewed with abundant caution. Quite aside from uncertainty inherent in the underlying ClimateWNA, Random Forest, and Science Team habitat suitability models, the scenarios presented here presuppose a linear response between climate change, and ecosystem and species response which undoubtly grossly misrepresents the complexity of such relationships. As well, using predicted changes to natural disturbance types to predict changes to the forage availability relationship derived in the Science Team's BBN model is a simplistic parameterization of the complex relationship in that model. None-the-less, the results here underpin the potential for significant impacts on the viability of caribou habitat in the region as a first order approximation.

4.3.5 Wolverine Habitat Suitability Scenarios

Wolverine climatic suitability scenarios were modelled following the finding by Copeland et al. (2010) that wolverine distribution in the northern circumpolar region is limited by late spring persistent snowpack and August maximum temperature > 22 ^{o}C. Late spring persistent snowpack was approximated as those areas where accumulated winter snowfall was greater than 60 cm and mean temperature is less than 2 ^{o}C. This approximation is derived as a combination of an arbitrary decision that a 60 cm snowpack should suffice for wolverine denning, and late spring snowmelt greater than that resulting when April mean temperature is greater than 2 ^{o}C would inhibit denning. The 2^{o}C threshold for snowmelt was again arbitrarily selected as the temperature at which 25% of a 60 cm snowpack would melt based on a model developed by Spittlehouse and Winkler (2004) that predicted snowmelt of 5 mm/day at 2 ^{o}C in forested canopies.

ClimateWNA was applied to map winter snowfall > 60 cm, April mean temperatures < 2 ^{o}C, and August maximum temperature < 22 ^{o}C. Maps indicating climatic suitability for wolverine were produced for the 1970s and 2080s normal periods based on this input and are presented in Figure 4.9.

The 1970s model was compared to habitat suitability ratings derived from the wolverine Resource Selection Function (RSF) data provided by the Nature Conservancy of Canada, and the changes projected for the 2080s (Table 4.6). For the purpose of this comparison, the RSF data were classified into two habitat classes (ie. unsuitable and suitable), as delineated using the quantile classification function in ArcGIS spatial

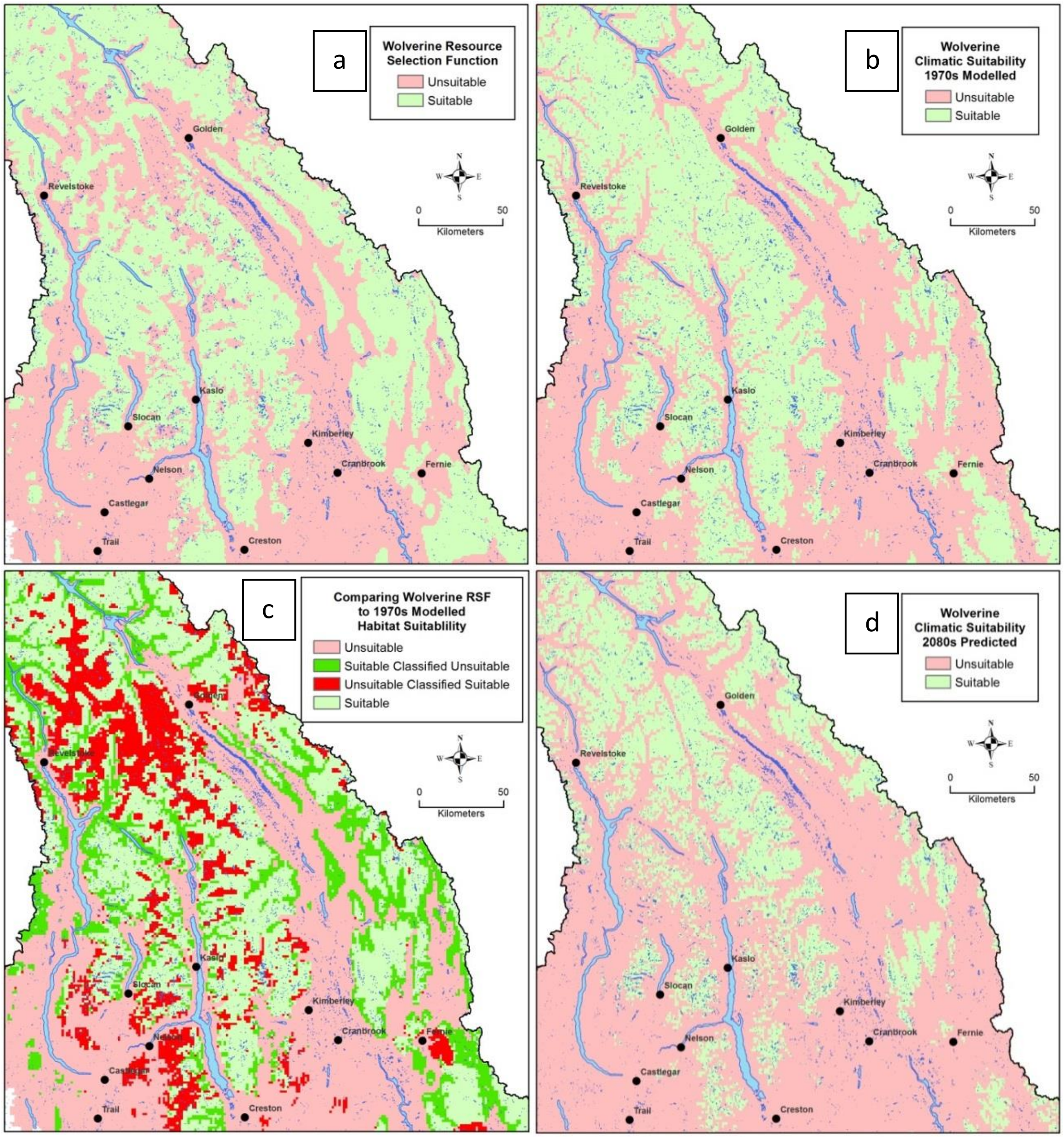

Figure 4. 9: Scenario Comparisons of Wolverine Habitat Suitability: a) Resource Selection Function Model, b) 1970s Model, c) comparison of Resource Selection Function Model with 1970s Model, and d) 2080s Scenario

Table 4. 6: Wolverine Model Comparisons (Area in each category in hectares): a) 1970s Model Compared to Resource Section Function Model, b) 2080s Compared to the 1970s

Model Comparison	1970s Model Compared to RSF Model		2080s Model Compared to 1970s Model	
	Hectares	Percent of Suitability Class	Hectares	Percentage of Suitability Class
Unsuitable	2,969,892	72	4,470,830	100
Suitable Classified Unsuitable	1,182,697	28	1,408,007	37
Suitable	2,738,186	74	2,374,634	63
Unsuitable Classified Suitable	962,541	26	0	0

analysis tools. The 1970s model predicted 74% of the RSF area classified as suitable habitat, and predicted 72% of the RSF area classified as unsuitable.

The model predicts a 37% loss of suitable wolverine habitat between the 1970s and 2080s. Suitable habitat loss occurs across the southern part of the range and at higher elevations. This change is primarily temperature driven, as future warmer temperatures influence precipitation that falls as snow, increase snowmelt rates in the spring, and result in maximum temperatures in the summer period exceeding optimal thermal conditions for wolverines. Application of this predictive model assumes a linear relationship between August maximum temperature and denning snowpack outlined in the Copland, et al. (2010) study for wolverines and needs to be treated with caution.

4.3.6 Habitat Suitability Inferences for Grizzly Bear, Fisher, Lynx, Wolf and Wolverine

The potential scope of climate change impacts on wildlife ecosystems in the Kootenay Region was explored by extrapolating the Resource Selection Function (RSF) data for grizzly bear, fisher, lynx, wolves, and wolverine. Relevant data were compared to the Biogeoclimatic Ecosystem Classification (BEC) maps to see if inferences could be drawn regarding current ecosystem use of each of these species, and whether bioclimate change in the future may potentially influence available suitable habitat. The RSF probability spatial data for each of the five species obtained from the Nature Conservancy of Canada were classified into three habitat suitability classes (ie. high, medium and low), as delineated using the Jenks natural breaks function in ArcGIS as discussed in Section 3.4.4 of Chapter Three (Nature Conservancy of Canada, 2004). The source of the resource selection function data was from the habitat modelling analysis conducted by Carroll (2001), Carroll, Noss and Paquet (2001), and Carroll, Noss, Paquet and Schumaker (2003). This RSF data layer was overlaid on the current BEC data layer to calculate an area-based habitat effectiveness (HE) score as follows:

HE = (% Suitability in BEC * BEC Area) / 1000

These results are shown in Table 4.7. The potential inference is future bioclimate change

Table 4. 7: Comparison of Species Habitat Effectiveness Scores between 1970s and 2080s

	Habitat Effectiveness Score					
	High			Medium		
	Current	A180 Scenario	Change	Current	A180 Scenario	Change
Grizzly Bear	177	167	-6%	311	357	15%
Fisher	54	68	26%	181	231	28%
Lynx	128	93	-27%	258	344	33%
Wolf	321	276	-14%	253	279	10%
Wolverine	102	88	-14%	281	244	-13%

may have significant impacts on habitat effectiveness. Caution must be applied in considering this relationship as it represents a considerable oversimplification of species dynamics and habitat use. Large carnivore species including grizzly bear and wolves are highly negatively correlated with human development activities, and their habitat use will be coupled to foraging resource opportunities (Carroll, 2001; Proctor, et al., 2012). Current warmer bioclimate types in this region have the most significant degree of human development particularly in the southern and lower elevation areas. Using a relationship between current habitat use, as represented by the RSF, should be expected to over-predict loss of habitat effectiveness for such species. It is noteworthy that wolverine habitat effectiveness is predicted to decline significantly with climate-induced changes in bioclimate. Although the habitat effectiveness score for fisher would superficially suggest that such changes may potentially be beneficial, fisher are considered to be associated with landscapes with closed forest canopies and are sensitive to landscape level disturbance (Carroll, Noss, & Paquet, 2001).

Assuming there is a correlation between species presence as predicted by the RSF function and Biogeoclimatic Ecosystem Classification was not tested, and was included in this study for illustrative purposes only.

4.4 SUMMARY

The process of analyzing and modelling historic and projected climate change in the study region and then creating scenarios of impacts on wildlife to the end of this century offers valuable insights on the process of developing scenarios, the predicted impacts of climate change, and the utility of resulting scenarios in anticipating management approaches.

The ClimateWNA model has been shown to be a useful tool to spatially downscale and map historic and future climate parameter scenarios (Spittlehouse & Wang, 2014; Wang, Hamann, Spittlehouse & Murdock, 2012). The model accurately predicts monthly temperature and precipitation normal statistics at climate station locations, although interpolation between climate stations and at higher elevations in the study area is untested. Uncertainty inherently results from the GMC models themselves and not knowing future greenhouse gas emissions. There is considerable variability between GCM model/emission scenarios, where the agreement between models is three times stronger for temperature predictions than for precipitation. All of the GCM/scenario models predict increasing warming consistent with historical trends. The models on average predict a warmer temperature trends over the next century (ie. mean annual temperature increasing by 0.30 ^{o}C/decade) than has occurred over the past century (ie. mean annual temperature increasing by 1.6 ^{o}C/decade).

All of four of the Climate WNA models evaluated predict precipitation will increase at a rate that is significantly less than the historical precipitation trend of 5.5%/decade over the past century. In the coming century annual precipitation is expected to increase by only 0.3%/decade, an order of magnitude lower than what has been observed. One model (ie. HadGEM1 A1B) for example, predicts summertime growing season precipitation will decrease in the next century. All models predict future warmer temperatures through all seasons, lower snowpack in winter, earlier snowmelt in spring, and drier conditions during the growing season. The CGM3 A1B scenario was selected to model future bioclimates because it represented the median between the four model runs tested.

Bioclimate envelope models have been widely used to model future climatic niche space for ecosystems and wildlife (Carroll et al., 2010; Hamann & Wang, 2006; Lawler, White, Neilson, & Blaustein, 2006; Lawler et al., 2009b; Pearson & Dawson, 2003; Wang, Campbell, O'Neill, & Aitken, 2012b). The output from the UoA Random Forest model was used in this study to assess potential scenarios of climate change impacts on ecosystems and wildlife habitat suitability because it was readily available for the study area and has been demonstrated to produce credible predictions of current and past ecological conditions (Gray & Hamann, 2013; Roberts & Hamann, 2011; Mbogga et al., 2010). But application of the model to future conditions is subject to a number of limitations inherent in the bioclimate modelling approach.

Bioclimate models correlate current species distributions with selected climate variables, then apply this relationship to predict new range distributions under scenarios of climate change. The correlative approach does not address issues that will have an impact on future ranges of species such as extensive habitat fragmentation limiting species dispersal, lag in soil changes, new disturbance regimes resulting from fire, pathogens and insects, impacts from rising CO2 on productivity, differences in genetic adaptation within populations, and changing biotic interactions, and should only be used where their limitations and uncertainties are understood (Heikkinen, et al. 2006).

The significant uncertainty and limits to interpretation must be explicitly addressed in future climate and habitat modelling scenarios. However simple habitat models do provide a mechanism to envisage the possibility and degree of impacts on wildlife resulting from climate change (Lawler, et al., 2009a). The models used here have not been tested independently as this was beyond the scope of this study. The intention was to illustrate the potential for significant and uncertain change in support of motivating need for better science, and a review of policies and institutional mechanisms.

Bioclimate model projections suggest that species with specialized climatic niche requirements such as mountain caribou, wolverine and perhaps lynx could be profoundly impacted by climate change. Habitat generalists such as grizzly bears could be indirectly influenced to the extent climate change impacts foraging opportunities (Servheen & Cross, 2010). Species adapted to ecosystem disturbance or warmer climatic conditions may experience new range opportunities.

The evidence suggests climate is undoubtedly changing and that this will have implications for the function and structure of ecosystems in the Kootenay region. Wildlife habitat conservation and species management programs therefore will need to incorporate a climate change perspective. The efficacy of conservation designations will need to consider landscape and regional scale connectivity. Species at risk management will need to have a focus on maintaining ecosystem-based functionality. A resilient ecosystems approach would emphasize maintaining structural and functional attributes across spatial and temporal scales. Disturbance will be a key agent of change with implications for fire management, forest harvesting design, forest health, and invasive species management. Diverse management strategies that span potential outcomes will serve to reduce risk and provide management feedback. The scale of management needs to encompass local, landscape and regional scales bringing with it the need to manage across land use categories and land ownership. New institutional mechanisms will be needed to coordinate land use conflicts, developing conservation goals and coordinating management intent.

This modelling study shows the potential of significant loss of high suitability habitat for mountain caribou and wolverines at the southern extent of their range and lower elevations. This calls into question current management approaches. The endangered and threatened status of these species should dictate a precautionary approach to conservation, management intervention and, in the case of wolverine and lynx, harvesting strategies.

Bioclimate models provide a simplified scientifically-based representation of future scenarios of potential climate change impacts on wildlife ecosystems. Despite the uncertainty of ecosystem response, models are useful in outlining a range of possible spatialized wildlife ecosystem scenarios that clearly demonstrate the need for new forms of conservation decision-making. Projections of significant habitat losses for mountain caribou and wolverine in the next sixty years, for example, indicate that current wildlife management approaches premised on the historic range of variability paradigm will be poorly suited to ensure ecosystems are resilient to the future dramatic changes in climate (Lawler, 2009; Lawler, et al., 2009a). The analysis presented here calls for new tools to understand ecosystem dynamics, especially given the significance of potential climate change impacts and conservation implications.

The range of uncertainty emphasizes the importance of an adaptive management approach. Complex models of ecosystem vulnerability to climate change that would support the development of adaptive policy options are not generally available (Keith, Martin, McDonald-Madden, & Walters, 2011). Certainly doing nothing in the face of uncertainty is tantamount to burying your head in the sand and hoping it will go away. A stronger scientific basis, including inventory, research and monitoring, as well as assessing risk and adaptively re-evaluating management goals, will be needed to provide the basis for an adaptive management approach (Keith, Martin, McDonald-Madden, & Walters, 2011; Lawler, 2009; Lawler, et al., 2009a; Walters & Holling, 1990).

Chapter Five – Engaging the Community: An Evaluation of Stakeholder Support for Wildlife Ecosystem Interventions

5.1 INTRODUCTION AND OVERVIEW

Current conservation policies in the Kootenays resulted from conflicts over land use and resource development that occurred in the 1970s and 1980's. Largely driven by land and resource management policy reforms that were shaped by land-use planning and new forest practices legislation implemented between 1994 and 2007, contemporary policies are firmly rooted in a number of public processes, negotiations, and compromises. While progressive, these conservation policies were largely designed without consideration of the potential for ecosystems to respond to significant changes in climate in complex and unpredictable ways. Previous chapters in this dissertation and other studies make the case that it is anticipated that current land and resource use policies based on static paradigms could fail to effectively conserve ecological integrity (Austin et al., 2008; Pojar, 2010; Lovejoy & Hannah, 2005; Hagerman et al., 2010a). Addressing the future resiliency of wildlife ecosystems therefore requires that communities both understand the emerging knowledge, complexity and uncertainty of climate change impact dynamics, and become involved in political support for conservation strategies (Folke et al., 2005).

Addressing predicted climate change impacts on ecosystems requires that conservation decision-makers revisit conservation objectives and consider strategies that will optimize ecosystem integrity and resilience (Hagerman et al. 2010b). At the heart of the challenge are the competing values inherent in diverse communities, along with vested interests in land and resources, significant social capital already invested in current land use plans, and lack of understanding of new and pressing issues related to climate change impacts. In a democratically accountable system of governance, community involvement is necessary to promote shared understanding of issues, build trust and seek resolution among conflicting interests, ensure decision-making transparency and accountability, and facilitate social learning (Burgess & Clark, 2009;

Dobson, 2009; Paehlke, 2005; Stirling, 2009). As stated by Stephen Owen, Commissioner for Resources and the Environment in British Columbia from 1992 to 1995:

> Public participation through multisector, public interest negotiation is an essential component in management for sustainability. Such negotiation not only enables government to obtain comprehensive and balanced information needed for the development and integration of economic, social, and environmental policy, but also encourages the stability of integrated policy that is perceived to be rooted in, and to reflect, the broad public interest. By encouraging conflicting interests to understand and reconcile their differences the process also builds goodwill and resilience within communities. This is in stark contrast to consultative models that can exaggerate the differences among conflicting interests as participants adopt extreme positions in the hope that a compromise decision will be in their favor. (Owen, 1998; p. 24).

This chapter focuses on an analysis of ways in which people's understanding of and support for conservation strategies are motivated by beliefs and attitudes about wildlife ecosystem vulnerability to climate change, and how their views may be influenced by engagement in a deliberation process, in keeping with principles of wild design described by Higgs and Hobbs (2010) as noted in Chapter One. It builds on the foundation created in Chapters Two and Three which describe factors that shape understanding of approaches to wildlife conservation in British Columbia and the study region. These highlight the importance and challenges of deliberative democracy in shaping public policy in recent years, as evidenced by the passionate and often contentious engagement in the formulation of wildlife conservation policy. In Chapter Four a range of scenarios is explored that project the impacts of climate change in the study region in order to establish the pressures that are likely to demand shifts to public policy. These set the stage for a focus in this chapter on the overarching question:

> Given the pressing need for new, more resilient approaches to wildlife conservation, how does stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems influence support for appropriate wildlife habitat and species intervention policies?

The specific lines of enquiry that are addressed include:

1) What are stakeholders' current understandings, beliefs and attitudes about climate change, its predicted impact on wildlife ecosystems, and current conservation and restoration approaches? How are these perspectives influenced by personal values and demographic factors?
2) Does participation in a workshop that explores scenarios and impacts of climate change on wildlife ecosystems affect stakeholder beliefs and attitudes related to wildlife conservation and restoration strategies?
3) What opportunities and barriers exist which may influence conservation and restoration policy options for increasing the resilience of wildlife ecosystems to climate change?

Given the critical role of social factors in the formulation of public policy, this chapter describes three intertwined data gathering and analysis initiatives undertaken in 2012 and 2013 to better understand how stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems motivates support for appropriate wildlife habitat and species intervention policies:

1) a survey of the values, beliefs and attitudes of a group of stakeholders in the study area;
2) a workshop in which stakeholders studied climate change scenarios, both online prior to the meeting and during the session, as a basis for an assessment of adaptation options for climate change impacts on wildlife ecosystems; and
3) a series of subsequent interviews with participants in the workshop focussing on how workshop engagement motivates support for wildlife habitat and species intervention policies.

5.2 METHODOLOGY

As the focus in this component of the study is local stakeholders' viewpoints before, during and after participating in a workshop addressing climate change adaptation, a mixed methods approach was utilized that enabled the collection of data that could be analyzed from both quantitative and qualitative perspectives. This included results from a web-based survey, notes and flip chart records from the workshop, and digital voice records and written notes from individual interviews.

5.2.1 Data Collection Overview and Rationale

Once the climate change scenarios described in Chapter Four were complete in August 2012, participants were recruited for the survey (see Section 2.2), with the workshop and interview processes taking place between October 2012 and May 2013. These processes afforded a means of gathering multi-dimensional data on environmental values, beliefs and attitudes on wildlife conservation, sharing and discussing information on projected climate change impacts, identifying potential barriers and opportunities that impact the capacity to address climate change adaptation, and assessing the degree to which a workshop approach shapes motivation to take new approaches in wildlife conservation policy. The mix of survey, workshop and interview methods was designed to progressively develop insight into participants' backgrounds and perspectives.

a) Survey Rationale: The initial web-based survey, described in detail in Section 3 and conducted in November 2012, was to establish benchmarks relating to participants' demographic backgrounds, and their attitudes and beliefs relating to environmental values, wildlife orientation, and climate change impacts and adaptation priorities. Responses offered data for quantitative analysis of group characteristics and for qualitative analysis of participants' perspectives on wildlife conservation.

b) Workshop Rationale: The one-day workshop, described in detail in Section 4, was held in Nelson, BC on November 29, 2012, to introduce participants to projected wildlife impacts of climate change scenarios, and to engage them in discussions on conservation and restoration strategies and options. This generated qualitative observational and group feedback data on workshop dynamics and outcomes. The resulting data allowed qualitative analysis of workshop dynamics and outcomes. The workshop approach was guided by climate change vulnerability assessment and adaptation approaches presented by Glick et al. (2011) and Cross et al. (2012) that outline the need to engage key stakeholders, identify future climate scenarios and resources at risk (ie. exposure and sensitivity), and identify and priorize management intervention. Key concepts the workshop addressed included: 1) confronting inherent tensions involved in human interventions in managing ecosystems; 2) addressing uncertainty through attention to ecological integrity, caution and adaptive management; and 3) building support through education and collaboration.

c) Interview Rationale: Subsequent individual interviews, described in detail in Section 5, were conducted between December 2012 and May 2013. These were designed to explore each participant's post-workshop perspectives on the issues, address potential strategies, and gauge support for policy options in more detail by probing thirteen themes relating to participants' attitudes and beliefs about climate change impacts on wildlife ecosystems and their concerns about the future, their support for implementing wildlife conservation strategies, and the perspectives gained from the workshop. Transcripts provided considerable data for a qualitative analysis of themes associated with wildlife conservation attitudes, approaches, obstacles and concerns.

5.2.2 Participants

Given the complexity of values, beliefs, knowledge, experiences, situations and attitudes underlying environmental motivation among diverse stakeholders in the study area, the intention of the participant selection process was to recruit a sample representing a range of interests associated with wildlife management in order to assess how the interplay of such variables affects support for wildlife conservation. Other similar studies have noted groupings or polarization in such community perspectives (Rutherford et al, 2009; Mattson et al., 2006; Byrd, 2002). In their study of public wildlife values in Colorado for example, Bright et al. (2000) found that people who are uninterested in wildlife tend not to participate in studies about wildlife. Given the inherent difficulties in attracting participants who might fully represent varied perspectives associated with wildlife management in the region, it was recognized that the selection process could only approximate the range of interests. Regional interests targeted for participation in this study included government bureaucrats who implement land and resource management policies; scientists researching wildlife ecosystems; First Nations; representatives from forestry, mining and commercial recreation industries; environmental non-government organization (ENGO) leaders; recreational hunting enthusiasts; and other members of the community identified as having an interest in wildlife/climate change issues. Prospects were identified through direct contact with known stakeholder groups, local advice from the workshop facilitators and other contacts, people known to have participated in other similar studies in the region, referrals from other participants, and people known to the researcher.

Prospective participants were sent a formal written request (recruitment letter is attached in Appendix 4). A total of 54 requests were sent. From these, 29 agreed to participate, 28 actually ended up completing the survey, 27 participated in the workshop, and 23 engaged in the follow-up interviews. The sample included forestry and wildlife managers from government; representatives of industrial forestry, mining and commercial recreation interests; ENGO leaders; independent wildlife biologists/ecologists; recent graduates of the wildlife program at the local community college; recreational hunting enthusiasts; and other interested people. Included among this group were individuals who had been on the Kootenay-Boundary land use plan negotiating table, the Mountain Caribou Science Team, or currently are on the Mountain Caribou Progress Board. Participants also represented diverse age groups, genders, political orientations, education levels, and geographic locations across the region. Further detail is discussed and summarized in Figures 5.1 and 5.2 further on.

Participation representative of large industrial forest licensees is one limitation in the sample. Although requests to 11 individuals working in the forest industry, only 3 responded agreeing to participate in the study. None of these were currently employed by one of the large forest licensees working in the region although 2 recently had been, and one was employed in a community forest.

Requests to participate were forwarded to First Nations contacts, including an official working for the Ktunaxa Nation Council and an individual recommended as having an interest in the subject. While these prospective participants expressed interest in the study, the six-week timeframe for responses was insufficient to allow permissions to be given in the first instance; the other individual had to withdraw prior to the workshop due to personal reasons. In hindsight, it is apparent that a longer response time and careful attention to First Nations permissions protocols is required to facilitate First Nations engagement.

5.2.3 Ethical Considerations

As this component of the project's research involved human subjects, it was conducted in accordance with the Tri-Council Policy Statement as outlined in Chapter One. The principle of 'free and informed consent' was maintained at each stage of volunteer participation through sign-off on the participant consent forms. In a few cases involving telephone interviews, participants gave verbal consent. Participants were informed of their ability to freely withdraw from the study at each stage of participation, and each participant was provided the opportunity to review and edit their individual interview transcript. The anonymity of participants has been protected in the analysis of the results by the exclusion of names or references by which individuals could be identified.

All data including digital audio recordings, documents, and field notes have been securely stored in password protected files on a personal laptop computer with back-ups on two password protected hard drives. As per the Ethics Approval, all original data that could identify individual participants is being kept for the duration of this study, which will conclude upon defense of the doctoral dissertation. Upon completion, electronic data will be erased and paper data will be shredded. Intermediate data analysis that does not identify individuals will be archived in a secure manner.

5.3 SURVEY METHODS AND OUTCOMES

5.3.1 Methods

An online survey (Appendix 5) using SurveyMonkey[120] offered a consistent means of conducting an initial assessment of participants' current values, beliefs, attitudes and knowledge relating to climate change and its predicted impacts on wildlife ecosystems, along with perspectives on conservation and restoration prior to their participation in the workshop. It also sought to establish how such perspectives were influenced by personal values and demographic factors. Each recruited participant was asked 52 questions related to their:

1) environmental values,
2) attitudes towards wildlife,
3) beliefs and knowledge of climate change and its impacts on wildlife ecosystems,
4) understanding of wildlife conservation issues in the Kootenay region,
5) support for wildlife conservation strategies, and
6) personal information relevant to establishing a demographic background for comparison.

Approximately half of the survey questions drew on or adapted a number of questions from well-established scales that measure environmental values. The New Environmental Paradigm (NEP) instrument, for example, grew out of challenges that environmentalism, beginning in the 1970s, was bringing to the dominant social paradigm rooted in material abundance and growth and a view of nature of something to be subdued (Dunlap, 2008). Variations to the NEP scale have been widely and successfully used to measure environmental concern and behaviour (Cordano et al., 2003; Dunlap, 2008; Dunlap et al., 2000; Milfont & Duckitt, 2009), ecocentric versus anthropocentric attitudes toward the environment (Thompson & Barton, 1994; Kortenkamp & Moore, 2001) and attitudes towards wildlife (Bjerke & Kaltenborn, 1999).

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[120] Survey Monkey Website. Retrieved from https://www.surveymonkey.com/.

The Wildlife Value Orientation (WVO) approach sorts wildlife value orientation into four categories, 1) mutualistic, 2) pluralistic, 3) utilitarian, and 4) those that are uninterested. The WVO is used to build greater understanding of public attitudes toward wildlife and conservation management (Manfredo, 2008; Manfredo et al., 2003; Manfredo et al., 2009; Teel & Manfredo, 2009; Bright et al., 2000; Loyd & Miller, 2010; Manohar et al., 2012; Jacobs et al., 2014; Layden et al., 2003; Butler et al., 2001; Hunter & Brehm, 2004).

The survey questions[121] that utilized or adapted such scales included the following:

- Questions 1-8, which addressed environmental values on the balance of nature, and human domination of nature using 8 questions from the abbreviated New Environmental Paradigm (NEP) scale outlined by Cordano et al. (2003);
- Questions 9-10, which were adapted from Brown and Reed (2000) to measure beliefs on the utility value of forests;
- Question 11 which was designed to measure attitudes toward environmental restoration; and
- Questions 12 – 21, which were adapted from the Wildlife Value Orientation (WVO) scale from Loyd and Miller (2010), Butler et al. (2004), and Manfredo et al. (2003) to address attitudes about the existence and economic value of wildlife.

‘Environmental values’ and ‘wildlife orientation’ scores were measured on a 5-point scale (strongly agree = 5, agree = 4, neutral = 3, disagree = 2, strongly disagree = 1). Questions 4, 6, 7, 8, 9, 10, 16, 17, 18 and 19 were transformed to orient all questions from most to least biocentric (least to most anthropocentric). An average aggregated ‘environmental value’ score was calculated as the average score across Questions 1 – 10, and similarly an average aggregated ‘wildlife orientation’ score was calculated as the average across Questions 11 – 21.

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[121] See Appendix 6

Participants' 'climate change beliefs' were assessed in Questions 22 through 24 (yes = 1, don't know = 0, no =-1). These queried whether participants believed that global warming results from greenhouse gas emissions, whether this was the primary cause of global warming, and whether they believed predicted climate changes are likely to happen in the study region. The 'climate change belief' score was calculated as the average score across the three questions, which was then scaled arithmetically from 1 to 5 for presentation purposes.

Question 25 was included to learn more about participants' rating of their level of knowledge about climate change impacts on wildlife ecosystems (expert = 4, knowledgeable = 3, somewhat aware = 2, unaware = 1). If the participant had directly participated in the West Kootenay Resilience Project (Question 26), their 'climate knowledge' score was increased by one point. The knowledge scores were also scaled arithmetically from 1 to 5 for presentation purposes.

Participants' assessment of their 'conservation policy knowledge' was evaluated by Question 28 (expert = 3, knowledgeable = 2, somewhat aware = 1, unaware = 0), and similarly their belief in 'conservation policy effectiveness' by Question 29 (very effective = 4, somewhat effective = 3, ineffective = 2, very ineffective = 1, don't know = 0). Responses to Questions 28 and 29 were scaled arithmetically from 1 to 5 for presentation purposes. Question 31 asked whether participants believed climate change impacts on wildlife ecosystems is a problem (yes or no). Support for conservation policies, including habitat reserves, migration corridors, prescribed fires and forest harvesting to manage habitat, habitat restoration, assisted species migration, predator control, riparian protection, and stronger regulation, was assessed by Question 35 (strongly support = +3, support = +2, neutral or don't know = 0, oppose = -1, strongly oppose = -2).

Demographic information was solicited in Questions 38 - 47 and addressed occupation, age, political orientation, lifestyle, gender, and education. Respondents were also asked to identify whether they had an urban or rural lifestyle, to describe their ethnic or cultural background, and to indicate for how long and where they have resided in the region. Responses on occupation were categorized into 5 classes: government agency, industry stakeholder, non-government environmental organization, science, and public. A general question was asked on frequency of participation in outdoor or nature based recreational activities (Question 48).

5.3.2 Survey Results

Of the 29 surveys distributed, 28 were returned and analyzed. Of the 28, 27 were fully completed, while one respondent declined to complete sections on environmental values or wildlife attitudes. The person who did not complete the survey did go on to participate in the workshop and interview process; subsequent interpretation of this participant's input takes into consideration the absence of baseline data. Not all questions were answered by every participant. Participants' demographic profiles, comprised of age, gender, education, lifestyle, occupational category, general political orientation[122], cultural background, residency, and geographic location are presented in Figure 5.1.

Given that the sample was comprised of people with a range of direct interests in climate change impacts on wildlife ecosystems, or people interested enough in learning more about the issue to volunteer to participate, there is an intuitive expectation of strong bias in the sample toward participants who value wildlife for its intrinsic significance and who tend to have a biocentric perspective on the environment. The sample was also biased towards university-educated, middle-aged people with a rural lifestyle and a 'progressive' political orientation. Nevertheless, the 28 participants represent a cross-section of stakeholder interests, age groups, gender, education, lifestyle, and political beliefs.

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[122] The political orientation question was taken from example questions provided by the SurveyMonkey template. The categories do not represent political parties, rather the intent of the question was to solicit participants' self-identified political orientations.

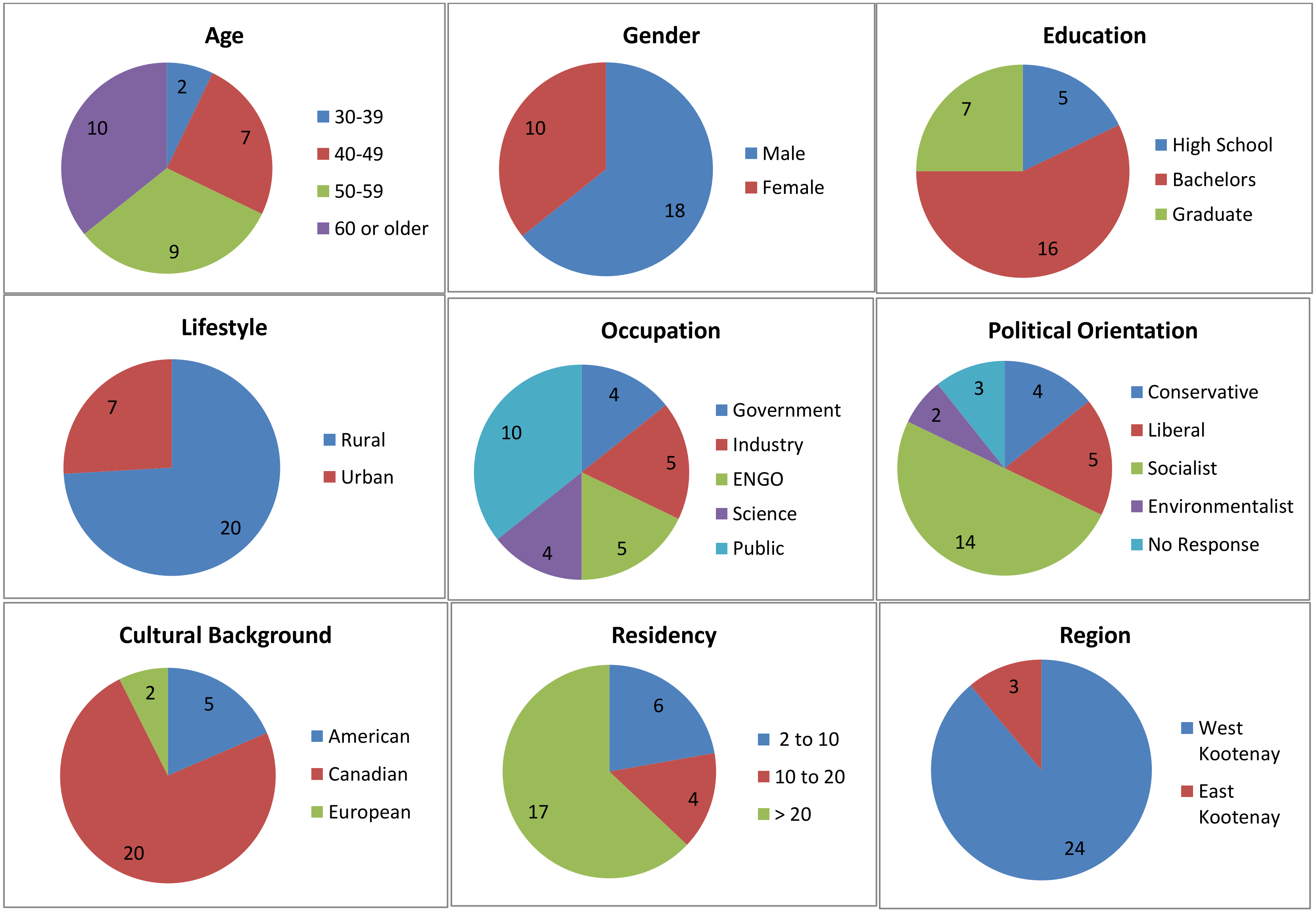

Figure 5. 1: Summary of Participant Demographic Factors from Survey

Figures 5.1 summarizes key sample characteristics:

- only 2 participants were under the age of 40 years old and the remaining 26 distributed quite evenly between 40 to over 60 years of age;
- 36% of the sample were female and 64% male;
- 57% held a Bachelor's degree, 25% held a graduate degree, and 18% had a high school diploma as their highest level of education;
- approximately 1/3 (10) of respondents were categorized as 'public', while 5 indicated ENGO affiliations, and 5 worked or had recently worked with industry – the balance were divided among government and scientist categories;
- half of the sample identified their political orientation as 'socialist', 5 respondents indicated a 'liberal' orientation, 4 indicated 'conservative', 2 indicated 'environmentalist' and 3 did not provide a response to this question;
- the predominant cultural background identification was Canadian (74%), with 19% indicating they have an American background and only 7% identifying as having a European background (no other backgrounds were given);
- most have lived in the west or east Kootenay region for more than 20 years (63%), while only 22% have lived there less than 10 years; and
- all participants have a direct interest in the West Kootenay region, and all but three reside in the region (the three who didn't do reside in the East Kootenay region but their work connects them directly to the West Kootenay region).

Graphing and statistical analysis functions in Microsoft Excel were used to analyze participants' perspectives as described in the previous section and the ways these are shaped by personal values and demographic factors. Survey results which compare environmental value, wildlife orientation, climate belief, climate knowledge, conservation knowledge, conservation policy effectiveness, and conservation policy support scores against demographic factors is presented in Table 5.1.

The results of the comparisons are discussed in the following sections.

Table 5. 1: Comparison of Demographic Factors with Environmental Values, Wildlife Orientation, Climate Beliefs, and Support for Conservation Strategies

	Environmental Values	Wildlife Orientation	Climate Belief	Climate Knowledge	Policy Knowledge	Policy Effectiveness	Reserves	Corridors	Prescribed Fire	Harvesting	Restoration	Translocation	Predator Control	Riparian	Regulation
Scale	1 to 5						-2 to +2								
Age															
30-39 (n=2)	4.1	4.5	5.0	2.7	3.8	3.5	2.0	2.0	1.5	1.0	2.0	0.5	-0.5	2.0	2.0
40-49 (n=7)	4.0	4.2	4.9	2.3	3.2	2.9	1.6	1.9	1.7	1.4	1.7	0.6	-0.3	1.6	1.6
50-59 (n=9)	3.4	3.4	3.9	2.1	3.6	3.6	1.0	1.1	1.6	0.8	1.4	0.1	0.4	1.4	0.8
60+ (n=10)	3.9	4.1	4.1	1.7	3.1	3.1	1.7	1.7	1.6	1.2	1.5	0.7	0.6	1.7	1.2
Mean	3.9	4.1	4.5	2.2	3.4	3.3	1.6	1.7	1.6	1.1	1.7	0.5	0.1	1.7	1.4
SD	0.3	0.5	0.6	0.4	0.3	0.3	0.4	0.4	0.1	0.3	0.3	0.3	0.5	0.2	0.5
Gender															
Female (n=10)	3.9	4.2	4.4	1.9	2.9	3.2	1.5	1.7	1.6	1.2	1.7	0.4	-0.1	1.5	1.3
Male (n=18)	3.8	4.1	4.2	2.2	3.6	3.2	1.4	1.5	1.6	1.1	1.5	0.5	0.4	1.7	1.2
Mean	3.9	4.2	4.3	2.1	3.2	3.2	1.5	1.6	1.6	1.1	1.6	0.5	0.2	1.6	1.2
SD	0.1	0.1	0.1	0.2	0.5	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.4	0.1	0.1
Education															
High School (n=5)	4.1	4.3	3.7	1.6	3.0	3.0	1.8	1.8	1.6	1.2	1.8	0.4	0.4	1.8	1.0
Batchelor (n=16)	3.8	4.1	4.3	2.1	3.5	3.3	1.3	1.4	1.6	1.1	1.4	0.5	0.3	1.4	1.2
Graduate (n=7)	3.8	4.2	4.6	2.4	3.2	3.3	1.6	1.7	1.7	1.1	1.9	0.4	0.1	1.9	1.4
Mean	3.9	4.2	4.2	2.0	3.2	3.2	1.6	1.7	1.6	1.1	1.7	0.4	0.3	1.7	1.2
SD	0.2	0.1	0.5	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.3	0.1	0.1	0.2	0.2
Lifestyle															
Rural (n=21)	3.9	4.2	4.2	2.1	3.4	3.1	1.6	1.6	1.5	1.0	1.6	0.4	0.1	1.6	1.3
Urban (n=7)	3.6	3.9	4.4	2.1	3.2	3.6	1.1	1.4	1.9	1.3	1.4	0.6	0.6	1.6	1.0
Mean	3.8	4.1	4.3	2.1	3.3	3.3	1.4	1.5	1.7	1.2	1.5	0.5	0.4	1.6	1.1
SD	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.1	0.2	0.2	0.1	0.1	0.3	0.0	0.2
Occupation															
Gov't (n=4)	3.6	4.1	4.4	2.5	4.4	3.8	0.5	1.5	1.8	1.3	1.5	0.5	1.0	1.0	0.8
Industry (n=5)	3.6	4.0	3.7	2.1	3.5	2.8	1.0	1.0	1.8	1.0	1.2	-0.2	0.2	1.4	0.6
NGO (n=5)	4.2	4.6	4.8	1.6	3.0	3.8	2.0	2.0	1.2	0.8	1.8	0.8	-1.0	2.0	1.8
Public (n=10)	3.8	4.0	4.0	1.8	2.9	2.7	1.6	1.5	1.5	1.2	1.6	0.5	0.5	1.6	1.1
Science (n=4)	3.9	4.3	5.0	2.8	3.8	3.8	2.0	2.0	2.0	1.3	1.8	0.8	0.5	2.0	2.0
Mean	3.8	4.2	4.4	2.2	3.5	3.4	1.4	1.6	1.7	1.1	1.6	0.5	0.2	1.6	1.3
SD	0.3	0.3	0.5	0.5	0.6	0.6	0.7	0.4	0.3	0.2	0.2	0.4	0.8	0.4	0.6
Political Orientation															
Conservative (n=4)	3.4	3.8	2.5	1.7	3.8	3.8	0.8	0.5	1.8	0.8	1.0	-0.3	0.8	1.3	-0.3
Liberal (n=5)	3.6	4.2	4.3	2.0	3.3	2.8	1.2	1.4	1.2	1.0	1.8	0.2	-0.2	1.6	1.0
Socialist (n=14)	4.0	4.1	4.6	2.1	3.2	3.0	1.6	1.8	1.8	1.3	1.6	0.6	0.5	1.6	1.4
Environmentalist (n=2)	4.1	4.7	4.6	2.6	3.8	4.0	2.0	2.0	2.0	1.0	2.0	0.5	-0.5	2.0	2.0
No Response (n=3)	4.0	4.5	5.0	2.1	3.3	3.7	2.0	2.0	1.0	1.0	1.7	1.0	-0.3	2.0	2.0
Mean	3.8	4.3	4.2	2.1	3.5	3.4	1.5	1.5	1.5	1.0	1.6	0.4	0.0	1.7	1.2
SD	0.3	0.4	1.0	0.3	0.3	0.5	0.5	0.6	0.4	0.2	0.4	0.5	0.5	0.3	0.9
Cultural Background															
American (n=5)	4.1	4.4	5.0	2.4	3.8	3.0	2.0	2.0	1.7	1.3	2.0	1.0	0.0	2.0	1.7
Canadian (n=20)	3.8	4.1	4.2	2.0	3.4	3.3	1.4	1.6	1.6	1.1	1.5	0.4	0.3	1.6	1.1
European (n=2)	3.6	3.9	4.2	2.5	2.5	2.5	1.5	1.0	1.5	1.0	2.0	0.0	0.5	1.5	1.5
Mean	3.8	4.1	4.5	2.3	3.2	2.9	1.6	1.5	1.6	1.1	1.8	0.5	0.3	1.7	1.4
SD	0.3	0.3	0.5	0.3	0.6	0.4	0.3	0.5	0.1	0.2	0.3	0.5	0.3	0.3	0.3
Residency															
2 to 10 (n=6)	3.8	4.3	4.7	1.8	2.7	3.2	1.8	1.7	1.2	0.7	1.7	0.5	-0.7	1.8	1.7
10 to 20 (n=5)	3.9	4.1	4.7	2.7	3.8	3.4	1.2	1.6	1.8	1.4	1.6	0.8	0.8	1.2	1.4
> 20 (n=17)	3.8	4.1	4.0	2.0	3.5	3.2	1.4	1.5	1.7	1.2	1.5	0.4	0.4	1.6	1.0
Mean	3.8	4.2	4.5	2.2	3.3	3.2	1.5	1.6	1.6	1.1	1.6	0.6	0.2	1.6	1.4
SD	0.0	0.1	0.4	0.5	0.5	0.1	0.3	0.1	0.3	0.4	0.1	0.2	0.8	0.3	0.3

5.3.2.1 Environmental Values and Wildlife Orientation

The results shown in Table 5.1 found that some minor differences in environmental values and wildlife orientation were observed with age, occupation, political orientation, and cultural background.

A comparison of the environmental value and wildlife orientation scores with demographic factors is shown in Figure 5.2. Inferences about the relationship between environmental values and wildlife orientation suggested from this analysis suggest that for this group of stakeholders:

- a utilitarian or domination wildlife orientation is stronger in the 50 – 59 year old category;
- people who identify with a conservative political orientation have the lowest biocentric environmental values and highest utilitarian wildlife orientation, while those identifying with a socialist or environmentalist orientation or who did not provide a response to their political orientation achieved the highest biocentric environmental value and wildlife orientation scores;
- the stronger biocentric environmental values and mutualistic wildlife orientation are people in the ENGO occupational category while both industry and government stakeholders had the weakest;
- people who consider their cultural background to be American tend to have stronger environmental values and wildlife orientation scores than those with Canadian or European backgrounds; and
- there were no significant differences in environmental values or wildlife orientation measured between the gender, education level, lifestyle, or length of residency factors.

The relationship between environmental values and wildlife orientation is plotted in Figure 5.3. As could be expected there is a reasonably strong correlation between these factors ($r^2 = 0.53$) supporting the perhaps obvious conclusion that people with stronger biocentric environmental attitude have a stronger mutualistic wildlife orientation, and

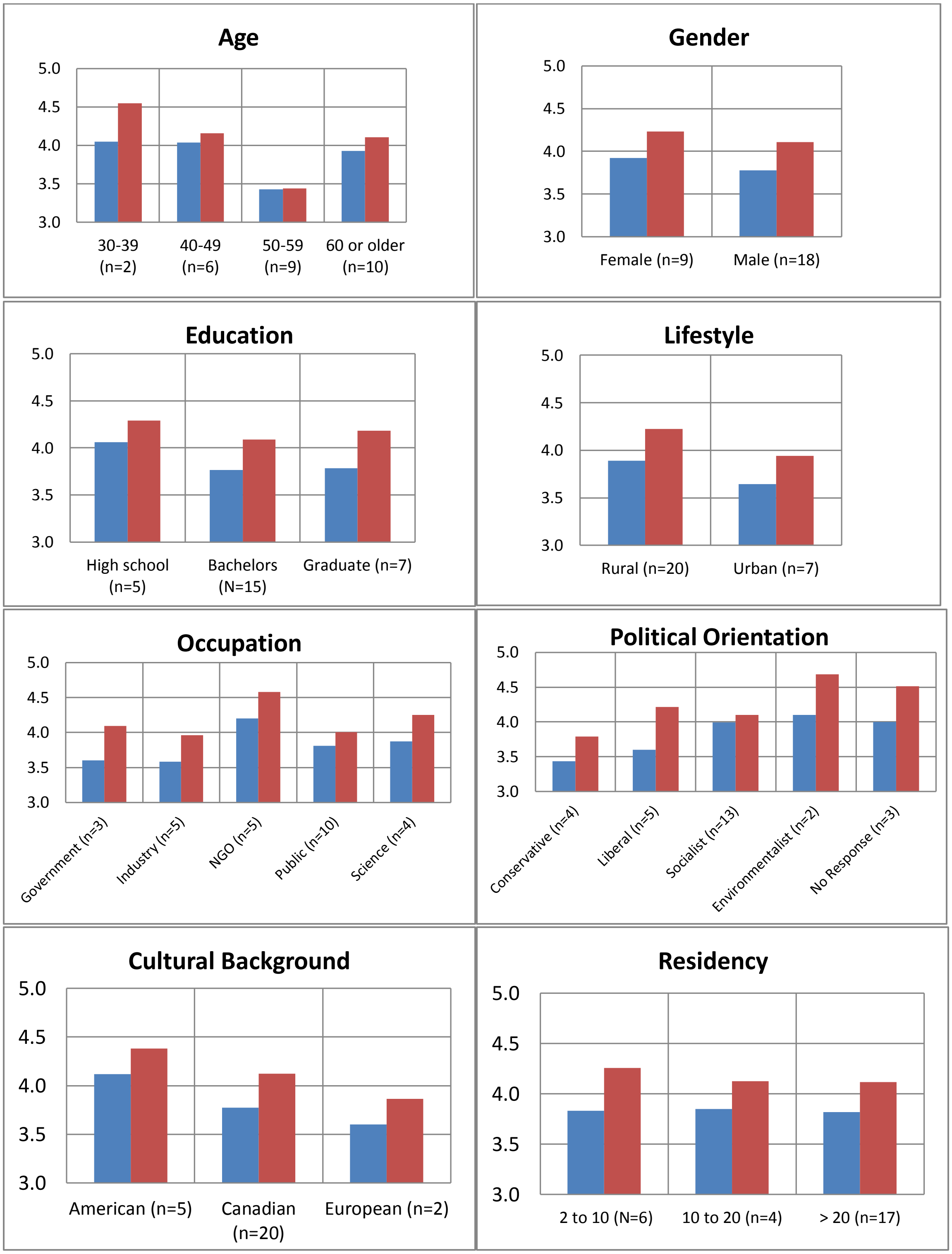

Figure 5. 2: Comparison of Environmental Value (blue) and Wildlife Orientation (red) Scores with Demographic Factors

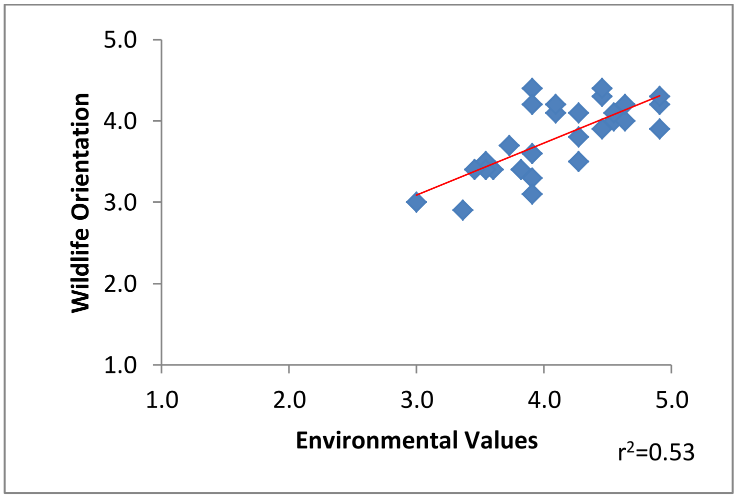

Figure 5. 3: Relationship Between Environmental Value and Wildlife Orientation Scores (regression line shown in red)

conversely a more anthropocentric perspective is consistent with a utilitarian wildlife orientation. Participants in the survey range from a neutral environmental value/wildlife orientation perspective to those with a strongly biocentric environmental value coupled with a mutualistic wildlife orientation. The participant sample did not include anyone with strongly anthropocentric environmental values or a disinterested wildlife value orientation.

5.3.2.2 Perspectives on Climate Change and Wildlife Conservation Policies

Participants were asked about their beliefs and knowledge about climate change, their knowledge of wildlife conservation policies, as well as whether: 1) they believed that these policies were effective in conserving wildlife ecosystems, 2) climate change would potentially impact wildlife ecosystems, and 3) climate change impacts on wildlife would be a problem. These data were collected in order to gauge perspectives on these issues prior to discussions of predictions of climate change impacts based on scenarios.

A comparison of participants' scores on climate beliefs and environmental values, is shown in Figure 5.4, revealing a moderately positive correlation with their environmental attitude score (Figure 5.4). Aside from the noise in the data inherent in

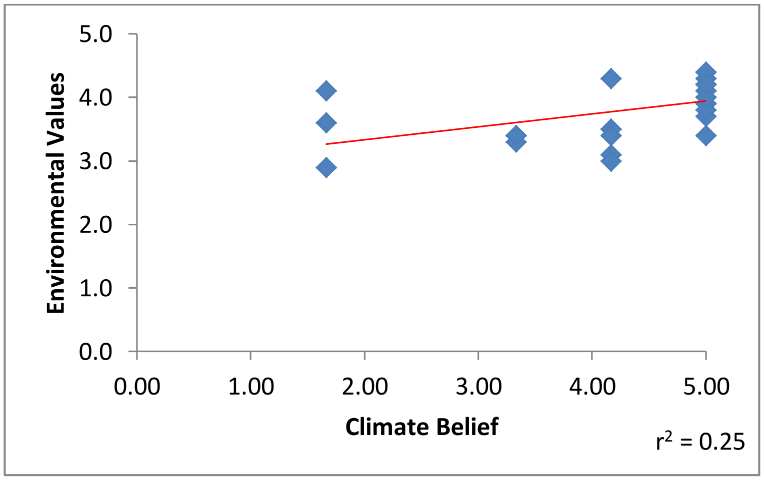

Figure 5. 4: Relationship Between Climate Belief and Environmental Value Scores (Regression line shown in red)

the small sample size and the accuracy of the measurement instruments, this suggests that there is a tendency among participants with stronger environmental concerns to more powerfully believe climate change is occurring. Conversely, participants with more anthropocentric environmental views seemed less convinced of climate change. However it would be reasonable to also assume that some individuals with less inclination to be concerned about the environment also may believe in climate change. The comparison between the climate belief factor and climate knowledge (Figure 5.5)

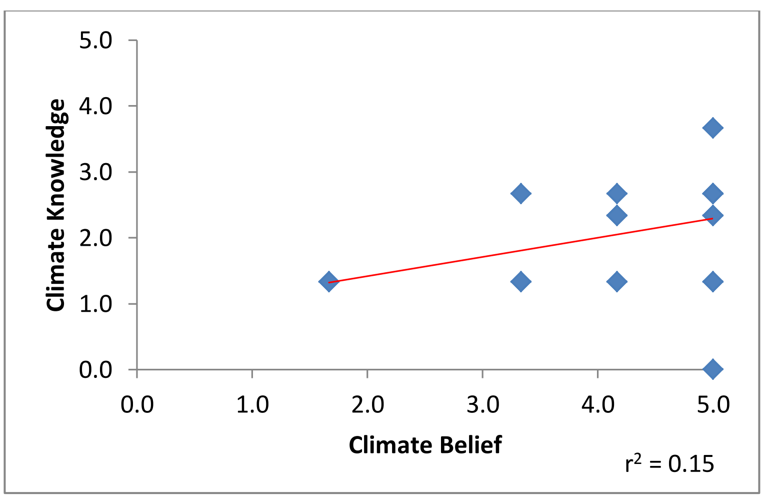

Figure 5. 5: Relationship Between Climate Belief and Climate Knowledge Scores (Regression line shown in red)

shows a weak positive correlation. It is interesting in that several participants indicated moderate to strong beliefs in climate change while claiming to have little to no knowledge about it. This suggests a degree of faith in what they have been exposed to through other means such as the media, internet, etc.

Climate change beliefs and knowledge are compared to demographic factors in Figure 5.6. Minor differences in climate change belief scores were observed by age, education, cultural background and residency, moderate differences were found in occupational category, and the strongest difference was in political orientation. Participants with a conservative political orientation had the lowest climate belief score within the sample. Government, industry and science occupational categories had higher levels on their climate knowledge scores.

The comparison of conservation policy knowledge and effectiveness with demographic factors is shown in Figure 5.7. Three of 28 participants indicated 'expert' knowledge of local conservation policies, 15 described themselves as 'knowledgeable', and 8 indicated 'unaware.' Males considered themselves more knowledgeable about conservation policies than females. This likely results from the presence of several males directly involved in policy application in the participant sample. Government and science categories considered themselves the most knowledgeable about conservation policies; ENGOs and the public participants considered themselves the least knowledgeable; and industry participants were intermediate between these two groupings.

No one considered current policies to be 'very effective' in conserving wildlife habitat and species, 16 people considered these policies to be 'somewhat effective', 7 believed them to be 'ineffective', no one considered them 'very ineffective', and 5 indicated they did not know if they were effective or not. It is interesting to note that government, ENGOs and scientists had the highest belief scores for conservation policy effectiveness.

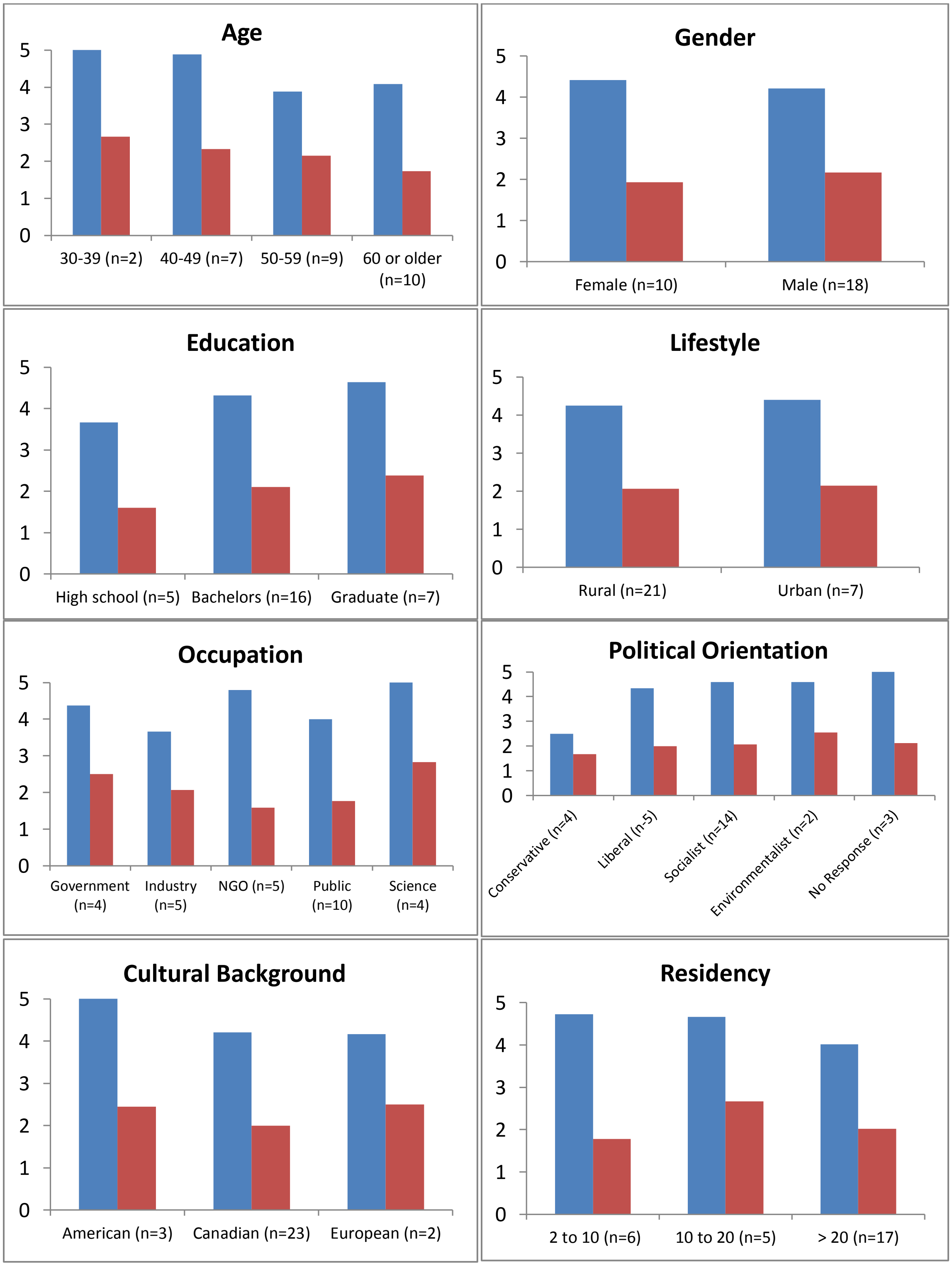

Figure 5. 6: Comparison of Climate Belief ( ) and Climate Knowledge ( ) Scores with Demographic Factors

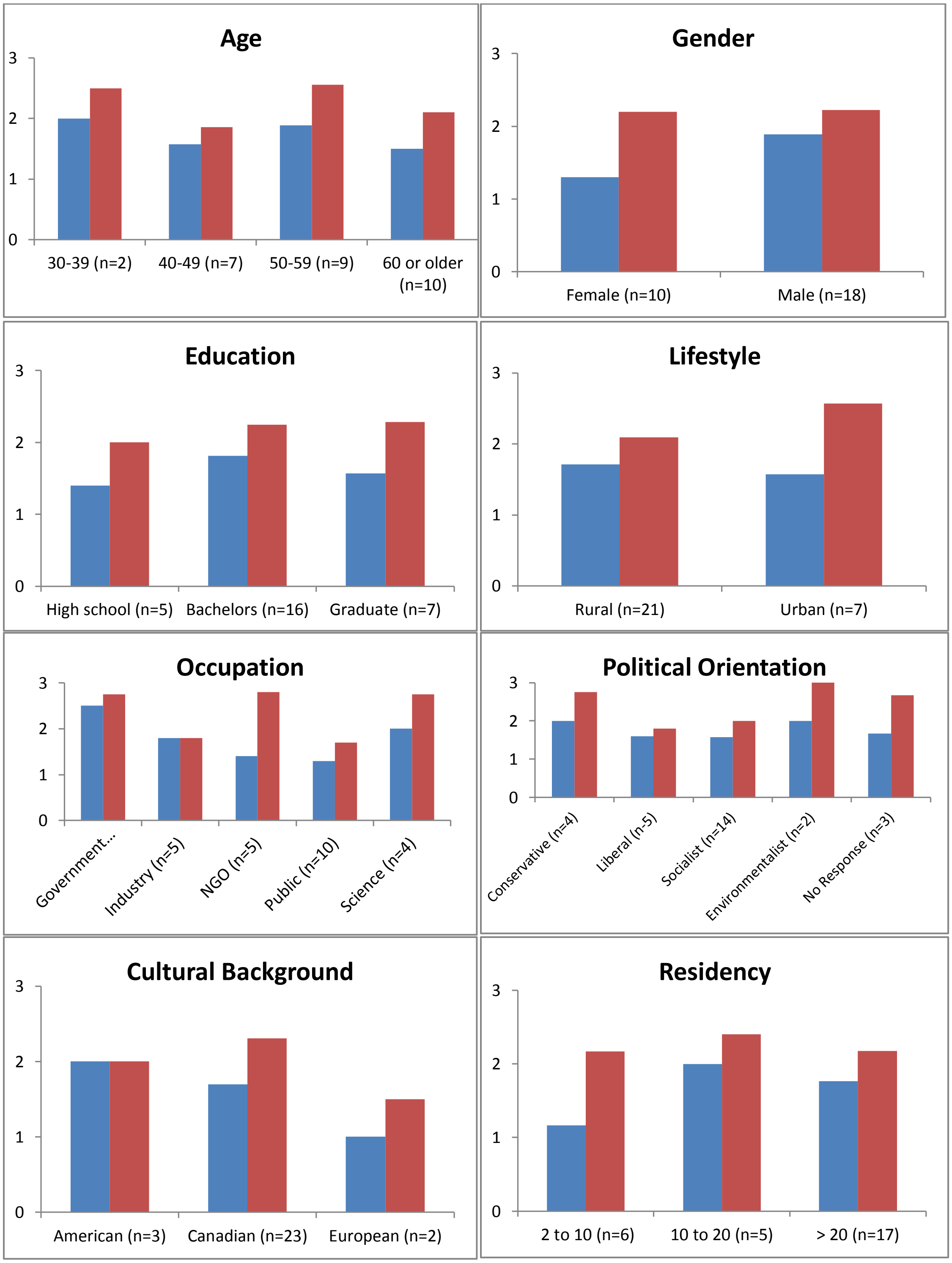

Figure 5. 7: Comparison of Conservation Knowledge ( ) and Conservation Effectiveness Belief ( ) Scores with Demographic Factors

Twenty-seven of 28 participants agreed that climate change will impact wildlife habitat and species, and one responded they did not know (Question 30). Twenty-three of 27 responded these impacts would be a problem, while 4 believe this would not be a problem (one person did not answer) (Question 31).

5.3.2.3 Support for Conservation Strategies

Participants' support for implementing conservation strategies needed to mitigate climate change impacts on wildlife ecosystems identified in Question 35 are presented in Table 5.2. Strategies addressed in the survey included support for habitat reserves, migration corridors, managed disturbance using prescribed fire or timber harvesting, habitat restoration, species translocation, predator control, riparian protection, and stronger environmental regulation.

Table 5. 2: Participant Support For Conservation Strategies to Mitigate Climate Change Impacts on Wildlife Ecosystems, showing number and percentage of participants in each category

	Strongly Support	Support	Neutral	Oppose	Strongly Oppose	Don't Know
Habitat reserves	18 (67%)	6 (22%)	2 (7%)	1 4%	0	0
Migration corridors	19 (68%)	6 (21%)	3 (11%)	0	0	0
Prescribed fire	18 (64%)	9 (32%)	1 (4%)	0	0	0
Forest harvesting	8 (29%)	15 (54%)	5 (18%)	0	0	0
Habitat restoration	17 (61%)	10 (36%)	1 (4%)	0	0	0
Species translocation	1 (4%)	14 (50%)	10 (36%)	1 (4%)	1 (4%)	1 (4%)
Predator control	2 (7%)	10 (36%)	10 (36%)	5 (18%)	1 (4%)	0
Riparian protection	19 (68%)	8 (29%)	0	1 (4%)	0	0
Stronger regulation	15 (56%)	6 (22%)	5 (19%)	0	1 (4%)	0

Support for conservation strategies was compared to demographic factors and is presented in Figure 5.8.To simplify this analysis, some conservation strategies were grouped as follows:

- Habitat protection = habitat reserves + migration corridors + riparian corridors
- Managed disturbance = prescribed fire + forest harvesting.

Significant demographic factors determining support for habitat protection included occupation and political orientation. The strongest support for habitat protection was indicated by ENGOs, public and science occupations; and socialist, environmentalist and no response political orientation categories. The weakest support was from the government, industry, and conservative political orientation categories. Education, occupation, political orientation, and cultural background resulted in minor differences in support for habitat restoration. Weaker support for habitat restoration existed with people with bachelor's degrees, conservatives, and people with a Canadian cultural background. People who had resided in the region less than 10 years expressed the least support for integrated management approaches. Significant differences existed in support for predator control between age groups, gender, occupation, and residency. Those less than 49 years old tended to oppose predator control, while people older than 50 years old tended to support this strategy. Females tended to be opposed to predator control, while males tended to support it. Predator control was most strongly supported by government staff and people who had lived in the region for longer than 10 years, and most strongly opposed by ENGOs and those who had resided in the region for 10 years or more. Support for stronger government regulation was highest with ENGOs, public, and science participants, and those with a liberal, socialist, environmental or no response political orientation. It was weakest with government and industry participants, and those with a conservative political orientation.

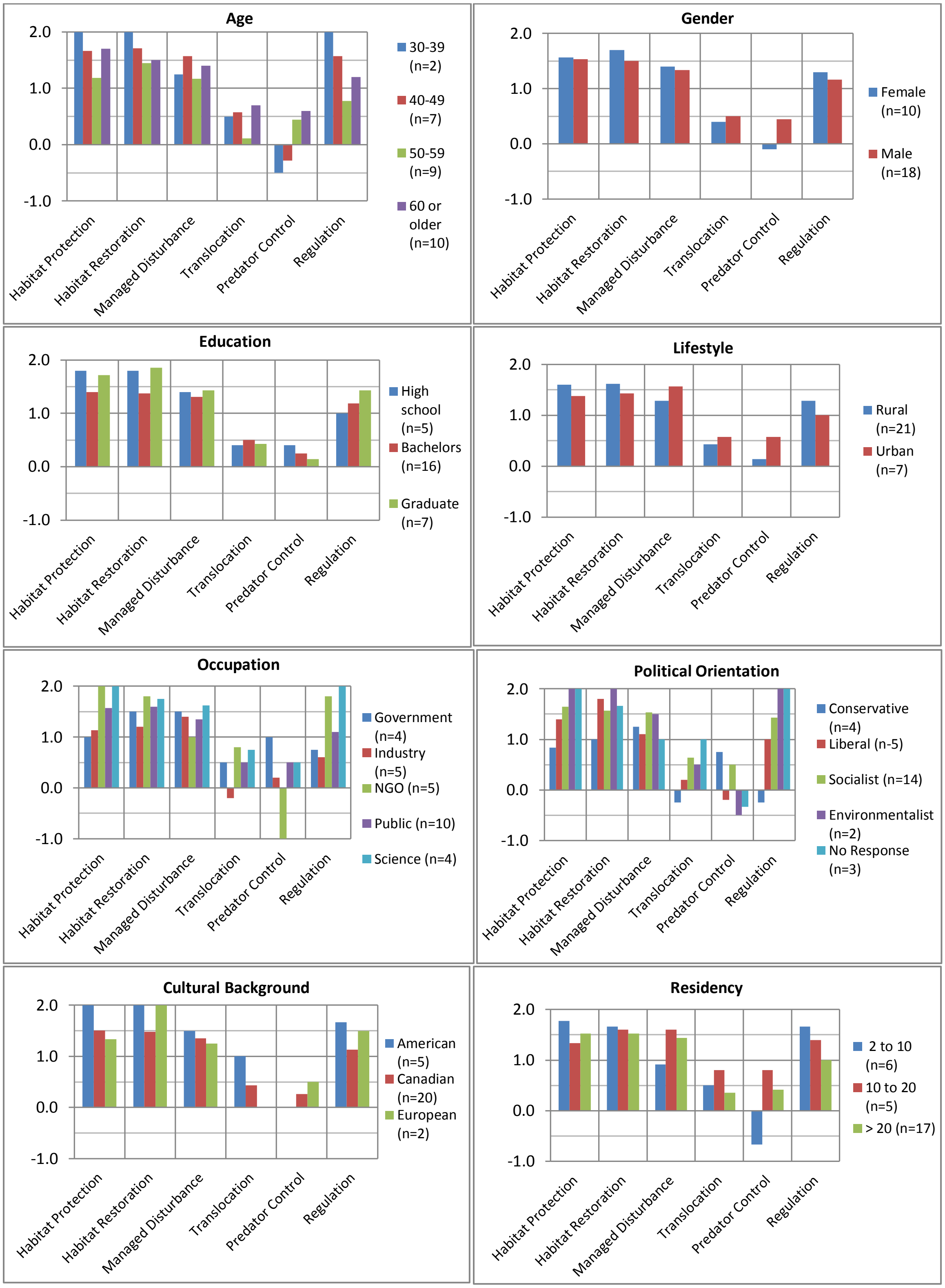

Figure 5. 8: Comparisons of Wildlife Ecosystem Conservation Support Scores with Demographic Factors

Wildlife orientation scores were compared to conservation support scores using regression analysis presented in Figure 5.9. Wildlife orientation was positively correlated with support for habitat reserves, wildlife corridors, riparian protection, habitat restoration, and stronger regulation.

Habitat reserves were strongly supported by 67%, supported by 22%. Seven percent were neutral, and 4% were opposed. Sixty-eight percent strongly supported wildlife corridors, 21% supported them, and 11% were neutral. Ninety-eight percent supported or strongly supported riparian protection, with only one person being opposed. Habitat restoration was likewise supported or strongly supported by 97%, with one person being neutral on this strategy.

Support for species management interventions was weaker. Only 2 participants strongly supported predator control (7%), 10 people supported the strategy (35%), 10 were neutral (36%), and 5 were opposed (18%). Species translocation was strongly supported by 4%, supported by 50%, 36% were neutral, 4% opposed, 4% strongly opposed, and 1 person (4%) said they didn't know. Although there is a tendency for a positive trend between wildlife values and support for species translocation and a negative trend between wildlife values and support for predator control), the correlation between these factors is relatively weak.

There was no correlation between wildlife orientation scores and support for managed disturbance. However use of prescribed fire was strongly supported by 64%, and supported by a further 32%, with one person being neutral. Similarly, use of timber harvesting as a restoration disturbance management strategy was strongly supported by 29%, supported by 54%, with 5 people choosing 'neutral'.

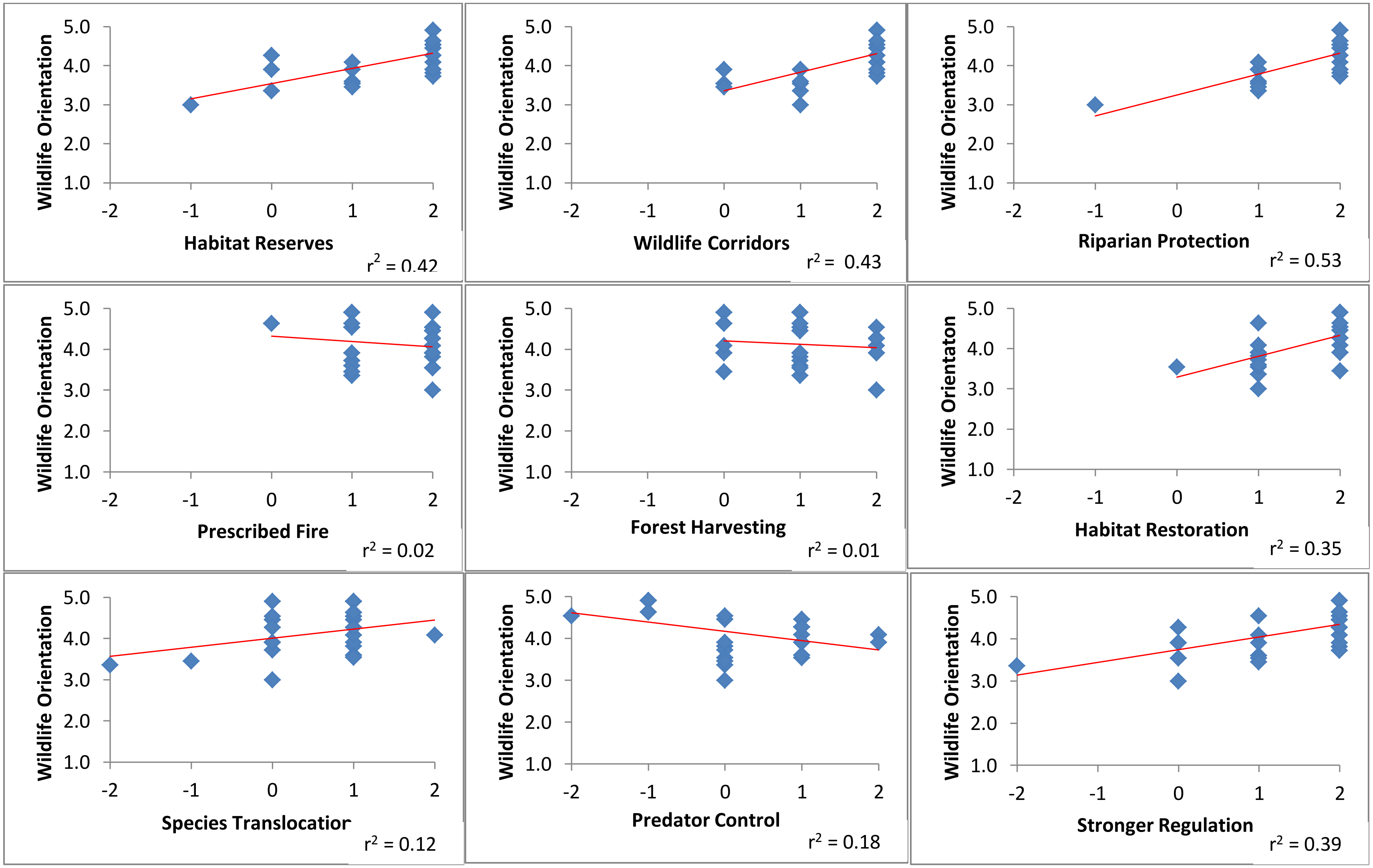

Figure 5. 9: Wildlife Orientation Scores Compared to Support for Conservation Strategies (Regression line shown in red)

5.3.2.4 Perspectives on Outdoor Recreation

Participants were surveyed about their involvement in outdoor recreational activities including ATV travel, backcountry skiing, camping, cycling, downhill skiing, fishing, hiking, hunting, nature photography, snowmobiling, or wildlife viewing, using the scale “often”, “occasionally”, or “not at all.” Participation was scored on a 3-point scale, allowing comparison with environmental value and wildlife orientation scores. All respondents participated in outdoor recreation activities, 93% actively and 7% occasionally. Fourteen percent were active recreational hunters, while 25% noted occasional hunting; and 18% were active recreational fishers and 57% occasionally. Primary recreational activities included hiking and camping, other popular activities included wildlife viewing, photography, cycling, downhill skiing, and backcountry skiing.

A regression analysis was done to compare participants’ scores for environmental values and wildlife orientation with their outdoor recreational interests (Table 5.3). Inferences about participants’ environmental attitudes or wildlife values from recreational interests were weak. Of interest is the negative correlation between hunting or fishing interests and wildlife orientation scores, indicating these participants had more of a utilitarian interest in wildlife, while the positive correlation between people hunting or fishing and their environmental value score, although very weak, suggests perhaps a stronger biocentric value present with these recreational interests.

Table 5. 3: Correlation between Recreational Interests and Participant’s Environmental Values and Wildlife Orientation

Recreational Activity	Environmental Values	Wildlife Orientation
Snowmobiling or ATV use	no correlation (r^2 = 0.02)	no correlation (r^2 = 0.00)
Downhill skiing or cycling	no correlation (r^2 = 0.01)	no correlation (r^2 = 0.00)
Hunting or fishing	positive correlation (r^2 = 0.09)	negative correlation (r^2 = 0.19)
Hiking, backcountry skiing, camping or wildlife viewing	positive correlation (r^2 = 0.04)	positive correlation (r^2 = 0.14)

5.3.3 Summary

The intent of the survey was to establish benchmark criteria for study participants relating to environmental values, attitudes toward wildlife, climate change beliefs, and their understanding and support for wildlife conservation prior to engaging them in collaborative discussions on scoping climate change impacts on ecosystems and wildlife, proposing conservation and restoration strategies and options, and identifying potential barriers for implementing strategies. Although limited by the size of the survey sample, the results indicate significant correlations between a number of cultural demographic factors and participants' views on nature, wildlife, climate change, and support for conservation action. The results are consistent with a number of other studies such as Cordano, et al. (2003) and Thompson & Barton (1994) who found a positive correlations between the degree of biocentrism vs anthropocentrism and support for pro-environmental behaviour; and Teel & Manfredo (2009) who in a survey of over 12,000 respondents in the western United States found wildlife orientation was useful in predicting support for wildlife conservation, management and use (eg. habitat and species protection, predator control, hunting and trapping).

The small sample size considerably limits the extent to which conclusions derived from this study can be generalized to the broader community; however the results offer useful insights into participants' perspectives. In particular the results provide a quantitative assessment of divergent perspectives that are revealed in greater detail through the qualitative results from the workshop and interviews to follow.

5.4 WORKSHOP METHODS AND RESULTS

In keeping with the contention in the environmental motivation model that education, experience and understandings of social norms can influence the values and beliefs that underpin attitudes and environmental motivation (see Figure 1.1, Chapter One), the workshop component was designed to raise participants' awareness of projected impacts of climate change on wildlife habitat in the study region and to discuss their implications. The one-day event was held at a community hall in Nelson, British Columbia on November 29, 2012. Participants included 27 invited stakeholders, 5 professional facilitators, as well as the principle investigator for this study and his PhD co-supervisor.

The workshop objectives were to engage key interested stakeholders in a collaborative exercise to:

1) assess the perspectives of a diverse group of community stakeholders concerning potential climate change impacts on wildlife ecosystems.
2) review scenarios of predicted climate change over the next century; communicate uncertainty in predictions of the future, and explore potential implications of changing climate on wildlife ecosystems, using modelled habitat suitability future scenarios for mountain caribou and wolverine as examples; and
3) assess potential conservation and restoration options, and identify opportunities and barriers to implementing adaptation measures for increasing the resilience of wildlife ecosystems to climate change.

The workshop program is included in Appendix 7.

5.4.1 Workshop Methods

To achieve its objectives, the workshop was structured to feature:

1) an overview of the research project and workshop purpose and process;
2) presentations on climate change and wildlife scenarios in the region;
3) a breakout session to discuss climate change impacts on wildlife conservation and how uncertainty influences how the problem and potential conservation strategies are perceived;
4) a presentation on conservation and restoration options;
5) a breakout session to discuss conservation and restoration opportunities and barriers; and

6) a plenary session where each breakout group reported on the results of their discussions in the two breakout group sessions.

The presentation on climate change scenarios and ecosystem impacts was based on the results of the West Kootenay Climate Vulnerability and Resilience Project (http://www.kootenayresilience.org/), and was delivered by the scientist who prepared those assessments for that project. This material was supplemented with a presentation by the principal investigator on potential climate change implications on Mountain caribou and wolverine habitat suitability based on the results presented in Chapter Four, as well as an overview of climate change conservation adaptation strategies being discussed in the recent scientific literature.

Facilitators were recruited to oversee the breakout sessions. They were recruited both through personal connections and referral by others, and were paid an honorarium for their services, the value of which depended on how much preliminary preparation each was requested to provide. Their primary roles were to facilitate discussion, ensure that key outcomes of group discussions were recorded on flipcharts, and organize group reports to a plenary session at the end of the day.

As noted, 27 of the 28 survey respondents went on to participate in the workshop. Given that this involved a day-long meeting in Nelson, and in some instances required significant travel to attend, a $100 honorarium was offered to each participant to offset costs they might occur. Participants received payment at the beginning of the workshop, and were not obliged in any way to remain at the workshop or continue to the interview stage to receive the honorarium. Not all participants accepted the honorarium offer.

As principal researcher, I observed each breakout group for a short period to note both the ideas that were being discussed and the collaboration process itself. My interactions in this process were limited to addressing questions from facilitators and participants seeking clarity on the intent of the questions. The PhD co-supervisor (Dr. Keller) similarly participated as an observer in the breakout discussions.

A website was created to provide participants with prior access to information on the project, climate change scenarios, land use, conservation designations, wildlife ecosystem impact scenarios, and conservation adaptation strategies. While website access was available one week before the workshop, usage by study participants was not tracked, although a question as to whether they found this material instructive was asked in follow-up interviews.

As workshop breakout groups were intended to have balanced representation, based on occupational category and gender (Table 5.4), participants were assigned. Differences in the degree of engagement of each group were observed. This seemed to be related to who was facilitating and which participants were grouped together.

Table 5. 4: Occupational Category and Gender Representation of Workshop Breakout Groups

Group 1	Group 2	Group 3	Group 4	Group 5
2 Government 2 ENGO 1 Public	1 Industry 1 ENGO 2 Scientists 2 Public	1 ENGO 2 Scientists 2 Public	1 Government 2 Industry 1 ENGO 1 Public	1 Government 2 Industry 1 ENGO 2 Public
1 Female 4 Males	2 Females 4 Males	3 Females 2 Males	1 Female 4 Males	2 Females 4 Males

During the subsequent interviews, a number of respondents noted that one group in particular produced the most detailed output and had interesting and effective discussions. My personal observation was that this group was well facilitated and included a number of knowledgeable people with diverse perspectives. The output from one group did not demonstrate the level of insight achieved by the others, perhaps because it was not as well facilitated or those participating were not as well informed on the issues. The breakout groups were asked to address six questions during two sequential sessions, as follows:

Session 1: Future climate change and wildlife ecosystem impact scenarios;

1) What impacts might be expected based on projected climate changes?
2) Do you have confidence in the evidence that climate change is likely to have an impact on wildlife ecosystems?
3) How does uncertainty influence how the problem and potential conservation strategies are perceived?

Session 2: Conservation and restoration approaches;

1) What ideas do participants have for conservation and restoration strategies to adapt to potential climate change impacts on wildlife?
2) What enablers exist to facilitate implementing such strategies? Can these be enhanced?
3) What barriers exist which would prevent implementing such strategies? What can be done to minimize these barriers?

Data generated in the workshop included flipchart recordings organized by the specific questions addressed in the breakout sessions, flipchart presentations made by each group in the plenary session, and personal notes collected when I participated in each breakout group and during the plenary session.

5.4.2 Workshop Results

The following themed reflections on workshop outcomes are based on notes taken during the group sessions, on report-back sessions, debriefing of facilitators and other observers, and participant observation. The results from the group discussions for each of the six questions above were reorganized into five themes:

1) beliefs on climate change & impact on wildlife;
2) information credibility & uncertainty;
3) attitude to human intervention in ecosystems;
4) policy barriers; and
5) policy opportunities.

Transcribed results addressing these five themes for each breakout group are included in Appendix 8.

5.4.2.1 Theme 1: Beliefs on Climate Change and Impact on Wildlife

The outputs from all five breakout groups indicated a pervasive although varied perspective that climate change is occurring. Participants cited a range of evidence to support their contentions. This conviction is most strongly expressed among those whose residences, or occupational and personal interests are closely aligned with the land and who therefore had opportunities to observe changes first-hand. Respondents living in urban settings and not actively engaging on the land in the region tended not to express the same level of conviction. The mountain pine beetle epidemic was broadly referenced as tangible evidence of climate change reinforcing the credibility of forecasts of non-linear dynamics and the potential for large and potentially catastrophic impacts. Other examples included changes in summer and winter temperatures, snowpack, spring runoff, wildlife and plant species range distributions, and increased wildfire occurrence and intensity.

Workshop participants expressed confidence in the science underlying climate change projections and noted that they believe it is improving. They also expressed confidence in the information provided them on the pre-workshop website including the historical climate data and the output of scenario models. A number reflected that their confidence is based, in part, on knowing the people who provided the information, and their abilities to explain the methods and data as well as the limitations of climate scenario modelling. Nevertheless, participants reflected upon the considerable uncertainty in the climate change and ecosystem impact models.

Climate was recognized by participants as being dynamic, with large changes having occurred historically. However it was acknowledged that the current rate of change is unprecedented in recent history. Discussion revealed that perceptions of impacts are highly subjective, indicating that perceived economic and social as well as ecological implications have the potential to result in value-based conflict in the community. Since ecological and social systems change at different rates, concern was expressed that existing systems may become uncoupled. Anticipated socioeconomic impacts that were discussed include implications for hydroelectric power generation, increased invasive species, and forest health issues. Predicted ecosystem changes include increased fire risk, significant transitions across ecological types resulting from changes in thermal and moisture regimes, impacts on habitat quality, availability and connectivity, and changes in wildlife species dynamics. Participants also anticipated increasing rates of species extinctions. Wildlife species with a wide variability in habitat niche were expected to do well, whereas species with restricted range and mobility were seen to be at greater risk.

A notable concern was that climate change that impacts socioeconomic systems may result in decreased support for ecosystem conservation. For example, changes in capacity for resource extraction as well as in habitat may call into question the application of conservation designations currently in place.

5.4.2.2 Theme 2: Information Credibility and Uncertainty

Participants noted that while there is a very high degree of confidence in climate change amongst scientists, the public is often confused between weather and short-term climate variability, and longer-term climatic trends. Participants observed that predictions of large, complex, and uncertain change can be hard for people to understand. Workshop discussions also reflected that predictions of negative impacts strike at human need for security. These factors, when taken together, were seen to cause people to be uncomfortable and sceptical. Consequently participants speculated that uncertainty contributes to a tendency to deny climate change as a significant concern and diminishes motivation for action to mitigate either the cause or the resulting effects. In the face of uncertainty, it is seen to be difficult to develop focussed strategies for conservation as there are too many unknowns and too many response options.

Discussions also highlighted concerns that climate change has not been generally understood to have an impact on wildlife ecosystems, so there is not wide recognition of the need to effect conservation strategies. Participants made generalized observations that people in the community don't understand the problem or the potential for mitigating strategies and hold a perception that nature will adapt. Indeed they speculated that some people will need to be directly and considerably impacted in order to be motivated to accept the problem or the need for conservation strategies.

Participants diverged on appropriate strategies to address uncertainty. Some expressed beliefs that future trends are too uncertain while past trends do not provide useful information, thereby making it difficult to plan and implement needed management strategies. For example they noted reluctance among many people to support strategies such as the caribou recovery, in the face of uncertainty. Other participants considered adaptive management approaches based on precautionary principles to be prudent, commenting that under an adaptive approach uncertainty needs to be incorporated into the decision-making process. In such cases clarity about the limitations of the data was seen to be important since uncertainty may result in bad decisions. However others expressed concerns that such a precautionary approach locks up lands from economic development. Participants noted a need to plan for surprises, although there is not a lot of information or understanding of what that means or how it can be implemented. One solution suggested is to concentrate on maintaining ecosystem function, embrace novel ecosystems that fill a function, and focus on habitat connectivity to reduce fragmentation and increasing ecosystem resilience.

Participants observed that resource managers who need a high degree of certainty for management decisions are challenged and need better science to support decision-making. While a need to identify costs and benefits of management strategies through risk analysis was anticipated, uncertainty was seen to make it difficult to invest in strategies where there are risks to outcomes or a rate of return. Also uncertainty is seen to allow the self-interest of many stakeholders to overcome concerns about the need to take action. Participants also speculated that uncertainty that feeds a lack of confidence in proposed adaptation actions will result in a lack of political will, shifting potential for action to civil society. A key workshop observation was the need for long-term vision and commitments as well as changes in institutional structures to accommodate uncertain futures including:

- reforming Timber Supply Analysis to account for climate change,
- establishing local community-based mechanisms for public education and political action on climate change,
- improving government's capacity for research, monitoring and regulatory oversight,
- providing social license and financial incentives for industry,
- mandating institutions such as the Columbia Basin Trust, Habitat Conservation Trust Foundation, BC Hydro Fish and Wildlife Compensation Program, and the Kootenay Conservation Program to address climate change in their program delivery,
- fixing regulatory and implementation issues with the *Forest and Range Practices Act*,
- ensuring transparency and accountability of professionals in the 'results-based' regulatory model,
- subjecting resource development approvals to cumulative impacts assessment,
- reinstituting strategic and landscape scale land and resource management planning mechanisms,
- reinstituting mechanisms for community dialogue in resource management decision-making, and
- implementing principles of adaptive management in resource management.

5.4.2.3 Theme 3: Attitudes Regarding Human Intervention in Ecosystems

Breakout groups were asked to discuss ideas for conservation strategies to support adaptation to potential climate change impacts. A number of strategy options had been presented to participants during opening plenary session in order to stimulate these discussions, including:

1) representing ecosystems across environmental gradients in protected areas;
2) protecting climatic refugia at multiple scales;
3) avoiding fragmentation and providing connectivity, especially parallel to climatic gradients;
4) practicing ecosystem based management approaches on matrix lands beyond protected areas;
5) maintaining natural disturbance regimes;
6) maintaining diverse gene pools; and
7) identifying and protecting the diversity of functional groups and keystone species.

Results from the breakout groups suggest participants are supportive of identifying new measures for wildlife ecosystem management adaptation. However many of the strategy options were seen as controversial, and a key recommendation called for well-designed strategy proposals with clear goals and objectives, careful assessment of risks and costs, assessment of priorities, effective monitoring and assessment of strategy implementation, and an integrated adaptive management approach.

There was broad recognition that, since social and ecological systems are interconnected, conservation strategies are inevitably value-laden. Understanding and addressing differing human values was therefore seen as an important component of management strategies.

Participants offered a number of observations and suggestions relating to the implementation of future conservation strategies. A widely endorsed priority was a focus on ecosystem resilience as a goal. This was seen to replace the traditional conservation paradigm based on historical range of ecological variability. Given the need to ensure resilience through comprehensive and dynamic approaches, concern was expressed that current management strategies may be too static. Adaptive conservation strategies that support natural ecosystem processes and mitigate risk by diversifying management were discussed at some length, although participants tended to be uncertain about the nature and scope of such approaches. New attention to evaluating present strategies, based on climate change considerations was recommended, along with priorities for action:

1) expansion and relocation of protected area reserves;
2) conservation of scarce ecosystem components (eg. riparian areas, wetlands, low elevation public lands, mountain passes, and old growth forests);
3) designing landscape-scale corridors linking protected areas to support species dispersal;
4) managing wildfire according to natural disturbance regimes;
5) invasive species management needs to incorporate climate change projections – practical cost/benefit approaches are needed before deciding on eradication; and
6) controlling motorized backcountry access and other land uses such as urban sprawl.

Expansion of protected areas was contested by some participants. Concerns were expressed from some government and industry participants that 'locking up lands' in new protected areas would prohibit resource development. Some participants expressed the view that parks offer a static solution to conservation, when dynamic solutions are needed to address the uncertainty of climate change adaptation. Many considered a review of what it means to be “protected” as important, and expressed concern that existing reserves were implemented through the highly politicized process that followed the CORE land use planning process where ecosystem components which they considered important were not included. However a fear voiced by some environmentalists was that a review of protected area boundaries would result in the loss of areas that were hard fought for in the first place. As considerable social capital has been expended on implementing current protected areas some participants have strong commitments to established processes.

Participants noted that given changing climate, matrix lands between protected area reserves need to be managed for future habitat attributes through an ecosystem-based management approach rather than for maximizing timber yield and government/industry revenues. While there was a general interest in species management approaches, especially for species of concern, apprehension was expressed that this is complicated by not knowing how species' relationships will be affected by climate change. Interventions such as assisted migration and species management (ie. predator and prey control, species at risk protection) are controversial and not broadly considered as being effective; the view of some participants is these strategies should be very carefully weighed against management goals, risk and ethical considerations. Some note a need to accept some conservation approaches as experimental; the caribou transplant into the south Purcell area was cited, although this project was seen by many as a failure.

Another point identified in group discussions was the need to manage old growth forest through a landscape planning process that considers climate change dynamics; one view emphasized the need to consider relocating and potentially modifying Old Growth Management Areas (OGMAs), while others expressed a desire to legally designate OGMAs.

While one respondent suggested that an option is to do nothing and accept consequences of change, most participants called for acceptance we are in a 'managed landscape' and that we therefore have an obligation to intervene according to sound ecosystem-based management principles.

There was general agreement that conservation strategies need to be led by government, conservation organizations, land trusts and industry; recognizing that there are limited opportunities for individual members of the community to contribute. The efforts of Wildsight and Conservation Northwest to undertake conservation planning intended to address climate change adaptation prompted considerable discussion and some praise, although concerns over planning being led by the ENGO sector were also heard. Participants expressed concern and frustration that government has abdicated its leadership mandate in resource management and land use planning, and noted the negative impacts of budget cuts and staff lay-offs.

Based on animated workshop discussion and a wide range of concerns and a smaller number of solutions, it is evident that participants perceive a need for revitalized planning institutions to address important value-based conflicts inherent in implementing such strategies. At the same time, it is evident that there is considerable uncertainty and lack of clearly defined concepts regarding appropriate interventions and structures within this group.

5.4.2.4 Theme 4: Barriers and Opportunities

Each breakout group addressed perceived barriers and opportunities for identifying and implementing conservation approaches to address climate change impacts on wildlife ecosystems. It was interesting to note that these discussions were animated. While participants were particularly focussed on a wide range of obstacles as the conversation provided an opportunity to revisit concerns raised in other parts of the workshop, they were also able to move to thoughts on potential actions or solution.

Because many of the themes introduced in the workshop are elaborated upon in subsequent interviews, a combined synopsis of key obstacles and opportunities that emerged through this research is presented in Section 5.2.6. Detailed results of the discussions on barriers and opportunities from each breakout group are included in Appendix 9.

5.4.3 Summary

The intent of the workshop was to engage study participants in a collaborative discussion of climate change impacts on wildlife ecosystems in the Kootenay region in a manner that would build understanding or at least awareness of the issue, and encourage shared ideas on options, barriers and opportunities. Participants seemed genuinely interested and engaged in the workshop. However it should be noted that those who attended were either well informed and convinced of the inevitability and significance of climate change and its impacts or at least largely accepting this is a possibility with important consequences. The workshop generated a wealth of reflections on the local social, environmental and economic implications of climate change, and on current and prospective management intervention opportunities and barriers. Indeed one prevalent viewpoint was the need to fully and properly implement conservation policies already in place as a key first step in managing ecological resilience. It was important to observe that uncertainty around the future prompted two divergent opinions on appropriate courses of action; on one hand some participants called for a principled and adaptive precautionary approach, while others were insistent that more information is needed to be able to make wise decisions on management decisions especially where this may have socio-economic impacts. Key observations that emerged from discussions include the need for better science, re-institutionalized planning processes, enhanced public awareness, and advocacy for political action.

It was interesting to note that opinions shared in the workshop were relatively muted in comparison to some divergent perspectives expressed in survey results and follow-up interviews. This may result from politeness in a group setting, concern about disrupting a student’s research process, or an aversion to interpersonal conflict.

Follow-up discussions with participants suggest a strong view that the workshop was an important community opportunity to learn and share ideas. However it is clear that one workshop with a limited audience has substantial limits to effect broader understanding in the community or even influence individual participants’ beliefs and motivation. This theme is explored further in the next section.

5.5 INTERVIEW METHODS AND RESULTS

5.5.1 Interview Structure and Methods

All workshop participants were contacted by email and/or a telephone conversation to arrange a follow-up discussion, resulting in twenty face-to-face and three online interviews. Only four people who attended the workshop did not respond to interview requests.

Most interviews were conducted during two separate field trips to the Kootenay region in December 2012 and January 2013. The first set of 9 was held between December 3 and 5 and on the second trip 11 people were interviewed between January 21 and 25. Two interviews were held by Skype video conferencing on January 31and February 6, and the final interview was conducted by telephone on April 28.

Interviews were scheduled for one hour and, on average, lasted 64 minutes. The longest was 87 minutes and shortest was 39 minutes. Interviews done in person were held either at the interviewee's residence or in a local coffee shop or café, depending on the interviewee's preference. Interviews were recorded on a digital recorder that was backed up on two separate hard drives at the end of each session.

5.5.1.1 Interview Questions

The interview was semi-structured, with a set of questions to prompt discussion around the following themes:

1) What are the respondent's connections with wildlife in the region?
2) What are the respondent's attitudes towards the value of wildlife and ecosystem conservation?
3) What are the respondent's beliefs regarding the efficacy of wildlife conservation measures implemented through the land use plan, resource management legislation and the caribou recovery plan?
4) What are the respondent's beliefs regarding climate change and its potential impacts on wildlife ecosystems?

5) Does the respondent believe climate change impacts on wildlife ecosystems to be a potentially significant problem, and if so do they believe it to be an urgent problem?
6) Does the respondent believe there is sufficiently credible information to understand and address climate change impacts on wildlife ecosystems?
7) What are the respondent's attitudes to change and concerns for the future? How does the respondent balance environmental, economic and social concerns of the future in their thinking about wildlife conservation?
8) What are the respondent's attitudes regarding human intervention in natural ecosystems [eg. extent & limitations of intervention]? Is there a relationship between attitudes on intervention and attitudes on wildlife conservation?
9) What are the respondent's attitudes towards government regulation to conserve wildlife ecosystem values?
10) What does the respondent consider as barriers to implementing wildlife climate change adaptation strategies?
11) What do they consider as opportunities in implementing adaptation strategies?
12) What are the respondent's beliefs regarding who bears responsibility for wildlife conservation?
13) How did participation in the workshop affect the respondent's beliefs and attitudes relating to wildlife conservation and restoration interventions needed to mitigate climate change impacts on ecosystems?

The specific questions asked during the interviews are included in Appendix 10.

5.5.1.2 Data Management

Interview recordings were transcribed as Word documents using Digital Voice Editor 3 software. Fourteen were transcribed by the researcher, 7 by a paid assistant, and 2 by a colleague. All interview recordings and transcripts were reviewed in their entirety by the researcher. A draft copy of the transcript was provided to each interviewee with a request for review and editorial corrections. Minor changes were requested by 6 of the participants. The final interview transcripts totalled 311 single-spaced pages. Finalized interview documents were then imported into NVivo 10 software for analysis, as were the results from the earlier survey questionnaire. This allowed for structured queries to be analyzed across the two datasets by participant, coded theme, interview question response or survey question response.

Interviews were coded initially using a ‘bottom-up’ hierarchical scheme developed on-the-fly as coding of each interview progressed. This set of emergent codes is included in Appendix 11. After this coding approach was completed, each interview was coded a second time, based on the 13 ‘top-down’ themed questions listed above. The ‘bottom-up’ approach produced 1,115 coding references across the 23 interviews. The ‘top-down’ coding approach similarly resulted in 711 coding references. The primary focus of this analysis is a comparison of each of the ‘top-down’ themes across each participant by developing a framework matrix in NVivo 10. A summary of attitudes, beliefs and ideas on each of the ‘top-down’ themes was produced from the coded response for each participant. These summaries were then compared across each participant.

The ‘bottom-up’ themes in themselves did not result in a consistent set of responses that could be meaningfully compared across respondents. However, coding from the ‘bottom-up’ and ‘top-down’ approaches allowed queries across approaches. For example, it enabled the query “what did people say about predator control (ie. a ‘bottom-up’ code) when asked about human interventions in ecosystems (ie. a ‘top-down code’)? ” or “what did females (ie. demographic data obtained from the survey) say about predator control?”. The query function was useful to quickly find and quote respondents’ statements in support of themes that emerged from the data and to follow-up on differences found between the various demographic factors analyzed and what people said about wildlife values, climate change beliefs, conservation policy effectiveness, and support for wildlife conservation strategies.

5.5.2 Interview Results

As interviews spanned a broad range of topics, discussion of results is divided into the following sections:

1) attitudes on the value of wildlife and beliefs on the effectiveness of current wildlife ecosystem conservation policies;
2) beliefs about climate change, impacts on wildlife, concerns about the future and urgency;
3) perspectives on strategies to effect resilient ecosystems;
4) governance and consultation issues;
5) influence of the workshop on perspectives on wildlife conservation; and
6) barriers and opportunities (emerging from both the workshop and interviews)

In order to maintain the anonymity for interview quotes included in this chapter, respondents are identified by a unique code (Table 5.5). The first component of the code represents the respondent's occupational category, the second their political orientation. These were chosen based on the findings from the survey results presented in Table 5.1 that these factors most strongly differentiate perspectives of respondents. Thirdly a randomly assigned number was appended to the code to differentiate between respondents with the same occupation and politics. For example, a respondent identified with the code (P/So 3), would be from the 'Public' occupational category, would consider themselves to have a 'socialist' political orientation, and would have been randomly assigned as being the third person in that category. This coding assures

Table 5. 5: Respondent Codes

Occupational Category	Code	Political Orientation	Code
Government	G	Conservative	C
Industry	I	Liberal	L
NGO	N	Socialist	So
Public	P	Environmentalist	E
Science	Sc	No Response	Nr

participants cannot be personally identified by the information presented here.

5.5.2.1 Attitudes on the Value of Wildlife and Beliefs on the Effectiveness of Current Wildlife Ecosystem Conservation Policies

Interview participants were asked about their connection to wildlife in the region, the importance they place on conserving wildlife ecosystems, and how effective they believe current policies and strategies are in conserving wildlife.

a) Valuing Wildlife: Participants' interview responses on wildlife values were varied. Some expressed strong beliefs on the intrinsic value and priority of natural ecosystems, the high value of wildlife as an ecosystem service commodity, and/or the need for people and wildlife to coexist but that problem wildlife need to be managed. Others commented that socio-economic concerns outweigh wildlife conservation needs. Perspectives on natural resource management ranged from a highly preservationist view of ecosystem management to strong beliefs in integrated resource management approaches that involve direct human interventions in ecosystem management where environmental goals are linked with need to optimize business objectives.

Manfredo's (2008) mutualistic category tends to include environmentalists and others with high biocentric attitudes who believe strongly that wildlife has intrinsic value, and that ecosystems should be protected and left as much as possible to function with a minimum of human intervention. Interviewees fitting this category spoke strongly on the importance of wildlife conservation. One called the responsibility 'massive' and noted that the area is an anchor for the last grizzly bears on the continent [N/So 1]. Another emphasized that:

> Our role is pretty significant, pretty important because we still do have an opportunity to maintain enough habitat to maintain a lot of those big predator-prey relationships. …We have a high responsibility to maintain that important Yellowstone to Yukon corridor, because key wildlife species have disappeared from most of the area south of the…border. [N/So 2]

The pluralistic category encompasses users of wildlife as a resource commodity including hunters, trappers, and commercial guide-outfitters. Tourism operators can also have strong wildlife conservation attitudes. Such users tended to support ecosystem protection measures and were supportive of practical interventions that optimize access to the resource. Several expressed the opinion that preserving intact ecosystems functionality is important, although it may not be practical to protect all species. Interviewees spoke of the importance of wildlife to their recreational hunting or business interests. One called for "reasonable representation of all species where they are adapted to be" [P/So 2], while another emphasized that conservation is "a critical component of how we look at our business." [I/C 2]. An interest in practical solutions was notable:

> I am a pragmatic person by nature. …I'm open to the logic that it may be better to spend our resources…on places where we have the best chance to protect species. [For example] the [mountain caribou] herds here aren't viable in the long term…given the current circumstances with climate change, and they are much more likely to be viable somewhere else. I'm also a pragmatist where resources should be spent…[they] should be spent where we have the best chance. [I/So 2]

Some participants in this category called for a sustainable balance between environmental and economic interests, noting that "A big part of the problem is that there [are] competing values and in many, many cases economic values trump conservation values" [G/So 2]. One participant commented on a need for balance:

> I like the life we live…I'm not a purist. …I don't tie all my own fishing flies…I like to ride up a chair lift…I like clean water, I love fishing. I'm a consumer, I hunt, I fish. Finding the balance is the key…economies don't sustain environments, environments sustain economies…but how do you find that balance? That's what we struggle with. I don't think people want to give up their lives. [Sc/Nr 1].

Participants who value nature primarily as an opportunity to access natural resources are included in the utilitarian category. This group tended to express lower levels of support for such measures as protected reserves, but did support integrated management measures that are seen to be practical and cost-effective. The perspective of participants in the utilitarian category reflected the importance of achieving balance between socio-economic priorities and environmental conservation, as noted by the participant who commented “I don’t think a vast park area is going to help the economy, or help resilience in climate change because no one…in these small little towns will have any work” [G/L 1]. The need to reconcile conflicting interest is expressed by others as well:

> When we are managing land bases through agriculture, forestry, or mining, you have to deal with [wildlife] issues. And you may not always get what you want on either end of it…it’s always going to come down to an economic case. [I/C 1]

> We don’t need a national park with all bureaucracy and regulations. Maybe there is a different way of doing it where…you have more of an integrated paradigm, where you have people who use the land for resource extraction, but it’s done in a way that sustains human and wildlife communities. [Sc/So 1]

Although none of the participants fit into the uninterested category, several commented that they were concerned that very few people living in the area really understand or care about the significance of wildlife in the region. As one notes, “I would think it’s a small percentage of people that actually do the caring…and the action associated with it.” [Sc/Nr 1] while another reflects that:

> I think the vast majority of the population has no idea of the range contraction of the species and how a lot of species now are concentrated in the cordillera region. I think the majority of the population is in favor of recovering endangered species, but their knowledge of the issues quite limited. [G/So 2]

Such comments raise interesting questions about the factors that motivate people to live in the area and suggest a need for better public education about wildlife values.

Respondents were categorized as mutualistic, pluralistic, or utilitarian based on their responses to Question #2 regarding the importance of conserving wide-ranging wildlife species in the Kootenay region. These categories were then compared to their environmental value score and wildlife orientation score (Figure 5.10).

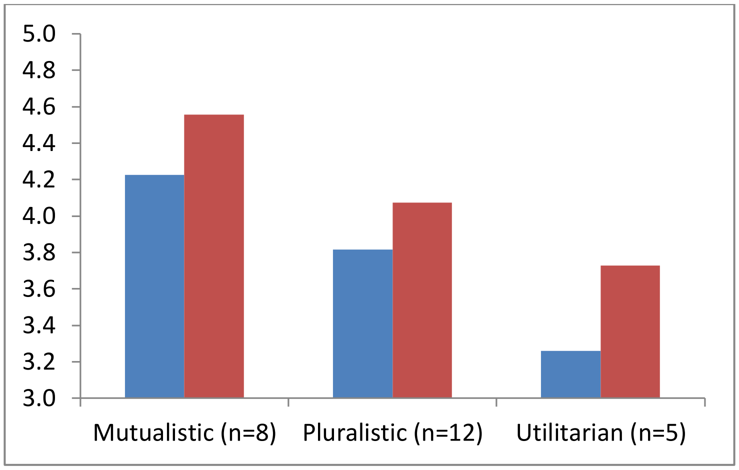

Figure 5. 10: Comparison of Environmental Value ( ) and Wildlife Orientation ( ) Scores with Wildlife Value Orientation Categories

Participants who expressed mutualistic views had a median wildlife orientation score of 4.56, compared to 4.07 for those with pluralistic views, and 3.72 for those with utilitarian views about wildlife.

b) Perspectives on the Effectiveness of Conservation Policy: Diverse responses on the effectiveness of current conservation policies were offered to Interview Question #3. Results indicate a wide range in levels of understanding of conservation policies that are being implemented and diverse opinions as to whether these strategies will be effective in conserving wildlife ecosystems. It is notable that important differences in opinion remain on many issues that have been central in land use debates since before the Kootenay-Boundary Land Use Plan.

ENGO participants for example noted that although 13.7% of the area is in a national or provincial park, the Protected Areas Strategy fails to protect lower elevation ecosystems or provide corridor linkages. An emerging objective for this sector is for conservation measures to be designated across 50% of representative ecosystems, with half being in protected reserves (ie. 25% of the land base). As one commented,

> Wildsight is helping to fund…a conservation plan for the West Kootenays that will be connected up to the East Kootenay plan. Things like that are really important because they consider the effects of climate change on our ecosystems and they provide alternatives to status quo plans that are not working to conserve ecosystems and wildlife. If the merits of the plan can be shown to the public, then people can buy into it. If we get a change in government, then we might be able to say "Here's an alternative way to look at things. This is how you could protect ecosystems and wildlife through adaptation to climate change." [N/So 2]

Several ENGO representatives expressed a belief that there has been progress on a number of conservation fronts, including protected areas, high conservation value forest areas and caribou zones, but expressed ongoing concern about the cumulative impacts from forestry, mining, hydroelectric projects, resort development, and motorized recreation. They emphasized the importance of applying pressure to counteract ongoing development that might regress these conservation achievements. The southern part of the region particularly is recognized as being a priority due to fragmentation that limits its value to landscape functionality. This highlights the importance of this area as a vital corridor linkage in the broader Y2Y eco-regional context, especially for maintaining wildlife habitat connectivity for wide ranging species including grizzly bears, wolverine and caribou that move across the Canada-USA international border.

There is a degree of tension among those who hold opposing conservation and development perspectives. Forestry professionals in industry and government tended to view wildlife as a 'constraint' to forest development. The comment that "the forest folks are ticked because [conservation] always locks up more forests" [G/L 1] highlights such concerns. Development voices comment that environmental advocates are ramping up the need for conservation objectives and suggest that the land use plan over-achieved government's objectives to set aside 12% in protected areas. A cluster of industry sector and government forestry managers commented that there is too much focus on creating protected areas that exclude integrated management policies. This perspective holds that the policy process has been too based on socio-political decision-making instead of science-based decisions that would allow for both healthy wildlife ecosystems and a resilient resource sector.

> If we use the best science, I think we can achieve keeping those habitats and those species healthy, and if we do it wisely [we can] still have an active resource sector. But we haven't been able to do that. It seems to me we focus on "we've got to protect it all or log it all." [I/C 3]

One respondent speculated that a scientific analysis might lead to changing park boundaries in response to change.

> I could even see harvesting in the park…[there] may no longer be a park because now we know we should be focusing somewhere else…because maybe somewhere else will have more value for many more species. [G/So 1]

A viewpoint that bridges conservation- and development-oriented perspectives is that land use zoning creates opportunities to develop non-conservation lands more effectively. Multiple respondents noted that conservation is not just about setting land aside for parks and protected areas; there is a need for stronger regulations and landscape design processes that integrate protected areas with ecosystem-based management of connecting matrices. This is an issue, given that government has shut down landscape unit planning. Diverse participants expressed concern about centralized regulatory approaches that may result in unintended consequences, and argued for decentralized decision-making. They suggest that conservation policies need to be developed locally in consultation with affected stakeholders.

There was strong feedback from both forestry professionals and industry stakeholders, as well as environmental advocates and scientists familiar with forestry operations, that the new 'results-based' approach to forest policy has led to an inconsistent approach to wildlife conservation. One forestry professional who had worked most of his career in industry said:

> I know when…I wrote [our forest stewardship plan] it was pretty bare-bones. …But when [the Forest and Range Practices Act] came in, I remember talking with our managers and saying "I really don't want this…just fix the Code. The Code is not far off." And even now…you say "How do you deal with the visuals at all? – You

> use the code guidebooks. How do you deal with the riparian? – You use the code guide book.”. …[T]hey were good documents and a bit of fine tuning could have maintained that. …But what I see happening…is initially when you first moved to FRPA everything kind of stayed the same because you are used to doing that. But over time, you realize nobody is telling me what to do and you start cutting corners and start dropping off, and now it’s become a minimum standard and people are moving towards the minimum, instead of “here’s a minimum standard and you’ve got flexibility to do whatever you want.” But nobody’s really moving to a higher level. I’m not sure if it’s because of the economics or it’s just that that’s the way people tend to move…it’s becoming more and more prevalent. [I/C 1]

This person’s conclusion that, without government oversight, the results-based model fails to produce sound stewardship on the ground, calls into question the efficacy of the results-based professional reliance model. Others’ comments suggest that the results-based approach, coupled with significant government budget and staff reductions, and integration of the forest and environment ministry staff into one agency at the regional level, have resulted in an unacceptable loss of oversight of forest operational plans and enforcement. Respondents observed that local management lacks capacity to intervene in timely ways and commented that the FRPA also resulted in a loss of opportunities for public review and comment on forestry operations. Inadequate public consultation on local forest development activities is attributed to FSPs that often cover large areas and do not spatially identify planning for forest development. As one industry participant noted, “We don’t have a land manager that can say “no” about anything... At least District Managers used to be able to do that” [Sc/Nr 2]. Another comments:

> It seems like the Ministry of Environment doesn’t have much power to really protect ecosystems and wildlife habitats or any teeth to enforce current legislation to protect the environment. Either the [Ministry of Environment] needs to be given back more control over what happens on our land base, or a new ministry has to be developed. [N/So 2]

Others cite complacency in enforcement and plan implementation, poor road construction and lack of consultation as evidence of widespread governance problems.

Many participants across sectors expressed concern that conservation policies do not apply evenly across resource sectors. While most respondents agree forestry policies have been at least somewhat effective in meeting conservation objectives, they observe a lack of an overall strategy that addresses other resource industries and their cumulative impacts. They call for planning and decision-making processes that incorporate cumulative impacts from all development activities, coupled with conservation objectives that have been spatialized on the land base.

A broad-based concern related to motorized backcountry recreational access by ATVs, motorbikes and snowmobiles which significantly impact wildlife and damage sensitive habitats. Strong beliefs were expressed on the need for access management plans. However this issue is strongly contested in the community. Concerns were also expressed about cumulative impacts from shale gas extraction, ski hill development, and independent power project proposals. Participants noted that while current conservation objectives may be effective there is insufficient monitoring to ensure they are being implemented or to evaluate them.

> Government regulations on resource development – I think that's really important. I just have a great distrust of government, and corruption, and big business buying them out. So I have reservations. …But I do think that setting up regulations…is a good thing. [P/So 6]

The experience of implementing the Mountain Caribou Recovery Implementation Plan shaped many respondents' beliefs about the effectiveness of current conservation strategies. Under this plan, government committed to significant new measures to protect habitat, regulate commercial and public recreation access to the backcountry, control predation through direct intervention in predator and alternative prey populations, and to augment populations through a translocation program. Because of their endangered status and megafauna image, mountain caribou have been the flagship species associated with the protection of wild habitat conditions for a range of other species within the study region. However participants were concerned that the conservation framework has focussed on a single species (ie. caribou) to the detriment of a broader ecosystem-based approach that focuses on maintaining ecological function and structure at multiple scales – an approach which is especially relevant to address ecosystem resiliency and climate change dynamics. And there was concern that the forest industry will be successful in lobbying to reduce mountain caribou habitat conservation measures where recovery efforts prove to be unsuccessful, or as the potential range of suitable habitat for caribou retreats as a result of changing climate.

The perspective of ENGOs, public and science participants on implementing MCRIP is interesting in that several participants commented that not enough is being done to conserve caribou habitat, and noted that actions on the ground were focussing on predator control. Conversely industry people and government staff observed that the habitat conservation provisions of the recovery plan affected industry's access to timber harvesting while other provisions, especially measures to control predators, have not been implemented effectively. Their sense was that the forest industry was required to ante up through loss of access to the timber harvesting land base, even as government had not met its commitment to control predators due to concern about potential for public backlash.

Participants also expressed conflicting perceptions of the MCRIP approach to protect habitat. An industry-oriented perspective expressed by three participants on mountain caribou recovery was that the best science was not used to make decisions about habitat conservation. They commented that the approach that was taken reduced caribou protection to smaller isolated patches on the landscape thereby concentrating more intensive harvesting and fragmenting habitat in the matrix between these patches; they suggest that an integrated management approach would have allowed harvesting to proceed in protected zones while ensuring that critical habitat structural elements were maintained. This would have permitted more extensive caribou conservation across the landscape.

Provisions in the MCRIP to control predation were intensely debated by respondents. Culling predators and alternate prey was opposed by some on ethical and practicality grounds, and participants questioned the reasonableness and cost-effectiveness of translocation of caribou due to the impacts on donor herds, animal welfare concerns during their capture and transport, and the adverse risks associated with putting animals in unfamiliar terrain subjected to high levels of predation.

Participation in the workshop focussed attention on the limitations of current wildlife conservation policies to address climate change resiliency. Building on this theme, several interview respondents expressed concerns during the interviews that conservation policies fail to address ecological resiliency related to climate change impacts. It is notable that a number of respondents emphasized that the community members are tired of land use planning, they are tired of the debate and the conflict, and just want to get on with their lives. Nevertheless there were also a widely-held view (ie. across sectoral interests and political orientation perspectives) on the need to reinstitute land and resource management planning mechanisms that would evaluate the effectiveness of these policies on an ongoing basis and begin to address the implications of climate change impacts.

What emerges from the responses to this line of question is that values-based differences of opinion shape participants views on a range of issues including: 1) the need for enhanced protection of habitat in protected areas, 2) the efficacy of integrated management in maintaining habitat pattern and processes, and 3) the effectiveness and ethics of direct species management interventions such as predator culls and animal translocations.

5.5.2.2 Beliefs About Climate Change, Impacts on Wildlife, Concerns About the Future and Urgency

a) Climate Change: Most participants expressed beliefs that substantial climate change is occurring as a result of human-caused greenhouse gas emissions and that this has the potential to profoundly impact them, their communities and their local environment (Figure 5.11). As one respondent commented "I think we are underestimating the projection of change…the current emission scenario…is above the worst-case scenario for the IPCC [International Panel on Climate Change" [P/So 5].

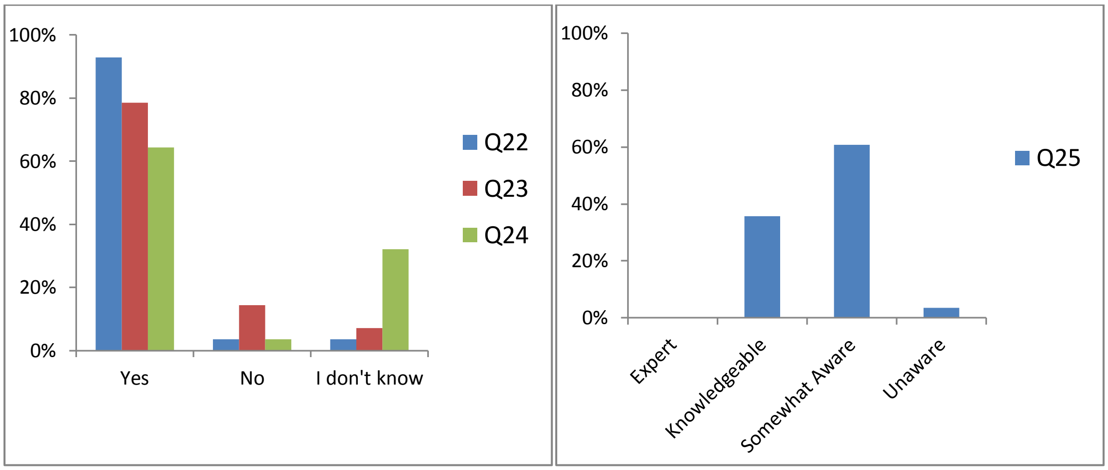

Figure 5. 11: Participant Responses to Survey Questions on Climate Change, Greenhouse Gas Emissions and Impact on Wildlife Ecosystems[123]

In the pre-workshop survey only one person noted that they did not believe climate change was occurring, and another said they did not know. Four people responded in the survey they did not believe that human greenhouse gas emissions were the primary cause of climate change, and another said they did not know. Only one person disagreed that climate change would impact wildlife ecosystems, while 9 of the respondents said they did not know. Of the three people who had indicated a degree of skepticism of climate change or its impact on wildlife ecosystems, only one participated

[123] Q22 - Do you believe that global warming will result from greenhouse gas emissions?

Q23 - Do you believe emissions of carbon dioxide and other greenhouse gases are the primary cause of observed global warming?

Q24 - Do you believe these predicted results for the Kootenay region are likely?

Q25 - How would you rate your knowledge of climate change effects on wildlife ecosystems?

in a follow-up interview. The following illustrates the attitudes found amongst the small group of participants who questioned rather than denied climate change, its causes and impacts:

> I recognize climate change happens. …My view is that we are overplaying carbon and underplaying other factors. …I'm just not sold on all of it. …I don't know if you saw that latest IPCC report? Those reports…are peer-reviewed by ENGOs, …supposed to be a scientific document, and we got government in there, we got ENGOs in there, and I'm sure industry is in there somewhere pushing some plugs, but…I'm pretty skeptical on the data. [I/C 1]

During the interviews, all participants appeared to accept that climate change is occurring, but several questioned the extent, the accuracy of modelled predictions, the degree that this is due to human greenhouse gas emissions, and the effect that this will have on ecosystems. Several responses indicated that the workshop plenary presentations and breakout discussions strengthened understanding of the issue.

b) Impacts on Wildlife: Although a majority of participants considered themselves to be aware of and believe in climate change, there was considerable variation in perceptions of urgency or necessary action. Most expressed a belief that climate change will impact wildlife ecosystems, but were pessimistic that humans will curtail carbon emissions to the extent necessary to prevent climate change impacts from occurring. One participant called the situation "pretty bleak" [Sc/Nr 2] while others commented that:

> I think it's horrendous…but I feel pretty helpless to manifest any significant, discernible, measurable change. I think it's incredibly urgent. But people have been working on it for decades as well, and we don't seem to be getting very far. …We seem to have already given up on trying to change it and are now just trying to deal with it. [Sc/So 1]

> …I'm not optimistic that we are going to be able to change the things…in time to make a difference. …it's going to get really hard to convince people that they need to be inconvenienced. …But it's going to happen. I don't doubt that the earth will survive, but I feel badly about the lot of populations that are innocent. [P/So 1]

However views on the consequences vary from a belief in the importance of a strong conservation response to a belief in the need for policies to ensure economic access to ecosystems goods and services.

Many respondents anticipated that the primary impacts from climate change will be economic and social, as expressed by [Sc/So 1] in saying climate change “is a problem for wildlife. But more on a personal level I think it’s a real problem for society, and our social support systems and agriculture.” Several suggested that ecosystems have a large capacity to adapt. “I think ecosystems are pretty resilient. There’s been a lot of climate change globally over the course of history. Things eventually adapt and create new systems” [Sc/So 1].

Although climate and ecological systems are dynamic, many respondents expressed concern that current rate of warming may negatively affect biodiversity, resulting in loss of ecological resilience. Some participants predicted that ecosystems will be further impacted by human responses to stresses on social and ecological systems. Others noted that the rapidity of environmental change is likely to exceed the adaptive capacity of ecosystems, resulting in loss of resilience and ecological function. “Ecosystems are always changing, they’re not static. But I think the startling part is the rate of change…having less biodiversity gives us less resilience” [Sc/Nr 1].

Regardless of the particular concern, participants broadly supported the need for sound planning mechanisms to facilitate good management. There was broad support for the need to practice sound conservation biology, maintain diversity and critical elements on the land base, and be prepared to adapt through time. Participants commented that climates and ecosystems have always been dynamic, despite static management approaches. Many respondents stated that ecosystems can be managed to adapt to change, provided that ecological structure and function are maintained. Others expressed a need to be conservative in preventing further habitat loss or fragmentation if wildlife species are going to survive. Although many were pessimistic, some respondents expressed confidence that local communities have the capacity to adapt. It is notable that the view of most respondents appears to be that socioeconomic considerations will take precedence over conservation of wildlife ecosystems. One scientist expressed sincere concern that unless climate change is mitigated, wildlife ecosystems will be impacted irrevocably.

> We could do 80% of the things we need to start to do now, and we can fine tune it. …We have to slow climate change down because otherwise there's absolutely no point. We will not have anything like the wildlife populations…we can shoot all the snowmobilers and all the loggers and all the backcountry skiers and it will make no difference if we don't do something about climate change – zero difference. And I hate to say that because then the other cynical people…say screw it, just log it all. That's the catch-22 dilemma. [Sc/Nr 2]

c) Concerns about the Future: As noted, while most participants expressed a belief that climate change is a significant and urgent issue, a number reflected that individuals are powerless to effect changes needed to mitigate the problem. Respondents were cynical that society will not be motivated to make the lifestyle changes necessary to mitigate carbon emissions. They questioned whether the public will politically support strategies needed to strengthen ecosystem resilience or support societal mitigation efforts. Although the issue was recognized as being urgent, questions on how to address the climate change problem were raised:

- how do you make decisions about wildlife conservation given values-based land use conflicts?
- how do you deal with institutional inertia resulting from uncertainty, lack of motivation, and insufficient resources?; and
- should advocacy efforts priorize mitigating carbon emissions or conservation measures?

The federal government was often accused of lack of leadership on mitigating carbon emissions given the overwhelming evidence of the inevitability of climate change if emissions are not significantly curtailed.

In the survey, one respondent questioned whether climate change is human-caused and whether it will have the predicted impacts on ecosystems. However during the interview, this person expressed the view that climate change is occurring and could have a dominant influence on future wildlife ecosystems. Another acknowledged that they did not have much knowledge of climate change, but takes climate change impacts on faith, having seen change to the environment due to development and pollution

Participants tended to divide into two groups in terms of support for conservation action. Some had only recently been exposed to emerging evidence about climate change, were beginning to realize the potential for impact, and supported the need to respond. Others had been aware of climate change for some time and focussed on advocacy for emissions mitigation, but were now appreciating the importance of a new focus on adaptation given the realization of the inevitability of climate change.

> I was under the naive notion that we were going to be able to stop [climate change]. So in some ways I was blind…to what reality was. …I didn't want to accept the fact that we had to adapt, but I think anybody knows that that's where we're at. So to me it's not whether it's desirable or not, it's a matter of what we have to do. …All the projections show regardless of if we totally changed our habits…we would still be dealing with it. [N/E 1]

A number of respondents expressed concern about the future in a broad global context, citing issues of population levels, food and water shortages, environmental degradation, global conflict and security. However most did not comment that they would be personally affected by such impacts. This suggests that such problems seem too big to be tractable for some, resulting in reluctance to dwell on such concerns.

Interview participants with children or grandchildren tended to relate concerns about the future to the security and social wellbeing of future generations rather than a concern for the environment. Some participants talked about personal commitments to sustainability and self-sufficiency, some expressed guilt for lifestyles that contribute to greenhouse gas emissions, while others were did not express concern about their lifestyles.

A prevalent perspective amongst government participants was that climate change is an important problem that needs to be addressed, but needs to be considered in a broader perspective alongside other business challenges. Within this group a range of views, from not seeing climate change as an urgent problem to more of a doomsday perspective, were noted. Government agency participants tended to focus on such current management issues as identifying sufficient timber to harvest on a land base constrained by environmental policies (ie. forestry managers) or on implementing current species and habitat management policies (ie. wildlife managers).

Industry respondents generally shared the same concerns and sense of urgency about climate change and its potential for socio-economic and ecological impacts as others within the group, but focussed on the need for solutions that balance protection of the environment with maintaining economic opportunities.

The environmentalist perspective tends to stress a precautionary approach that emphasizes conservation. This perspective advocates that an appropriate response to rapid climate change should be conservation of connectivity and transition zones and more core reserve areas at lower elevation areas, particularly riparian areas. A perhaps wishful perspective of a few environmentalists was optimism that a simpler resilience-based economy will develop at the community level and human dependence on fossil fuel will be replaced by alternate forms of energy – although most were pessimistic in their belief that there will be serious social, economic and environmental issues globally.

5.5.2.3 Perspectives on Strategies for Resilient Ecosystems

Interview respondents were asked about their views on the various strategies that could be implemented to mitigate climate change impacts on wildlife ecosystems in the Kootenay region. These strategy options had been presented online during the pre-workshop phase of the study, served as a reference during the completion of the initial survey questions, and were discussed in the workshop.

Both survey and interviews responses suggest that people are generally more supportive of habitat manipulations than direct interventions with wildlife. Data offer two apparent arguments for this conclusion:

1) Respondents who are scientists or government or industry resource managers tended to support a science-based argument that ecosystems-based management approaches are more effective in maintaining ecological resiliency and more sustainable in the long-term than manipulating wildlife through assisted migration and population cull programs. Such programs were largely seen as stop-gap short-term solutions which are not sustainable in the long term.
2) Wildlife manipulations such as culls of predator or prey species or species translocations elicited strong ethical responses from many participants who either oppose such approaches outright or believe they should only be used under circumstances that can be shown to be biologically feasible and cost-effective.

An underlying concern was that human interventions to maintain wildlife ecosystems may interfere with and simplify natural ecosystem function. However most participants expressed belief that habitat interventions are necessary to restore natural ecosystem function where human activities have significantly impacted the landscape. Conflicting ideas on peoples' ability to effectively intervene in ecosystems emerged. One general perspective was that ecosystems are so complex, dynamic and unpredictable that notions of intervening are hubris. One respondent equates this to "playing God" and goes on to say "I'm skeptical… that we're going to save the world by moving a few species around or shooting a few predators …We perpetually failed at this stuff…why do we keep doing it?" [Sc/Nr 2] An opposing perspective was that humans do understand enough to effectively manipulate ecosystems:

> We are the only critters on the world that know [how ecosystems function], and can do something about it. I think our population has enough expertise and knowledge that we can…control [our environment] so that humans stay around, rather than creating an ecosystem that is unsuitable for human life. [P/So 5]

Several respondents commented that strong biological and cost/benefit rationales are needed to support human interventions in ecosystems. For example, resource managers should be encouraged to incorporate variability and uncertainty into management design and be cautious in thinking they understand how ecosystems can be managed. A prevalent view among respondents was that human interventions need to be based on the best science available. As one respondent notes, “We are like beavers, we do change the landscape. …We can engineer for the better” [Sc/So 1]. However the risks and returns of an intervention must be considered to ensure conservation investments are effective.

> I’m very, very concerned about [predator control and species translocation]. I think that they’re…an arrogant approach. ...It’s such a human-centered approach where we think we’ve got it all figured out and we just go in and do this and everything will be fine. …In my opinion they’re band-aid solutions that ultimately are unlikely to succeed because they’re just such dramatic changes to either the populations or the ecosystems for which we don’t have all the information. …[Translocation is] going to be potentially very costly to society and the likelihood of it succeeding is, in my opinion, probably quite low. [I/C 2]

Participants’ attitudes towards nature and wildlife values and their occupational interests and political orientation strongly influence support for habitat protection, habitat restoration, species translocation, and predator control approaches to conservation.

a) Protected Area Strategies: Environmentalists and conservation biologists in the sample tended to favour significantly expanded protected area reserves to provide both core habitat and landscape connectivity, as advocated by Noss et al. (2012), Pojar (2010) and others. For example, the recent Conservation Northwest/Wildsight proposal suggests that 25% of the region be in protected reserves (eg. a park), 25% in landscape corridors, and another 25% in integrated management designations that priorize ecosystem conservation (G. Utzig, personal communication[124]). This biocentric approach seeks to protect nature so nature can take care of itself and reduces the need for human intervention. Biocentrists generally supported habitat restoration interventions that are ecologically justified and that can be demonstrated to be effective.

> I believe in protecting large areas…I really appreciate the 'Wildlands Project'…to protect a minimum of 50% of the land base. …that should have been done a long time ago before so many unique and important habitats were disturbed or lost to development. [N/So 2]

Industry and government forestry management respondents tended not to agree that more parks are the solution. They favoured an approach that emphasizes ecosystem-based integrated management, emphasizing this is better suited to addressing the dynamics of climate change impacts. In their view protected reserves remove productive land base and limit their ability to harvest timber. They also expressed the perspective that designating more parks creates further pressure to log the remaining matrix. As one industry participant commented "I don't like the ideas of complete reserves. I think those are counterproductive because as soon as you put in a…boundary [people say] well, fine I'm going to log right up to it." [I/C 1].

Concerns were expressed regarding the efficacy of protected areas, along with suggestions that conservation objectives be rationalized in a landscape context, and that there may be other conservation mechanisms that would better meet wildlife conservation objectives while allowing integrated uses. The concern was that parks are never evaluated against their purpose; the pressure is always to add new parks, so some participants questioned the capacity of protected reserves to address the dynamics of environmental and ecosystem change, given their of static protectionist stance. One participant [I/C 2] suggested that rather than lock the land into a park, it would be more

[124] This was suggested in a GNLCC webinar Utzig gave on June 12, 2013 and was recently posted on the Kootenay Resilience Project's website (http://www.kootenayresilience.org/Conservation-Project.html)

pragmatic to look for new 'tools' to achieve multiple objectives including meeting wildlife objective within an integrated management context.

> We need a dynamic level of management. We need something that [enables us to] do different things... Parks aren't going to solve the problem. …I think that WHAs [Wildlife Habitat Areas] are good…tie them in with old growth management areas, tie them in with riparian areas. [G/L 1]

This person questioned whether setting the land aside in a reserve is the only way to achieve wildlife conservation goals, and called for serious effort be put into an evaluation of ecological objectives and ways to optimize the costs and benefits of various conservation approaches including protected areas and a range of integrated resource management. Some respondents recommended that resource extraction be allowed in reserve areas and noted lack of flexibility presents a barrier to industry acceptance; suggesting protected reserves need to be tailored to meet specific conservation objectives and allow resource development to occur if consistent with those objectives.

There were calls to use conservation designations in a more dynamic way to address the ecological impacts of climate change. One respondent called for change in park management. “We have to stop what we're doing with fire suppression, reduce some fuel loading, and do some prescribed burning. Or harvesting as a tool….As long as it's properly done, not done as a money grab…it's a management tool. [Sc/E 1].

The notion that parks might evolve and even disappear over time in the face of climate change was also explored. “I don't think anything is out of the question. I'm looking at a park [and] have a feeling…it might not be a park forever…maybe the parks will be somewhere else. …different types of environment might migrate, so maybe that becomes a working forest” [G/So 1]. The need for openness to new ideas was explored by an industry representative:

> There is an area up the Incomappleux, beautiful area…it should be in a park…you [could] have that, but…reduce the biodiversity objectives down south where it's pine and fir. And there is real reluctance to do that, so [environmentalists have]

> got to be willing to make trade-offs. …They've got to look at the whole picture …be open to everything. [I/C 1]

Participants' perspectives on protected areas spanned the spectrum from a hands-off approach with minimal intervention to a hands-on paradigm in which parks are actively managed (eg. support for the use of prescribed fire or timber harvesting as a habitat restoration tool), to a conviction that parks are an ineffective tool to protect wildlife ecosystems given ecological dynamics that will result from climate change.

b) Integrated Management Strategies: As noted in Chapter Two, an integrated management paradigm for protected areas is predicated on society's interest in maximizing ecological goods and services from the land base. Some lands need to be protected as core wilderness areas and kept in as natural a state as possible. Sound stewardship needs to guide activities on the balance. In theory, there is very little debate about this. In practice, conflict among stakeholders relates to how much land needs to be protected and the extent of cumulative effects from development to be allowed on the matrix. Such tensions were reflected in participants' stances on integrated resource management.

Participants who support this approach expressed beliefs that resource development and conservation can coexist on the matrix by using ecosystem-based management that promotes harvesting practices to create disturbance patterns at the landscape scale and maintain structural elements at the site level. They called for monitoring and making adjustments to achieve objectives. However timber harvesting as an ecosystem restoration tool was controversial. For example, while harvesting beetle-killed pine was considered to be a win-win solution that allowed recovery of economic value while reducing the risk of wildfire, concern was expressed that provincial salvage policies allowed significant green tree harvesting as well.

One area of controversy was whether old growth management areas should be legally designated. As described in Chapter Two, there are aspatial OGMA targets legally designated in the Kootenay-Boundary Land Use Plan and spatial OGMAs delineated which are not legally designated. The mechanism to spatially implement OGMAs on the ground is through identification in individual Forest Stewardship Plans (FSP) developed by each licensee[125]. Government forestry managers and forest licensees in the sample did not support formal legal designation, arguing that old growth conservation needs to be dynamic to accommodate both ecological and economic interests. Conversely, environmentalists expressed the strong belief that old growth needs to be legally designated, although this seems to be based more on the lack of trust that old growth will be protected than concerns about what is occurring on the ground[126]. One government participant [G/So 1] suggested that park reserves should be similarly managed as fire risk may potentially impact their effectiveness. Although the OGMA designation issue does not seem to be significant to conservation on the ground, participants called for stronger policy guidance on objectives for OGMAs, conditions to dictate how the targets could be redistributed, and direction on broader contribution to ecosystem conservation. Respondents indicated that climate change has significant ramifications for the designation and risk of OGMAs, and expressed concern over the current static approach to a dynamic system. Their views reinforce the need to reinstitute a landscape design planning mechanism in the region.

c) Translocation of Species: Participants' views of translocation are clearly influenced by the recent failure of caribou transplants. In March 2012 the provincial government translocated 19 caribou from north-western British Columbia to the southern Purcell Mountains area. As of July 2013, 17 caribou had died, one is known to be residing with a local herd, and the status of the other is unknown (Province of British

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[125] A review of several FSPs suggests that licensees simply adopt the spatial OGMAs which become legally enforced through approval of this plan by government.

[126] Government policy dictates that where a licensee proposes to harvest within an OGMA, a new one of equal ecological value must be proposed. Roughly half of the regions in the province have legally designated spatial OGMAs and half have not.

Columbia, 2013). Frustration was expressed that the initiative focussed on animals that were marginal in their territory and was poorly conceived:

> [Rather than] translocating to save something that's…in [the] periphery of its range then…let's focus…on where they are very successful…[translocating] because you think they should be there, or it's a political thing, I don't know if that's the right thing to do. [I/C 1]

> If everything had been planned…that would have been great. But I'm pretty sure that almost all of those [caribou] are gone. …you might want to make sure that it would work out better. Proper habitat, proper food…I guess you have to have trial and error. …It didn't work, so maybe figure out why and try again. Reintroducing species is a grey area for me. [P/Nr 1]

> Caribou transplants have not been all that successful… I realize that it is a worthwhile experiment but I know people…who think it's a waste of time and money. We just don't know all of the answers about the effects of translocating species. [N/So 2]

Some questioned assisted migration from biological and social perspectives, suggesting that "assisted migration…can bring a host of other issues if you're moving a species outside of its normal distribution or out of its normal range. It is almost an invasive species" [Sc/E 1]. However, most participants supported translocation, provided that it is well planned and executed, addresses a significant ecological issue, is ethically managed, and is cost-effective.

> I absolutely think there's value in it... For example the caribou [situation is] really a direct…result of previous human intervention in the landscape. If…we've lost a species because…of climatic adaptation, that's one thing. Obviously translocation makes no sense whatsoever. [With] mountain caribou…it is quite clear that although climate may have an impact on the periphery of those zones, that's not…the problem at this point [is] due to fragmentation of habitat in the long term, and then that gets into a complication, on down through predators. [N/E 1]

Balancing the costs of such interventions with other social priorities was noted as an issue however.

> I think…we owe it to the world to conserve them…[But] you read things…there was an article about the local women's shelter closing down, and on the next page

> there was the cost of the caribou transplant. …The next week there was a letter to the editor in the *Townsman* saying if you just take that $700 thousand that you spent on the caribou…and give it to the women's shelter…[it] probably would be far better. [G/L 1]

d) Predator Control Programs: Predator control was not supported by most participants. Many were adamantly opposed on ethical grounds, others commented that it is both ecologically and economically unsustainable, while some stated reluctantly that it can be justified to recover a species such as caribou where the ecosystem has been brought out of balance by human impacts.

> We've so messed up the whole natural system that now we're just…putting out brush fires every time we turn around. It's a dilemma we've gotten ourselves into, and I don't like that our options for conserving species come down to eliminating other species by shooting, poisoning or other methods. [N/So 2]

> Who are we to determine how many deer, how many cougar [should be saved]? …Cycles work themselves out in that sense. I think [predator control is] too invasive, and we're taking too much control if we do something like that. [P/Nr 1]

Participants who saw some value in predator control were clear that programs must be humanely implemented to address management objectives.

> It will always be controversial because there is always going to be people who feel so passionately about wildlife, they dedicate their lives to protecting it in many, many, many different ways. …[Culling] just rips our guts out, because on the one hand we worked so hard to protect the caribou. …Personally, I just struggle with the rights of the individual animal, and I feel so often individual animals pay the price for human inability to reign ourselves in. That just feels so unfair, and on a most visceral level. There is no truly humane way to kill wolves…it's just heart-breaking. …We would only support predator control where it was targeted, where animals were known to be preying on specific at risk populations of caribou. …What appalled me…is the approach that we see in Alberta…"well just keep doing it, just keep logging, just keep digging up for the tar sands, and just keep killing wolves…and we'll manage to keep a few of these caribou on the ground." That's not the kind of ecosystem-level protection that I want to leave behind… I don't think its dealing with the real problem. …I think the ethical issue for me is the cull. It's sort of an arrogant approach as we as humans tend to think we've got all the things figured out and we can do those sort of dramatic experiments on a pretty grand scale. [N/So 1]

> We have been clear right from the beginning that [ENGO groups are] not big fans of predator control. If a pack of wolves can be targeted because they are causing extirpation of the species that's been brought out of balance by human stuff…that sort of intervention is legitimate and should take place. But it absolutely has to be done in a humane manner and…in such a fashion that it's totally targeted. [N/E 1]

A small minority supported the predator cull as being a reasonable strategy to achieve caribou recovery.

> No, I don't [have ethical issues with predator control]. I mean if we are managing everything that should be part of the equation. …if you want to protect something but you are not willing to manage the other side of it because it doesn't sound right, then you are probably not going to get much out of it. [I/C 1]

Significant concern was expressed that the current government approach to wolf control is haphazard, poorly planned and executed. One respondent termed its approach “stupidity” and went on to say:

> I can't believe how naive [it is] to think “oh well we're going to go hunt some wolves and we're going to trap some wolves over here.” If it's not targeted, it's meaningless and the research has shown that time and time again. [N/E 1]

Lack of trust that culling programs would be limited to conserving species at risk was also a concern. Most participants expressed very limited support for programs designed to augment game species for hunting or to protect livestock. Exceptions to this included participants with recreational hunting interests and a local farmer.

> I have no trouble with predator control. I'm getting annoyed with wolves right now…they're competing with the same species I want to put in the freezer. …A lot of people have this Walt Disney attitude towards wildlife and they think that killing a wolf or a grizzly bear is the last thing you should be doing… And as we move towards a more urban culture…we've seen a whole pile of societal changes where the acceptance of firearms in the family home just ain't on anymore. But I grew up with it, and it's still part of my life. People who trap and fish and hunt…it's all part of my cultural background and I don't have any trouble with it. And predator control goes along with it. [P/So 2]

The MCRIP predator control program remains highly controversial. What seems apparent from interviews is that most participants who express ethical opposition to killing predators would be supportive, albeit reluctantly, provided that it can be shown as critical to the survival of an endangered species such as caribou. There are several caveats to this support including that predator control be ethically conducted, be science-based, have a reasonable chance of protecting the prey species successfully over time, and be cost-effective. Government has not broadly engaged with the community to address these issues, and perhaps should consider doing so to build a stronger understanding and support for the renewed efforts at culling wolves by helicopter they have recently taken.

e) Addressing Uncertainty: Substantial uncertainty on how regional climates will respond to global warming and on ways this could affect local wildlife ecosystems was expressed. “It’s so hard to prepare for something [when] you don’t know which way it’s going to go. …You could put all efforts into planning for one thing and something totally different happens” [G/So 2]. The processes involved were seen to be highly complex and respondents noted that scientific understanding is woefully incomplete, and non-linear processes and stochastic events make the future essentially unknowable. Participants were questioned on how uncertainty about climate change impacts on wildlife ecosystems influence their support for management interventions needed now to create ecological conditions that optimize future resiliency to change. Two perspectives on uncertainty emerged: approximately one-third of the respondents expressed a belief that better information is needed to reduce uncertainty before adjusting resource management approaches. As one noted, “Right now the error is so wide we could be shooting anywhere” [G/So 1]. The other two-thirds called for a new precautionary approach to replace or adapt existing resource management by reviewing how to maintain options, emphasize resilience-thinking, and employ adaptive management.

> I think we’re sort of talking about the unknown unknowns. …you don’t even know what is going to pop up. …I think we already operate from a standpoint where there is quite a bit of ignorance about functional processes and what’s important. …Sometimes you’re going to be successful if you make big gambles. …And other strategies should be playing it safe. That’s within the range of human personalities

> and animal behaviour…maybe you need to have variability in how you're addressing the future. [Sc/So 1]

> I'm putting a climate change lens on everything [as] it is clear that there are things that I can be doing…like what species we can regenerate a stand to. For doing logging, I'm always retaining legacy veterans, structure, for natural seed source…for example when we are logging on our west facing, relatively drier slopes. …I'm planting ponderosa pine and grass. That's an easy thing to do…it's stand level, it's operational, it's something you've got to make a decision on. …We are also building the likelihood of increased fire frequency into long-term thinking about what the cut should be, and where we should be logging and where we shouldn't be. …That's just one tiny bit of the whole thing, but it does illustrate we have to start working in the context of change in climate. [I/So 2]

One participant remarked that resource management tends to mistakenly assume available scientific information is complete or accurate. This person strongly advocates a risk management approach in which scientific uncertainty is explicitly incorporated into adaptive management.

> As a decision-maker in government…I remember people [saying]…"this is the latest stuff, it's really good." So you would force a decision, then find out a few years later that the science wasn't that robust…it was based on weak variables. …I would have really appreciated as a decision-maker…[if] somebody would have been upfront on that. …You'd make a different decision, based on that than you do when you think you've got something that's 80 to 85% reliable. That's where I think science can do all society a big favour. [Sc/Nr 1]

Perspectives on the need for further research prior to implementing action versus employing an immediate precautionary approach were surprisingly unrelated to demographic factors.

5.5.2.4 Governance and Consultation Issues

Governance issues emerged as a major theme among participants. A common perspective was that ultimately all interests including government, industry, ENGOs, recreationalists, and academics have important roles to play in ecosystem management. There was broad acknowledgment, particularly among public, science and environmental interviewees, that much decision-making regarding wildlife ecosystems should be locally-based and involve the interests of stakeholders and community. Rationales for this included improved ability to address community concerns, a need to build awareness and stronger local support for management strategies, and to be able hold government and industry accountable for implementation.

But there was also strong feedback that the primary responsibility for managing wildlife ecosystems should rest with government, with a mandate to provide top down direction, arbitrate between competing interests on the land base, and enforce legal and policy requirements. Other entities or stakeholders are considered to not have the authority, resources nor the necessary expertise, or have competing vested interests. The industry sector operating on public land, and on private land to a much lesser extent, have a legal responsibilities for wildlife stewardship. This sector needs to be held accountable for delivering the results directed by government. At the same time, many participants also expressed a view that government agencies have insufficient capacity to provide leadership due to significant 'down-sizing' of staff and budget reductions. A concern is that short-term political cycles prevent effective management of long-term issues. Many also commented that current provincial and federal governments seem biased towards toward resource development:

> Politicians [tell staff] “don’t do anything that rocks the boat for industry.” They don’t tell them to maintain the healthy ecosystems. They tell them [to] stay out of the way. “We don’t want industry to have any problems.” That’s a very, very clear direction that I’ve heard from the [government] biologists. [N/E 1]

Yet another concern that emerged was perceived tension between government professionals, their managers and perhaps by extension, the current government. One respondent speculated that government professionals are limited in their capacity to speak on professional matters.

> There is no one in government that oversees. …I, with my really meagre technical background, have much more of a picture of what’s going on out there than the people in the Ministry right now because they’re not even allowed to comment. …They’re told that they’re out of bounds to do that. There are really capable

> people, [but] I've watched people dance around the fact that they're not supposed to comment on management. …As a result, management is pretty weak. [N/E 1]

Some suggested that while government has a responsibility to provide leadership by establishing broad objectives, setting policy, and implementing a regulatory framework, it may not be the best agency for implementing policy or operational programs.

As participants noted, non-governmental organizations are widely involved in important roles in advocating environmental protection, promoting conservation stewardship, and acquiring conservation lands. Such organizations include independent trusts established by government, resource professional associations, private land trusts, certification organizations, and numerous environmental stewardship and advocacy organizations. While participants observed that ENGOs are influential, some concern was expressed that ENGOs can be too strident in their perspectives and are not interested in reasonable compromise. On their own, ENGOs are only able to address limited stakeholder interests due to their self-interest in the issues. ENGOs were not seen as being neutral or broadly accountable for their actions and there was concern about the nature of the community conservation dialogue currently being coordinated by Wildsight. Most participants recognized that ENGOs have important advocacy and public awareness roles, contribute by holding government and industry accountable by advocating for environmental perspectives, and increasingly provide science-based perspectives to inform decision-making.

Particular concerns about the results-based forest policy regime were raised by participants across government, ENGO and industry categories. The current results-based policy framework consists of high-level objectives that are legally established, and requires that industry specify operational results and strategies in a Forest Stewardship Plan that meet these objectives. Qualified professionals then certify content of FSPs to meet the prescribed requirements set through government objectives, and finally government oversees adherence to standards. A range of policy failures from this results-based approach was identified by participants from ENGOs, industry and government. Their concerns included failures to legally implement OGMAs, minimal legal and spatial content of government approved FSPs covering very large geographic areas, and unenforceable prescribed results and strategies. A common complaint was that the new FRPA legislation limited the legal requirement to consult with the community at the FSP planning level, and did not legally mandate consultation at the detailed spatial planning level or at the permitting stage for harvesting, road construction and silvicultural activities.

There is little confidence that reliance on resource professionals is working as intended because industry's economic bottom line is seen to overshadow forest stewardship. As one participant noted, this system sets adherence to professional standards at “the minimum bar” [G/L 1]. Another calls for greater government engagement in setting and monitoring expectations:

> Licensees have to be involved because they…know what they have to do to …[to] stay in business. And they have the operational expertise. …[But] I think the government has to be there to provide the expertise… Biological or ecological objectives coming from the government would be more acceptable to most people because they should be free of bias, theoretically. [I/C 1]

Numerous associated problems were identified. There is little incentive for licensees to put more than minimal content in FSPs, many of government’s objectives are broad and unclear, professional training has not been integrated, and there are no apparent mechanisms to hold professionals accountable. As one respondent noted, in the face of such problems, “the whole thing has broken down”[G/L 1]. The need for government to provide direction to address the minimalistic approach to content in licensees’ Forest Stewardship Plans was noted:

> We need to have…better planning around where we’re going to go harvesting. And maybe back to government helping do that. Now it’s all licensees have their chart areas or operating areas, and we do all our own planning where we’re going…making sure the planning is coordinated…across the landscape. That’s what’s really lacking. [G/L 1]

In the view of participants, professionals have a responsibility to implement practices on the land to mitigate impacts of climate change, and therefore must gain the knowledge necessary to do that:

> A lot of [professionals] are doing good things. But you see [forest practices] are becoming minimalized. …I think…the Association needs some way of really stressing to the membership, especially younger guys, that they've got to take their professional designation very seriously. And it should be "I've got an RFP and I can sign an SP [Silvicultural Prescription]…and I'm marketable." It should be "you've got a land ethic" which I think is missing in a lot of people. [I/C 1]

To this end, the Association of BC Forest Professionals has recently developed a task force on climate change.[127]

Most participants emphasized that broad community-based demand for conservation action is needed before government will begin to consider wildlife conservation actions to be a priority. And there was considerable support, in principle, for new planning mechanisms grounded in community consultation to ensure that intervention strategies meet the needs of local stakeholders. At the same time, conflicting opinions were expressed on what constitutes appropriate levels of community engagement in conservation planning and management. It was notable that government and industry participants advocated for more technocratic planning approaches that tended to minimize broad public engagement. This perspective seems to be linked to the previous inability to resolve value-based conflict dynamics that resulted from KBLUP. Participants in this group expressed concern about opening up any new dialogue on land use issues. Industry participants anticipated that environmental interests would use a consultative model as an opportunity to ramp up demands for conservation. Even some environmentalists, who tend to favour collaborative models, voiced the concern that climate change may be used as a reason to rescind conservation

[127] Association of BC Forestry Professionals. Retrieved from http://www.abcfp.ca/practice_development/climate_change/Climate_Change.asp

measures already place, particularly those measures recently implemented as part of the MCRIP.

Participants acknowledged the challenges inherent in negotiating conflicting perspectives to facilitate consensus decision-making at the community level. It was observed that, after years of innovative community consultation initiatives in the area, local stakeholders remain highly conflicted on land use issues and can be cynical about engagement processes. Several participants who have been involved in land use debates over the past 25 years from both the environmental and industry stakeholder perspectives pointed to ‘burnout’ or process fatigue even as stances on many land use issues remain polarized. Concern was expressed that communities don't get involved in consultation because they don't care, are focused on other priorities, are tired or disinterested in engaging in divisive and unproductive processes, don't think they can make a contribution, or are dependent on resource extraction for their livelihood. These deep concerns highlight the contradictions inherent in advocating for strong community engagement in principle, while struggling to achieve a commonly accepted approach to consultation in practice. Better understanding of the social dynamics involved in managing for major change and more effective systems that bring community and government together in meaningful ways emerge as a critical need. Even as participants explored challenges of meaningful consultation, they emphasized that responding to climate change, given the global context of the problem, will require a coordinated social movement that involves civil society, government and industry working together to provide the necessary leadership.

The list of governance issues in wildlife conservation management that emerged from interviews is complex and long:

1) troubling limits to government’s capacity to effectively manage ecosystems or hold industry accountable;
2) ongoing land use tensions between competing interests;

3) demise of effective opportunities for community dialogue (ie. land use planning);

4) emerging understandings of First Nations land claims;

5) the role of ENGOs in asserting a new kind of influence through advocacy, civil disobedience, and market pressure;

6) emerging roles of independent 3rd party regulation (eg. professional regulating bodies) and certification bodies (with external influences from ENGOs and industry as the case may be);

7) delegation of authority to local levels or to agencies independent from government (participants emphasized that such mechanisms be neutral and publicly accountable); and

8) a broad perception that implementing the 'results-based' resource management policy framework is failing to achieve its objectives.

Discussions on governance and consultation, on one hand, highlight a collective recognition of a critical need for comprehensive multi-sector regional and landscape scale planning processes to address climate change impacts on wildlife ecosystems, for reforms to fix policy failures in the delivery of the results-based resource management legislative framework, and for new processes for broader community engagement in the issue. It is evident that participants recognize that current methods are not effective in meeting either current or future needs. The interview discussions reveal divergent opinions on best approaches going forward on these issues. Finding ways to reconcile deeply held and conflicting interests and convictions remains a considerable challenge.

5.5.2.5 Influence of the Workshop on Stakeholder Perspectives on Wildlife Conservation

One of the primary lines of enquiry in this chapter is whether participation in a workshop that explores scenarios and impacts of climate change on wildlife ecosystems influences stakeholder's beliefs and attitudes related to wildlife conservation and restoration strategies. For this reason the interview question that sought participants' perspective on the impact of the workshop is of particular interest.

As shown previously, environmental attitudes and wildlife values expressed by people who agreed to participate in this study ranged from neutral to strongly biocentric with a strong affinity for wildlife for both intrinsic and utilitarian reasons. It seems reasonable to conclude that people interested enough to participate in the study would be on the 'caring for the environment and wildlife' end of the value spectrum. One limitation to this research is that the sample did not include those on the other end of the spectrum who are unlikely to care as much about or perhaps understand these issues. As participants noted:

> I think everybody in the room, to a large degree were believers. You were, to a degree, preaching to the converted, so you didn't have the radical [view that] climate change is bullshit, all that environmental conspiracy – there weren't any of those [voices] in the room. There were a couple, but not many. [I/C 2]

> Most of the people there were there because they were interested. But you didn't really get the people you needed to. [Sc/Nr 1]

The sample did include a range of stakeholder interests with varying degrees of values, beliefs, and attitudes about climate change and impacts on wildlife ecosystems to be able to identify a number of policy issues which will be important in addressing future action. However as discussed in Section 3 above, it will be critical to understanding the broader context missing from this study, including First Nations, more people employed in the resource sector, industrial interests, local government officials, and many others.

By augmenting participants' existing understanding of climate change implications with new information on likely climate change impacts on wildlife, the workshop appears to be a have resulted in some shifts in participants' varied attitudes and beliefs and to have influenced environmental motivation in varying degrees. Observations during the workshop noted positive and serious engagement. Participants actively contributed to discussions, and appeared very involved in deliberations of climate change scenario implications. Direct interview feedback from participants confirms that most participants found the workshop informative, especially to the extent that it addressed the range of scenarios, their implications, and uncertainty about future conditions. Many noted that they had not been exposed to such detailed information before and thus found the information and discussions illuminating and in some cases inspiring. Participants offered a range of largely positive comments:

> I liked it. I wasn't sure what to expect…but there's not many workshops that I come away from going "yeah that was worthwhile, worth coming down here for the day". When I left there I had more questions, especially seeing that map that showed twenty year increments on what the landscape is going to look like. [I/C 1]

> I think that the information that you gave at the beginning was thought-provoking and really got us focussed and thinking about the solutions. It gave us a good sense of the current information. …I think also the group discussions were really fascinating. You had some pretty good facilitators. …I think it got us all thinking about things from a number of different perspectives and I think it was really good. I really enjoyed it and I came away kind of refreshed [in] my thinking. I've been doing lots of reading on climate change [since then] and thinking about it all the time. For me it brought [a focus] back to the Kootenays again, and …the context in which we work, and the challenges we face. …There's a lot of my colleagues that I wish could have been there, just in terms of getting them thinking about this stuff and the implications. [I/C 2]

> It definitely gave me a broader perspective because I got different peoples' opinions about what could be done…what the possible solutions are, who and what the possible enablers are. It was good to learn what barriers to change there are too. [N/So 2]

> It definitely deepened my perception of [the challenges of climate change], but it hasn't changed the tone very much. There weren't too many really big 'ah ha' moments where my whole perspective shifted. [Sc/So 1]

> I really wanted to thank you. I think that's wonderful that you brought this to our community. I really appreciate it. I did get a ton out of it, and I do like listening to other people's perspectives and you can always learn something from that. It was thoroughly enjoyable. [Sc/E 1]

One government manager [G/L 1] stated that workshops like this help to create an understanding of climate change impacts that people are not normally exposed to by bringing a focus at a social level and by sharing anecdotal evidence of climate change that reinforces that it is really occurring. This has caused this person to reflect on how education can be incorporated into resource management responsibilities. Similarly, a scientist [Sc/E 1] commented that they gained a new perspective on the complexity of making resource management decisions that address the effects of climate change. This person also noted that participating in this study provided motivation to learn more about how resources management policies are made and to become more involved in trying to influence policy decision-making processes. Another participant remarked on the ongoing value of the maps and scenarios:

> I really got turned on by those capability and suitability models… They really help drive planning in a pretty good way. [I/C 1]

All respondents commented in the interviews that they appreciated being able to engage with others in workshop discussions on what they believe to be an important topic. There were a number of comments that being able to understand other people's perspectives was an important outcome that influenced their perspectives.

> I felt that it was helpful to have some of the cross conversations that happened in that room. I really enjoyed it…because it's not often I get the chance to have a structured but informal conversation with a range of folks. …Actually found it…kind of an historic moment. Nobody's been having this conversation yet, and I thought "oh God really, we're just starting to have this conversation now." That was really for me where people's thinking is about this. …It's definitely got me talking to people about it more. [N/So 1]

> The workshop was a good approach to presenting current information on climate change and potential impacts to our ecosystems and discussing barriers and solutions to adapting our ecosystems to the effects of climate change. It's [the] first time I've been to a workshop that's attempted to get the participants to collaborate on discussing the strategies and trying to design a process to come up with these strategies. [N/So 2]

> It was good to see so many people there…just to see that other people cared that much. Sometimes I [feel I'm] the only one who cares. …I know that's not true, but sometimes it can feel like that. The complexities of this issue, and how many people are actually trying to help it…that's what I got out of it. [P/Nr 1]

In the context of reviewing the workshop, participants generally repeated their strong convictions that an open dialogue in which people are willing to listen and work collaboratively will be critical to finding constructive solutions to complex problems. However most participants expressed caution about how much can be learned from or accomplished in just one workshop, and pointed out that not having broader viewpoints among participants was a limitation in the workshop outcomes. Several commented that engaging the community on the issue will require concerted effort and leadership at a variety of levels and commented that a workshop as part of a PhD research study can only have limited scope or long-term influence.

> Everyone seemed enthusiastic and fired up at this workshop, but my concern was "what do people do when they leave here?" People are so busy in their lives doing what they need to do to meet their work and family obligations that I wonder what really is going to happen. …I think progress is going to be slow and change may not occur fast enough to get us to a place where we are prepared for what's going to come with rapid climate change. [N/So 2]

The workshop clearly engaged participants and stimulated their thinking. Participants were attentive during the initial presentations and fully involved in breakout session discussions. It was evident that most had reviewed the pre-workshop materials relating to climate change scenarios and implications, since they were referenced in discussions during the workshop and the subsequent interviews. And given the interest in the climate change scenarios and their implications for the study region as well as participants' willingness to discuss management responses, it seems evident that for many participants, the workshop offered an opportunity to learn, to consider threats to local ecosystems, and to further develop perspectives on wildlife conservation strategies that might influence future efforts to mitigate climate change impacts. Based on positive feedback offered during the interviews, it seems reasonable to conclude that the workshop contributed to most participant's interest and understanding of the issue, and stimulated their personal level of interest in seeking solutions, at least during the workshop and subsequent interview. However it is also evident from this feedback, that the extent to which the workshop affected participants' beliefs and attitudes relating to wildlife conservation and restoration strategies was limited to shifts in personal awareness and concern, rather than to plans for action.

5.5.2.6 Barriers and Opportunities

When asked to reflect on barriers and opportunities in both the workshop discussion groups and the interviews, participants tended to revisit many of the concerns expressed in other questions. As a result, this section becomes a summary of the many threads that were explored relating to the challenge of wildlife management in the face of climate change. Barriers were a particular preoccupation as participants reflected deeply on the complex issue inherent in determining appropriate interventions for wildlife protection. Obstacles that emerged in both the workshop and interview settings can be clustered under a number of themes:

1) **Social obstacles**: Participants commented that uncertainty as to the scope and nature of change lie at the heart of a range of factors inhibiting action. Poor public understanding of issues was seen as key, and was linked with observations of institutional and social inertia along with psychological resistance to embracing change. Climate change denial in the media was seen to contribute to confusion around appropriate responses. Considerable debate over ethical considerations relating to human interventions in eco-systems (eg. predator control programs) was also noted as a barrier to widely supported intervention strategies. And while there was a general sense that community engagement offered a valuable means of exploring wildlife management options, participants observed an erosion of social mechanisms needed to animate community discourse on the problem and solutions.

2) **Land tenure and economic obstacles:** Land ownership and commercial uses were noted as deeply ingrained socio-economic obstacles to new approaches in wildlife management. Private land ownership is seen as a critical issue in dealing with wildlife connectivity, and not surprisingly, many participants expressed or observed conflicting values linked with resource extraction that pose obstacles to implementing ecosystem conservation measures.

3) **Governance Obstacles:** Participants also identified a range of political and organizational obstacles that inhibit meaningful action. A dominant theme in workshop discussions and in interviews was the degree to which the current provincial government lacks the political will to address emerging issues. This general critique has a range of dimensions. Perceived lack of willingness to allocate needed staffing, budget and other resources, pro-development policies, inadequate levels of scientific knowledge along with an inclination to suppress science, centralized decision-making, deregulation and short-term political agendas were all cited as problems.

   While participants noted that considerable effort has been devoted to the development of policies that balance resource extraction and wildlife conservation, many expressed disappointment over the consistency and quality of policy implementation. Specific concerns relate to the ways in which forest practices legislation, the Kootenay Boundary Land Use Plan, species at risk legislation and the caribou recovery strategy have been operationalized. Some participants commented that timber appraisal policies push industry operations to the lowest common denominator, while others noted a lack of industry incentives (eg. volume-based tenures). A number commented that the annual allowable cut is too high from a sustainability perspective. Others noted a lack of enforcement of environmental regulations. The reliance on professionals for implementation and monitoring was seen as problematic. And many participants expressed regret over the demise of land use planning.

While listings of barriers were complex, interconnected and extensive, participants also identified opportunities to strengthen capacity for effective responses. These can be clustered under a number of themes:

1) **Building understanding through better information and communications:** Just as lack of understanding was perceived to cause a range of social barriers to effective wildlife management strategies, a range of efforts to address this problem was seen to offer important opportunities. New, more reliable evidence of climate change impacts was identified as key to resource management decision-making and public education. The use of online media and community-based dialogue to develop public awareness of the problem and the values at risk was called for and the power of a better-informed media was recognized.

2) **Strengthening institutional mechanisms:** A number of alternatives to established organizational approaches to wildlife management emerged from group discussions, many of which reflected a preference for local solutions. There was considerable enthusiasm for involving community-based conservation institutions such as Habitat Conservation Trust Foundation, Columbia Basin Trust, BC Hydro Fish and Wildlife Compensation Program, and Kootenay Conservation Program and other ENGO advocacy groups and land trusts in funding and decision-making processes, although some cautions around conflicting interests were expressed. At the same time, many participants reflected on the value of local-level planning mechanisms, based on the successes achieved through these processes in the 1990s; others expressed concern that such engaged approaches to planning had not been entirely successful and were challenging to replicate.

   New economic incentives (eg. certification, tax incentives, carbon offsets) were encouraged to foster innovation in resource development and promote social license for industry. At the same time, there was a call to build on the current conservation framework which includes 95% of the land base under public ownership with a core set of protected areas and private conservation lands located in critical areas. And finally, participants emphasized the value of improved professional accountability frameworks to address conservation objectives under the result-based paradigm.

3) **Building social capital:** Participants expressed strong commitment to community-engaged management approaches, but recognized a need to build trusting and respectful local networks that are grounded in a strong sense of connection with the local environment. The general interest in building social capital had a number of dimensions, including strengthening local trust and engagement in political and government bodies, encouraging grassroots and individual efforts and promote local champions; increasing funding and other supports to non-profits and ENGOs; and utilizing local conservation funds to fund pilot/demonstration areas/projects to build engagement in local solutions to wildlife conservation problems.

4) **Improving regulatory mechanisms and program delivery:** Not surprisingly, concern around flawed policy implementation was accompanied by many suggestions for improved approaches. The value of local advocacy for the regulatory reforms needed to address climate change was discussed at some length. Strategies included adjusting the annual allowable cut; implementing access management regulations to regulate ATVs and snowmobiles; and implementing ecosystem restoration, invasive weed control and interface wildfire management programs. Other opportunities focussed on requiring habitat compensation for all development approvals; providing public access to information on forestry development plans; requiring full cost accounting in resource development. The value of building relevant knowledge and capacity for government staff was also emphasized.

5) **Building political support:** Although discussion of political opportunities was relatively brief, the importance of influencing political will by building political relationships was emphasized, as was the value of electing pro-active governments.

It was notable that, participants appeared more inclined to focus on barriers than opportunities. Conversations were animated and clearly drew on closely held opinions and diverse experiences.

5.5.3 Summary

Post-workshop interviews provided a rich opportunity to follow up with 27 of the 28 participants who took part in the initial survey and the workshop. Interview respondents were hospitable, gracious with their time, and universally sincere in addressing the questions put to them in the discussion. As well, they were notably frank about opinions that were expressed more guardedly in the workshop. Land use, resource development, environmental protection, and wildlife conservation are subjects that invoke considerable passion, resulting in in-depth and candid conversations. While the interviews were time-consuming to conduct and transcribe, they generated a significant amount of data for analysis. And they afforded an opportunity to explore the subject matter with participants in greater detail and more personally than was possible from either the survey or the workshop. During the interviews most participants commented on how reviewing the maps and reports provided on the website at the outset of the project and having the opportunity to participate in the presentations and breakout sessions in the workshop contributed to their understanding of the issue and the potential opportunities and problems associated with strategies to address the issue. This suggests that progressing through the survey and the workshops set the stage for a more enlightened conversations during the interviews.

Many participants used the interview setting to express deeply-felt concerns about the future. They indicated that they worry generally about matters reported frequently in the media regarding the environment, the economy, and global security. Although several commented that they may be insulated or perhaps even indemnified from such significant impacts by being remotely isolated in the Kootenay region, there is a general fear and uncertainty of what the future holds and a feeling of powerlessness. There is a level of concern that climate change is and will increasingly have an impact on local ecosystems and wildlife. While they expressed a strong affinity for the natural beauty, recreational opportunities and integrity of wildlife ecosystems, it seems there is a 'Maslow's hierarchy of needs' (Maslow, 1943) with many people dictating a higher concern in an uncertain world for personal and family economic security, well-being and safety over abstract concerns about climate impacts on nature. It was during the interviews that it became clear that participants' perspectives on conservation are firmly embedded in their culturally rooted values and attitudes. Perspectives on wildlife range from this being a significant conservation concern that needs to be urgently addressed to this being a significant constraint to resource extraction.

Participants noted a number of issues including lack of scientific understanding, inability to predict the future accurately, negative media reporting, and inherent human inertia to change contributing to uncertainties on how to manage for ecological resilience, and have called for a stronger focus on scientific research, building community and political understanding, and implementing adaptive management. Barriers identified to addressing the issue include public and political awareness of the problem, the need to negotiate continuing interest-based conflicts relating to land and resource use, and the need to resolve governance issues contributing to failure of a number of existing policy mechanisms, and to address new institutional mechanisms for formulating new policies which will be needed to employ resilience-based adaptation to climate change. Potential solutions to address these issues included broadening public educational opportunities, leveraging the capacity of existing local institutions, and advocating for political action to address policy implementation issues and to support revitalized community-based planning mechanisms.

5.6 DISCUSSION

The focus of this chapter has been to evaluate how stakeholders' support for wildlife ecosystem conservation policies are motivated by their beliefs and attitudes about ecosystem vulnerability to climate change, how such support may be influenced by participation in an assessment of climate change impacts, and to identify opportunities and barriers to implementing conservation policies for increasing the resilience of wildlife ecosystems to climate change. A sequence of survey, pre-workshop information, workshop engagement, and follow-up interviews probed the values, beliefs and attitudes that shape participants' understanding of climate change impacts and their motivation to implement resilient adaptation strategies.

A number of inferences can be drawn from the initial survey of participants' values, beliefs and attitudes in relation to background demographic factors. Despite the limited sample size and significant degree of participant bias towards both a belief that climate change is occurring and a direct interest in wildlife, comparative analysis of demographic factors with participants' perspectives was helpful in identifying patterns underlying environmental motivation.

The subsequent day-long workshop in Nelson served as the primary means of engaging participants in a vulnerability assessment of climate change impacts on wildlife. As noted, most participants were reasonably well informed and in some cases worried about climate change dynamics before taking part in the study. However prior to participation in the survey, review of the pre-workshop materials online, and engagement in the workshop, few had considered the scope of potential implications for wildlife in the region. The introduction of climate change scenarios on the website and in the introductory workshop sessions played an observable role in focussing the group on local implications of climate change for wildlife.

The final interviews offered the most revealing insights into participants' perspectives on appropriate conservation measures in light of projected climate change impacts.

These conversations tended to be intense and thoughtful as they drew on the foundation laid by the survey and workshop and as their private and confidential nature allowed for more relaxed but frank comments.

While the capacity of the workshop to shift attitudes and shape motivation was limited by its short duration and its generalized nature, it did play a number of valuable roles in this research. It demonstrated the strong if diverse commitment to wildlife held by the group; it illustrated the levels of understanding and tenor of argument that various participants brought to public discussion; it generated concerns and ideas; and it stimulated participants' thinking in ways that shaped the quality of discussion in subsequent interviews. And, as a number of participants noted, it strengthened their personal networks and elevated awareness, perhaps commitment, to learn more about the complex and uncertain future of wildlife in the region. However, given the diversity of participants' levels of prior knowledge, and the brief time available to integrate new knowledge with personal experiences in a meaningful way, the workshop likely had limited impact on participants on shaping new perspectives on conservation measures.

Although there was wide-ranging agreement that better conservation strategies are needed, the challenges that a lack of consensus as to what constitutes appropriate actions emerged as one core challenge in both the workshop and interviews. While participants expressed deep interest in conservation strategies and measures that might mitigate impacts, their support for various approaches to increasing the resilience of wildlife ecosystems varied significantly according to their environmental value paradigm and the way it shaped their perceptions of potential socio-economic and environmental implications. Even in situations in which shifts in attitudes and beliefs were noted as a result of workshop participation, clarity around meaningful action was elusive. It was notable that participants' perceived lack of personal capacity to influence significant social and environmental change and their frustrations in the face of uncertainty prompted a number to reflect on the challenges of playing a meaningful role.

Lack of both general consensus on appropriate interventions and a sense of personal agency to effect change suggest that if engagement is to shift beliefs and attitudes in order to strengthen motivation, much more extensive and effective processes to address these issues will be needed to engage both individuals and communities. In particular, it seems likely that engagement activities to motivate resilient conservation strategies will need to respond to the characteristics and circumstances of the many vested interests and divergent perspectives of stakeholders.

The second core challenge emerging from the study is that stakeholders have little confidence in the current institutional mechanisms for implementing land and resource management policies nor for engaging the community in processes which would be reflective of their interests. Given participants' general lack of confidence that the provincial government is positioned to play an effective leadership role in mitigating the impacts of climate change, it seems evident that new and/or local institutional mechanisms will be needed to take on this complex responsibility.

A number of interesting perspectives on participants' attitudes about wildlife conservation emerged from the study. Results from the interviews, corroborated by the survey results, indicate a correlation between support for conservation adaptation strategies and participant's environmental beliefs and wildlife orientation. A summary of a comparison of wildlife value orientation and conservation motivation was developed to organize observations of attitudes and motivations from the survey as well as from information from the follow-up interviews according to the typology outlined in Teel and Manfredo (2009) and is shown in Figure 5.12. This figure summarizes stakeholders' concerns emanating from this study about wildlife conservation and their support for conservation measures according to their wildlife orientation. Participants' attitudes about wildlife range from biocentric, which supports a belief that the study area has global significance and responsibilities to conserve wildlife, to more anthropocentric views that regard wildlife as a resource for recreational hunting, a menace to livestock, or being a constraint on resource development. Mutualistic wildlife perspectives were

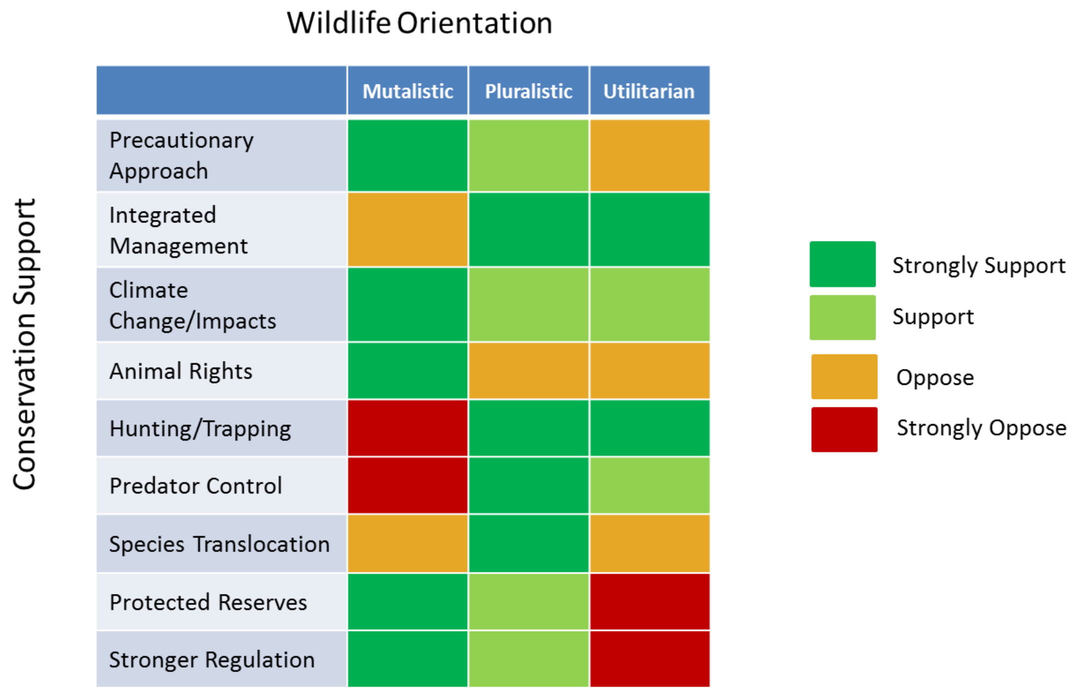

Figure 5. 12: Relationship Between Wildlife Orientation and Stakeholder Motivation

found to be associated with a tendency to support more protected reserves and stronger habitat protection regulation, but oppose human interventions such as predator control or translocation. Pluralists also a strong affinity with nature and generally support conservation. The have strong use orientation to wildlife and as such are pro-hunting. Utilitarian wildlife attitudes are associated with weaker support for ecosystem conservation measure including protected areas or stronger regulation, preferring traditional integrated management as a mechanism for achieving conservation objectives. This perspective tends to question whether management interventions are needed to address the issue and believe there is insufficient knowledge to support decision-making.

Participants' perspectives on how to take action in the face of uncertainty diverged significantly. Some expressed a tolerance for risk and called for experimentation with diverse strategies. This adaptive management approach would use best available information and then adjust as new information becomes available. A perhaps more conservative perspective favoured a precautionary approach to minimize human impacts on ecosystems and maintain the widest possible options for wildlife in the future. None of the participants advocated a 'business as usual' perspective.

Both workshop and interviews highlighted a number of significant barriers to implementing resilient ecosystem-based conservation strategies, while also emphasizing the importance of resolving these if predicted climate change impacts on wildlife ecosystems are to be managed. Participants recognized that lack of reliable information combined with uncertainty relating to all aspects of the nature and resolution of the problem contribute to lack of understanding and political will to address the issue. Institutional mechanisms to address climate change impacts are seen to be lacking at both provincial and local levels. It was notable that participants expressed a degree of cynicism/pessimism that anything can or will be done to mitigate the causes or effects of climate change, citing a lack of current leadership combined with historical challenges in collaborative processes. It seems evident that a key barrier to consensus around meaningful action is the strong value-based land use interests that result in divergent opinions on 1) how significant the problem is in the first place, and 2) whether and how the problem should be addressed. These views changed very little as participants engaged through the sequence of the survey, workshop and interviews. Mediating such differing views on nature and the role of humans in nature is critical in addressing the problem.

Key recommendations that emerged from the workshop and were confirmed strongly in the interviews are:

- revitalized public institutions, including renewed support for science, inventory and monitoring,
- government and professional oversight of resource development,
- review of strategic land use objectives, and

- reinstitution of landscape-scale planning mechanisms.

However, no clear common view emerged on alternative new ways of going forward. Discussions in both workshop breakout groups and individual interviews suggest that, participants continue to be focussed on thinking within the current land use and resource management paradigm with its inherent conflicts and on-going debates on how to resolve issues. It seems important to remember that this community group, like many others in British Columba, have already been involved in arduous efforts to arrive at their current land use designations and resource management and conservation policies. This study reinforces how challenging it will be to revisit these policies and practices through a climate change lens. New approaches must be rooted in a need for broader understanding at the community level, better science, conflict resolution, reinstitutionalized planning, and new adaptive approaches to implementing program delivery. The solution to this issue will be to develop institutional processes which will effectively mediate these conflicting values and interests in the land base.

On reflection, a number of methodological choices impacted this study. While the survey, workshop and interview process produced rich qualitative data and stimulated discussion and reflection, this approach inevitably limited the size of the sample thereby restricting the range of stakeholder perspectives. Future research could broaden the range of participant input through community-based surveys, recruiting participants through local advertisements or extensive mail-outs, or perhaps by engaging more individuals in several focus group or forum sessions conducted across the community. Other opportunities for consideration would include use of social media and websites to communicate the issues, or development of information that could be used in local school programs; Wildsight's 'Education in the Wild' program[128] would serve as a useful model. While the workshop approach used in this study allowed relatively intensive dialogue among a number of resource professionals and engaged

[128] Wildsight website. Retrieved from http://www.wildsight.ca/education

stakeholders, more extensive and community-focussed engagement on the issues will need to involve a broader audience.

Chapter Six – Engaging Stakeholders in Conservation Strategies that Respond to Climate Change: Challenges, Opportunities and Further Enquiry

6.1 INTRODUCTION

In this dissertation I investigate a number of interconnected themes relating to contemporary contexts for wildlife conservation in the Kootenay Region of British Columbia, projections of climate change impacts, and resulting stakeholder values and perspectives, to consider the central research question:

> Given the pressing need for new, more resilient approaches to wildlife conservation, how does stakeholder engagement in an assessment of climate change impacts on wildlife ecosystems influence support for appropriate wildlife habitat and species intervention policies?

In order to understand and examine this central question, a number of preparatory steps had to be undertaken to establish context and yield background information, including a critical review of historical conservation strategies in British Columbia and related matters (Chapter Two), an assessment of wildlife conservation in the study area (Chapter Three), and an assessment of projected consequences of climate change for wildlife ecosystem conservation in the study area (Chapter Four). These steps set the stage for an evaluation of community stakeholders' motivations to effect conservation measures in a changing environment (Chapter Five). As well, these steps provided a valuable basis for considering policy implications of management actions directed at sustaining ecosystem resilience and integrity. Chapter Five employed a sequence of survey, website information, workshop and in-depth interviews to engage a small group of regional stakeholder participants in an assessment of climate change impacts on wildlife ecosystems in the study area.

The study concludes that while participants express deep concern about impending environmental change and agree that there is need for vision and commitment to protect these values, their engagement in an assessment of the vulnerability of wildlife ecosystems to climate change can only be seen to be marginally effective in shifting their support for appropriate wildlife habitat and species intervention policies that might mitigate impacts. Even as this study reinforces the critical importance of vision in this time of worrying change, findings about stakeholder engagement highlight the difficulties inherent in translating passionate commitment into meaningful consensus around conservation management practice. At the heart of these difficulties are complex and divergent public values that must be reconciled in addressing an uncertain future. A number of identified policy failures and the absence of institutional mechanisms to address issues constitute significant governance barriers which must be resolved to support wildlife ecosystem resilience in the future. This study highlights the challenges that society faces in the study area – and well beyond – as people seek to thoughtfully balance their diverse needs and interests relating to wildlife conservation in the face of daunting and uncertain change.

This final chapter summarizes key findings from this research and relates them to challenges and opportunities for supporting wildlife ecosystem resilience. It also notes a number of study limitations and suggests areas for further research.

6.2 CONTRIBUTIONS TO THEORY

As described in Chapter One, in this dissertation I draw on wild design (Higgs & Hobbs, 2010) as a construct with which to address my key research question and associated lines of enquiry. Wild design reflected my initial research conjectures by balancing ecosystem integrity, change dynamics, historical and cultural fidelity, and focal engagement to achieve resilient outcomes in ecological and social processes. The wild design model was originally crafted to address contemporary debates in ecological restoration focussing on tensions related to setting restoration goals, ethics of human intervention in natural ecosystems, and applicability of fidelity to historical conditions given understanding of environmental change and evidence of emerging novel ecosystems (Higgs, 2003; Light, Thompson, & Higgs, 2013). Wild design emphasizes the importance of addressing tensions between processes of wild nature and human design, and has been of particular interest as a model for integrating concepts about stakeholder motivation for policy change in this study. Associated theoretical constructs that have also been useful in this study include policy sciences, scenario planning, environmental motivation theory, and socio-ecological resilience theory since these offer important insights in the conceptualization and application of wild design. Even as these constructs have offered useful explanatory tools in organizing and analyzing this research, this study, in turn, offers insights on their relevance and utility.

In reflecting on the contributions of this research to theory, it is notable that this study has scaled-up the wild design model by deploying some of its core principles to explore a broader and less certain future context for conservation design practice than is anticipated in the current model. For example, since wild design theory is anchored by restoration science and practice, the relevance of wild design principles to scenarios of rapidly changing environmental conditions over the next century have been largely untested. Indeed the vigorous contemporary debate in ecological restoration about the acceptance of novel ecosystems (Hobbs, Higgs, & Hall, 2013) may eventually be moot, given projections of large ecosystem change over the next century shown in this study. Specifically, the research contributes to understanding of the relevance of wild design and related concepts – and practices – through an innovative combination of policy assessment to trace the origins of contemporary approaches to conservation, scenario development to project future possibilities and highlight uncertainty, and community stakeholder consultation to explore associated challenges and opportunities.

The results from this research corroborate wild design’s call for clarity through the establishment of clear goals, while ensuring that active adaptive management processes are in place to accommodate a degree of change. However, while wild design emphasizes the need to understand historical ecosystem trajectories, this research underlines the need to also integrate new understandings of the extent, risks and uncertainty of potentially significant change within the framework. Adaptation emerges as a cornerstone of resilience in social and ecological systems in the study area. New and innovative approaches will require careful deliberation and humility – both essential tenets of wild design. However, in light of the scale of change linked with climate change, bold new thinking that challenges embedded paradigms and instills a willingness to take considered risks in an uncertain world are also required.

While community engagement in decision-making plays a central role in wild design and is explored, in part, with reference to motivation theory, this study reveals the complex challenges inherent in implementing this component. The study results uphold the necessity of focal engagement, as it was evident that such engagement is critical building public knowledge, motivating support for action, bringing local perspectives to the identification of barriers and opportunities, mediating conflicting concerns, and finding common solutions. The complexity of values to be reconciled, and the difficulties of building understanding as a basis for informed engagement are evident in the combined outcomes of the survey, workshop and interviews. Stakeholders expressed strongly-held views on conservation. Measures such as protected area implementation and management, habitat connectivity, management interventions to mimic ecosystem disturbance, and wildlife species culls and translocation were intensely conflicted as a result. While the emphasis in wild design on focal engagement is reinforced, this study highlights the logistical difficulties that are likely to be encountered in negotiating conflicts over value-based interests and addressing the institutional barriers and policy failures that are critical to building community support for policy change. Addressing these inherent tensions and developing the political will to overcome the barriers requires renewed focus on the techniques and implementation of consultative and learning strategies needed to support change.

This study reveals potential barriers to wildlife ecosystem resilience, including an outdated static ecological paradigm that underlies BC's conservation policy framework, along with governance failures such as regressive approaches to community engagement and ineffective program implementation. The core principles advocated in the wild design framework are clearly of value in a future scenario context as they offer a helpful and integrative framework for addressing challenges to effective wildlife ecosystem conservation, particularly if they encourage adaptive approaches to deal with uncertainty and emphasize meaningful consultation. By striving to find a balance between nature and human intervention, and between historical fidelity and resilient future ecosystems, wild design positions a wide range of stakeholders to work collectively to address complex challenges. The following sections reflect on the relevance of the findings to these theories.

6.3 KEY FINDINGS

6.3.1 Effect of Values in Influencing Support for Conservation

A key area of findings relates to how participants' backgrounds and values are interrelated with their support for various approaches to wildlife conservation. As noted, this project sought to determine whether participation in a collaborative design workshop would build understanding of the climate change impacts on wildlife conservation and influence participants' support for conservation measures. Although there is growing acceptance that climate change is occurring and has the potential to significantly affect ecosystems, there was little consensus among participants on what, if anything, can or should be done to mitigate potential future impacts for wildlife. Study results indicate that participation in this assessment of climate impacts improved most participants' understanding of the issue. However it was evident that support for conservation is correlated in complex ways according to participants' values about both wildlife and the environment, as well as to their broader socioeconomic concerns relating to livelihood, employment, and security. Beliefs about climate change impacts for wildlife as well as support for conservation measures were found to be interrelated with attitudes on the environment that are rooted in values, political orientation and occupation. The data gathered in the workshop and in follow-up interviews generally did not indicate significant change in levels of support for a common vision of appropriate wildlife habitat and species intervention policies, nor did it offer clear solutions on how best to address managing wildlife ecosystems for resilience to climate change impacts.

While most participants expressed concern about the perceived significance of predicted change, their diverse perspectives on the appropriateness, utility, implications, and accountabilities relating to various interventions illustrate the tensions that are likely to constrain consensus across the region for the implementation of management strategies. These results suggest complex implications for establishing community support for species recovery and habitat conservation priorities; evaluating the benefits and risks of predator control, prey management and population augmentation through translocation or captive breeding; or managing wildlife harvest programs.

6.3.2 Governance Failures as a Key Barrier to Action

A pervasive concern that emerged is that participants believe that the provincial and federal governments have abdicated a leadership role in addressing climate change impacts on wildlife, despite their mandated responsibility to preserve large mammal wildlife diversity. As noted in Chapters Two and Three, governments have put innovative conservation measures in place over the past forty years, many grounded on extensive consultation with local stakeholders. However, government interest in and support for conservation activities has been significantly curtailed in the past two decades in the face of economic downturns and political priorities on socio-economic concerns. Governance failures elucidated in this study include inadequacy of mechanisms for public education and consultation, cessation of processes to foster multi-stakeholder collaboration necessary to build consensus and resolve conflict, and ineffective implementation of the results-based resource management policy framework. In particular, participants cited the loss of land use planning at both strategic regional and tactical landscape scales; failures in government oversight, industry performance and professional reliance resulting in ineffective Forest Stewardship Plans; and a lack of essential research, monitoring, effectiveness evaluation and enforcement capacities as major obstacles to addressing wildlife conservation.

As emphasized in the literature (Austin, Buffett, Nicolson, Scudder, & Stevens, 2008; Lovejoy & Hannah, 2005; Gunderson & Holling, 2002; Hagerman, Dowlatabadi, Satterfield, & McDaniels, 2010; Pojar, 2010) and reinforced through participants' comments, a number of issues inhibit approaches to conservation management that address climate change impacts. While innovative conservation measures resulted in land use policies that provided extensive and important wildlife habitat and connectivity at both the landscape and regional scale, conservation designation categories are not evenly distributed across all ecosystem types. As the conservation value of such designations has not been evaluated, especially those which are implemented through compliance of Forest Stewardship Plans with objectives mandated in the Kootenay Boundary Higher Level Plan Order, the basis for adaptive and resilient management approaches is lacking. On their own protected areas are considered to be too small to conserve wide-ranging wildlife populations (Noss, et al., 2012; Franklin & Lindenmayer, 2009; Soule & Terborgh, 1999). Integrated conservation strategies across regional landscapes are needed to maintain resilient metapopulation dynamics and for functional ecosystem predator-prey dynamics (Franklin & Lindenmayer, 2009). The analysis in Chapter Three shows that the conservation designations contribute by providing important habitat for a wide of species. They constitute substantial investments through land use negotiations and subsequent decision-making processes, as well as lost resource development opportunity costs. These designations vary considerably in their ecosystem contribution and condition resulting from past human disturbance. The pressing need for a comprehensive review of the efficacy of wildlife habitat conservation and connectivity at the landscape and regional scales was broadly corroborated by study participants.

Participants' reflections on the risks of perceived government abdication of leadership and responsibility suggest that diverse stakeholders will fill the void, not so much to support genuine progress to conserve wildlife under conditions of climate change, but to optimize their own values, beliefs and interests. The absence of firm leadership from a democratically elected government, runs the risk that the most politically powerful and best resourced perspectives are most likely to be acted upon. The importance of revitalized institutional mechanisms to ensure public and stakeholder consultation, balanced decision-making, effective evaluation of policy implementation, and enforcement of expectations was reinforced through this study.

6.3.3 Awareness of Climate Change Impacts on Wildlife

Most participants indicated that their exposure to the climate scenarios and their engagement in discussions around wildlife management concerns during their involvement in this study had a degree of influence on their beliefs about climate change and its potential to impact wildlife ecosystems. The study revealed a broad awareness of climate change within the group, and a degree of awareness of potential impacts of climate change impacts on ecosystems among the few who were familiar with the West Kootenay Climate Vulnerability and Resilience Project[129] that had been undertaken locally the previous year. However most respondents indicated a lack of specific awareness of the potential implications for wildlife in the region, indicating the value of building broader awareness with resource managers, stakeholders and the public.

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[129] West Kootenay Climate Vulnerability and Resilience Project website. Retrieved from http://www.kootenayresilience.org.

The workshop discussed in Chapter Five represents one way of educating stakeholders about the impacts of climate change on wildlife habitat and the importance of anticipating climate impacts when developing wildlife conservation strategies. While it offered useful insights on participants' perspectives and concerns and was somewhat effective in building participants' understanding of the urgency and scope of climate change implications, it was time-consuming and expensive to put on, managed to reach only a select few key stakeholders, and had limited capacity to strongly shape individual or collective motivation. Given the importance of raising public awareness and building broad capacity for informed action around the inevitable changes that are projected to take place, it is important that other public education strategies be explored and implemented, possibly capitalizing on social media and other emerging digital communication modes. Utilizing a climate change lens to evaluate the benefits and consequences of varied management approaches may offer a means of reconciling divergent views. Among the challenges are how to design educational strategies so that they are perceived as credible, and not biased toward the interests of competing stakeholder groups. Scientifically neutral analysis and mapping of climate change impact scenarios using today's best knowledge and data certainly offer one possible tool that enables people to imagine future change. However it is important that people understand that modelled change scenarios are not predictions; rather they allow the development of a range of management approaches that can be evaluated for plausible futures.

Whatever the strategy, benefits of education to generate meaningful community support for the conservation planning and design needed to address long-term resiliency for wildlife ecosystems requires broad and sustained efforts at building awareness and collaborative mechanisms.

But education by itself is not enough since there clearly exist conflicting goals and the need for expertise, leadership and accountability within a democratic model of governance that supports indirect and direct public engagement in policy development and implementation. In an ideal world, broad and sustained efforts that include conflict resolution strategies are required to resolve the contentious value-based land use conflicts that constitute a particular barrier to action. Such initiatives require the coordinated effort of civil society broadly, and government, industry, and environmental stakeholders.

These actions can be informed by further research that builds understanding of ways in which contentious value-laden land use conflicts have been reconciled and resolved in other jurisdictions. And further research to determine the practical issues that must be reconciled in the Kootenay Region would be of value. While this qualitative study brought together a range of key stakeholders as a starting point, other methods can be used to engage all sectors with a stake in wildlife conservation, including First Nations, people employed in the resource sector, perhaps more strident environmental and industrial interests, elected government officials, and others.

6.3.4 Opportunities for Action

While many challenges were explored within the workshop and interviews, a number of opportunities for action to address wildlife management issues also emerged.

The abdication of government responsibility for example, is creating opportunities for more local engagement, although the lines of accountability are complex and not fully integrated. With declining governmental involvement and oversight, a number of locally-based and provincial agencies were cited as potentially having the capacity to provide leadership in addressing wildlife ecosystem climate resilience. Such locally-based agencies include the Columbia Basin Trust and the BC Hydro Fish and Wildlife Compensation Program, and provincially includes the provincial Habitat Conservation Trust Foundation, and the federal Habitat Stewardship Program, and the Pacific Institute for Climate Solutions.

Resource professionals can also be called on to play more meaningful roles in conservation management. Results from the study suggest that resource professionals and their licensing bodies are not seen to be upholding the intent of the results-based professional reliance model. While it should be noted that the Association of BC Forest Professionals has established a Climate Change Task Force (2012)[130] which provides extension services on emerging issues on forestry and climate change, and has implemented ongoing audits of members' professional practices[131], there is an expectation that the professional sector could and should do more. Given that resource professionals are a key element in implementing resource development and conservation measures, it follows that they must play an integral role in effecting climate change policies, planning and implementation.

Under the deregulated, 'results-based' resource management policy framework, industry emerges as a major actor in land and resource management. A number of mechanisms exist for industry to maintain its social license in this regard, including partnerships with environmental groups such as Teck Industries and Canadian Forest Products have done with the Nature Conservancy of Canada. Participation in third-party certification is yet another mechanism.

Environmental non-government organizations such as Wildsight, Yellowstone-to-Yukon Conservation Initiative, West Kootenay EcoSociety and Valhalla Wilderness Society are also assuming important roles, including activities that promote environmental advocacy, facilitate community dialogue and education, and hold government and industry accountable. For example, in addition to various advocacy and

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[130] Association of British Columbia Forest Professionals website. Retrieved from http://www.abcfp.ca/practice_development/climate_change/Climate_Change.asp

[131] Ibid. Retrieved from http://www.abcfp.ca/practice_development/continuing_competency/peer_review.asp

educational initiatives, Wildsight has undertaken to fill the void that emerged as government abandoned its resource planning mandate, and has initiated a number of processes to proactively engage government, industry, and various stakeholders in conservation planning and access management. This ENGO also works directly with forest companies to negotiate High Value Conservation Forest areas as part of those companies' interest in FSC forest certification.

Wildsight in particular is committed to facilitating community dialogue on conservation issues, aimed at dragging reluctant industry and government representatives to the table. Its position is that ENGOs are able to exercise important influence by working directly with industry rather than through government's policy and decision-making mechanisms because industry is essentially in the driver’s seat both politically and through the results-based regulatory framework. However, despite these laudable efforts, Wildsight is not perceived as neutral by either government agencies or industry stakeholders. As Wildsight is involved with political advocacy on a number of environmental issues and campaigns, this is seen to limit its credibility in building balanced community partnerships. There is concern that industry and the community have not have been sufficiently involved in Wildsight conservation consultations; this is linked with a concern that many ENGOs can be too strident in their conservation agendas and are not interested in reasonable compromise. Despite their commitment to conservation, ENGOs are not seen as being neutral or broadly accountable for their actions and there is concern about the community conservation dialogue being coordinated by Wildsight. Nevertheless, most participants in this study recognize that ENGOs play important advocacy and public awareness roles, and contribute by holding government and industry accountable by advocating for environmental perspectives.

Land owners also have emergent roles to play in conservation management. Private land occupies a significant area of low elevation habitat which has been disturbed though settlement and development, creating barriers to wildlife ecosystem connectivity. Land trusts, government, and in some cases industry and private citizens have made important contributions to the conservation of low elevation habitat. Evaluating and priorizing such investments in land acquisitions, conservation covenants, private land stewardship, and ecosystem restoration will be an important component of a broader strategic approach to addressing wildlife ecosystem resilience and climate change. Selling carbon credits provides one potential opportunity for helping finance such investments.

The ongoing tension between preservation and resource extraction will, nevertheless, continue to shape commitments to conservation. Industry maintains that conservation constraints on the land base prevent economic harvest of licensed timber supply, and it is especially concerned about recent proposals by conservationists to protect 50% of the land base, including 25% in protected reserves. Reinstituting processes to negotiate this growing conflict is clearly an area of provincial government responsibility.

6.3.5 Implications of Climate Change Impacts on Wildlife Habitat and Species

This study provides insight on the scope and urgency of potential impacts that climate change is predicted to have for a range of key species in the study area. The modelling results presented in Chapter Four indicate significant loss of habitat for mountain caribou, wolverine, and lynx. This data is valuable in bringing information to bear on wildlife management concerns and strategies.

For example, modelling of climate change impacts on caribou habitat suitability indicates the potential for significant loss of high suitable habitat in the southern extent of caribou range in the region, particularly in the southern Purcell Mountains and at mid-elevations across the region. The information provided from the model has a number of implications for the management of caribou recovery. As one example, it offers insight to the selection of high suitability habitat for translocations. Had such information been available in 2012 when 19 caribou were unsuccessfully moved to the southern Purcell area, the choice might have been to focus on the South Selkirk area that offers the last vestige of high suitability habitat linkage with the United States. A successful transplant project grounded on better data might, in turn, have positively affected stakeholder support for caribou recovery. The Mountain Caribou Recovery Implementation Plan should ground its recovery objectives and priorities in greater understanding of climate change impacts, metapopulation linkages, predator/prey management, and recreational access.

Another example relates to hunting and trapping of wolverines and lynx that is currently permitted across the Kootenay Region under the *Wildlife Act* 'Hunting and Trapping Regulations.'[132] Predicted habitat changes suggest that hunting and trapping activities will be inappropriate and highlight the importance of reviewing wildlife harvesting policies for all species in consideration of climate change impacts on wildlife population viability. While climate change may not directly affect habitat generalists such as grizzly bears or wolves, it is likely to influence foraging resource opportunities. This has the potential for negative consequences where this results in increased interactions with human settlements, backcountry recreationists, agricultural operations, transportation corridors, and poaching (Proctor et al., 2012; Servheen & Cross, 2010; Carroll, Noss, & Paquet, 2001). Although this analysis is necessarily a considerable simplification of species dynamics and habitat use, it does suggest differences in species habitat response to predictions of climate changes. Wildlife ecosystem conservation analysis and management needs to consider implications of wildlife-habitat interactions, including habitat condition, connectivity, trophic interactions, and human conflicts.

Given the complexity of climate change implications for wildlife habitat, another perceived weakness of the current management paradigm is that it focuses on species

[132] 2014-2016 Hunting and Trapping Regulations Synopsis. Retrieved from http://www.env.gov.bc.ca/fw/wildlife/hunting/regulations/

rather than ecosystems (ie. species-at-risk, mountain caribou recovery strategy, grizzly bear conservation strategy). The value of a species approach is that it provokes strong ethical, iconic and ecological arguments for conservation. However, given that scenarios of climate change indicate that distributions of species ranges will shift with climate change, biodiversity will not best be conserved through single species protections. Instead, conservation will depend on a multi-species ecosystems-based approach founded on the principles of maintaining ecological integrity and resilience. Landscape scale wildlife conservation plans that integrate protected areas, critical habitat areas, connectivity zones, and ecosystem-based management approaches on the integrated resource management matrix offer an integrative and holistic approach.

6.4 LIMITATIONS AND AREAS FOR FUTURE RESEARCH

This study necessarily offered a broad and interconnected analysis of public policy, climate change projections and stakeholder perspectives to arrive at its key findings. While this breadth is a critical element in framing and responding to the questions and in linking a range of complementary topics, it might also be seen as a limitation. The broad scale of the conservation analysis, a number of short-comings in the analysis of future climate change scenarios, and the small and inevitably biased sample of community stakeholder interests position this study as an integrative overview, and suggest opportunities for more focussed further study in a range of areas that were beyond the scope of this research.

For example, a detailed conservation analysis needs to be a component of landscape design through a renewed planning process at that scale. This would involve a detailed assessment of how conservation is implemented through a variety of types of designations, and how integrated management is delivered on the ground through requirements dictated under individual forest licensee's operational plans. As well a more detailed habitat and connectivity analysis across a broader array of species than analyzed here would be of value. This project was limited to analyzing information from data sources which were available from the Nature Conservancy of Canada, the

Mountain Caribou Science Team, or available from the provincial government through DataBC.

The broad nature of the overall study also limited capacity to utilize varied approaches to analyzing future climate change scenarios. A single climate scenario offered insight on potential impacts of climate change on ecosystems over the balance of this century (ie. A1B emission scenario using the CGM3 model).[133] Utzig (2011 & 2012) modelled ecosystem impacts using three climate model scenarios in the West Kootenay region showing wide range of potential impacts that emphasizes the uncertainty in such forecasts. This study applied the CGM3-A1B model as a 'middle of the road' and perhaps more likely scenario intended to demonstrate the significance of potential impacts. This scenario was judged to be more plausible, based on its consistency with recent temperature, precipitation, and greenhouse gas emission trends. Bioclimate modelling provides a simplistic perspective on potential impacts on ecosystems and species habitat and must be interpreted with caution. Future research could use multiple scenarios to compare and contrast likely futures.

The breadth of the overall study, as well as the in-depth methodology used to sample participants' perspectives focussed this study on a small group. While the small sample of community stakeholder interests provided valuable insight into the values, concerns and motivational challenges that impact management approaches to mitigating the impacts of climate change, a larger and more inclusive sample might offer more nuanced and reliable data to future researchers. Further analysis of broader public perspectives, especially those with a primary anthropocentric viewpoint, broader representation of socio-economic perspectives (eg. industry, resource sector workers), and First Nations might support more generalizable conclusions. Nevertheless the data

[133] Climate change impacts on Biogeoclimatic Ecosystem Classification, and Mountain caribou and wolverine habitat suitability were also modelled using the CGM3-B1 emission scenario, but were not included in the analysis presented in Chapter 4.

collected from the study sample did stratify a number of values and perspectives on conservation and identified both barriers to and opportunities for conservation action. The sampling methodology relied on personal knowledge and local recommendations to find participants who would agree to volunteer to participate through a survey, workshop and follow-up interviews. Efforts were made to ensure a balance of stakeholder values and gender representation. As a result, while the findings cannot be generalized beyond the sample population, they serve as an important initial step in focussing attention on understanding the issue, and the barriers and potential opportunities to address the problem. And it can be said that decisions are most influenced by those that show up – so understanding the perspectives of those interested enough to participate in itself is useful. On reflection it would have been useful to have administered the initial survey to a broader sample of the community. The survey was particularly useful in differentiating people's perspectives on climate change adaptation and wildlife conservation.

It should also be noted that this study does not reflect the views of First Nations who have important and evolving rights and title to land and resources in British Columbia. The significance of this limitation is highlighted by the recent Supreme Court of Canada decision *Tsilhqot'in Nation v. British Columbia*[134] that mandates that the design and implementation of resilient wildlife conservation policies will require consultation and accommodation of First Nations interests through shared planning and decision-making. In retrospect, including First Nations perspectives in the study design would have been a substantial undertaking in itself. This is clearly a critical perspective that requires further research.

While the intent of this study was to better understand how values, beliefs, and participation in the study influenced participants' perspectives on and support for

[134] Tsilhqot'in Nation *v.* British Columbia, 2014 SCC 44, [2014] 2 S.C.R. 256. Downloaded from https://scc-csc.lexum.com/scc-csc/scc-csc/en/item/14246/index.do

conservation actions further research to assess how a broader community discourse could potentially influence political and institutional decision-making would be of value.

Finally, the breadth of this project inevitably reflects the range of diverse professional experiences and interests that serve as background to my research. The depth of experience that I bring to this topic inevitably influences both my interpretations and findings. I sought to integrate and learn from my instrumental involvement in the development and implementation of the policies being evaluated, my professional experience in wildlife conservation, my involvement with community engagement in public policy development, my concerns about the efficacy of current policies and their implementation, and my direct observations of the effects of government's budgetary restraint measures. My intent was to faithfully document perspectives of all those who volunteered to participate in the study; nonetheless conclusions from the research do draw considerably from my personal perspectives. This complex mix of perspectives, combined with a review of relevant theory, climate scenario modelling, and qualitative research, leads to a study that is inherently broad and inclusive.

The dissertation has identified a number of possibilities for future research, including strategies to educate and inform the public, alternative methods of stakeholder engagement practices in other areas of planning, and a comparative analysis of wildlife conservation strategies under climate change uncertainty and associated risks undertaken elsewhere in the world. It would be instructive to conduct additional comparative research to explore whether different levels of government in other parts of the world have embraced leadership to advance wildlife conservation under climate change, and to seek insight from their approaches that may have relevance and meaning to British Columbia and the Kootenays.

6.5 CONTRIBUTION AND CONCLUSIONS

This dissertation advocates for a renewal of conservation design practice in British Columbia to ensure the resilience of wildlife ecosystems in the Rocky Mountains Ecosystem and well beyond. Climate change impacts are shown to be significant, complex and uncertain. Wildlife conservation policies were not designed to respond to the implications of climate change. And although there is growing awareness of such impacts on natural ecosystems at scientific and management levels, there is a critical lack of public and political awareness and motivation that inhibits timely responses. Existing approaches, including management paradigms, policies, and legal mechanisms rooted in static paradigms are unsuitable for managing dynamic change and novel outcomes. There are significant resource values and ecosystem services at risk, and solutions to resolve such issues are likely to intensify conflicts between competing land and resource management objectives.

There is a consistent call in the literature (Ansell & Gash, 2007; Clark, 2002; Hajer & Wagenaar, 2003; Gregory & Keeney, 2006; Gunton & Day, 2003; Harshaw, 2010; Healey, 1998; Margerum, 1999; Powell & Vagias, 2010) and in the study for more consistent and meaningful community engagement in conservation management. The long tradition of community involvement in the Kootenays began in response to conflict in the 1970s and 1980s over resource development and 'wilderness' protection. This land use planning process was an experiment in the emerging ideas about engagement and collaborative decision-making, and sought to find community consensus that balanced environmental and economic interests. This process did result in a considerable degree of conservation progress. However, where consensus on issues was not achieved, powerful industry and local political interests concerned about socio-economic impacts sought to limit land use plan outcomes. Conservation planning to address climate change and wildlife ecosystem resilience needs to confront the value-based interests that are inherent in such initiatives. Failure to do so will inevitably result in political conflict and inaction. New levels of public understanding are necessary to effect a political will to address this. The significance of the problem for wildlife is not well known or understood by an increasingly urbanized population, and a strong concern tends to be for socio-economic priorities rather than environment issues.

While the Kootenay Boundary region has been the site of innovative public consultation work through the CORE tables, and through the remarkable advocacy of individuals and community groups to protect its natural systems, the importance of community engagement remains a critical challenge. The study found that many stakeholders believe the public is disengaged with natural ecosystems, wildlife or the implications of climate change. Their comments illustrate that overcoming barriers to initiate political will and action will require clearer community understanding of the values at stake and risks relating to climate change. Involving the community will require concerted and coordinated efforts at public education among other things. Future research is required to understand how best to achieve such education, and by whom.

In summary, this study sheds light on the uncertainty of current conservation frameworks to respond to projected significant climate change impacts on key wildlife in the Kootenay study region. It goes on to reflect that stakeholder engagement in a vulnerability assessment of climate change impacts on wildlife ecosystems has only limited impact on consistent support for appropriate wildlife habitat and species intervention policies. Nevertheless, from the exploration of conservation policy and from stakeholder consultations, a range of management initiatives that can respond to complex change are identified, with particular emphasis on more integrative eco-systems approaches that are grounded on clear science and that balance community interests are suggested. At the same time, the many factors that will make this challenging are highlighted.

As noted in Chapter One, the linked concepts of resilience and wild design were influential in framing both the research question and the study methods. The former concept emphasizes the need to understand natural systems as evolutionary and adaptive (Holling, Gunderson, and Ludwig, 2002) while the latter stresses that the interconnected insights of historic fidelity, natural system processes, and community engagement and participation are critical in determining appropriate conservation interventions. These concepts are reflected in the fundamental premise of this study that wildlife conservation is inevitably a design process that balances evolving, conflicting and uncertain human and natural dynamics.

Wild design, with its objective of socio-ecological resilience, has also served as an important point of reference in weighing the effectiveness of current conservation policies and in assessing the dynamics of the workshop. Throughout the account of recent history of conservation policy development in British Columbia and the Kootenays (Chapters Two and Three), the opportunity for community engagement is repeatedly demonstrated as a means of responding to demands for accountability and conflict resolution. However, outcomes of community engagement have varied considerably and the political processes including changes in government have often over-ridden efforts at achieving consensus through broad and public consultation. These consultations also did not anticipate dynamic change associated with climate change, weighing the implications of uncertainty and embracing adaptation. Past and current approaches to community engagement have not achieved the resilience needed in this age of uncertain change.

Not surprisingly, participants in the study also emphasize the importance of community engagement to build common understanding and objectives, resolve conflicts and incorporate local knowledge, and secure ‘buy-in’ since these tools have become commonplace in public processes. On one hand this study reinforces Higg’s contention that engaging community in processes that stimulate understanding and enable socially sustainable decision-making is critical (Higgs & Hobbs, 2010; Higgs, 2003), thereby elaborating on this guiding theory. Even as it does this however, it points out the myriad of worrying difficulties inherent in bringing such processes to a degree of consensus that allows for the selection of appropriate interventions.

This study reinforces the need for adaptive wildlife conservation policies that address future climate change scenarios and associated risk and uncertainty, by implementing diverse strategies, monitoring results, and effecting adaptive changes accordingly. It also highlights the institutional, legal and psychological barriers that complicate the selection and implementation of climate change adaptation strategies. New understandings of climate change must address complex ecological and social questions relating to the potential impacts on ecosystem structure and function, native species ranges, and trophic interactions between species; implications on disturbance regimes including wildfire, insect infestations, and forest pathogens; and setting management goals and objectives given lack of information and future uncertainty. Reformed institutional structures and systems are needed to build consensus amongst conflicting perspectives and for implementing decisions.

A planning mechanism that incorporates an adaptive approach to change dynamics, improves the scientific understanding of climate change and its implications of wildlife ecosystems, and engages the community to build understanding and motivate political will is called for. Wild design with its focus on functional 'healthy' ecosystems for the future, engaging communities in learning about climate change impacts and collaborating on approaches to sustainable and adaptive land use, offers a possible approach. Its strength is that this framework is forward thinking and requires attention to problems associated with human interventions in natural ecosystems. Applying the wild design framework and principles explicitly accommodates tensions between maintaining natural wild ecosystems and implications of human intervention by seeking to resolve competing stakeholder interests, objectives and priorities.

This study demonstrates a pressing need for integrative and deliberative processes that grapple with scientific information, credibility and uncertainty, and encourage diverse strategies that promote diversity, adaptive management, and social learning. Ultimately the answer to addressing this problem lies in the value community, and by extension government, places on wildlife. Overcoming the barriers to initiate political will and action requires a clearer understanding of wildlife values and a strong appreciation of what is at risk.

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APPENDIX 1 – UNIVERSITY OF VICTORIA ETHICS APPROVAL

Human Research Ethics Board
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University of Victoria

Certificate of Approval

PRINCIPAL INVESTIGATOR:	**Roderick Davis**	**ETHICS PROTOCOL NUMBER:**	**11-368**
UVic STATUS:	**Ph.D. Student**	ORIGINAL APPROVAL DATE:	07-Sep-11
UVic DEPARTMENT:	**ENVI**	APPROVED ON:	07-Sep-11
SUPERVISOR:	**Dr. Eric Higgs; Dr. Peter Keller**	APPROVAL EXPIRY DATE:	06-Sep-12

PROJECT TITLE: **Resilient Ecological Intervention Strategies to Adapt to Climate Change: Evaluating a Wild Design Approach to Wildlife Habitat Conservation and Restoration**

RESEARCH TEAM MEMBERS: **None**

DECLARED PROJECT FUNDING: **Doctoral Fellowship, Pacific Institute for Climate Solutions (2009-2012); Doctoral Fellowship, SSHRC (2009-2011); Interdisciplinary Graduate Fellowship, UVic (2007-2009)**

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.

Dr. Rachael Scarth
Associate Vice-President, Research

Certificate Issued On: 07-Sep-11

11-368 Davis, Roderick

APPENDIX 2 – DATA SOURCES

Data	Description	Source	Accessed
Baseline Thematic Mapping V.1	Digital thematic map depicting land use as determined by a combination of analytic techniques, mostly using Landsat 5 image mosaics at a scale of 1:250,000 (specifications described at: http://archive.ilmb.gov.bc.ca/cis/initiatives/ias/btm/)	DataBC	Sept. 2010
Biogeoclimatic Ecosystem Classification V.8	Digital Biogeoclimatic Ecosystem Classification (BEC) Zone/Subzone/Variant/Phase map (version 8, February, 2012)	DataBC	Aug. 2013
Ecoregion Ecosystem Classification of BC V.2.1	Digital mapping of ecoregions and ecosections (described in Demarchi, 2011)	DataBC	Feb. 2014
Landscape Units and Biodiversity Emphasis Options	Landscape Units are spatially identified areas of land and/or water used for long-term planning of resource management activities. Forest seral stage targets are defined for high, intermediate and low biodiversity emphasis areas for each landscape unit through Landscape Unit Planning, the Provincial Non-spatial Old Growth Order, or in the case of the Kootenay-Boundary region by the KBLUP HLPO.	DataBC	Jan. 2014
Crown Land Tenures	Spatial locations and attributes of current *Land Act* leases, licenses and reserves and applications for such tenures	DataBC	Dec. 2013
National Parks	Spatial data delineating federal national parks	DataBC	Nov. 2010
Provincial Parks and Protected Areas	Spatial data delineating provincial parks, ecological reserves and designated protected areas	DataBC	Nov. 2010
Conservation Properties	Privately-owned conservation properties in the East Kootenay, West Kootenay and North Columbia. The data includes land owned primarily by the Province of British Columbia, BC Hydro, Canadian Wildlife Service, Nature Conservancy of Canada, Nature Trust, Teck Resources, and The Land Conservancy.	DataBC	Nov. 2010
Wildlife Management Areas	Crown land designated as Wildlife Management Areas under the *Wildlife Act* administered for their significance of wildlife and fisheries values	DataBC	Dec. 2013
Wildlife Habitat Areas	Areas designated under the *Forest and Range Practices Act* or the *Oil and Gas Activities Act* as	DataBC	Dec. 2013

	habitat required by a species at risk or designated as regionally important wildlife		
Ungulate Winter Range	Areas designated under the *Forest and Range Practices Act* or the *Oil and Gas Activities Act* as habitat that is necessary to meet the winter habitat requirements for designated specified ungulate species	DataBC	Jan. 2014
Old Growth Management Areas	Spatially defined areas of old growth forest that were identified during landscape unit planning or operational planning processes [in the Kootenay-Boundary region, these OGMAs were not legally implemented, and are considered guidelines to meet the old and mature seral requirements mandated in the KBLUP HLPO]	DataBC	Nov. 2010
Forest Licensee Operating Areas and Tree Farm Licenses	Administrative boundaries for Forest Licenses and Tree Farm Licenses administered under the *Forest Act*	DataBC	Oct. 2010
Forest Tenure Cutblock Polygons (FTA 4.0)	Cutblock boundaries for tenures issued under the *Forest Act*	DataBC	Jun. 2014
Indian Reserves	Federal lands designated as a reserve under the *Indian Act*	DataBC	Oct. 2010
Grizzly Bear Population Units	Boundaries identifying similar behavioural ecotypes and sub-populations of grizzly bears identified in the 1995 Grizzly Bear Conservation Strategy	T. Hamilton (MoE)	Oct. 2010
Guide Outfitter Areas & Cabins	Guide outfitter tenure boundaries administered under the *Wildlife Act*	DataBC	Oct. 2010
Access Management Areas (East Kootenay)	Areas with restrictions on public access under the *Wildlife Act* due to concerns for wildlife (eg. hunting access, mechanized vehicle disturbance, etc.)	DataBC	Nov. 2011
Grizzly Bear Connectivity Corridors	Areas legally designated under the KBLUP HLPO as grizzly bear connectivity corridors requiring mature and old forests to be maintained	DataBC	Nov. 2011
Enhanced Timber Resource Management Zones	Areas legally designated under the KBLUP HLPO to support intensive forest management by reducing the green-up adjacency rules for cutblock to successful regeneration [normal green-up requirements require trees in adjacent cutblocks be	DataBC	Nov. 2011

	at least 1.3 metres in height, with at least 10% being 3 metres in height, before harvesting a new cutblock]		
Mountain Caribou Habitat Areas	Areas originally designated for caribou conservation under the KBLUP HLPO in 2000, however these were rescinded as part of implementation of the Mountain Caribou Recovery Plan which has implemented current mountain caribou conservation measures through designation of new Ungulate Winter Ranges under FRPA	DataBC	
Vehicle Access Hunting Closures	Areas designated under the *Wildlife Act* as closed to hunting using vehicle access	DataBC	Nov. 2011
Major Projects	Project types include mines, hydro-electric development, pipelines, resorts, utilities. These include projects reviewable under the BC *Environmental Assessment Act*, as well as those that do not.	DataBC	Dec. 2013
Mineral Tenures, and Mineral and Placer Claims	Mineral exploration and extraction tenures issued under the authority of the *Mines Act*	DataBC	Dec. 2013
Range Tenures	Area of Crown rangeland tenured under the *Range Act*	DataBC	Oct. 2012
Snowmobile Area and Trail Closures	Areas and trails where snowmobile access is controlled under the *Wildlife Act*	DataBC	Feb. 2014
Traplines and Trapline Cabins	Areas tenured for the trapping of fur bearing animals under the *Wildlife Act*	DataBC	Feb. 2014
Canadian Rocky Mountains Ecoregional Assessment	• Priority ranked conservation areas • Species and habitat element occurrences • Landscape linkages • Resource selection function maps for grizzly bear, lynx, wolverine, fisher, and gray wolf • Land ownership	Nature Conservancy of Canada	Nov. 2011
Mountain Caribou Habitat Suitability	The spatial output from the Mountain Caribou Recovery Science Team Bayesian Belief Network model was provided courtesy of S. Wilson, Chair of the Science Team. The habitat model is described in (McNay & McKinley, 2007) (McNay, et al., Use of Habitat Supply Models to Establish Herd-based Recovery Targets for Threatened Mountain Caribou in British Columbia: Year 2 Progress Report, 2006)	Mountain Caribou Recovery Science Team	Aug. 2011

	(McNay, Marcot, Brumovsky, & Ellis, A Bayesian approach to evaluating habitat for woodland caribou in north-central British Columbia, 2006)		
Miscellaneous geographic features	Lakes, streams, roads, communities, etc.	DataBC	2010
Valhalla Wilderness Society Park Proposal	Spatial layer of proposed park	Valhalla Wilderness Society (C. Pettitt)	May 2014
Wildsight Park and Wildlife Management Area Proposal	Spatial layer of proposed park and wildlife management area	Wildsight (R. Nelson)	May 2014

APPENDIX 3 - RASTER MAPPING AND ANALYSIS SCALE

Product	Grid Size (m)
Chapter 3	
BTM land use (Fig. 1 & 2)[135]	100
Road density map (Fig. 3)	1000
Forest harvest density (Fig. 4)	100
KBLUP RMZs (Fig. 5)	20
Conservation designations (Fig. 6)	20
Conservation percentages (Fig 7, Table 1 & 2, Fig. 8, 9, Table 3, Fig. 10)	20
Conservation ecosystem representation (Table 7 & Fig. 11, 12)[136]	50
Land use classification of conservation designation (Table 9 & Fig. 13)	100
Vegetation cover condition in forested BEC zones (Fig. 4) [137]	100
KBLUP land use zones in a conservation designation (Fig. 15)	20
Conservation designations in SMZs (Fig. 16)	20
NCC conservation area priority rankings (Fig. 17, Table 10, Fig. 18)	20
Mountain caribou habitat suitability (Fig. 21, 22, Table 13, Figure 23, 24)[138]	100
Habitat RSF suitability ratings (Fig. 25, 26, 27 & Table 14)[139]	1000
Grizzly bear conservation priorities (Fig. 29 & 30)	20
Grizzly bear conservation priorities comparison with Grizzly bear RSF habitat suitability ratings	1000
Wildsight and Valhalla conservation proposals (Fig. 31, 32, 33, 34 & 35)	20
Chapter 4	
BEC modelling scenarios (Fig. 7, Table 3, Fig. 9)	1000
Mountain caribou modelling scenarios (Fig. 10, Table 6)	1000
Wolverine modelling scenarios (Fig. 11, Table 7)	1000
Habitat effectiveness score comparisons (Table 8)	1000

[135] BTM data is based on Landsat imagery at 50m resolution (Ministry of Environment, Lands and Parks, 1995)

[136] The lower range in the size of BEC variants is ~ 0.5 hectares = 70 m^2 (Hamann & Wang, 2006)

[137] BTM data is based on Landsat imagery at 50m resolution (Ministry of Environment, Lands and Parks, 1995)

[138] Mapping resolution of Mountain Caribou BBN habitat suitability model = 100m (McNay, et al., 2006)

[139] Mapping resolution of the original RSF dataset = 1000m (Carroll, et al., 2001)

APPENDIX 4 – GENERALIZED BIOGEOCLIMATIC ECOSYSTEM CLASSIFICATION

Alpine Tundra (AT)

BEC Units: Atun, Atunp
Alberta Seedzones: A11
USA Level IV Ecosystems: 17h, 19a, 41b
Alaska Ecosystems: AK_116GL, AK_119GL, AK_119RC, AK01_112, AK01_113, AK01_116, AK02_112, AK04_112, AK04_113, AK04_116, AK04_116
Other: Avci, AVco, Avmc, Avnb, Avnc, Avnr, Avsb, AVsi, Avsr, RCK

Alpine Transition

BEC Units: ESSFmw
Alberta Seedzones: SA21
USA Level IV Ecosystems: 15h, 77c
Alaska Ecosystems: AK06_112, AK08_112, AK08_116

Wet Engelmann Spruce – Subalpine Fir (Wet ESSF)

BEC Units: ESSFvc, ESSFvcp

Moist Engelmann Spruce – Subalpine Fir (Moist ESSF)

BEC Units: ESSFmm, ESSFmmp, ESSFwc, ESSFwcp, ESSFwm, ESSFwmp, ESSFwv, ESSFmc, ESSFmk, ESSFmv, ESSFwk, MHmm, Mhun
Alberta Seedzones: M3, M4, M5, SA2
USA Level IV Ecosystems: 17l, 41c, 41e

Dry Engelmann Spruce – Subalpine Fir (Dry ESSF)

BEC Units: ESSFdc, ESSFdcp, ESSFdk, ESSFdkp, ESSFxc, ESSFxcp
Alberta Seedzones: M1, M2, SA1, SA2, SA3, SA4, UF1
USA Level IV Ecosystems: 13e, 15a, 16i, 17ai, 17am, 17ao, 17i, 17k, 17k, 17q, 9d, 19e, 23d, 41a, 41a, 77d, 77g

Coastal Western Hemlock (CWH)

BEC Units: CWHwm
Alaska Ecosystems: AK03_115, AK04_104, AK04_119, AK05_115, AK06_115, AK07_115, AK08_111, AK09_113, AK09_115, AK09_119, AK09_120

Coastal Transition (Ctrans)

BEC Units: CWHds, CWHms, CWHws, ICHmc, ICHwc, ICHvc

Dry Montane – Sub-boreal Spruce (MSD)

BEC Units: MSdk, MSdm, MSdc, MSdv, Msun ,MSxk, MSxv, SBPSdc, SBPSmc, SBPSmk, SBPSxc, SBSdh, SBSdk, SBSdw
USA Level IV Ecosystems: 17e, 17m, 17r, 17x, 17x, 41d

Wet Montane – Sub-boreal Spruce (MSW)

BEC Units: BWBSwk, SBSmc, SBSmh, SBSmm, SBSmw, SBSmk, SBSvk, SBSwk

Wet Interior Cedar – Hemlock (Wet ICH)

BEC Units: ICHvk, ICHwk

<u>Moist Interior Cedar – Hemlock (Moist ICH)</u>
BEC Units: ICHmk, ICHmw, ICHmm
USA Level IV Ecosystems: 15p

<u>Dry Interior Cedar – Hemlock (Dry ICH)</u>
BEC Units: ICHdw, ICHdk, IDFun
USA Level IV Ecosystems: 15i

<u>Very Dry Interior Cedar – Hemlock (V Dry ICH)</u>
BEC Units: ICHxw
USA Level IV Ecosystems: 16c

<u>Wet Interior Douglas Fir (Wet IDF)</u>
BEC Units: IDFww

<u>Moist Interior Douglas Fir (Moist IDF)</u>
BEC Units: IDFmw

<u>Dry Interior Douglas Fir (Dry IDF)</u>
BEC Units: IDFdk, IDFdm, IDFun, IDFxh, IDFxm
USA Level IV Ecosystems: 11e, 11f, 15x, 17ag, 17aj, 17g, 19c, 20e, 20e, 77e, 80c

<u>Ponderosa Pine (PP)</u>
BEC Units: PPdh, PPxh
USA Level IV Ecosystems: 15c, 16j, 17a, 17b, 17c, 20g, 21c, 21f, 23f, 43p

<u>Grassland (GRA)</u>
BEC Units: BGxh, BGxw
Alberta Seedzones: FF11, FP11, MG1
USA Level IV Ecosystems: 10a, 10f, 10j, 10m, 11g, 11k, 13c, 13f, 13i, 15b, 17ab, 17af, 17s, 18b, 18d, 19f, 20c, 25l, 42o, 42q, 42r, 43m, 43n, 43q, 43s, 43v, 43w, 80b, 80i

APPENDIX 5 – PARTICIPANT RECRUITMENT LETTER

Dear…

I would like to invite you to participate in a study entitled "Evaluating Wildlife Habitat Conservation and Restoration Climate Change Adaptation Strategies", which is examining community support for conservation and restoration measures to assist wildlife ecosystems to adapt to climate change. I am undertaking this study as part of the requirements for a PhD degree in the School of Environmental Studies at the University of Victoria.

The purpose of this research is to evaluate community interests, support for, and concerns regarding conservation and restoration interventions that may be necessary to maintain the integrity of wildlife ecosystems impacted by changing climate. There is evidence of significant recent climate change impacts on ecosystems and predictions of much more significant and disruptive impacts in the near future, as well as a strong emerging consensus on a range of incremental conservation measures needed to mitigate such impacts to promote ecological integrity. The project intends to engage community participants through a workshop and interviews to assess their perspectives relating to climate change impacts on wildlife ecosystems, assess issues and options, and identify opportunities and barriers to implementing wildlife ecosystem conservation and restoration strategies. To support this assessment, scenarios of future climate change effects have been developed for two species of interest for the study area (ie. mountain caribou and wolverine) through modeling and expert engagement.

Your participation would include attending a one-day workshop on November 29, 2012 in Nelson, completing a short pre-workshop questionnaire, and taking part in a follow-up interview, and would require about a day and a half of your time in total. The purpose of the workshop is to involve participants in a collaborative discussion to understand the issues based on the impact scenarios, address potential conservation and restoration strategies, and to identify areas of agreement and conflict, as well as potential opportunities or barriers to implementing such strategies. Following the workshop, each participant would take part in a follow-up personal interview to further evaluate their perspectives resulting from the workshop. Further details will be provided to you prior to the workshop should you choose to participate in the study. Interviews would ideally be arranged within a few weeks following the workshop, and would take place at a time and place most convenient to each participant. The interview is expected to involve about an hour of your time. The goal is to have approximately 25 people participate in the study that will represent a broad cross-section of community views.

My intention in this study is to present a balanced and constructive approach. Although it is not possible to ensure each participant's anonymity in a workshop setting, the analysis and results of this study will be depersonalized by not making specific reference to individuals by name. Information collected in questionnaires and personal interviews will be held strictly confidential. Participation in this study will provide you an opportunity to learn more about this important issue, and provide your voice to finding community-based solutions. Each participant attending the workshop will offered a $100 honorarium, which is intended to offset transportation or other costs to the participant related to attending the workshop. As well, lunch and snack breaks will be provided at the workshop.

Should you agree to participate, you will be asked to consent to the provisions outlined in the attached Participant Consent Form which provides details on the study objectives, methodology, and confidentiality provisions. By agreeing to participate in this study, you affirm that you understand the conditions of participating in this study and that you are providing your consent to participate in the pre-workshop survey. You will be asked to reaffirm your consent prior to the workshop, and again prior to post-workshop interviews. Should you have any concerns about participating, there will be opportunities to discuss these at the outset and at any time during the study. If you do decide to participate, you may withdraw at any time.

This project is being conducted under the supervision of Dr. Eric Higgs, Professor, School of Environmental Studies, and Dr. Peter Keller, Professor, Department of Geography, at the University of Victoria. You may contact Dr. Higgs by telephone at (250) 721-8228 or by email at ehiggs@uvic.ca, and Dr. Keller by telephone at (250) 472-5058 or by email at soscdean@uvic.ca. This research project is funded through fellowships that have been provided by the Pacific Institute for Climate Solutions, the Social Sciences and Humanities Research Council, and the University of Victoria.

Thank you for considering this request, and please contact me at the contact information provided below should you have any questions. I hope to hear back from you soon.

Sincerely,

____

Rod Davis
PhD Candidate
School of Environmental Studies
University of Victoria - PO Box 3060
Victoria, BC CANADA V8W 3R4

Ph: (250) 882-0072
Email: roddavis@uvic.ca

APPENDIX 6 – PRE-WORKSHOP SURVEY

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

Introduction:

Thank you for agreeing to participate in this study. Workshop participants are requested to complete this pre-workshop survey questionnaire which will provide background information for the study. The survey is designed to evaluate community attitudes on wildlife conservation and the potential effects of climate change.

Further information on the up-coming workshop and follow-up interviews will be provided to you before November 29th.

Participation in this survey indicates you have provided your consent as outlined in the 'Participants Consent Form' sent to you previously. Your consent will be reaffirmed at each stage of the study, and you may withdraw from the study at any time. All personal information collected from this survey and follow-up interviews will be held strictly confidential

This research has been approved by the Human Ethics Research Board at the University of Victoria, and you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office by telephone at 250 472-4545 or by email at ethics@uvic.ca.

Please let me know if you have any questions or concerns.

Sincerely,

Rod Davis
University of Victoria
Ph: (250) 882-0072
Email: roddavis@uvic.ca

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

Assessment of Environmental and Social Perspectives:

Please indicate the category that best answers your perspectives on each of the following.

1. The balance of nature is very delicate and easily upset.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

2. When humans interfere with nature their actions often produce disastrous consequences.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

3. Humans are severely abusing the environment.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

4. The so-called 'ecological crisis' facing humankind has been greatly exaggerated.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

5. If things continue on their present course, we will soon experience a major ecological catastrophe.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

6. Humans have the right to modify the natural environment to suit their needs.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

7. Humans will eventually learn enough about how nature works to be able to control it.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

8. Forests and wildlife exist primarily to be used by humans.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

9. The primary value of forests is to provide places to play and recreate.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

10. The primary value of forests is to provide timber, grazing land, and minerals for people.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

11. Humans have a responsibility to repair damaged ecological systems.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

12. Healthy populations of wildlife are important to me.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

13. We should be sure future generations have an abundance of wildlife.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

14. Wildlife have value whether people are present or not.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

15. Endangered species should be protected even at the cost of the economy and jobs.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

16. Some species are not worth spending money to save.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

17. The primary value of wildlife is for game hunting.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

18. Wildlife present a personal safety hazard to people.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

19. Wildlife create unacceptable levels of property damage.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

20. It is important for humans to manage populations of wildlife.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

21. Not enough attention is given to wildlife in our society.

Strongly Agree ○ Agree ○ Neutral ○ Disagree ○ Strongly Disagree ○

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

Assessment of Beliefs on Climate Change Impacts and Adaptation Options:

Measurements of carbon dioxide emissions taken at Mauna Loa Observatory in Hawaii have shown an approximately 24% increase since 1959 when measurements began. Measurements have also shown a 0.74 °C increase in the average temperature of the Earth's atmosphere.

The Intergovernmental Panel on Climate Change has recently predicted significant global warming resulting from greenhouse gas emissions based on climate simulation models. The "best estimates" of global mean temperature increase over the next 100 years based on these model simulations range from 1.8 °C to 4.0 °C depending on what assumptions are used about future greenhouse gas emissions.

22. Do you believe that global warming will result from greenhouse gas emissions?

- ◯ Yes
- ◯ No
- ◯ I Don't Know

23. Do you believe emissions of carbon dioxide and other greenhouse gases are the primary cause of observed global warming?

- ◯ Yes
- ◯ No
- ◯ I Don't Know

A group of research scientists at the University of Victoria has recently conducted an analysis of future climate conditions in the Kootenay region of British Columbia. Future climate conditions were predicted from climate models using a range of plausible greenhouse gas emission scenarios. This analysis projects a "most likely" climate change scenario, with annual mean temperature warming trends of 1.3 °C by the year 2020, 2.6 °C by 2050, and 4.3 °C by 2080. Annual precipitation for the Kootenay region for the same periods is predicted to increase 2 %, 3 %, and 7 %, respectively. Summers are projected to be 5 – 16 % drier and annual snowpack would decrease by 11.5 % by 2080.

24. Do you believe these predicted results for the Kootenay region are likely?

- ◯ Yes
- ◯ No
- ◯ I Don't Know

25. How would you rate your knowledge of climate change effects on wildlife ecosystems?

Expert	Knowledgeable	Somewhat Aware	Unaware
◯	◯	◯	◯

26. Have you participated in the recent West Kootenay Adaptation study funded by the Future Forest Ecosystems program region which is examining climate change impacts on forest ecosystems and forest management in the West Kootenay region?

- ◯ Yes
- ◯ No

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

27. If not, were you aware of this study?

◯ Yes

◯ No

28. How would you rate your knowledge of wildlife ecosystem conservation policies in the Kootenay region (eg. legislation and policies relating to land use plans, parks, wildlife management areas, extractive resource management activities, and backcountry recreation)?

Expert	Knowledgeable	Somewhat Aware	Unaware
◯	◯	◯	◯

29. How effective do you consider these policies to be in conserving wildlife habitat and species?

Very Effective	Somewhate Effective	Ineffective	Very Ineffective	Don't Know
◯	◯	◯	◯	◯

There is increasing scientific evidence that climate change, including increasing temperature and changed (ie. increasing or decreasing) precipitation regimes, is effecting natural ecosystems, and that such effects are predicted to accelerate over the next 50 to 100 years. Predicted changes to ecosystems include changes to the distribution of species, disruption of the interdependencies between species, the extinction of species, proliferation of invasive species, pests and diseases, and increased frequency and intensity of wildfire.

30. Do you believe that climate change could potentially have impacts on wildlife ecosystems in the Kootenay region?

◯ Yes

◯ No

◯ I Don't Know

31. Do you consider climate change impacts on wildlife ecosystems to be a problem?

◯ Yes

◯ No

32. Why do you think this may or may not be a problem?

33. Have you personally noticed changes in natural ecosystems or wildlife species in your local environment?

◯ Yes

◯ No

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

34. If yes, what changes have you observed?

35. Would you support any of the following conservation and restoration approaches to mitigate impacts to wildlife habitat or species?

	Strongly Support	Support	Neutral	Oppose	Strongly Oppose	Don't Know
Habitat reserves	○	○	○	○	○	○
Wildlife migration corridors	○	○	○	○	○	○
Prescribed fire to manage habitat	○	○	○	○	○	○
Forest harvesting to manage fire risk	○	○	○	○	○	○
Habitat restoration	○	○	○	○	○	○
Assisted species migration (ie. translocation)	○	○	○	○	○	○
Predator control	○	○	○	○	○	○
Riparian protection	○	○	○	○	○	○
Stronger regulation	○	○	○	○	○	○

36. Who should have the responsibility for managing negative impacts on wildlife habitat and species?

- ☐ Government
- ☐ Local community
- ☐ First Nations
- ☐ Environmentalists
- ☐ Industry
- ☐ Other

37. If other, then who?

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

Background Information:

38. What is your occupation?

39. Which category below includes your age?

- ◯ 17 or younger
- ◯ 18-20
- ◯ 21-29
- ◯ 30-39
- ◯ 40-49
- ◯ 50-59
- ◯ 60 or older

40. How would you best describe your political philosophy?

- ◯ Conservative
- ◯ Liberal
- ◯ Socialist
- ◯ Other

41. If other, please describe.

42. Which best describes your lifestyle?

- ◯ Rural
- ◯ Urban

43. What is your gender?

- ◯ Female
- ◯ Male

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

44. What is the highest level of education you have completed?

- ◯ High school participation
- ◯ High school degree or equivalent
- ◯ Some college or university, but no degree
- ◯ Bachelors degree
- ◯ Graduate degree

45. How would you describe your ethnic or cultural background? (Pick more than one answer if appropriate)

- ☐ Aboriginal or First Nations
- ☐ African
- ☐ Asian
- ☐ Canadian
- ☐ European
- ☐ Hispanic
- ☐ North American
- ☐ Other

46. If other, please describe.

47. How many years have you lived in the Kootenay Region?

- ◯ < 2
- ◯ 2 - 10
- ◯ 10 - 20
- ◯ < 20

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

48. Do you participate in outdoor or nature based activities outside of your work?

	Often	Sometimes	Never
ATV travel	☐	☐	☐
Backcountry skiing	☐	☐	☐
Camping	☐	☐	☐
Cycling	☐	☐	☐
Downhill skiing	☐	☐	☐
Fishing	☐	☐	☐
Hiking	☐	☐	☐
Hunting	☐	☐	☐
Photography	☐	☐	☐
Snowmobiling	☐	☐	☐
Wildlife viewing	☐	☐	☐
Other	☐	☐	☐

49. If other, please describe/

50. Where do you live?

City/Town:

51. Name (this information is optional, however where provided this and all personal information collected from this survey and follow-up interviews will be held strictly confidential):

Wildlife Climate Change Adaptation Study - Pre-workshop Survey

Thank you for participating in this survey.

52. Please provide any other comments you may have.

APPENDIX 7 – WORKSHOP AGENDA

Workshop Objectives:

1. Assess the perspectives of a diverse group of community stakeholders concerning potential climate change impacts on wildlife ecosystems.
2. Review scenarios of predicted climate change over the next century, understand uncertainty in predictions of the future, and explore potential implications of changing climate on wildlife ecosystems, using modelled habitat suitability future scenarios for mountain caribou and wolverine as examples.
3. Assess potential conservation and restoration options, and identify opportunities and barriers to implementing conservation adaptation measures for increasing the resilience of wildlife ecosystems to climate change.

Agenda:

8:00 am	Check-in & greetings (continental breakfast provided)
8:30 am	Welcome & introductions - Rod
8:45 am	Research overview – Rod Agenda review & initial impacts list - Cindy
9:00 am	Climate change & wildlife impact scenario presentations • West Kootenay Resilience Project - Greg • Mountain caribou & wolverine habitat suitability scenarios - Rod Discussion (15 mins)
10:30 am	Break
10:45 am	Breakout session (5 groups) – review future change scenarios presented and consider potential impacts on wildlife conservation 4) What impacts might be expected based on projected climate changes? 5) Do you have confidence in the evidence that climate change is likely to have an impact on wildlife ecosystems? 6) How does uncertainty influence how the problem and potential conservation strategies are perceived?
12:00 pm	Lunch (provided)
12:30 pm	Conservation and restoration options presentation – Rod
1:00	Breakout session - discuss conservation and restoration approaches 1) What ideas do participants have for conservation and restoration strategies to adapt to potential climate change impacts on wildlife? 2) What enablers exist to facilitate implementing such strategies? Can these be enhanced? 3) What barriers exist which would prevent implementing such strategies? What can be done to minimize these barriers?
2:30 pm	Break
2:45 pm	Plenary report (5 minutes / group) and discussion
3:30	Priorities for action - Small group discussion/post-it wall
4:30 pm	Adjourn

APPENDIX 8 – THEMED WORKSHOP RESULTS

Workshop Theme 1: Beliefs on climate change & impact on wildlife

Group 1

- transitional conifer ingress now will increase fire risk, expect grasslands to expand
- forest fires could cause habitat fragmentation, increasing early seral ecosystem conditions
- west Kootenays will lose western cedar and other conifers [at lower elevations]... will transition to drier ecosystems
- hybrid spruce and subalpine fir will transition to higher elevations to be replaced by western cedar and western hemlock
- at mid-elevations (ie. ICH/MS) ponderosa pine and grand fir increasing, hybrid spruce and subalpine fir will be decreasing
- at higher elevations (ie. ESSF/AT) decreasing lichen availability for caribou
- expect more precipitation which will come as snow at higher elevations
- core habitat established for caribou will transition to decreasing early seral conditions [from previously logged areas] which will improve conditions for caribou and decreasing suitability for other ungulates... deep snowpack reduces predation on caribou, however a variable snowpack creates winter foraging issues for caribou
- transition to grasslands and early seral conditions resulting from fires will improve ungulate winter range which will influence predator/prey dynamics... increasing populations of elk, mule deer, whitetail deer, and bighorn sheep
- improved habitat conditions for prey species will increase predator populations
- reduced habitat for mountain caribou [loss of snowpack at mid-elevations, loss of late winter forage availability]
- reduced habitat for wolverines due to decreasing snowpack at lower elevations
- increasing invasive species, especially following disturbance such as fire suppression, cattle grazing
- increasing stream temperatures will impact bull trout
- group has confidence in models and historical data trends
- knowing the people doing the modelling helps credibility
- already significant evidence of climate change impacts on ecosystems, people who are close to the land see the evidence urban people may not
- global evidence such as the polar ice cap melt supports the credibility of climate change predictions
  many people believe the hydroelectric reservoirs have influenced the local climate

Group 2

- forest fires will be expected to increase, creating impacts on the landscape and the community (ie. fire risk to homes)... the impacts will be significant to the community and ecosystems
- forest fires will have a negative impact for some species and a positive impact for others
- disturbance will result in migration of other species... increasing invasive species opportunities which may be considered undesirable… the MPB epidemic has provided tangible evidence of this... this has reinforced the credibility of forecasts of non-linear dynamics and the potential for large and potentially catastrophic impacts
- how the resulting impacts from climate change is perceived is considered to be a value judgement
- species with a wide variability [in habitat niche] should do well, however species with a restricted range will be at greater risk... there will be an increasing rate of extinctions
- impacts are already observable on the landscape... some species and ecosystems will be resilient, others may not be
- important to manage for diversity... actual species composition should not be the focus, but need to maintain diversity
- the impacts will be economic and social as well as ecological which will cause value-based conflict in the community... addressing the issue will require a paradigm shift in approach which will be impeded by the lack of leadership and political factors
- confidence in the underlying science is getting better, however it is recognized that much is unknown and there is a high degree of inherent uncertainty
- the modelling projections of climate change impacts on ecosystems and species habitat is recognized as being largely theoretical... it is recognized that climate change will cause impacts, but there is not confidence in the predictions from the climate change and ecosystems impacts models

• decision-making needs to address the high degree of uncertainty... there is a need to address knowledge gaps to increase confidence in management approach to address the issue... failure to take action based on uncertainty will be an issue

Group 3 • climate change is expected to impact ecosystems, water resources, communities, and the economy • public policy needs to adapt by being responsive to trends and change... this includes the need to put infrastructure, budgets, personnel, planning and priorities in place to address the issues • uncertainty detracts from ability to take necessary action to address the issue • there may be stronger, more effective opportunities at the local level because of the knowledge and experience... climate change is observed locally • the rigour of science methodology contributes to the continuation of uncertainty • the impact is understood to be huge and multi-faceted... however although climate envelopes will shift, species and soils will respond differently • there is confidence that climate change will result in significant impacts, however little confidence in the ability to understand what the impacts will be over time... confidence increases with information, education and personal experience • episodic events can shift people's perceptions
Group 4 • wildfire will be a large driver of ecosystem change • expected change in the hydrological cycle will affect hydroelectric power generation • migration/invasion of exotic species, insects, pathogens • increased ungulate habitat potential due to increased precipitation in the spring and lower snowpack in the winter • human feedback loops influencing ecosystems include increasing settlement due to warmer climate resulting in wetland draining, cottonwood removal, etc. • consensus within the group they are confident in the evidence that climate change is likely to have an impact on wildlife ecosystems... strong belief that climate change impacts on ecosystems are evident now • uncertainty relates to the magnitude of change which means local impacts can't really be understood • change may have positive as well as negative impacts • changes are ongoing and therefore subtle, with episodic sometimes catastrophic events occurring... because there is generally a lack of perception of subtle change there is the need for better communication of the evidence... ways to improve public confidence would include communicating quantified information, time lapse photography, maps, phenological information
Group 5 • impacts will be ecological, social and economic... there is strong evidence of recent change and change has always occurred historically • different systems [ecological and social] change at different rates... existing systems may become unsynchronized or uncoupled • change will include surprises [ie. unknown, non-linear, threshold changes]... and may be counter-intuitive • ecologists working in the area see evidence of change (eg. remapping BEC, tree ring evidence) • hunted species will change which will affect commercial guide outfitting and sustenance hunting • ecosystem change will result in winners and losers [both in the economic and ecological sense] • the rate of change is unprecedented [so little evidence on how it will be manifested] • concerned that as human costs go up, then support for conservation will decrease • changes to structural attributes and habitat will result in changes to species and species interactions... this calls into question the application of conservation designations (eg. UWR) • feedback loops between ecological and socioeconomic systems • the intensity and frequency of fires will increase exacerbated by fire suppression... resulting impacts will be

highly uncertain spatially [ie. stochastic process]... will have impacts on wildlife conservation and water resources

- surprises considered to be negative economically
- management strategies to mitigate climate change will be difficult to justify politically due to the high degree of uncertainty... the choice will be a proactive versus reactive response
- insects [and other pathogens] can adapt quickly and have an ecological advantage [eg. MPB], and can have a significant and potentially disastrous impact on ecosystem services
- potential for climate conditions which would be beneficial for agriculture
- examples of integrated socio-ecological implications... MPB impacts reducing mid-term timber supply resulting in a call to log in conservation areas, loss of public support for conservation resulting from the failed caribou translocation project while funding was cut at a local women's shelter, the costs and public safety concerns resulting from the Johnson's Landing landslide
- need to move to a dynamic management paradigm that take change into account
- species likely to be impacted most at the southern extent of their range [eg. Mtn. Caribou]... new ecosystems and new species expected to migrate in
- extreme events could cause drastic and irreversible change
- climate change related disturbances could contribute to habitat fragmentation caused by human activities
- habitat change will influence predator-prey dynamics (eg. Mtn. Caribou)
- there is a high degree of confidence that climate change is occurring and will have an impact on ecosystems, but that such changes are highly complex and uncertain... what the impacts to wildlife will be is very uncertain
- characterizing the effect of climate changes on wildlife ecosystems as an 'impact' is negative... changes may have beneficial or negative consequences

Workshop Theme 2: Information credibility & uncertainty

Group 1

- uncertainty provides the potential to deny climate change is occurring or to motivating the need to take action to mitigate the cause or the resulting effects
- the timeframe for change extends beyond people's lifespan... the result is a lack of credibility and of motivation to effect changes necessary to mitigate or adapt to the problem
- it will be difficult to develop focussed strategies for conservation... there are too many unknowns and too many response options
- predictions of large, complex, and uncertain change is hard for people to understand... predictions of negative impacts strike at human need for security... these together cause people to be uncomfortable [or perhaps disbelieving]
- climate change has not been generally understood to have an impact on wildlife ecosystems, so there is not wide recognition of the need to effect conservation strategies
- need major experiences, events/disasters to make the issue personally tangible to overcome the inaction due to uncertainty
- people not living close to the land do not experience changes that are occurring
- most people don't understand the problem or the potential for mitigating strategies... there is a perception that nature will adapt
- some people may see climate change as being beneficial
- there is confusion between weather and short-term climate variability, and longer-term climatic trends

Group 2

- there is a very high degree of confidence in climate change amongst scientists
- there is a disconnect with managers who need a high degree of certainty as rationale for management decisions
- this need for better science to support decision-making… uncertainty delays action and decreases management options... uncertainty could result in bad decisions... need to be clear about the limitations of the data... uncertainty needs to be incorporated into the decision-making process
- uncertainty allows self-interest of many stakeholders to overcome concerns about the need to take action
- skeptism is driven by uncertainty and being overwhelmed by the potential for uncomfortable results
- if there is better information on the evidence or the concept, then uncertainty may be less on an issue
- uncertainty results in political paralysis... government inaction results in it becoming less important or relevant... government policies are difficult to implement or monitor... leadership seems to be moving more to civil society... current socio-political systems lack resiliency
- it will likely take big change to effect changes in thinking... climate change needs long-term vision and commitments... there is a need for changes in our institutional structures to effect this
- need to find the balance between cost and uncertainty

Group 3

- uncertainty creates a vacuum which results in unresponsiveness and a propensity for inaction
- routine results in unwillingness to accept and adapt to change... it will take for people to be directly and considerably impacted for them to be motivated to accept the problem or the need for conservation strategies

Group 4

- uncertainty make communications about the problem and solutions difficult
- uncertainty increases the potential for doubt and denial
- combination of uncertainty and complexity leads to difficult decision-making
- resiliency-thinking provides an avenue to find adaptive solutions
- are new strategies needed or do we just need to implement our old strategies... perhaps the solution is to concentrate on maintaining ecosystem function and embrace novel ecosystems that fill a function
- need to identify costs and benefits of management strategies through a risk analysis... [be practical... but be willing to take calculated risks]
- uncertainty feeds a lack of confidence in proposed adaptation action, therefore no major backers of proposals and lack of political push

Group 5

- one solution is to focus on habitat connectivity to reduce fragmentation, increase resilience... this is countered by concerns about 'locking up lands'
- parks are seen as static solutions to conservation, given uncertainty the need is for dynamic solutions
- the matrix needs to be managed for future attributes through an ecosystem-based management approach rather than for maximizing timber yield and government/industry revenues
- uncertainty makes it difficult to commit to a strategy... it is difficult to invest in strategies where there are risks to outcomes or a rate of return
- the future trends are too uncertain making it difficult to plan strategies... the past trends do not provide information required to effect needed management approaches
- the need is to plan for surprises, however there is not a lot of information or understanding of what that means or how to implement this
- the hydroelectric developments in the region have been very influential on how people think in the west Kootenay region
- there will be a reluctance to support strategies where there is uncertainty [eg. Mtn. caribou recovery including habitat conservation, predator control, and translocation]

Workshop Theme 3: Attitude to human intervention in ecosystems
Group 1 • conservation strategies need to be led by conservation organizations and the provincial government... there are limited opportunities for individuals • legalize OGMAs [although given OGMA target are legal at the aspatial level, and FSPs largely recognize the non-legal designations and propose new ones where OGMAs are proposed for harvesting, it is not obvious how this strengthens conservation strategies which mitigate climate change... old growth patches provide key habitat attributes and refuge for many species, however how these patches are patterned on the landscape will matter - this level of landscape design has never been done] • Wildsight has been conducting an independent landscape planning process that includes a climate change lens [ie. map future values based on climate change scenarios... this is the work Greg Utzig has been doing for Wildsight]... the intent is to provide an information base to provide leverage for conservation action... the process includes mapping values, seek agreement on values, develop management strategies/options to maintain values, overlay values and strategies to identify how to maintain multiple goals, tools include new wildlife management areas, parks, forest certification... need for industry to have social license is seen as important leverage... process is identifying new critical habitats and connectivity areas given climate change scenarios... the process tests trust in the modelling of climate change scenarios • management strategies supported include expanding/relocating protected reserves, protecting and restoring critical habitat and refugia, establishing dispersal corridors, maintaining natural disturbance regimes, directly managing wildlife populations through predator management, directing hunting through regulation, and translocation
Group 2 • a priority focus for conservation should be on components of the ecosystem which are scarce, such as riparian/wetlands, low elevation public lands, mountain passes and old growth forests • need to focus on ecosystem resilience as a goal rather than restoration to a historical state by maintaining ecological process rather than climax state • need to priorize and focus resources by taking a triage approach • adaptive conservation strategies need to support natural ecosystem processes, such as supporting dispersal • recognition the social and ecological systems are interconnected... conservation strategies will be value laden • using umbrella species focus is complicated by not knowing how species relationships will be affected by climate change... using an ecosystems-based approach is complicated when future ecosystem structure and function is not well understood • will be important to maintain future options, particularly by protecting vulnerable components of the ecosystem... a coarse filter/fine filter approach is needed where broader scale ecosystem components [structure and function] are maintained, and better information is developed about finer scale components • expansion/relocation of protected area reserves will be important... existing reserves were implemented through a highly political process where important ecosystem components were not included... protected areas need to be implemented with a longer term perspective [people tend associate parks with conservation, not the ensemble of the various conservation designations/integrated management approaches] • managing fire disturbance regime seen as a priority... there is a need to be proactive and defensive • the European management paradigm is to manage and control the natural world... need to accept we are in a 'managed landscape' • understanding human values will be an important component of management strategies
Group 3 • there is a need to slow down resource development and to control human access to remote areas • link existing protected areas with ecosystem corridors • need to incorporate climate change and ecosystem impacts into educational curriculum • need to facilitate community dialogue to influence ecosystem stewardship • forestry policy needs to adapt to climate change by allowing for planting new species

Group 4

- one option is to do nothing, and accept the consequences of change
- need to understand what the management goals are, including provision of ecological services versus maintaining natural ecosystem function... management approaches may be different depending on what the management goals are
- emphasis needs to be on maintaining ecological function (ie. resilience) rather than individual species or commodities
- invasive species management need to incorporate climate change projections... practical cost/benefit approaches may be needed before deciding of trying to eradicate invasives
- there is a concern about trying to move protected areas... considerable social capital expended on implementing current protected areas, and the risk is losing areas that were hard fought for in the first place... new protected area proposals need to be based on representation criteria revised based on climate change scenarios
- need for habitat supply modelling based on climate change scenarios
- need to manage old growth forest considering climate change dynamics... ie. consider relocating and potentially modifying OGMAs
- interventions such as assisted migration and species management [ie. predator and prey species management, species at risk protection] should be considered
- other strategies include protection of low elevation critical habitats [managing urban sprawl], maintaining landscape connectivity, controlling access and other land uses
- effective implementation of present strategies should be priorized based on climate change considerations

Group 5

- concern that current approaches to conservation and restoration are based on a static paradigm [eg. Mtn. Caribou recovery]
- need to accept some conservation approaches as experimental... the caribou transplant into the south Purcell area is an example... however this project was largely seen as a failure
- need to implement principles of adaptive management [presumably including monitoring] by diversifying management
- current list of potential management strategies are considered as static approaches
  the need is dynamic strategies which incorporate experimental design and to incorporate ecosystem processes [based on structure and function]
- ecosystem-based management, maintaining connectivity, and maintaining natural disturbance regimes are considered to be very important
- the concern is how to implement this given the complexity and uncertainty

Workshop Theme 4: Policy barriers

Group 1

- lack of climate change education [ie. knowledge and understanding]
- poor information in the media
- uncertainty of climate change projections
- conflicting values relating to access to ecological services (eg. resource development, motorized access, differences in local versus urban perspectives)
- potential for socio-economic impacts, particularly the threats of employment loss... this is accentuated by recent economic recessions
- present provincial government's priorities on deregulation, and reducing budget and staffing
- lack of consistency in implementing the professional reliance model
- regional/municipal governments with a pro-development perspective
- present federal government's failure to implement species at risk legislation
- potential solutions to address these barriers include information sharing, practice guidelines, judicial reviews, education

Group 2 • politics, economics, and special interest groups seen as barriers • private land occupies much of the productive low elevation areas [address through land purchases] • public's lack of understanding, human psychology resistant to change... there is a need to develop more public 'discomfort' with the potential outcomes from the status quo than with the changes needed to respond to climate change • the issue of maintaining resilient wildlife ecosystems in the Kootenay region is contrasted with the broad scale public opposition to pipelines... the pipeline issue is tangible with much more clear issues and protagonists • federal government is seen as beholden to an economic development agenda, and as such are strongly aligned with resource development and actively suppressing science [and dissent] • provincial government seen to be politically motivated • governments have short-term political agendas inconsistent with addressing long-term implications of climate change impacts • breaking through political institutional barriers will "take very big hammer"
Group 3 • concerns about economic impacts of implementing more protection on the crown land base • insufficient resources available to properly address the issue • lack of political will • poverty • industry short-term planning horizons • lack of education
Group 4 • public acceptance of human interventions such as predatory management or species translocations • lack of local government mechanisms or control • deregulation • political willingness given the lack of public concern lack of funding or willingness to pay • lack of enforcement for environmental regulations lack of relevant planning mechanisms or confidence that planning will be implemented erosion of social mechanisms providing adequate community discourse on the problem and solutions
Group 5 • lack of land use planning and overall coordination of plan implementation • mid-term timber supply review as a response to the mountain pine beetle epidemic • government staff downsizing • lack of incentives for the private sector [eg. volume-based tenures] • forest tenure appraisal system - cost recovery from government pushes industry operations to the lowest common denominator • governments have short-term priorities dictated by the four year election cycle • poor ecosystem knowledge • loss of expertise as scientists and government staff retire, and not recruiting and training new people • knowledge is not easily accessible • regulations are seen to be punitive... "all stick and no carrot" • citizen's resist being regulated • lack of leadership at local, provincial or federal levels • cost of implementing dynamic solutions may be very high, while resources are finite [and decreasing]

Workshop Theme 5: Policy opportunities

Group 1

- evidence of climate change impacts
- better informed media
- advocacy by NGOs [especially Wildsight]
- scientific research which improves information for decision-making
- public awareness and education
- industry's need for social license
- being able to influence political will
- building political relationships
- grassroots and individual efforts
- getting communities to value this work
- internet communications

Group 2

- having a core set of protected areas and private conservation lands
- NGOs
- more research which informs conservation needs
- adjusting the AAC
- having 95% of the land base under public ownership
- need to build political will
- economic tools and incentive
- building innovation in resource development
- opportunity to establish community think tanks
- regulatory approaches
- more and better education
- institutions such as HCTF, CBT, FWCP, KCP

Group3

- building on the capacity of staff in government
- NGOs [both advocacy and land trust acquisition]
- industry [social license and tax incentives]
- forest management regulation change
- university-led research
- increase funding to non-profits and NGOs

Group 4

- attaching habitat compensation requirements to all development approvals - formal process (like FWCP)
- access to information - eg. development plans
- pilot/demonstration areas/projects - eg. local conservation funds
- more dialogue
- sharing information
- political involvement
- financial incentives
- identify champions
- share successes - information on good programs
- local level planning [municipal and regional districts]
- electing pro-active governments
- existing studies and data on species and habitat management
- tax incentive/disincentives
- access management regulations [need to regulate ATVs and snowmobiles]
- ecosystem restoration
- interface wildfire management

  invasive weed control
- forest certification - social license for industry
- opportunities for carbon offsets
- better regulation

Group 5

- increase knowledge about adaptive management
- reconnect the government to the people and the environment
- reconnect people to their local environment
- encourage less driving
- professional accountability
- full cost accounting
- implement adaptive management

APPENDIX 9 – WORKSHOP BREAKOUT GROUP AND RESPONDENT BARRIERS AND OPPORTUNITIES

a) From Workshop:

Policy Barriers	Policy Opportunities
• socio-economic impacts resulting from implementing ecosystem conservation measures, • institutional and social inertia, • human psychology resistant to change, • inherent uncertainty in predicting the future, current level of scientific knowledge, poor public understanding of the issue, lack of political will (eg. government's priorities on deregulation, reducing budgets/staffing, short-term political agendas, predevelopment policies, suppression of science, centralized decision-making), • ineffective implementation of current policies, including forest practices legislation, timber allocation policies (ie. AAC too high), Kootenay Boundary Land Use Plan, timber appraisal policies (eg. pushes industry operations to lowest common denominator), professional reliance, species at risk legislation, caribou recovery strategy, lack of enforcement of environmental regulations; demise of land use planning • erosion of social mechanisms providing adequate community discourse on the problem and solutions, • effect of climate change denial in the media confusing the issue, • private land ownership in critical areas, insidious effects of climate change, • ethical considerations relating to human interventions in ecosystems (eg. predator control programs), lack of industry incentives (eg. volume-based tenures).	1. Improving communications and information: • communicate evidence of climate change impacts to develop public awareness, • use internet communications as a tool for disseminating information, • promote a better informed media, • build public understanding of the problem and values at risk through community dialogue and sharing information through community-based forums, • integrate data from existing studies on climate change and wildlife ecosystems into resource management, • provide new scientific research necessary for resource management decision-making, • increase knowledge with resource managers and political decision-makers about implementing adaptive management. 2. Strengthening institutional mechanisms: • use economic tools and incentives to encourage innovation in resource development and promote social license for industry (eg. certification, tax incentives, carbon offsets), • build on current conservation framework which includes 95% of the land base under public ownership with a core set of protected areas and private conservation lands located in critical areas, • involve key community-based conservation funding institutions such as Habitat Conservation Trust Foundation, Columbia Basin Trust, BC Hydro Fish and Wildlife Compensation Program, and Kootenay Conservation Program, • support NGOs advocacy groups and land trusts, • reinstitute local level planning mechanisms, • improve the professional accountability framework through professional associations. 3. Building social capital: • reconnect people to their local environment, • reconnect the government to the people and the environment, • provide support to enhance grassroots and individual efforts, and promote local champions, • encourage political involvement, • increase funding to non-profits and NGOs, • fund pilot/demonstration areas/projects with local conservation funds. • Improving regulatory mechanisms and program delivery: • advocate for regulatory reforms need to address climate change, • adjust the annual allowable cut, • implement access management regulations to regulate ATVs and snowmobiles, • require habitat compensation for all development approvals, • provide public access to information on forestry development plans, • require full cost accounting in resource development, • build knowledge and capacity of government staff,

	• implement ecosystem restoration, invasive weed control and interface wildfire management programs. 4. Building political support: • influence political will by building political relationships, • elect pro-active governments.

b) From Interviews:

Policy Barriers	Policy Opportunities
• polarization of land use interests • private land ownership in low elevation habitats • pro-development policies of federal and provincial governments • environmental deregulation initiatives at the federal and provincial levels (eg. environmental assessment and fisheries legislation) • insufficient funding… there are insufficient resources to properly fund significant additional planning process that will be necessary • institutional inertia • human tendency to focus on themselves and generally not caring about the environment… there is pessimism there will be significant social support for the change needed to effect conservation measures necessary • the implications of climate change are long-term and are complex to understand making it difficult to galvanize public support for action on conservation adaptation strategies • urbanization has caused isolation of society from nature which limits motivation for political support for conservation • preoccupation with initiatives directed at human community climate change adaptation meaning wildlife adaptation won't be a priority • lack of regulations which would restrict motorized backcountry access • humans' natural aversion to accepting change and having their beliefs challenged • breakdown in communications between staff working in the Forest Service, the Ministry of Environment and industry is a barrier to practical approaches to conserve habitat for wildlife • private land occupies a significant area of highly productive habitat which otherwise would support key species, and much of the area has been disturbed to the extent it no longer has critical habitat attributes and creates barriers to wildlife connectivity • community reluctance to accept new conservation approaches where they have been economically impacted through the land use plan or the caribou recovery strategy • the allowable annual cut policy framework is already an over-estimate of timber that is economically available and does not incorporate climate change implications on timber supply or other integrated resource values… this will result in timber shortages for local mills and affect employment, which will increasingly exacerbate conflicts between a viable forest industry and wildlife conservation • the results-based approach under the new *Forest and Range Practices Act* has resulted in the minimum being done to meet broader forest management objectives, including ecosystem conservation goals... the legislation has assigned the responsibility for design and implementation of forest management objectives to	• need to incorporate climate change adaptation into natural resource planning and management policies • building connectivity into ecosystem design • more attention to integrated forest management approaches; active management of the forest can enhance habitat attributes and promote ecosystem diversity; an industry perspective is that integrated forest management can be done economically and will be accepted by the logging community • a broad scale planning approach which would balance objectives... one suggestion was to trade off conserving the Incommappleux watershed for timber access further south • Wildsights' proposal for park status for the Flathead watershed and connectivity designations which would link that area with the national mountain parks to the north • private land conservation focussing on riparian habitats • businesses and communities have the resilience to address the problems and opportunities resulting from climate change, for example the Nature Conservancy of Canada was able to sell carbon credits for the Darkwoods lands that helped enable financing purchase of this significant conservation property • addressing climate change will require addressing the economic implications, as well it is necessary to consider economic incentives for conservation to succeed, for example economic incentive were necessary to achieve conservation objectives in the Great Bear Rainforest • there is a need for innovative approaches to address the problem, using old approaches to solve new, complex and difficult issues is unlikely to succeed • need for industry to maintain social license provides leverage for conservation action • a crisis will be needed to generate the level of social and political will needed to galvanize action needed, it will require significant effort and a clearly identified problem to achieve this • having large areas of publicly owned Crown land provides some latitude for conservation • promoting stewardship on privately owned land • more research is needed to understand how ecosystems will be affected by climate change, and what habitat and corridors are necessary to effect ecosystem resilience, this new information will be needed to address policy uncertainty • there is need for better information to support community engagement... people have a poor awareness of the longer term implications of climate change • need to encourage community dialogue to raise understanding and encourage involvement in climate change adaptation decision-making, one suggestion to facilitate community engagement would be using small pilot projects • there is a need to get communities involved in working on

licensees and resource professionals; licensees are managing to the minimum required, and the previous communications between resource professionals in government and industry no longer occurs [to the extent this is broadly applicable, then the legislation is not being implemented as designed • stumpage appraisal system is a detriment to sustainable forest management by driving management down to the lowest common denominator • the planning done through KBLUP and in support of the MCRIP were significant political undertakings, however the processes were stressful and it's unlikely there is a strong appetite to reinitiate planning needed to address changing conditions… this 'process fatigue' resulting from the land use debates that resulted in the Kootenay-Boundary land use decision by government will be a significant barrier to addressing strategies needed to confront climate change impacts on ecosystems • industry views new planning processes as a strategy to usurp further areas for conservation purposes, especially given new calls for protecting 50% of the land base for conservation purposes • political system with four-year election cycle focusses political priorities and accountability on short-term issues, the challenge will be to engage the political process and community in a long-term planning horizon • competition with consumer-driven demand for natural resources and recreational access to the land base • extent of the land base allocated to resource development will be barrier to effectively conserving natural ecosystem function, the cumulative impacts of resource extraction and commercial recreation tenures needs to be addressed • environmental protection agencies don't have sufficient resources to manage cumulative impacts, such agencies are purposely being cut back to prevent them hindering resource development • the results-based approach has removed government agencies from operational decision-making • consumer economy driven by public demand drives resource development • the current recessionary economy has reduced profitability of the forest industry, reduced local employment, and impacted government revenues... additional constraints and costs of new conservation measures would be considered by many to negatively affect the local economy • increasing human population and consumer demand is exceeding sustainable limits of the planet • limited opportunities for action given the scale of changes predicted, ecosystem response could result in hybrid habitat systems developing and that any response is uncertain and unpredictable	solutions through a process of informing and engaging... such processes will involve building scientific understanding, engaging community organizations and politicians in a debate, and getting climate change impacts on legislative agendas • the Columbia Basin Trust and the BC Hydro Fish and Wildlife Compensation Program are suggested as potential opportunities to engage the community at the local level in climate change issues • an example of a successful community engagement project is the involvement of local snowmobiling clubs in the caribou recovery strategy in putting up signage and monitoring compliance • ENGOs such as Wildsight and the West Kootenay EcoSociety are considered by many to have important roles in promoting conservation actions to address wildlife ecosystem resilience • a change in government both federally and provincially was suggested as being needed to address the problem • renewal of the intent of Forest Stewardship Plans through stronger oversight capacity by government agencies (ie. plan approval and enforcement), strengthening the intent of professional reliance through professional licensing bodies, and providing more effective opportunities for public review • access management planning is needed to control motorized backcountry access to protect wildlife ecosystems • Wildsight has been directly engaging with industry and other stakeholders in processes related to conservation planning and access management, as well as engaging in broader educational programs through community engagement and school programs • while most participants favoured broad community consultations as a solution towards building support for conservation action, one perspective was the need for an agency-based technocratic planning approach to the problem • resource development projects need to address full environmental costs

APPENDIX 10 – INTERVIEW QUESTIONS

Brief participants on:

1. the themes addressed in the interview:
    a. understanding motivations which support conservation strategies
    b. evaluation of how the workshop influenced the participant's perspectives [effect of information, uncertainty, values, beliefs, workshop dialogue]
    c. identifying opportunities and barriers to wildlife conservation climate change adaptation strategies
2. the amount of time the interview should take [~ 1 hour]
3. interested in what they have to say, so questions are only intended to stimulate discussion
4. encouraged to seek clarification at an point
5. reminder of conditions put on research by university's Ethics Approval and requirement of ongoing participant consent:
    a. respect for anything they may say in confidence
    b. interview transcripts and follow-up analysis will be shared later to ensure accuracy
    c. they may withdraw at any time and request their data be deleted and not used in the study

To begin with, I'm interested in learning more about your interests in wildlife conservation:

1. To start out, please identify yourself, and explain your connection with the Kootenays and its wildlife.
2. The natural range of many key wildlife species such as caribou, wolverines, grizzly bears, wolves, and others have significantly contracted in the past 150 years. It would seem that British Columbia has become a refugium for multi-species mega-fauna as a result of habitat loss since European colonization. What do you think is our role in conserving large mammal wildlife diversity?

Now I'd like to focus on your thoughts about current and future wildlife management:

3. Wildlife habitat conservation in the Kootenay region is guided by the Kootenay-Boundary Land Use Plan, and other policies such as the Mountain Caribou Recovery Implementation Plan and the *Forest and Range Practices Act*. I'd appreciate it if you would comment on how effective these policies have been in conserving wildlife in this region.
4. In what ways do you anticipate that climate change will impact wildlife? If so, would such impacts be unacceptable?
5. In what ways do you think that climate change will be a problem for wildlife or for ecosystems? Do you think it urgent? Is there sufficient information with which to properly manage the impacts of climate change? What is your perspective on being able to manage wildlife conservation given the level of uncertainty in climate change impacts?

I'm interested in how people anticipate future conditions and consider their impacts. The next few questions focus on how you make sense of predictions of climate change and their

implications for wildlife in the Kootenays:

6. The information presented at the workshop suggests we face an uncertain future that will be different from what we know now.
    a. Do you think about future changes?
    b. What do you see as the most significant impacts?
    c. How do you think this will affect wildlife?
    d. How do you think this will affect the economy?
    e. What effects will have this on you, your family, and your community?

I'd like to focus on your views on strategies to mitigate the impacts of climate change:

7. I'm going to list a series of conservation and restoration approaches. For each, please comment on whether you think they would be effective and whether or not you would support their use to mitigate climate change impacts on wildlife habitat or species
    a. new habitat reserves (ie. large parks -> specialized niche patches)
    b. wildlife migration corridors
    c. prescribed fire to manage habitat
    d. actively moving species (eg. translocation of species)
    e. predator control
    f. habitat protection regulation governing resource extraction and recreation activities
    g. others???
8. Climate and ecosystems are dynamic, and always have and will continue to experience significant change. Can human interventions be justified to mitigate human-caused impacts on the environment?
9. What barriers or competing land uses will prevent conservation measures from being implemented?
10. What opportunities do you think there are there are to adapt wildlife ecosystems to climate change effects?
11. Who should have responsibility for managing wildlife conservation? What roles should different sectors play?
12. What new understandings and perspectives, if any, have you gained from participating in the workshop and preliminary survey? [ie. How will this make a difference in how you perceive wildlife conservation in the Kootenays]
13. Do you have any further comments or observations?

Wrap-up:

1. Thank you for participating in my study
2. Will follow-up as soon as possible with a request to review interview transcript
3. Ultimately will follow-up with copies of my dissertation, reports, and publications

APPENDIX 11 – BOTTOM-UP THEMATIC CODES

1. climate change
    - 1.1 adaptation
    - 1.2 agriculture & food
    - 1.3 communicating change
    - 1.4 ecosystem impacts
    - 1.5 fire risk
    - 1.6 hydrology
        - 1.6.1 flooding
        - 1.6.2 glaciers
        - 1.6.3 water quality & supply
    - 1.7 mitigation
    - 1.8 social impacts
2. conservation strategies
    - 2.1 adaptive management
    - 2.2 barriers
    - 2.3 education
    - 2.4 effectiveness
    - 2.5 land acquisition
    - 2.6 opportunities
    - 2.7 risk
    - 2.8 support for strategies
        - 2.8.1 connectivity [corridors]
        - 2.8.2 dynamic reserves
        - 2.8.3 ecosystem based management
        - 2.8.4 GAR designations [WHA, UWR, OGMA]
        - 2.8.5 land securement
        - 2.8.6 managed disturbance [prescribed fire, harvesting]
        - 2.8.7 predator control
        - 2.8.8 prey management
        - 2.8.9 protected reserves
        - 2.8.10 regulation
        - 2.8.11 restoration
        - 2.8.12 translocation
    - 2.9 Y2Y Conservation Initiative
3. information
    - 3.1 data
    - 3.2 knowledge
    - 3.3 maps
    - 3.4 models
    - 3.5 monitoring
    - 3.6 science
    - 3.7 uncertainty & credibility
    - 3.8 West Kootenay Resilience Project
4. land use
    - 4.1 agriculture
        - 4.1.1 food security
    - 4.2 backcountry recreation
        - 4.2.1 motorized
            - 4.2.1.1 ATVs & dirt bikes

- 4.2.1.2 heli & cat skiing
- 4.2.1.3 snowmobiling
- 4.2.2 non-motorized
  - 4.2.2.1 hiking
  - 4.2.2.2 mountain biking
  - 4.2.2.3 skiing
- 4.3 development
  - 4.3.1 access
  - 4.3.2 consumerism
  - 4.3.3 cumulative impacts
  - 4.3.4 recreation
    - 4.3.4.1 Jumbo Resort
  - 4.3.5 emissions
    - 4.3.5.1 developing world
    - 4.3.5.2 domestic
    - 4.3.5.3 exporting pollution
  - 4.3.6 forestry
    - 4.3.6.1 silviculture
    - 4.3.6.2 timber harvesting
      - 4.3.6.2.1 allowable annual cut
      - 4.3.6.2.2 Special Committee on Timber Supply
  - 4.3.7 hydro power
  - 4.3.8 mining
  - 4.3.9 residential development
  - 4.3.10 tourism
- 4.4 economy
  - 4.4.1 carbon footprint
  - 4.4.2 cost benefits
  - 4.4.3 cost of energy
  - 4.4.4 economic incentives
  - 4.4.5 employment
  - 4.4.6 full cost accounting
  - 4.4.7 human consumption
  - 4.4.8 human population
  - 4.4.9 multinational corporations
  - 4.4.10 short-term economics
  - 4.4.11 value added
- 4.5 governance
  - 4.5.1 advocacy
  - 4.5.2 BC Hydro FWCP
  - 4.5.3 certification
  - 4.5.4 Columbia Basin Trust
  - 4.5.5 democracy
  - 4.5.6 deregulation
  - 4.5.7 enforcement
  - 4.5.8 ENGOs
  - 4.5.9 federal government
  - 4.5.10 First Nations
  - 4.5.11 government mandate
  - 4.5.12 industry
  - 4.5.13 market leverage

- 4.5.14 policy
- 4.5.15 political system
- 4.5.16 professional reliance
- 4.5.17 provincial government
- 4.5.18 Wildsight
- 4.6 planning
  - 4.6.1 Kootenay Boundary Land Use Plan
  - 4.6.2 landscape unit planning
- 4.7 private land
- 4.8 wildlife management
  - 4.7.1 bears
  - 4.7.2 caribou
  - 4.7.3 deer
  - 4.7.4 habitat conservation
  - 4.7.5 hunting
    - 4.7.2.1 guide-outfitting
    - 4.7.2.2 recreational hunting
    - 4.7.2.3 trophy hunting
  - 4.7.6 species at risk
  - 4.7.7 trapping
  - 4.7.8 wolverine

5. miscellaneous
   - 5.1 Auditor General's report on biodiversity
   - 5.2 Mountain Legacy photography
   - 5.3 participation categories
     - 5.1.1 government
     - 5.1.2 industry
     - 5.1.3 NGO
     - 5.1.4 public
     - 5.1.5 science
   - 5.4 publishing results
   - 5.5 sampling design
   - 5.6 workshop effect
6. motivation
   - 6.1 attitude
     - 6.1.1 concern for future
     - 6.1.2 negative (pessimism)
     - 6.1.3 personal commitment
     - 6.1.4 positive (optimism)
     - 6.1.5 precautionary principle
     - 6.1.6 social norms
     - 6.1.7 urgency
   - 6.2 beliefs
     - 6.2.1 acceptability of change
     - 6.2.2 climate change
     - 6.2.3 education
     - 6.2.4 experience
     - 6.2.5 wildlife impacts
   - 6.3 New Environmental Paradigm
     - 6.3.1 biocentric
     - 6.3.2 anthropocentric

- 6.4 values
  - 6.4.1 moral responsibility to maintain wildlife
  - 6.4.2 social/cultural background
- 6.5 Wildlife Orientation

7. wild design
   - 7.1 change dynamics
   - 7.2 cultural values
   - 7.3 ecological integrity/resilience
     - 7.3.1 ecosystems at risk
       - 7.3.1.1 grasslands
       - 7.3.1.2 old growth
       - 7.3.1.3 riparian habitat
       - 7.3.1.4 wetlands
     - 7.3.2 fire
     - 7.3.3 invasive species
   - 7.4 focal practice
     - 7.4.1 community
       - 7.4.1.1 community resilience
     - 7.4.2 engagement
     - 7.4.3 participation
     - 7.4.4 social justice
   - 7.5 historical fidelity
   - 7.6 human intervention
     - 7.6.1 hubris
     - 7.6.2 ethical dilemma
   - 7.7 paradigm shift

APPENDIX 12 – LIST OF ACRONYMS

AT - Alpine Tundra
BBN – Bayesian Belief Network model
BEC - Biogeoclimatic Ecosystem Classification
BEO - Biodiversity Emphasis Options
BTM - Baseline Thematic Mapping
CORE - Commission on Resources and Environment
CRM - Canadian Rocky Mountains
CRMEA - Canadian Rocky Mountains Ecoregional Assessment
Ctrans - Coastal Transition
CWH - Coastal Western Hemlock
Dry IDF - Dry Interior Douglas Fir
Dry ESSF - Dry Engelmann Spruce – Subalpine Fir
Dry ICH - Dry Interior Cedar – Hemlock
DUC - Ducks Unlimited Canada
EAA - Environmental Assessment Act
EBM - ecosystem-based management
ENGO - environmental non-government organization
ERDZ - enhanced resource development zones
FLNRO - Ministry of Forests, Lands and Natural Resource Operations
FPC - Forest Practices Code
FPCA - Forest Practices Code Act)
FRPA - Forest and Range Practices Act
FSP - Forest Stewardship Plans
GRA - Grassland
GWM - General wildlife measures
HE - Habitat effectiveness score
HPLO - Higher Level Plan Orders
ILMP - Integrated Land Management Bureau
IPCC - Intergovernmental Panel on Climate Change
IUCN - International Union for Conservation of Nature
KBLUP - Kootenay-Boundary Land Use Plan
LRMP - Land and Resource Management Planning
LUCO - Land Use Coordination Office
MCRIP - Mountain Caribou Recovery Implementation Plan
Moist ESSF - Moist Engelmann Spruce – Subalpine Fir

Moist ICH Moist Interior Cedar – Hemlock
Moist IDF - Moist Interior Douglas Fir
MSC - Wet Montane – Sub-boreal Spruce
MSD - Dry Montane – Sub-boreal Spruce
MTA - Mineral Tenures Act
NCC - Nature Conservancy of Canada
NDP - New Democratic Party
NEP - New Environmental Paradigm
OGA - Oil and Gas Activities Act
OGMA - Old growth management areas
PP - Ponderosa Pine
RSF - Resource selection function
SARA - Species At Risk Act
SLUPs - Strategic Land Use Plans
SRMZ - Special resource management zones
USD – United States Dollar
UWR - Ungulate winter range
V Dry ICH - Very Dry Interior Cedar – Hemlock
WCED - World Commission on Environment and Development
Wet ESSF - Wet Engelmann Spruce – Subalpine Fir
Wet ICH - Wet Interior Cedar – Hemlock
Wet IDF - Wet Interior Douglas Fir
WHA - Wildlife habitat areas
WHF - Wildlife habitat features
WMA - Wildlife management area
WTR - Wildlife tree retention
WVO - Wildlife Value Orientation
WWF - World Wildlife Fund Canada
Y2Y - Yellowstone to Yukon regional corridor