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Social Dimensions of Community Vulnerability to Mountain Pine Beetle

Norah MacKendrick and John Parkins

Mountain Pine Beetle Initiative
Working Paper 2005–26

Natural Resources Canada, Canadian Forest Service,
Pacific Forestry Centre 506 West Burnside Road, Victoria, BC V8Z 1M5
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Social Science Research Group
Natural Resources Canada, Canadian Forest Service
5320-122 St. Edmonton, AB, T6H 3S5

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Natural Resources Canada
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506 West Burnside Road
Victoria, British Columbia V8Z 1M5
Canada

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* Corresponding author:
John Parkins, Senior Sociologist
Canadian Forest Service, 5320-122 St., Edmonton, AB T6H 3S5
Tel: (780) 435-7373
Email: jparkins@nrcan.gc.ca

Abstract

There is widespread recognition that the outbreak of mountain pine beetle will have significant social and economic impacts on forest-based communities in British Columbia (BC). Although some communities can be assumed to be vulnerable owing to their proximity to infested regions, there is little knowledge as to the nature and extent of this vulnerability, representing a serious impediment to planning and policy making. This report presents the results of a vulnerability assessment in eleven communities in BC and two communities in Alberta located in regions experiencing various levels of mountain pine beetle activity.

To assess community vulnerability, this project first builds a vulnerability framework based on social science research in the areas of climate change, community capacity, hazards management and risk perception, as well as focus group meetings in five of the study communities. Variables and indicators included in this framework are then measured and combined into a vulnerability index, with index scores assigned to each study community. The spatial variation in vulnerability is further illustrated using Geographic Information Systems analysis.

The final assessment reflects that vulnerability is not simply a function of physical exposure to beetle activity, but also of various social, economic, and political factors that contribute to community adaptive capacity. Therefore, some communities located in areas with high levels of beetle activity have less than expected vulnerability, owing to various capacities inherent in the community, while in other areas with low to moderate levels of activity, vulnerability is somewhat elevated owing to a relative absence of these capacities.

Keywords:

Mountain Pine Beetle, Community Vulnerability, Adaptive Capacity, Community Capacity, Community Sustainability

Résumé

Il semble acquis que l’infestation de dendroctone du pin ponderosa qui sévit actuellement en Colombie-Britannique aura des impacts socio-économiques importants sur les collectivités qui dépendent de la forêt. Même si certaines de ces collectivités peuvent être considérées comme vulnérables du fait de leur proximité par rapport aux secteurs infestés, on sait très peu de choses sur la nature et l’ampleur de cette vulnérabilité. Cette méconnaissance constitue une entrave importante aux processus de planification et d’élaboration de politiques. Le présent rapport expose les résultats d’une évaluation de la vulnérabilité de onze collectivités de la Colombie-Britannique et de deux collectivités de l’Alberta situées dans des régions infestées à des degrés divers.

Pour évaluer la vulnérabilité de ces collectivités, nous avons d'abord élaboré un cadre de la vulnérabilité en nous fondant sur les résultats de recherches en sciences sociales dans les domaines du changement climatique, de la capacité des collectivités et de la gestion et de la perception des risques, ainsi que sur les conclusions de séances de discussion tenues dans cinq des collectivités concernées. Nous avons ensuite mesuré et combiné les variables et les indicateurs intégrés dans ce cadre pour obtenir un indice de vulnérabilité et assigner une cote de vulnérabilité à chaque collectivité. Enfin, nous avons eu recours à des techniques d'analyse du système d'information geographique pour illustrer la variation spatiale de la vulnérabilité.

L'évaluation finale nous révèle que la vulnérabilité ne dépend pas uniquement de l'exposition physique des collectivités à l'activité du dendroctone du pin ponderosa, mais aussi de divers facteurs sociaux, économiques et politiques qui agissent sur la faculté d'adaptation de ces mêmes collectivités. En conséquence, certaines collectivités situées dans des régions gravement infestées ont une cote de vulnérabilité moins élevée que prévue parce qu'elles présentent un certain nombre de capacités intrinsèques, alors que d'autres, situées dans des régions légèrement à modérément infestées mais moins choyées sur le plan des capacités, semblent passablement vulnérables.

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INTRODUCTION

There is widespread recognition by industry, government, and forest-based communities that the outbreak of mountain pine beetle will have significant socio-economic impacts in the province of British Columbia (BC). However, there are few planning or predictive tools that provide a broad-based assessment of community-level vulnerability to the current mountain pine beetle outbreak. This report provides a framework for community-level vulnerability assessment and baseline information for 11 study communities in BC and two comparison communities in the Foothills Model Forest region in west-central Alberta.

Vulnerability can be conceptualized as the risk of unfavourable outcomes to human or environmental communities from large-scale environmental or social change (Smit et al., 1999; McLaughlin and Dietz, Forthcoming). Within a human systems context, vulnerability consists of a physical component (in this case exposure to mountain pine beetle activity) and a "capacity to adapt" component which often includes an assessment of the economic, political, and social systems that support human settlement.

Within the international climate change literature, human vulnerability is often assessed through national measures and global comparisons of, for example, poverty, food security, or the availability of physical infrastructure. Although such methods provide insights at the national level, this project involves an assessment of vulnerability at the community level. Therefore, our tools for assessing differences in vulnerability, from one community to the next, require more precision than the methods typically used for regional and national level vulnerability assessments. In keeping with this challenge, the objectives for this project are as follows:

1. From the published literature, develop a comprehensive framework for community vulnerability assessment to the mountain pine beetle outbreak.

2. Involve community members in determining the key factors associated with vulnerability.

3. Construct a baseline vulnerability assessment of 13 study communities that includes primary and secondary data and report results in tabular and spatial formats.

Within the last two years, the Social Science Research Group, Natural Resources Canada, Canadian Forest Service, has undertaken several studies under the Mountain Pine Beetle Initiative. A recently completed economic analysis involved the development of a regional general equilibrium model (Patriquin et al. 2005). This model can assist in predicting economic impacts under various management regimes. The study presented in this report takes a broader approach by examining other dimensions of vulnerability. Using a different set of research assumptions and data sources, this study identifies political, social, economic, and some institutional factors contributing to the vulnerability of forest-based communities to impacts from the pine beetle infestation. Taken together, these independent research projects carried out by the Canadian Forest Service provide a comprehensive analysis of community and regional impacts and capacities associated with the current infestation.

Government and industry response to community-level impacts from the pine beetle has so far been directed at managing beetle infestation and salvaging timber. As a result, over the next 10 to 15 years, many communities within the BC interior are well positioned to reap significant economic returns as salvage operations run their course. However, as timber supply declines, some communities will be better able than others to cope with this transition. In other words, some communities possess a latent capacity that will serve them well during this transition, and others will struggle to maintain viability. Results from this study show that social, economic, and political factors have a significant impact on community vulnerability compared to a strictly physical assessment of risk.

The vulnerability assessment presented here can assist with provincial and local planning and policy development around the mountain pine beetle outbreak. By comparing vulnerability across a number of forest-based communities, policy makers and planners can better understand how the ability of communities to adapt to the social and economic impacts from the beetle infestation varies regionally, and is not only a function of exposure to beetle activity, but also of various social, economic and political factors. With these more clearly recognized, community leaders and policy makers will be in a better position to make new investments in their communities, and support existing initiatives that could contribute to adaptation strategies.

To more clearly illustrate regional variations in vulnerability, the final outcome of this assessment is a single vulnerability index score. A richer and more informative reflection of vulnerability, however, can be found in the specific variables and indicators that are used to calculate this score, as well as in the findings from the focus group sessions (MacKendrick and Parkins, 2004b). Policy makers, community leaders and planners, therefore, will want to pay most attention to the individual measures that went into this index, and place less emphasis on the final score assigned to each study community.

Background to the mountain pine beetle infestation

The mountain pine beetle infestation in BC has grown to epidemic levels, and is the most extensive infestation ever documented in the province. In 1999 the area of infested forest was approximately 165,000 hectares and in 2003 this area grew to 4.2 million hectares (BC Ministry of Forests 2003). The Ministry of Forests predicts that the current outbreak will create 500 million hectares of ‘grey’ wood, where just under half of this area will not be harvested (BC Ministry of Forests 2004a). In some timber management units, it is predicted that an average of 50% of pine stands could be affected by the beetle over the next one to three years, which will represent a substantial decrease in the Annual Allowable Cut (BC Ministry of Forests 2004a).

Ecological and economic impacts are the first wave of impacts being experienced by communities, as mountain pine beetle infestations result in extensive tree mortality, and have prompted a significant increase in the Annual Allowable Cut to manage the spread of the beetle. The provincial government, for example, has increased the Annual Allowable Cut in beetle-affected areas by 7.8 million cubic metres per year and has made regulatory changes to streamline timber harvest (BC Ministry of Forests 2004a). Increases in harvest will be temporary, as significant decreases in timber supply from tree mortality is predicted to outpace beetle management strategies (BC Ministry of Forests 2003). The province estimates that 30 communities and 25,000 families are being affected by the beetle infestation (BC Ministry of Forests 2004b). In spite of these impacts, the social and economic impacts following this first wave have not yet been examined in much detail.

Provincial and community response to the beetle outbreak gained momentum in 2001, with the introduction of the Mountain Pine Beetle Action Plan (BC Ministry of Forests 2001)—updated in 2004 (BC Ministry of Forests 2004a)—and the Tri-Community Committee Mountain Pine Beetle project (Tri-Community Committee 2002). These plans stress timber management goals and the coordination of the harvesting and milling of wood, but have little focus on managing the socio-economic impacts at the community level. These plans, nevertheless, recognize that communities will be affected by decreases in timber supply, deteriorating forest conditions and possible increases in fire hazard. In the government of British Columbia's most recent action plan, (BC Ministry of Forests 2004a) there is one socio-economic goal relating to human communities, which is to "minimize the loss of economic benefits to local communities" (p. 2). This document suggests that harvest increases for beetle management will have economic benefits for communities as well as for the Crown. There is little recognition, however, that these benefits are short-term and will diminish when the timber supply eventually decreases. In 2001, the Tri Community Committee was formed—also known as the Regional Community Economic Development Management Committee—involving representatives from the communities of Fraser Lake, Vanderhoof, and Fort St. James. This committee has developed a community-driven beetle strategy (Tri-Community Committee 2002) to deal with short and long term socio-economic impacts from infestation controls in the local forest region. Critical issues identified in this report relate largely to forest health, the capacity to harvest and mill wood, funding availability for beetle control measures.

Study Sites: BC

The importance of the forest industry as a primary economic sector and the proximity to mountain pine beetle activity indicates that many communities in the interior region of BC are vulnerable to the social and economic impacts from this epidemic. The study communities selected for analysis reflect the various degrees of pressure being experienced across the province. Eleven communities located in 10 Timber Supply Areas throughout the interior region of BC are examined in this study and are listed in Table 1. Figure 1 provides a map of the study region and level of mountain pine beetle damage in BC and Alberta.

Table 1. Study communities, BC

Community Name	Corresponding Timber Supply Area
100 Mile House	100 Mile House
Burns Lake	Lakes
Cheslatta Carrier First Nation	Lakes
Cache Creek	Kamloops
Houston	Morice
Invermere	Invermere
Mackenzie	Mackenzie
Quesnel	Quesnel
Salmon Arm	Okanagan
Vanderhoof	Prince George
Williams Lake	Williams Lake

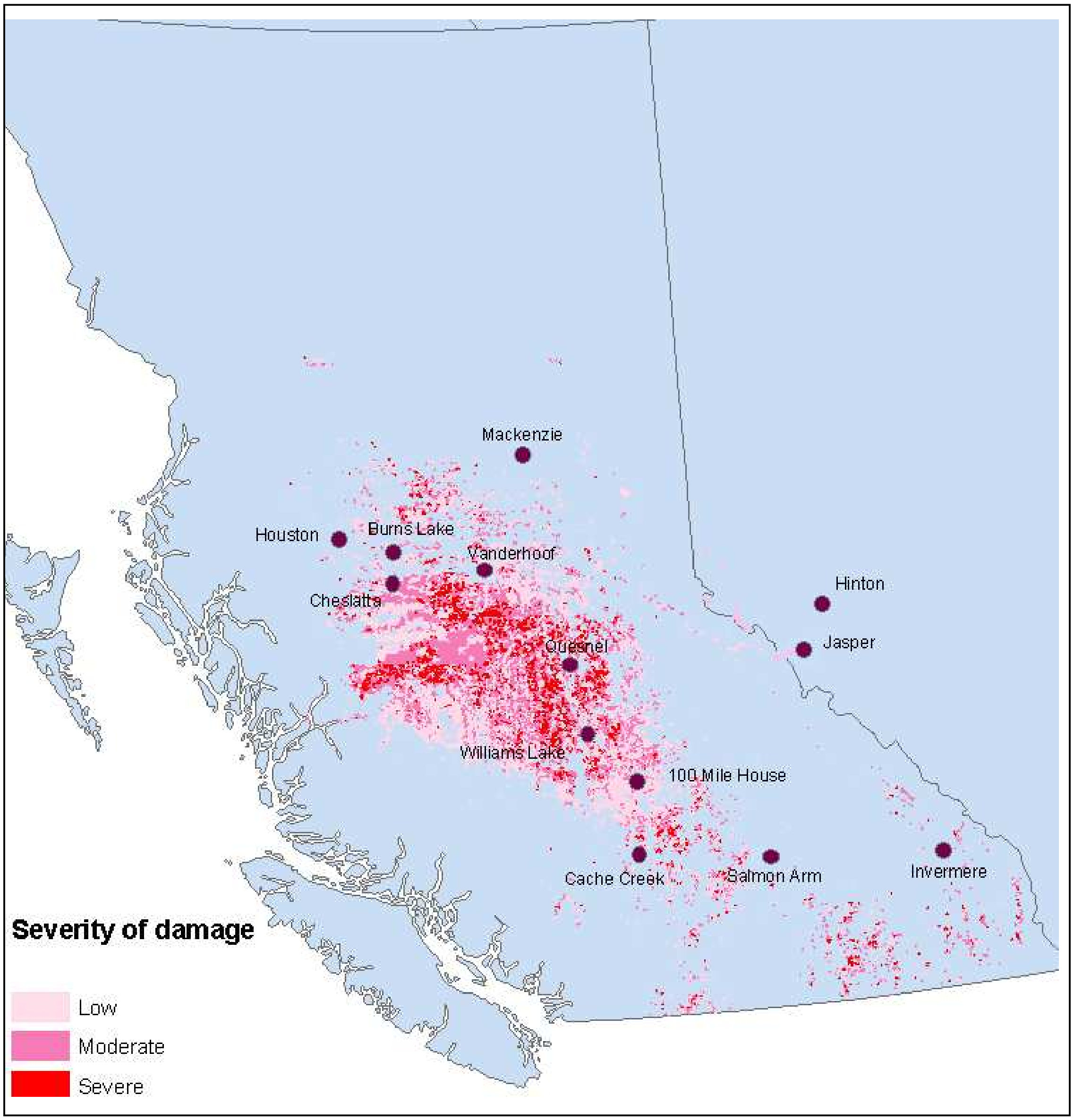
Study communities vary in size, degree of forest dependence, and proximity to mountain pine beetle activity. Three of the study communities, Quesnel, Salmon Arm and Williams Lake, are small cities, while the remaining communities are classified as villages or municipal districts. The study also includes the Cheslatta Carrier First Nation. For the most part, study communities in the northern interior of the province are more dependent on the forest sector than those in the southern interior region. Mackenzie, for example, has 100% of labour force income coming from forest activities while Invermere has only 27%. As illustrated in Figure 1, in 2004 the severity of mountain pine beetle damage around study communities varies widely, with greatest damage close to the communities of 100 Mile House, Burns Lake, Cheslatta Carrier First Nation, Quesnel, Williams Lake and Vanderhoof. Moderate damage is found near Cache Creek, Houston and Salmon Arm. Very little damage is found near the communities of Invermere and Mackenzie.

Study Sites: Alberta

Along with the analysis of BC communities is a parallel project looking at similar relationships in the Foothills Model Forest region—an area located in west-central Alberta. This report will also include findings for the two communities of Jasper and Hinton within the Foothills Model Forest area, and vulnerability in this region will be compared to the experience in BC study communities, particularly as the Foothills Model Forest area has not yet experienced significant mountain pine beetle activity, but owing to large tracts of older pine forest, is predicted to have greater activity in the future.

The Foothills Model Forest is a 2.75 million-hectare area of land in west central Alberta. There is very little mountain pine beetle activity in this region, especially compared to the outbreak in neighbouring BC. Existing activity is restricted to small areas within Jasper National Park. Hinton is the largest urban centre in this region, and its local economy depends on the natural resource sectors such as forestry, oil and gas, and mining. Jasper is a much smaller community located in Jasper National Park. This community has no forestry sector, but depends largely on the tourism and public service sectors.

Figure 1. Map of Study Communities and Severity of Mountain Pine Beetle Damage[1]



VULNERABILITY FRAMEWORK

International assessment

The literature on vulnerability can be divided into two broad areas: research dealing with issues at the international or global scale, and research dealing with issues at the community or local

1 Severity of damage data for 2004 were provided by the BC Ministry of Forests, Forest Practices Branch. Alberta data provided by Alberta Sustainable Resource Development, Forest Health Section. Jasper National Park data provided by Jasper National Park.

N.B: Data for Jasper National Park does not represent severity of beetle attack but rather observations of beetle presence (represented by small pink-shaded areas). In addition, this data does not include all sites that may have mountain pine beetle, and some sites documenting beetle presence may have not been field verified.

scale. Table 2 provides a summary of themes in these areas. Within the international literature, one of the most widely recognized definitions of vulnerability comes from the Intergovernmental Panel on Climate Change (IPCC), which defines it as " the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes." (IPCC 2001). In general, climate change researchers agree that vulnerability is the extent to which a system is exposed to an event and its capacity to be harmed. Vulnerability is also viewed as a function of the system's adaptive capacity and the IPCC has identified various determinants of adaptive capacity, such as technology, social capital, resource availability, human capital, institutional decision-making capacity, and public perceptions of climate change events (IPCC 2001).

Although widely cited, the IPCC conceptualization of vulnerability has been criticized in favour of definitions recognizing a greater complexity in the meaning of vulnerability. Social science approaches to climate change vulnerability begin to address some of these criticisms. Adger et al. (2004), O'Brien (2004), and Brooks (2003), for example, argue that the definition of vulnerability for social systems must be distinct from that of biophysical systems, and that vulnerability must not only emphasize impacts and damage to systems, but the characteristics of the system that allow it to cope with change. In general, this literature recognizes that vulnerability is a state or a process, rather than a set of biophysical impacts arising from a particular event (Brooks 2003; Adger et al. 2004; O'Brien 2004). Some global assessments of vulnerability use poverty, food security, or a general absence of economic or physical infrastructure as proxies for vulnerability, particularly when comparing developed and undeveloped nations (Adger and Kelly 1999; Handmer et al. 1999).

When assessing vulnerability for industrialized nations, a number of other measures emerge. Vulnerability in these countries, for example, is thought to depend on institutional and political factors, as institutions are expected to plan for and respond to events and mitigate ensuing impacts (Dow 1992; Adger and Kelly 1999; Handmer 1999). Vulnerability is also influenced by economic circumstances that magnify damages from undesirable events including debt, market dependency, economic inequality and limited access to financial and natural resources (Dow 1992; Adger and Kelly 1999; Cross 2001). Regions with economies dependent on a single sector or employer, for example, will be worse off than those with multiple sectors and employers that can sustain the community through periods of stress or offset impacts to one sector (Cross 2001). Social capital—social networks that enable collective action—is also thought to influence vulnerability (Adger 2003).

Barry Smit, a geographer from the University of Guelph, has been instrumental in exploring national-level adaptation, adaptive capacity and vulnerability in the context of climate change. He argues that adaptation is the ecological, economic and social adjustments in response to stimuli or impacts (Smit et al. 1999), which can be analyzed using a framework that first identifies the stimuli to adaptive response (e.g., stress, hazard or disturbance), the system that is adapting (local vs. global, or social system vs. ecosystem) and how adaptation occurs. Determinants of adaptive capacity are thought to include economic wealth, technology and information skills, infrastructure, institutions, social capital, and equity (Smit and Pilifosova, 2001).

Policy learning and adaptation to changing conditions by key political, social and economic institutions is also considered essential to adaptive capacity, as institutions can contribute to vulnerability and adaptation efforts (Adger and Kelly, 1999; Handmer et al., 1999; Adger, 2000). Few—with the exception of Adger (2000)—have examined these processes empirically. According to Adger (2000) institutional adaptation is the outcome of institutions evolving in response to external and internal forces, while policy learning is the strengthening of organizational objectives in response to change. Adger argues that institutional evolution is a function of both decision-making and “non-decision making”, where non-decision is a process where issues are prevented from entering the political domain.

Some of the social science literature has taken insights from the literature above and developed specific indicators of vulnerability to climate change at the national level that take into account adaptive capacity and policy learning and adaptation. Recently, for example, Adger et al. (2004) identified nearly 50 vulnerability indicators for national analyses. Some of these indicators include: population wealth, inequality, educational commitment, isolation of rural communities, quality of basic infrastructure, willingness of key institutions to invest in adaptation, and various measures of environmental sustainability (Adger et al. 2004).

Although the scale of analysis for the literature reviewed in this section is national and global, many of the factors thought to influence adaptive capacity and vulnerability can be operationalized for community assessments. In the next section, we review the literature that takes a community-level approach to vulnerability assessment.

Community assessment

One approach to community assessment involves the natural hazards and disaster literature. In this context, community capacity is examined in response to hazard or disasters that are not expressly linked to climate change or related phenomena. This hazard literature, similar to the climate science approach, also adheres to the understanding of vulnerability as a function of exposure to an event, system sensitivity, and resilience or adaptive capacity (e.g., National Oceanic and Atmospheric Administration, Coastal Services Centre 1999; Cross 2001; Alcantara-Ayala 2002; Pelling 2002). Often using the language of risk, this research takes into account the probability of occurrence, how much of the system was exposed, and the resilience of the system. For example, Tobin (1999, 2002) has examined community resilience and adaptation to disasters in the context of hazards planning, and has developed various models that can be used to understand how communities survive and recover from extreme events such as volcano eruptions and hurricanes. Although best suited to the study of hazards, one of these models, the structural cognitive model, includes vulnerability indicators that could be modified for research examining more gradual climate change events, such as the mountain pine beetle outbreak in BC. This model emphasizes structural factors such as age, family structure, wealth, gender, and education contributing to vulnerability, as well as cognitive factors such as attitudes towards mitigation and recovery efforts (Tobin 1999). Tobin’s work also identifies support from political agencies and leaders as key to successful hazards planning (Tobin 1999). Other research has likewise recognized that communities with coordinated scientific, social, and economic organizations, along with informed and proactive political bodies, are better able to reduce vulnerability than those without this coordination or organizational capacity (Comfort et al. 1999).

A second approach to community assessment involves the forest sociology literature. The United States Department of Agriculture Forest Service has recently published several community studies of resilience. Similar to this study, these studies collect and analyze perceptual and secondary data to measure characteristics of resilience including population change, forest economic dependence, quality of life, and economic diversity. One study by Harris et al. (2000) found that community size has a considerable influence on resilience where smaller communities tend to be less resilient than larger communities. These authors also conclude that economic diversity, community autonomy and leadership, and forest dependence all contribute to greater community resilience. A more recent study by Daniels (2004) makes similar conclusions for communities experiencing considerable forest management transformation, and emphasizes the importance of well-developed transportation infrastructure, proximity to major urban centres, and economic diversity. Unlike the study by Harris et al., Daniels finds—not surprisingly— that forest dependent communities are more vulnerable to changes in forest management.

The forest sociology literature also addresses community capacity in response to the destabilizing effects of economic cycles on forest communities. Community capacity is defined in this literature as the ability of a community to "respond to external and internal stresses; to create and take advantage of opportunities; and to meet the diverse needs of residents," in addition to the community's ability to "respond and positively adapt to a variety of circumstances" (Kusel 2001). This concern over the type of community response to stress reveals its compatibility to the literature discussed earlier. Other definitions of community capacity also exist, such as that offered by Beckley et al. (2002) who define it as "the collective ability of a group (the community) to combine various forms of capital within institutional and relational contexts to produce desired results or outcomes" (p. 7). The number of capitals, and how they are described varies within the literature, but in general community capacity is thought to depend on economic resources and physical infrastructure, social networks, natural resources and ecosystem services, and individual skills and knowledge. Beckley et al. (2002) describe these resources as economic capital, social capital, natural capital, and human capital. Within each of these capital domains are indicators that allow researchers to assess community capacity. Within economic capital, for example, are variables measuring property values, labour force retention, and community license over natural resources, while human capital variables measure education and training, and social capital variables measure trust and social networks (MacKendrick and Parkins 2004a). Owing to these many facets of community capacity, assessments normally employ large indicator sets.

Health promotion research has also focused community capacity and resilience as a key concept. Although no single definition of community capacity emerges from this body of research, it is broadly described as a process where community members are increasingly able to define, analyze and mobilize themselves around issues of concern, and is dependent on community assets, as well as resource constraints (Goodman et al. 1998; Gibbon et al. 2003; Kwan et al. 2004). Similar to other community capacity research, the health promotion literature recognizes that community capacity requires the mobilization of human and social capital to solve collective problems and improve or maintain well-being (Goodman et al. 1998; Chaskin 2001).

Being multi-disciplinary, the community assessment literature offers considerable overlap between key concepts and factors contributing to our understanding of vulnerability. These concepts provide a strong foundation for the development of a vulnerability assessment framework that guides the empirical phase of this project. Table 2 illustrates this overlap and documents the key concepts and scales of analysis found within both the climate change literature and the community assessment literature.

Table 2. Summary of major themes in climate change and community assessment literature

LITERATURE	TOPICS AND ISSUES
International assessment	
Climate science	Examines extent to which a system is exposed to an event and its capacity to be harmed; total impacts or residual damage caused by major events Identifies social determinants of adaptive capacity
Social science	Vulnerability considered a state or process Indicators for underdeveloped nations: -Poverty -Debt -Food security -Economic & physical infrastructure Indicators for developed nations: -Economic inequality -Access to financial & natural resources -Social capital -Technology and information skills -Institutional and political factors -Policy learning and adaptation
Community assessments:	
Hazard and disaster research	Age distribution, family structure, wealth, gender, and education Attitudes towards mitigation and recovery Coordination of scientific, social, and economic organizations Planning and information
Rural communities & climate change	Autonomy of local institutions National governance structures Political capacity Human capital overadaptation
Community capacity	Economic capital Social capital Natural capital Human capital
Health promotion: community capacity	Mobilization of human and social capital Sense of community Participation in local organizations Community leadership Resource access and mobilization Linkages with external organizations/individuals Local control over planning & management Resource distribution Community involvement in development of indicators

Public Perceptions of Risk

One final component of community vulnerability involves a thorough consideration of public perceptions of impacts from the mountain pine beetle. For many physical scientists and experts involved with the science and management of beetle outbreaks, it is often difficult to give credence to public perceptions. Public perceptions of risks are often thought to be misinformed and out of line with expert understandings of the physical and economic impacts. A common reaction to this mismatch is to either disregard public perceptions or develop education and communication strategies that are designed to bring public risk perception into line with expert risk perception. In spite of this reaction, there is a rich body of evidence to suggest that public risk perception should not be discounted as irrational. Rather, these public perceptions should be taken seriously and incorporated into environmental risk decision-making.

Within the social science literature, there are several ways in which public knowledge of risks is treated. Within the health literature, the notion of popular epidemiology involves a process of laypersons gathering information, knowledge and resources in order to understand the epidemiology of a particular disease. Such processes can lead to valuable data that often would be unavailable to scientists through more traditional scientific methods (Brown 1996). Other scholars talk about cultural forms of rationality (Perrow 1984), civic science (Fischer 2000), and social rationality whereby risks are defined primarily by their perceived threat to familiar social relationships; such as those of established local communities and economies, rather than by "numerical magnitude or physical harm" (Szerszynki 1999).

In general, there is a strong recognition in the social science literature that nearly all risk assessments and risk management strategies are laden with uncertainty, and that experts as well as the public are subject to bias regarding values and priorities Therefore, an emphasis solely on technical information privileges one form of knowledge over another (Dietz et al. 2000). Perhaps the strongest argument in privileging public risk perception comes from a leading risk perception researcher who makes a strong claim for the rationality of public risk assessment. Based on numerous studies, Slovic concludes that, "although one may legitimately disagree with public perception of risk, they are clearly not irrational. More generally, psychometric research demonstrates that, whereas experts define risk in a narrow, technical way, the public has a richer, more complex view that incorporates value-laden considerations such as equity, catastrophic potential, and controllability" (Slovic 1992). Given this prominent shift in understanding of public perceptions of risk, it is becoming increasingly difficult to either discount these perceptions as irrational and meaningless or attempt to bring public risk perceptions on side with expert risk perceptions. Rather, a clear alternative involves acknowledging that a combination of expert and public risk assessment offers specific advantages and opportunities to improve on environmental risk decisions. (Dietz et al. 2000).

In assessing vulnerability at the community level, a number of authors have identified risk perception as a critical factor and call for a vulnerability assessment framework that integrates community capacity and risk perception research (Davidson et al. 2003; McLaughlin and Dietz Forthcoming). For the most part, researchers have operationalized risk perception at the individual level, reasoning that individuals who perceive a presence of risk or vulnerability are more inclined to act in ways that will mitigate risk. Heightened risk perception works to engage actions that lead to adaptive strategies.

Within this risk perception literature, there are two clear ways in which public perceptions contribute to a vulnerability assessment:

- Public risk perception is connected to physical risks and leads to a holistic understanding of the 'real risks' associated with the mountain pine beetle epidemic.
- Public risk perception is connected to adaptive capacity in terms of linking knowledge and understanding to the actions oriented around mitigating risk.

Given this strong push within the social science literature for integration between expert and public risk assessments, public risk perception data is included in the vulnerability assessment framework alongside numerous science-based and technical indicators.

Vulnerability assessment framework

As vulnerability is a function of exposure and adaptive capacity, a vulnerability assessment framework should address both of these elements. The combination of these two major elements of vulnerability results in a more holistic approach to vulnerability assessment. The vulnerability assessment also considers the physical exposure to mountain pine beetle activity along with social, economic, political, and institutional domains associated with community capacity. Given that a thorough treatment of each domain would involve numerous indicators, the final assessment framework builds on existing data sources wherever possible. The final vulnerability assessment framework is presented in Table 3.

The indicators and domains identified below are combined in the final stage of the research process into a final vulnerability index score. This development of a single vulnerability score is practical in that it provides a simple method of identifying regions most vulnerable to the social and economic impacts from the mountain pine beetle outbreak. However, this score is also somewhat misleading, as it does not reflect the various elements within study communities that work to increase and decrease vulnerability. For this reason, one should not place too much emphasis on the final vulnerability index score, and should instead consider more carefully the specific community characteristics measured under each dimension and indicator.

In the following section, each component of the vulnerability assessment framework is discussed in detail.

Physical dimension

As defined in the literature review, vulnerability involves an assessment of physical susceptibility to a particular threat. The physical dimension involves an assessment of both the current and future susceptibility of regional forests to beetle attack along with perceived impacts on the community from the beetle outbreak.

<u>Current forest susceptibility</u>

Current forest susceptibility is determined by an assessment of the density of susceptible pine (m^3/ha) by Timber Supply Area (2003). Data are supplied by the BC Ministry of Forests.

Future forest impact

Future forest impact is determined by the projected cumulative density of pine killed (m^3/ha) by Timber Supply Area. Data are supplied by the BC Ministry of Forests.

Perceived impact

Consistent with the social science literature that has identified a rational and complementary role for public risk perception in environmental risk assessments, this indicator provides an opportunity for the physical dimension to be more tightly coupled with physical risk perceptions at the household level. Data for this indicator are derived from the household survey.

Political dimension

The literature review identified a prominent role for the political dimension of vulnerability. Support from political agencies and leaders is thought to be key to successful harm reduction and this dimension of vulnerability is measured using community evaluations of the quality of leadership around mountain pine beetle management. Household risk assessments are also key to this dimension and are related to support for political organizations working on adaptation strategies. Data for this dimension are derived from the household survey.

Community risk awareness

If risk and awareness are high among community members, they are more likely to respond proactively to plans and policies associated with social and economic transitions that result from the beetle outbreak. Consequently, this indicator combines several measures of community risk awareness: personal importance of beetle activity, perceived risk to community from beetle activity, and basic knowledge and awareness of the mountain pine beetle.

Evaluation of community leadership

This indicator combines several measures related to community level activities in response to the beetle outbreak. One measure deals with trust in government institutions, one measure provides an evaluation of community mountain pine beetle management efforts, and one measure focuses on satisfaction with local beetle management efforts.

Economic dimension

The economic dimensions of vulnerability feature prominently within the published literature. Within the international assessment literature, economic and physical aspects often serve as proxies for vulnerability. Within the community assessment literature, economic forms of capital, or economic assets, are thought to contribute substantially to the collective ability of groups to respond positively to various circumstances. An assessment of this dimension involves technical information and information on public perception of local economic resilience.

Economic diversity

Economic diversity is a measure of the uniformity (evenness) of employment across all sectors of the economy. This index (technically known as Shannon-Weaver entropy index) is calculated by determining the portion of total personal income derived from one sector, divided by the total income from all sectors. It is a common measure of economic diversity in the forest sector (Christensen et al. 2000) and it provides an assessment of the ability of a community to absorb shocks in one sector of the economy by moving employees into other local economic activity. Data are derived from the 2001 Census of Canada.

Forest dependence

Forest dependence was calculated with an economic base methodology that determines the proportion of employment income in a Census Subdivision (CSD) that was derived from the forest sector (see Korber et al. 1998 for detailed methodology). Communities with a higher proportion of employment income from the forest sector are more vulnerable to economic shocks within the forest sector. Data are derived from the 2001 Census of Canada.

Long-term forest resources available to community

This indicator focuses on the biophysical dimensions of vulnerability that are most closely associated with economic activity. The rationale behind this indicator is that when pine is not the dominant harvestable species in the surrounding Timber Supply Area, the local forest sector will be more able to withstand impacts of a mountain pine beetle outbreak. The indicator is derived from BC Ministry of Forests as percent pine by area for the Timber Harvesting Land Base.

Community assessment of local economic resilience

Consistent with the physical and political dimensions of vulnerability, this indicator provides a public risk perception component to the technical assessment of economic vulnerability. It is derived from the household survey as perceived local economic resilience.

Socio-economic dimension

The social dimensions of vulnerability are thoroughly discussed in the published literature. Within the international assessment literature, issues of poverty and equality are clearly linked to vulnerability. National vulnerability indicators include measures of population wealth, education attainment and assessments of basic infrastructure. Within the community assessment literature, notions of human capital (such as human health and individual skills and abilities), along with notions of social capital (such as social cohesion and community attachment) play a big role in determining the levels of community capacity.

Socio-Economic Index

Collecting primary data on the vast array of social factors within this dimension for each of the study communities would require substantial time and resources, whereas existing socio-economic data sets are readily accessible in BC. Consequently, a socio-economic index from BC Stats (2004) is used as a way of building on existing data for the communities in the region. Indicators included in this measure of socio-economic well-being include human economic hardship, crime, health, education, children at risk and youth at risk. This index provides a foundation for assessing the capacity of communities to respond positively to the mountain pine beetle outbreak. In the Foothills Model Forest region, 2001 Census data for educational attainment and incidence of low income is used to construct a similar index to assess socio-economic well-being.

Coupled with a more detailed assessment of the physical, political and economic dimensions of the outbreak, the vulnerability index attempts to provide a more holistic assessment of community level vulnerability to this unprecedented forest health issue in the BC interior.

Table 3. Vulnerability index

Index Dimension	Indicator	Variables	Data Source
Physical	Current forest susceptibility	▪ Susceptibility of pine (m^3/ha) by Timber Supply Area (2003)	BC Ministry of Forests, Research Branch (Special data request)
	Future forest impact	▪ Projected cumulative volume of pine killed (m^3/ha) by Timber Supply Area by 2010	BC Ministry of Forests, Research Branch (Special data request)
	Perceived impact	▪ Perceived degree of impact on community from beetle activity ▪ Nature of perceived impact on community (positive vs. negative)	Household Survey
Political	Community risk awareness	▪ Personal importance of beetle activity ▪ Perceived risk to community from beetle activity ▪ Basic knowledge and awareness of mountain pine beetle	Household Survey
	Evaluation of community leadership	▪ Trust in government institutions to manage impacts and risk from beetle ▪ Evaluation of community efforts to respond to beetle presence ▪ Satisfaction with local beetle management efforts	Household Survey
Economic	Economic diversity	▪ Economic diversity index	2001 Census data
	Forest Dependence	▪ Percent labour force income from all forest activities	2001 Census data
	Long term forest resources available to community	▪ Percent pine by area for Timber Harvesting Land Base	BC Ministry of Forests, Forest Analysis Branch (Timber Supply Analysis Reports)
	Community assessment of local economic resilience	▪ Perceived local economic resilience	Household Survey
Socio-economic	Human economic hardship, crime, health, education, children & youth at risk	▪ Socio-economic index rating	BC Stats (2004)

Institutional Capacity Analysis

Another component of this analysis is an examination of institutional capacity. Originally part of the vulnerability framework, this component of the study was separated from the vulnerability index, largely owing to problems collecting data in all study communities. The purpose of this assessment is to determine the capacity of local institutions to engage in policy learning and adaptive strategies.

As illustrated in Table 4, external and internal constraints on planning as perceived by organizational leaders, as well as the perceived quality of coordination among community organizations are thought to be vital to the functioning of organizations dealing with impacts from the mountain pine beetle outbreak.

External and internal constraints on planning

This indicator measures the perceived influence of external factors (such as geographic location and economic factors) and internal factors (such as organizational resources, knowledge and skills) on planning and policy-making. Data are derived from the leaders survey.

Organizational coordination:

This measure assesses the perceived ability of organizations within the community to cooperate and coordinate activities directed toward common goals. Data are derived from the leaders survey.

Table 4. Institutional Capacity Analysis

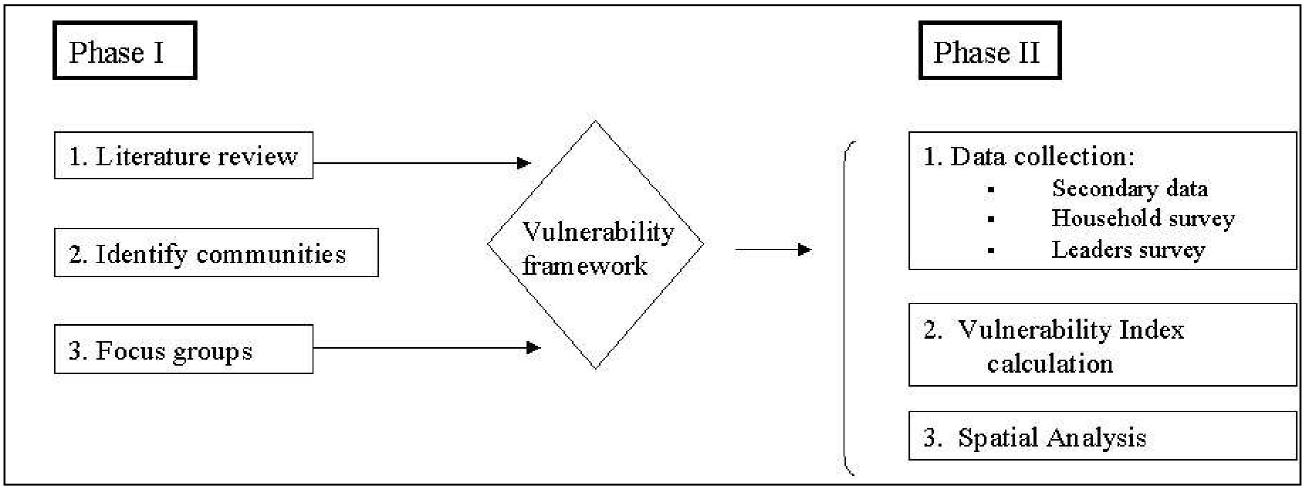
Indicator	Variables	Data Source
External and internal constraints on planning	▪ Perceived internal constraints ▪ Perceived external constraints	Leaders Survey
Organizational coordination	▪ Perceived level of overall cooperation and coordination among organizations in the community	Leaders Survey

Material and Methods

The research process was divided into two phases, and is illustrated by Figure 2. The first phase was an exploratory phase that included a comprehensive review of the social science literature examining vulnerability, the identification of study communities, and focus group sessions. The purpose of this phase was to develop a vulnerability framework to guide the second phase of the study. In the second phase, components of the vulnerability framework were measured in all of the study communities, and integrated into a Vulnerability Index. Data was collected from a household and leaders survey, and secondary data was compiled from several government agencies. The second phase also involved a Geographic Information Systems (GIS) analysis of Vulnerability Index data.

There were some key differences in the research methodology for the Foothills Model Forest study. As this Alberta component was added to the study after the development of the Vulnerability Framework, focus groups were not held in this region. Because of differences in the type of data available there are also some differences in how certain variables were measured for this region and the BC communities, particularly regarding physical data and the socio-economic index. These variations are noted in the findings section.

Figure 2. Research Process and Phases



Phase I

The purpose of phase I was to develop a vulnerability framework. The vulnerability framework was developed by first creating a preliminary framework based on a review of the current climate change, risk, and community capacity literature, and then refining the framework using feedback from the community focus groups.

Upon completion of the preliminary framework, study communities were identified and focus groups organized. Eleven study communities located within the boundaries of the 2004 Emergency Bark Beetle Management Area [2] were identified, each representing a unique combination of geographic location, magnitude of exposure to beetle activity (as of 2004), and social and economic characteristics. Refer to Table 1 for a list of the BC study communities and Figure 1 for a map of the study region. For the Foothills Model Forest Region, Jasper and Hinton were chosen as study communities as they are the two largest communities in this region.

Once study communities were identified, focus group meetings were organized to ensure that the preliminary framework would adequately address local concerns, as well as to identify any indicators that were missing from the framework. In general, focus groups involve a group interview and discussion moderated by a researcher. They are a widely used method of social research typically used in the exploratory phase to generate hypotheses or learn more about the basic issues and relationships under investigation (Morgan 1998; Neumann 2000).

[2] The Emergency Bark Beetle Management Area map was obtained from the Ministry of Forests Mountain Pine Beetle website (http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/) at the beginning of the study in April 2004. The map was recently updated with a 2005 version, which is available at: http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/maps/ebbma/Ebbma_Jan05.pdf

Focus group meetings were held in five study communities representative of the study population and various magnitudes of beetle exposure. Communities were also chosen based on the municipal district's interest in the project and willingness to assist with the organization of the focus groups, particularly as the municipal government was vital to the identification of key community members and organizations that should be involved in such meetings. The communities of 100 Mile House, Burns Lake, Invermere, Quesnel, and the Cheslatta Carrier First Nation were chosen as focus group sites.

Invitees, drawn from lists provided by municipal governments and associated agencies, were invited by fax or email four to six weeks in advance of the meeting. Approximately twenty individuals from each community representing the areas of forestry, local government, provincial government, economic development, social services, public health, education, and tourism were invited to attend the meetings. Invitees were also invited from neighbouring communities and rural areas.

Approximately four to ten individuals attended each focus group session. The principal investigators facilitated the sessions using both close-ended questions requiring participants to write a response and share their views in a roundtable format, as well as open-ended questions to allow for unstructured discussion. Notes were taken throughout the meeting, and all focus groups were tape-recorded.

Participants were asked to discuss the following subjects:

1. Current and future social and economic impacts from mountain pine beetle
2. Factors contributing to their community's adaptive capacity
3. Past hardships in community that could influence present or future adaptive capacity
4. Community awareness of mountain pine beetle
5. Organizational responsibility for dealing with social and economic impacts from mountain pine beetle.

The format of the meeting with the Cheslatta Carrier Nation representatives was slightly different from the other four focus group communities. Researchers met over one and a half days with a senior policy analyst with the Cheslatta Carrier Nation. Researchers also met with a community elder and two other Cheslatta Carrier Nation employees, and were given a tour of Cheslatta Carrier Nation land heavily affected by mountain pine beetle. The same questions addressed in the four previous focus group meetings were also addressed during these meetings.

After the focus group sessions, key findings were synthesized from meeting notes, participant question sheets, and audiotapes.

Similar to the perspective of the published literature on community vulnerability, focus group participants highlighted the policy and economic dimensions of community vulnerability from the beetle outbreak. Focus groups, for example, highlighted the need for proactive community planning which is analogous to the emphasis in the literature on the need for sufficient political and institutional capacity to prepare for change. Focus groups also emphasized the importance of economic diversity and social well-being as components of a vulnerability assessment.

The focus groups also highlighted two factors not identified in the literature but later added to the final vulnerability framework (outlined in Table 3 above). Specifically, respondents noted that the forest resources available to the community are key to the measurement of vulnerability, as communities with access to species other than pine will have more options for forest harvest after a beetle outbreak. Respondents also reasoned that a vulnerability analysis should take into account the current and future wood supply's susceptibility to beetle attack. As a result of these comments, a physical dimension was added to framework, and within the economic dimension, a variable measuring the forest resources available to the community was also included. Detailed focus group results are presented in a separate report (MacKendrick and Parkins 2004b).

Phase II

Data for the measurement of many indicators were obtained through secondary sources, as well as a household and leaders survey.

Under the physical dimension, secondary data for the current forest susceptibility and future forest impact variables were provided by the Research Branch of the BC Ministry of Forests. Current susceptibility refers to the volume per hectare in 2003 of live pine greater than sixty years old in a biogeoeclimatic classification zone climatically suitable for mountain pine beetle activity. Future forest impact refers to the cumulative volume per hectare of pine killed by 2010, and is based on a draft simulation model whose development was funded by the Mountain Pine Beetle Initiative.[3] For further information on this model refer to Eng et al. (2004).

In the Foothills Model Forest susceptibility was calculated somewhat differently. It was measured by looking at the percent area of the Foothills Model Forest region considered highly susceptible to beetle attack. Data for this variable was based on Arcview grid data from a model developed by Alberta Sustainable Resource Development, Jasper National Park, Weldwood of Canada, Foothills Model Forest, Canadian Forest Service (Pacific Forestry Centre), and Gowlland Technologies. Future impact is not calculated, as data is not available for this region.

Under the socio-economic index dimension, values for BC communities were taken from the Regional Socio-Economic Profiles & Indices compiled by BC Stats. The index is comprised of six indicators (Human economic hardship, crime, health, education, children at risk and youth at risk) and are each weighted according to their conceptual importance to the overall index. BC provides scores at two jurisdictional levels: Local Health Areas and Regional Districts (also known as Census Divisions). Local Health Area jurisdictions were chosen as community-level approximations because they are much smaller areas than the Regional District. These areas, nevertheless, include the larger rural area, as well as other small urban regions, and therefore scores for study communities should be interpreted with some caution.

As socio-economic index scores from BC Stats are available only for BC communities, a different socio-economic index was used for Jasper and Hinton. Two variables from the 2001 Canadian Census of Population, collected and compiled by Statistics Canada, were combined to form a simple socio-economic index for this region. These variables are highest level of schooling and incidence of low income. For highest level of schooling, two measures were used: percent of the population without a high school diploma/certificate, and percent of the population without any post-secondary education (including a post-secondary diploma). Incidence of low income was calculated from incidence for economic families and unattached individuals. Final

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3 Data were provided by Marvin Eng, Landscape Ecologist, Research Branch, British Columbia Forest Service 722 Johnson Street, Victoria, BC, Canada PO Box 9519 Stn Prov Govt, Victoria, BC, Canada, V8W 9C2

socio-economic index values were calculated by assigning a score from one to ten to Jasper and Hinton according to their relative position in the provincial distribution of values for each education and incidence of low income variable. Rankings were then averaged to obtain the final index score.

Data for the assessment of the economic dimension variables of economic diversity and forest dependence was provided through a separate analysis conducted by staff of the Social Science Research Group at the Canadian Forest Service's Northern Forestry Centre. Both of these variables use custom labour force data from the 2001 Canadian Census of Population compiled by Statistics Canada. Economic diversity values for BC range from 0.00 to 3.63, where higher diversity values indicate greater economic diversity. Forest dependence figures refer to the percent of total labour force income from forest sector economic activity. For the long-term forest resources variable, forest resources data (percent pine by area) were provided by the Timber Supply Analysis reports for each Timber Supply Area, which are published by the Forest Analysis Branch of the BC Ministry of Forests (refer to BC Ministry of Forests – Forest Analysis Branch, 2005). The third economic dimension variable, perceived impact, was measured using household survey data. The following section describes the survey methodology.

Household survey

Primary data for measurement of political and economic dimension variables were collected using a random sample household survey mailed out to 2217 households in BC, and 589 households in the Foothills Model Forest Region. Respondents were randomly selected using a household telephone directory and then recruited by telephone. A survey was mailed to households agreeing to participate in the survey within ten days of recruitment. Enclosed with the survey was a letter explaining the purpose of the study and the deadline for survey returns, as well as a postage paid self-addressed envelope for returns. After four weeks, if the respondent had not yet returned their survey, a second survey was mailed to the home with a letter reminding the respondent to reply by the deadline. To further randomize the sample, all households receiving the survey were asked that the individual in the household over the age of 18 and with the most recent birthday complete the survey.

In the Cheslatta Carrier First Nation community a different survey methodology was used. Rather than contact respondents by telephone, surveys were administered door to door by a local individual familiar with the community. Because of the small size of the community, a member from all twenty-five households were invited to participate in the survey.

The survey itself contained twenty-three questions addressing the respondent's knowledge and awareness of mountain pine beetle activity, the perceived impact of beetle activity in the community, satisfaction with community management efforts, opinions on the risk of beetle activity to the well-being of the community, and levels of trust in community leaders and organization. The survey instrument can be found in Appendix C. Survey questions were closed-ended, with a small number of open-ended questions to clarify responses and allow the respondent to make general comments about their community. Many of the closed-ended questions asked respondents to rank their responses, using a five or seven-item Likert scale.

A total of 1404 surveys were completed and returned from BC communities, for a response rate of 63%. In the Foothills region 360 surveys were returned for a 61% response rate. The total response rate for all study regions is 62%. Table 5 breaks down the sample by community.

Table 5. Household survey sample size

Community	Sample Size
100 Mile House	76
Burns Lake	69
Cache Creek	45
Cheslatta Carrier First Nation	21
Houston	128
Invermere	99
Mackenzie	167
Quesnel	231
Salmon Arm	209
Vanderhoof	154
Williams Lake	205
Total (BC)	1404
Jasper	145
Hinton	215
Total (Alberta)	360
Total	**1764**

Survey data were entered into an SPSS 10.0.5 statistical software program. As male respondents were over-represented in the sample, data were weighted to reflect the actual gender distribution in the community population. Table 6 shows the gender distribution by community in 2001 and the survey distribution.

Table 6. Population and gender distribution by study community, 2001

	Population		Male		Female	
	Population	Percent of provincial popn	Percent of Population*	Percent of Survey Sample	Percent of Population*	Percent of Survey Sample
British Columbia	3,907,738	100.0	49	--	51	--
100 Mile House	1,739	0.04	45	59	56	41
Burns Lake	1,942	0.05	50	62	50	38
Cache Creek	1,056	0.03	52	53	48	47
Cheslatta	69	0.00	58	52	44	48
Houston	3,577	0.09	53	71	47	29
Invermere	2,858	0.07	49	52	52	48
Mackenzie	5,206	0.13	54	60	46	40
Quesnel	10,044	0.26	49	50	51	50
Salmon Arm	15,210	0.39	47	52	53	48
Vanderhoof	4,390	0.11	49	66	51	34
Williams Lake	11,153	0.29	49	49	51	51
Alberta	2,974,807	100.0	49	--	51	--
Jasper	4,180	0.14	51	53	49	46
Hinton	9,405	0.32	51	60	49	39

*Source: Statistics Canada, 2001 Census

Survey data were analyzed and indicators measured using basic descriptive statistics. Questions were re-coded so that the direction of responses corresponded to the direction of the vulnerability index, where higher scores correspond to greater vulnerability. The mean scores were calculated for indicators using Likert scale response categories in the survey. For questions with nominal data, frequency distributions were calculated.

Leaders Survey

Leaders in study communities were also surveyed to determine local institutional capacity and risk perceptions. Local leaders were considered municipal government representatives, forest district managers, senior managers of the local chamber of commerce, and representatives of the provincial human resources ministry or equivalent employment assistance agency. For the Cheslatta Carrier First Nation community, local leaders were identified as members of band council, as well as managers and policy advisors for the community.

An on-line questionnaire, provided in Appendix D, was used to survey 108 survey community leaders. Leaders were invited by email to participate in the survey. To complete the survey, respondents visited a public, password-protected web site and filled out the survey on-line. Survey responses were downloaded directly into a database that was later imported to an SPSS

10.0.5 statistical software program. Reminder emails and phone calls were sent two and four weeks after the initial invitation. Those respondents that preferred to complete a paper copy of the survey received a copy by fax.

The survey contained twenty-five questions addressing the respondent's knowledge and awareness of mountain pine beetle activity, the perceived impact of beetle activity in the community, satisfaction with community management efforts, opinions on the risk of beetle activity to the well-being of the community, and levels of trust in community leaders and organization. The survey also asked respondents about the constraint posed by internal and external factors on their organization's ability to develop policies and plans, and the level of coordination between organizations within community. Respondents were also asked to list documents and funding from their own organization that was being directed toward beetle management or community adaptation to impacts from beetle activity.

A total of 45 surveys from 10 of the 11 BC communities were completed and returned, for a 42% response rate. In the Foothills Model Forest region, 11 of 20 surveys were returned for a 55% response rate. Table 7 breaks down the sample by community.

Table 7. Leaders survey sample size by study community

Community	Sample Size
100 Mile House	5
Burns Lake	7
Cache Creek	0
Cheslatta Carrier First Nation	6
Houston	1
Invermere	2
Mackenzie	6
Quesnel	6
Salmon Arm	4
Vanderhoof	5
Williams Lake	3
Jasper	4
Hinton	7
Total	**56**

Data analysis followed a similar procedure to the household survey analysis, with basic descriptive statistics performed for the questions of interest, and questions were re-coded so that the direction of responses corresponded to the direction of the vulnerability index. Because of a low response rate for certain communities, an analysis was performed only for those questions assessing community coordination and constraints on planning. The communities of Cache Creek, Houston, Invermere, Salmon Arm and Williams Lake were eliminated from the analysis because of an insufficient number of responses ($n<5$). Although Jasper had only four respondents, this community is included in the analysis because it is one of only two Foothills communities. As a result of the low response rate to the leaders survey across communities, institutional capacity is a separate analysis, and is not included in the vulnerability index.

Three factors were examined as part of an institutional capacity analysis: perceived external and internal constraints on organizational planning, and the perceived quality of organizational coordination in the community.

Vulnerability Index

Once all variables were measured, the final vulnerability index was constructed. Index scores are on a scale from 1.0 to 10.0, with higher scores indicating higher levels of vulnerability. As indicated in Table 3 above, the Vulnerability Index was measured using a number of indicators, where each indicator was measured using one or more variables. Indicator values were calculated by first standardizing the values for each variable and calculating the individual indicator values within each vulnerability dimension (physical, political, economic and socio-economic). Final Vulnerability Index scores were then calculated by averaging the indicator values. Values for variables and indicators are reported in the key findings section below.

The standardization procedure converted original values for each variable to a single score out of ten. Variables measured using secondary data sources were assigned a vulnerability score by ranking a range of values from one to ten based on the overall distribution of values for each variable. Often these scores were determined by examining data for all provincial jurisdictions; hence for many indicators, study communities were ranked relative to all municipalities throughout the province. The scores for other variables, such as forest dependence and forest susceptibility for the Foothills Model Forest region, were calculated by converting values expressed as percentages to a ten-point value. For more details on the standardization methods for each variable, refer to Appendix A, Tables 1 to 8.

Variables measured with the household survey were assigned scores based on mean survey responses (mean scores were calculated for questions already re-coded to correspond to the direction of vulnerability index). Questions measured on a five or seven-point scale were weighted to reflect a value on a ten-point scale. Some variables were constructed from indices made up of several survey questions measuring similar concepts. The community knowledge and awareness variable, for example, is a composite index of true false questions about mountain pine beetle biology. Higher values on this index indicate more incorrect responses. An institutional trust scale was also created from a composite index of questions measuring overall trust in government institutions. Higher institutional trust values reflect lower levels of trust.

Institutional capacity was measured using responses from the leaders survey. An institutional capacity index was created from two indicators assessing internal and external constraints on planning, and a third indicator measuring the perceived quality of organizational coordination and cooperation in the community. A higher value on the institutional capacity index indicates lower levels of institutional capacity. Standardization methods for each index are found in Appendix A.

Geographic Information Systems Mapping

Map images were generated using ArcMap 9.0.[4] Data used in the mapping stage are listed in Table 8. Prior to mapping, spatial data was projected into a common projection. The projection

4 ArcView, ArcInfo and ArcMap are developed by Environmental Systems Research Institute of Redlands, California.

used was Albers Equal-Area Conic (spheroid GRS80; origin 45°N, 126°W; parallels 50°N, 58.5°N), which is the standard projection used by the BC Ministry of Forests. Vector maps were then re-projected using ArcView 3.2. As susceptibility and projected damage data for the Foothills Model Forest were raster maps (grids) they were re-projected using ArcInfo 9.0. Maps of vulnerability data can be found in Appendix B.

Table 8. Spatial data sources

Variable/Layer	Data Source
Damage by year (1992-2004)	BC Ministry of Forests http://www.for.gov.bc.ca/ftp/hfp/external/!publish/aerial_overview/
Census division and subdivision polygons	2001 Census, Statistics Canada
TSA polygons	Surveyor General Branch, B.C. Ministry of Sustainable Resource Management
Infestation data for Jasper National Park	Jasper National Park
Susceptibility and projected damage for Foothills Model Forest	Provided by Alberta Sustainable Resource Development, Forest Health Section. Model created by Alberta Sustainable Resource Development, Jasper National Park, Weldwood of Canada, Foothills Model Forest, Canadian Forest Service (Pacific Forestry Centre), and Gowlland Technologies.
Ancillary spatial data (roads, rivers, lakes, towns)	GeoGratis 1:2 million scale base map data http://geogratis.cgdi.gc.ca/nationalatlas/e_intro_g.html

RESULTS AND DISCUSSION

Vulnerability is a function of the degree of exposure to a threat and the adaptive capacity of a community. The key assumption driving this analysis is that some communities will, owing to certain social and economic characteristics, be more able than others to adapt to the consequences of mountain pine beetle activity. In the following analysis we examine the performance of each study community according to these key factors, which are outlined in the final vulnerability framework (Table 3).

The data tables below report the assessed value for each vulnerability indicator and index. These scores have been adjusted for measurement on a ten-point vulnerability scale, where higher scores suggest greater vulnerability. In brackets next to these adjusted scores are the original values, which are in original units for each variable and are not adjusted for vulnerability calculations. Findings for all study communities, including the Foothills Model Forest region, are presented below. In some cases, findings do not overlap between BC communities and Foothills communities—largely owing to differences in available secondary data—and these differences are noted in the text. Therefore, it is important not to compare BC communities and Foothills communities in all aspects of the vulnerability framework.

The spatial representation of vulnerability data is provided by a number of maps generated by ArcMap 9.0. ***Maps of the vulnerability data are provided in a separate section, and can be found in Appendix B.***

Physical Dimension

The first dimension of vulnerability in our analysis is the physical aspect, which is understood to be a combination of current forest susceptibility and future forest impact from pine beetle activity, as well as the perceived impact on the community from this activity. For BC communities, current forest susceptibility and future forest impact are measured by looking at provincial data describing the density (m^3/ha) of susceptible pine in 2003 and the cumulative volume of killed pine (measured in m^3/ha) by 2010. Values were calculated for the surrounding Timber Supply Areas for each study community. In the Foothills region, only forest susceptibility was calculated, and this variable was determined from grid data displaying susceptibility in the region. For both BC communities and the Foothills region, the perceived impact variable was measured from two survey questions asking the respondents how much of an impact mountain pine beetle has had on their community, and the nature of this impact (positive or negative). Tables 9a, b, and c list the scores of these three indicators.

Communities with greatest **forest susceptibility** and **future forest impact** are Quesnel, Burns Lake and the Cheslatta Carrier First Nation. Timber Supply Areas surrounding these communities have the greatest volume of susceptible pine, and corresponding high future volumes of cumulative pine killed from beetle activity. This overlap in forest susceptibility and future forest impact is further illustrated in Figure 2 in Appendix B. Those communities with low densities of susceptible pine, and not predicted to have significant densities of dead pine by 2010 are Invermere, Cache Creek, Mackenzie, and Salmon Arm. 100 Mile House, Houston, Williams Lake, and Vanderhoof have moderate forest susceptibility and are predicted to have moderate cumulative densities of dead pine in the future. Jasper and Hinton have very low forest susceptibility, but it is difficult to compare these scores to those in BC because of differences in how this variable was measured.

The **perceived impact on the community** from beetle activity was generally high, particularly in 100 Mile House, Vanderhoof, Burns Lake, and Quesnel. In communities such as Hinton, Jasper, Invermere, and Salmon Arm, the perceived degree of impact on the community was higher than the forest susceptibility scores. A closer look at the original mean survey scores for the two variables that were used to calculate the perceived impact indicator (in brackets next to the indicator scores) show that respondents characterized the degree of impact on the community as significant while the nature of the impact of the beetle was considered neither overly positive nor negative. The lowest mean survey score for the nature of the impact variable (measured on a seven-point Likert scale with lower values denoting a more negative impact) is around 3.0 in most communities and is highest in the Cheslatta Carrier First Nation. Findings for this variable may be explained by the short-term positive impacts from the pine beetle such as the increase in employment opportunities from forest management practices aimed at controlling the beetle and accessing timber before infestation occurs.

Figure 3 in Appendix B displays perceived impact scores for the study communities along with the severity of beetle damage data for 2004. This map illustrates that perceived impact does not always correspond with current levels of pine beetle damage. In the Cheslatta Carrier First Nation, Cache Creek, and Salmon Arm, for example, perceived impact is low while current damage around these communities is moderate to severe. Invermere, in contrast, has fairly high perceived impact and low levels of damage. Other factors, such as awareness of beetle activity around the community, and the nature of economic impacts from beetle activity, may explain this discrepancy.

When all physical dimension scores are compiled, we find that most communities have moderate to high scores under the physical dimension, even for those with minimal forest susceptibility and future forest impact. Highest physical dimension scores are assigned to Quesnel, Cheslatta Carrier First Nation, and Burns Lake, and lowest scores are assigned to Invermere, Salmon Arm, Cache Creek, and Mackenzie. One of the factors driving up the scores is perceived impact, where survey respondents in all communities note that mountain pine beetle is currently having a significant impact on the community.

In the Foothills Model Forest area, final physical dimension scores are low, with scores of 3.9 for Jasper and 3.6 for Hinton. Scores are low because of low current forest susceptibility and moderate perceived impact.

Table 9a. Physical dimension indicator scores §

	100 Mile House		Burns Lake		Cache Creek		Cheslatta		Houston	
Current forest susceptibility +	5.0	(65.6)	10.0	(121.8)	2.0	(28.4)	10.0	(121.8)	4.0	(50.9)
Future forest impact +	5.0	(28.4)	7.0	(40.9)	2.0	(9.0)	7.0	(40.9)	2.0	(11.6)
Perceived Impact Ŧ	8.0	(4.5) (3.0)	8.5	(4.8) (2.8)	6.4	(3.2) (3.5)	6.5	(4.6) (5.3)	7.5	(4.5) (3.8)
Physical Dimension	**6.0**		**8.5**		**3.5**		**7.8**		**4.5**	

§ Numbers in brackets are original values
*Data provided by BC Ministry of Forests, Research Branch
+ Original value measured in (m^3/ha)
£ Original value measured on a 5-point Likert scale
Ŧ Top value in brackets is the original score for the degree of impact (measured on a 7-point Likert scale) and bottom value is the original score for the nature of perceived impact (measured on a 5-point Likert scale).

Table 9b. Physical risk indicator scores §

	Invermere		Mackenzie		Quesnel		Salmon Arm		Vanderhoof		Williams Lake	
Current forest susceptibility +	2.0	(26.8)	3.0	(31.3)	10.0	(119.8)	3.0	(35.7)	5.0	(56.3)	4.0	(44.7)
Future forest impact +	1.0	(2.0)	1.0	(2.5)	10.0	(67.0)	1.0	(5.6)	4.0	(23.0)	3.0	(18.1)
Perceived of impact Ŧ	7.2	(3.7) (3.2)	7.4	(4.2) (3.5)	8.5	(4.8) (2.9)	6.2	(3.1) (3.6)	8.3	(4.8) (3.1)	7.9	(4.6) (3.4)
Physical Dimension	**3.4**		**3.8**		**9.5**		**3.4**		**5.8**		**5.0**	

§ Numbers in brackets are original values
*Data provided by BC Ministry of Forests, Research Branch
+ Original value measured in (m^3/ha)
Ŧ Top value in brackets is the original score for the degree of impact (measured on a 7-point Likert scale) and bottom value is the original score for the nature of perceived impact (measured on a 5-point Likert scale).

Table 9c. Physical risk indicator scores [§]

	Jasper		Hinton	
Current forest susceptibility *	1.6	(16.1)	1.6	(16.1)
Future forest impact +	*Not assessed*		*Not assessed*	
Perceived impact Ŧ	6.2	(2.9) (3.4)	5.5	(2.1) (3.2)
Physical Dimension	**3.9**		**3.6**	

§ Numbers in brackets are original values
*Data provided by Alberta Sustainable Resource Development, Forest Management Branch, Forest Health Section. Original data refers to percent area of the Foothills Model Forest area that is considered highly susceptible to beetle attack.
+ Data not available for Foothills Model Forest region
Ŧ Top value in brackets is the original score for the degree of impact (measured on a 5-point Likert scale, where 1 = no impact and 5= significant impact) and bottom value is the original score for the nature of perceived impact (measured on a 7-point Likert scale, where 1= very negative impact and 7 = very positive impact).

Political Dimension

The second dimension of vulnerability examined in this study is political. This was measured by assessing community awareness of risk from mountain pine beetle impacts, and community evaluations of local leadership. Both of these factors were examined using variables incorporating mean values from several household survey questions, and then adjusting these values for inclusion in the vulnerability index. In the tables below, values in brackets are the mean values for the original survey question. In the case of many variables, original values were reversed so that higher values correspond with greater vulnerability.

This first component of the political dimension is **community risk awareness**. Greater risk awareness is thought to lower community vulnerability, whereby heightened levels of awareness are thought to be linked to action. Community risk awareness was measured by examining the personal importance of the beetle issue to survey respondents, their assessment of the risk it posed to their community, and their knowledge of basic beetle biology. Refer to Tables10a to 10c for a breakdown of scores for each community. Scores for this indicator are fairly low in 100 Mile House, Burns Lake, Houston, Quesnel, Vanderhoof, Williams Lake and Hinton, suggesting that community members are fairly aware of the risks posed to their community from the pine beetle. In some communities scores are higher, particularly in Salmon Arm and the Cheslatta Carrier First Nation, which is explained by fairly low personal importance and low levels of knowledge about pine beetle biology. Below is a description of the results for the individual variables that were used to measure this indicator.

In all study communities, household survey respondents noted that the mountain pine beetle issue was of great importance to them personally. As such, all communities received a low score for this particular variable. Scores for this variable range from 2.4 in Vanderhoof to 4.2 in Jasper.

Respondents were asked to rate the risk the mountain pine beetle outbreak posed to their community. In most communities, the risk was thought to be quite high. For this variable, therefore, scores are low, as increased risk awareness is thought to decrease vulnerability.

Another component of community risk awareness is an evaluation of community members' knowledge of basic beetle biology (e.g., whether mountain pine beetle causes visible damage to trees). This was measured using a knowledge index made up of responses to four true/false questions, where greater knowledge corresponds to a lower indicator score. With the exception of the Cheslatta Carrier First Nation, most survey respondents were well informed of basic beetle biology and management and therefore received low scores for this indicator. In the Cheslatta Carrier First Nation community, however, awareness was much lower than other communities, and therefore received a fairly high score.

Table 10a. Political dimension indicators: Community risk awareness scores §

	100 Mile House	Burns Lake	Cache Creek	Cheslatta	Houston
Personal importance of beetle activity+	2.7 (4.7)	2.4 (4.8)	3.3 (4.3)	2.9 (4.6)	2.5 (4.7)
Perceived risk to community from beetle ŧ	2.4 (6.3)	2.0 (6.6)	3.6 (5.5)	2.3 (6.4)	2.0 (6.6)
Basic knowledge of beetle^	1.0	5.0	5.0	10.0	5.0
Community risk awareness	**2.0**	**3.1**	**4.0**	**5.1**	**3.2**

§ Numbers in brackets are original values
+ Original value measured on a 5-point Likert scale, where 1= not at all important and 5 = very important
ŧ Original value measured on a 7-point Likert scale, where 1 = poses no risk and 7 = poses a great risk
^ Value based on respondents' score on a mountain pine beetle knowledge index

Table 10b. Political dimension indicators: Community risk awareness scores §

	Invermere	Mackenzie	Quesnel	Salmon Arm	Vanderhoof	Williams Lake
Personal importance of beetle activity+	3.5 (4.3)	2.5 (4.7)	2.4 (4.8)	3.8 (4.1)	2.4 (4.8)	2.6 (4.7)
Perceived risk to community from beetle ŧ	3.7 (5.4)	2.3 (6.4)	2.0 (6.6)	3.3 (5.7)	2.3 (6.4)	2.4 (6.3)
Basic knowledge of beetle^	5.0	5.0	5.0	10.0	5.0	5.0
Community risk awareness	**4.1**	**3.3**	**3.1**	**5.7**	**3.2**	**3.3**

§ Numbers in brackets are original values
+ Original value measured on a 5-point Likert scale, where 1= not at all important and 5 = very important
ŧ Original value measured on a 7-point Likert scale, where 1 = poses no risk and 7 = poses a great risk
^ Value based on respondents' score on a mountain pine beetle knowledge index

Table 10c. Political dimension indicators: Community risk awareness values §

	Jasper	Hinton
Personal importance of beetle activity+	4.2 (3.9)	3.7 (4.1)
Perceived risk to community from beetle ŧ	4.0 (5.2)	3.3 (5.7)
Basic knowledge of beetle^	5.0	1.0
Community risk awareness	**4.4**	**2.7**

§ Numbers in brackets are original values
+ Original value measured on a 5-point Likert scale, where 1= not at all important and 5 = very important
ŧ Original value measured on a 7-point Likert scale, where 1 = poses no risk and 7 = poses a great risk
^ Value based on respondents' score on a mountain pine beetle knowledge index

The other indicator included in the political dimension is **community evaluation of leadership**. Scores for this indicator can be found in Tables 11a to 11c. This indicator includes several variables measuring the perceived quality of local leadership. These are trust in government institutions to manage for beetle impacts, evaluation of community efforts to respond to beetle presence, and satisfaction with local beetle management efforts. Scores for this indicator are higher than the community perception of risk indicator, suggesting that community members identify some relative weaknesses in local leadership. The communities of the Cheslatta Carrier First Nation, Vanderhoof, Jasper, Hinton, Burns Lake, and Williams Lake received scores between 5.2 and 5.8, suggesting that community members gave moderately positive evaluations of community leadership. Other study communities gave more negative evaluations of community leadership, particularly Salmon Arm and Cache Creek, which both received scores above 7.0. Below is a breakdown of the scores for all of the leadership variables.

Trust in government institutions was measured using an index composed of several questions asking respondents to indicate how much they trusted various government institutions—including the federal government, provincial government forestry and parks agencies, and municipal government—to manage properly for the mountain pine beetle. Trust for all government institutions was quite low, and therefore the vulnerability score for trust is high, as lower trust in political institutions suggests greater vulnerability. Low levels of trust were most evident in the communities of Cache Creek, Vanderhoof, Burns Lake, and Houston whereas in the Cheslatta Carrier First Nation, Jasper and Hinton, trust is slightly higher.

Respondents were asked to evaluate community efforts in response to beetle presence. Evaluations were positive in most communities, which correspond with low to moderate scores ranging from 3.1 to 5.9. In Salmon Arm and Cache Creek, however, evaluations were considerably more negative with scores of 6.9 and 7.6 respectively. These high scores may be explained by a relatively small presence of pine beetle thus far; hence local institutions may not yet be managing for the pine beetle.

With respect to community satisfaction with management activities, in BC, scores were all above 6.0 with the highest score in Cache Creek. This suggests that community members are generally not satisfied with the local management of the pine beetle outbreak. In the Foothills region, where mountain pine beetle activity is still fairly low, individuals in Hinton and Jasper are slightly more satisfied with management efforts than communities in BC. Scores in these communities are 5.6 and 5.7.

Table 11a. Political dimension indicators: Evaluation of community leadership scores §

	100 Mile House	Burns Lake	Cache Creek	Cheslatta	Houston
Trust in government institutions to manage beetle impacts^	7.2 (2.4)	7.6 (2.2)	7.5 (2.3)	6.5 (2.8)	7.6 (2.2)
Evaluation of community efforts to respond to beetle presence Ŧ	4.9 (4.6)	3.3 (5.7)	7.6 (2.6)	3.1 (6.0)	4.1 (5.1)
Satisfaction with local beetle management efforts Ŧ	7.4 (3.3)	6.7 (3.3)	7.9 (2.5)	6.0 (3.8)	6.4 (3.5)
Evaluation of community leadership	**6.5**	**5.8**	**7.7**	**5.2**	**6.0**

§ Numbers in brackets are original values
^ Value based on an institutional trust index. Numbers in brackets are original index values before weighting or adjustment for direction of measurement to correspond with vulnerability index. Original index value on a 5-point Likert Scale, where 1 = No trust and 5 =Complete trust
Ŧ Original value measured on a 7-point Likert scale, where 1 = very dissatisfied and 7 = very satisfied

Table 11b. Political dimension indicators: Evaluation of community leadership scores §

	Invermere	Mackenzie	Quesnel	Salmon Arm	Vanderhoof	Williams Lake
Trust in government institutions to manage beetle impacts^	7.0 (2.5)	7.4 (2.3)	7.4 (2.3)	7.2 (2.4)	7.5 (2.3)	7.3 (2.4)
Evaluation of community efforts to respond to beetle presence Ŧ	5.5 (4.2)	4.4 (4.9)	3.9 (5.3)	6.9 (3.2)	3.1 (5.8)	3.7 (5.4)
Satisfaction with local beetle management efforts Ŧ	6.3 (3.6)	6.4 (3.5)	6.8 (3.3)	6.8 (3.2)	6.2 (3.7)	6.5 (3.5)
Evaluation of community leadership	**6.3**	**6.1**	**6.0**	**7.0**	**5.6**	**5.8**

§ Numbers in brackets are original values
^ Value based on an institutional trust index. Original values are not reported.
Ŧ Original value measured on a 7-point Likert scale, where 1 = very dissatisfied and 7 = very satisfied

Table 11c. Political dimension indicators: Evaluation of community leadership scores §

	Jasper	Hinton
Trust in government institutions to manage beetle impacts^	6.4 (2.8)	6.4 (2.8)
Evaluation of community efforts to respond to beetle presence Ŧ	5.5 (4.2)	5.9 (3.9)
Satisfaction with local beetle management efforts Ŧ	5.0 (4.5)	4.9 (4.5)
Evaluation of community leadership	**5.6**	**5.7**

§ Numbers in brackets are original values
^ Value based on an institutional trust index
Ŧ Original value measured on a 7-point Likert scale, where 1 = very dissatisfied and 7 = very satisfied

When the above two indicators—community risk awareness and evaluation of community leadership—are averaged, we obtain a final political dimension score. This score, documented in Tables 12 a and b, reflects the overall political capacity of the study communities in terms of their ability, as perceived by community members, to satisfactorily prepare for and manage the social and economic impacts of the beetle outbreak. The lowest political dimension score—and therefore the most positive assessment of capacity—is for Hinton at 4.8. Scores for the other study communities are also quite low, with most scores below 6.0. Cache Creek and Salmon Arm, nevertheless, have scores above 6.0, suggesting that political capacity is perceived to be lowest in these two communities.

For the political dimension indicators, Hinton has the lowest score of all study communities. Although this community is not yet exposed to significant mountain pine beetle activity, this score suggests that community members consider their local political institutions in a good position to manage community-level impacts from an outbreak.

Table 12a. Political dimension scores

	100 Mile House	Burns Lake	Cache Creek	Cheslatta	Houston	Invermere	Mackenzie	Quesnel	Salmon Arm	Vanderhoof	Williams Lake
Political Dimension Score	**4.3**	**4.5**	**5.8**	**5.1**	**4.6**	**5.2**	**4.7**	**4.6**	**6.3**	**4.4**	**4.6**

Table 12b. Political dimension scores

	Jasper	Hinton
Political Dimension Score	**5.0**	**4.2**

Economic Dimension

The economic dimension of the vulnerability framework consists of four indicators: economic diversity, the dependence of the local economy on the forest sector, the perceived resilience of the local economy by community members, and the availability of forest resources. Tables 13a, b, and c, provide data for these indicators, as well as the final economic dimension score.

Economic diversity was measured using an economic diversity index, and higher index scores suggest greater economic diversity. Most communities received low scores for this indicator, with scores ranging from 2.0 to 6.0, as economic diversity is moderately high in the majority of study communities. Cache Creek and 100 Mile House, however, have the lowest diversity of all study communities, and are assigned scores of 5.0 and 6.0 respectively. The lowest value (2.0) was assigned to Jasper, which has the greatest economic diversity of all the study communities.

The extent to which communities depend on the forest sector for labour force income is known as **forest dependence**. As forest dependence increases, so too does vulnerability, as the beetle outbreak is predicted to result in serious long-term declines in the forest sector. As illustrated in the tables below, scores for this indicator varied greatly, with the national park community of Jasper having the lowest possible score of 0.0, and Mackenzie having the maximum value of 10.0. Other communities with high forest dependence are Hinton, the Cheslatta Carrier First Nation, Williams Lake, Houston, and Quesnel.

Perceived economic resilience was evaluated by asking survey respondents to evaluate the ability of the local economy to bounce back after shocks from natural disturbance, such as fire and insect outbreaks. In many communities, respondents did not consider their local economy as highly resilient, and consequently vulnerability scores for this indicator are fairly high. Invermere and Jasper respondents perceived the most resiliency in their local economy, with scores of 5.9 and 6.1 respectively, while the communities of Burns Lake, Quesnel, Mackenzie, and 100 Mile House perceived the least resiliency, with scores around 7.6 and 7.4.

What contributes to perceived economic resilience is not entirely clear. The degree of forest dependence, for example, does not necessarily correspond with perceived economic resilience, as illustrated in Figure 3 in Appendix B. According to this map, Invermere, which is moderately forest dependent, perceives much greater economic resilience than communities with similar forest dependence, such as Cache Creek. Economic diversity, similarly does not seem to explain perceived economic resilience, as illustrated in Figure 4, Appendix B. Areas with similar perceived economic resilience, such as Vanderhoof and Quesnel, have very different economic diversity.

The fourth indicator under the economic dimension is the **availability of forest resources**, as communities with several species of harvestable timber in the surrounding Timber Supply Area will be in a better economic position than those with mostly pine. The availability of forest resources was measured by documenting how much area of the Timber Harvesting Land Base in the surrounding Timber Supply Area was covered with pine. This variable was not assessed for the Foothills communities. Those with more pine, such as the Cheslatta Carrier First Nation, Burns Lake, and Quesnel were assigned higher scores under this indicator. Communities in the southern interior region such as Cache Creek, Salmon Arm, and Invermere have a greater diversity of timber species and therefore receive low scores.

The final economic dimension value was calculated by averaging the scores of the four economic indicators. Jasper has the least economic vulnerability with a score of 2.7, while Quesnel has the most, with a score of 6.9. Those communities with greater economic vulnerability tend to be those with greatest forest dependence and limited availability of non-pine forest resources.

Table 13a. Economic dimension indicator scores [§]

	100 Mile House		Burns Lake		Cache Creek		Cheslatta		Houston	
Economic diversity[£]	6.0	(1.8)	4.0	(2.3)	5.0	(2.0)	4.0	(1.9)	4.0	(2.4)
Forest dependence[~]	6.2	(0.62)	6.2	(0.62)	4.9	(0.49)	8.4	(0.84)	9.0	(0.90)
Perceived economic resilience [Ŧ]	7.7	(2.6)	7.6	(2.7)	7.3	(2.9)	6.8	(3.2)	7.0	(3.1)
Availability of forest resources *	5.5	(55.0)	7.7	(76.5)	3.1	(30.6)	7.7	(76.5)	5.1	(51.0)
Economic Dimension Score	**6.4**		**6.4**		**5.1**		**6.7**		**6.3**	

[§] Numbers in brackets are original values
£ Original value measured using an economic diversity index
~ Value in brackets represents the proportion of labour force income from forest economic activities
Ŧ Original value measured on a 7-point Likert scale asking respondents the extent to which they agree with the statement that their local economy will bounce back quickly from shocks. 1 = Strongly Disagree and 7 = Strongly Agree
*Data provided by BC Ministry of Forests, Research Branch

Table 13b. Economic dimension indicator scores §

	Invermere		Mackenzie		Quesnel		Salmon Arm		Vanderhoof		Williams Lake	
Economic diversity£	3.0	(2.7)	4.0	(2.5)	3.0	(2.7)	2.0	(3.2)	3.0	(2.7)	2.0	(3.0)
Forest dependence~	2.7	(0.27)	10.0	(1.00)	9.5	(0.95)	2.7	(0.27)	6.3	(0.63)	8.6	(0.86)
Perceived economic resilience Ŧ	5.9	(3.9)	7.6	(2.7)	7.6	(2.7)	6.4	(3.5)	7.3	(2.9)	7.3	(2.9)
Availability of forest resources*	4.2	(42.0)	4.4	(43.8)	7.7	(76.7)	3.4	(34.0)	5.1	(51.0)	6.7	(66.9)
Economic Dimension Score	**3.9**		**6.5**		**6.9**		**3.6**		**5.4**		**6.1**	

§ Numbers in brackets are original values
£ Original value measured using an economic diversity index.
~ Value in brackets represents the proportion of labour force income from forest economic activities
Ŧ Original value measured on a 7-point Likert scale asking respondents the extent to which they agree with the statement that their local economy will bounce back quickly from shocks. 1 = Strongly Disagree and 7 = Strongly Agree
*Data provided by BC Ministry of Forests, Research Branch

Table 13c. Economic dimension indicator scores §

	Jasper		Hinton	
Economic diversity£	2.0	(2.3)	4.0	(3.0)
Forest dependence~	0.0	(0.00)	7.2	(0.72)
Perceived economic resilience Ŧ	6.1	(3.7)	6.6	(3.4)
Availability of Forest Resources*	*Not assessed*		*Not assessed*	
Economic Dimension Score	**2.7**		**5.9**	

§ Numbers in brackets are original values
£ Original value measured using an economic diversity index.
~Value in brackets represents the proportion of labour force income from forest economic activities
Ŧ Original value measured on a 7-point Likert scale asking respondents the extent to which they agree with the statement that their local economy will bounce back quickly from shocks. 1 = Strongly Disagree and 7 = Strongly Agree
*Data not available

Socio-economic Dimension

The data for this dimension of the vulnerability framework was obtained from BC Stats for the BC communities, and from 2001 census data for the Foothills Model Forest communities.

Values for the BC Stats index are from 2004. Six social and economic indicators of wellbeing (economic hardship, crime, health problems, education concerns, and children and youth at risk) are included in the index, with some indicators accorded greater weight than others. Tables 14 a, b, and c, outline the converted vulnerability score for the index scores for each community, as well as the original values for two of the six indicators: human economic hardship and education. These correspond to the two variables used in the Foothills Model Forest Index. For more information on how to interpret the original index values, refer to BC Stats (2004).

For the Foothills Model Forest communities, a similar socio-economic index was calculated, using census data on educational attainment (percent of population without a high school certificate, and percent of population without any post-secondary schooling), as well as the incidence of low income for economic families and unattached individuals.

Within the BC study communities, the lowest socio-economic index scores and therefore the highest socio-economic well-being, are found in Invermere, Houston, and Salmon Arm. All other study communities have significantly higher scores, particularly in Burns Lake, the Cheslatta Carrier First Nation, Mackenzie, Vanderhoof and Williams Lake, where these communities have the highest score of 10.0. In these communities the scores for human economic hardship and education are particularly high. As such, socio-economic wellbeing is fairly low in these communities. Of all of the communities, the lowest socio-economic scores, and therefore the highest socio-economic wellbeing, are in Jasper and Hinton. However, it is difficult to compare these scores to those of BC communities owing to key differences in how the socio-economic index in each province was measured.

In Appendix B, Figure 5, socio-economic dimension scores are mapped with future forest impact data to illustrate how socio-economic vulnerability varies with future declines in timber supply. Higher scores tend to correspond with greater future forest impact, suggesting that communities already under socio-economic stress are also predicted to experience the greatest timber losses from the mountain pine beetle outbreak.

Table 14a. Socio-economic dimension indicator scores, 2004[§]

	100 Mile House	Burns Lake	Cache Creek	Cheslatta	Houston
Socio-economic Index*	8.0 (0.2)	10.0 (0.7)	8.0 (0.4)	10.0 (0.7)	4.0 (-0.1)
Human econ hardship	6.0 (0.0)	10.0 (0.8)	6.0 (0.0)	10.0 (0.8)	4.0 (0.0)
Education	10.0 (0.5)	10.0 (1.0)	10.0 (1.0)	10.0 (1.0)	4.0 (-0.3)

§ Numbers in brackets are original index values
*Scores calculated by BC Stats. Other variables are also included in the calculation of this index, but are not shown in this table. For more information, refer to BC Stats (2004).

Table 14b. Socio-economic dimension indicator scores, 2004[§]

	Invermere	Mackenzie	Quesnel	Salmon Arm	Vanderhoof	Williams Lake
Socio-economic Index*	4.0 (-0.3)	10.0 (0.5)	8.0 (0.3)	4.0 -(0.1)	10.0 (0.6)	10.0 (0.4)
Human econ hardship	1.0 (-0.9)	10.0 (0.6)	10.0 (0.4)	6.0 (0.0)	10.0 (0.5)	8.0 (0.4)
Education	4.0 (-0.2)	8.0 (0.3)	10.0 (0.5)	4.0 (-0.1)	10.0 (0.7)	10.0 (0.6)

§ Numbers in brackets are original index values
*Scores calculated by BC Stats. Other variables are also included in the calculation of this index, but are not shown in this table. For more information, refer to BC Stats (2004).

Table 14c. Socio-economic dimension indicator scores, 2001[§]

	Jasper	Hinton
Socio-economic Index*	3.5	3.5
Incidence of low income+	2.5 (6.3/26.1)	2.5 (8.7/26.6)
Education attainment^	4.5 (18.8/64.0)	4.5 (32.0/62.8)

* Data from Statistics Canada, 2001 Census. Unlike BC communities using a BC Stats Socio-economic index, this index is calculated using only income and education variables
+ Values in brackets are the incidence of low income for economic families and unattached individuals
^ Values in brackets are the percent of population without high school diploma or certificate and percent without any post-secondary education

Final Vulnerability Index Scores

When all of the dimensions are averaged, we obtain final vulnerability scores. The scores are mapped in Figure 6, Appendix B. Vulnerability scores range from 3.8 to 7.4 where higher scores indicate higher levels of vulnerability. No study community obtained the lowest score of 1.0 or the maximum score of 10.0. Tables 15 a, b, and c contain the final vulnerability scores for all of the study communities. For all communities, political dimension index scores are fairly similar, therefore the combination of physical, economic, and socio-economic dimension index scores seem to explain the most variation in vulnerability between study regions.

In BC, the lowest vulnerability index value is for Invermere, which has a value of 4.2. Other communities with low scores are Salmon Arm and Houston. The low vulnerability scores for these three communities can be attributed to fairly low physical exposure, high socio-economic well-being, and low scores for the economic dimension index.

Cache Creek has moderate vulnerability with a score of 5.7. This community has low physical exposure, moderate economic and political dimension index scores, but a fairly high socio-economic score.

Slightly higher vulnerability scores are assigned to communities of 100 Mile House, Mackenzie, Williams Lake, and Vanderhoof. These communities have moderate physical exposure, high socio-economic dimension scores, and moderate economic dimension scores.

The communities with greatest vulnerability are Quesnel, Burns Lake and the Cheslatta Carrier First Nation. These communities have high physical exposure, socio-economic, and economic dimension scores. Because of fairly positive evaluations of political capacity, these communities do not reach the maximum vulnerability score.

Jasper and Hinton have low vulnerability scores. Jasper has a score of 3.8, largely because of fairly low scores across all dimensions of vulnerability. Hinton has a slightly higher score at 4.5, which is explained by a higher economic dimension index score (from greater forest dependence). It is difficult to compare these scores to the scores for communities in BC because of some significant differences in how certain dimensions of vulnerability were measured, particularly for the physical and socio-economic dimensions.

Table 15a. Final Index Scores

	100 Mile House	Burns Lake	Cache Creek	Cheslatta	Houston
Physical Dimension Index	6.0	8.5	3.5	7.8	4.5
Socio-economic Dimension Index	8.0	10.0	8.0	10.0	4.0
Political Dimension Index	4.3	4.5	5.8	5.1	4.6
Economic Dimension Index	6.6	6.3	5.6	6.6	6.5
VULNERABILITY INDEX VALUE	**6.2**	**7.3**	**5.7**	**7.4**	**4.9**

Table 15b. Final Index Scores

	Invermere	Mackenzie	Quesnel	Salmon Arm	Vanderhoof	Williams Lake
Physical Dimension Index	3.4	3.8	9.5	3.4	5.8	5.0
Socio-economic Dimension Index	4.0	10.0	8.0	4.0	10.0	10.0
Political Dimension Index	5.2	4.7	4.6	6.3	4.4	4.6
Economic Dimension Index	4.2	6.9	6.9	4.0	5.7	6.2
VULNERABILITY INDEX VALUE	**4.2**	**6.3**	**7.2**	**4.4**	**6.5**	**6.4**

Table 15c. Final Index Scores

	Jasper	Hinton
Physical Dimension Index	3.9	3.6
Socio-economic Dimension Index	3.5	3.5
Political Dimension Index	5.0	4.2
Economic Dimension Index	2.7	5.9
VULNERABILITY INDEX VALUE	**3.8**	**4.5**

Institutional Capacity

An institutional capacity analysis is also included in this study, but is not part of the vulnerability index because of insufficient data for all study communities. Specifically, there was a low response rate to the leaders survey, which was used to measure this dimension of vulnerability. Consequently, the communities of Cache Creek, Houston, Invermere, Salmon Arm, and Williams Lake are eliminated from this analysis because of small sample size (n<5).

Institutional capacity was evaluated by examining the perceived **external constraints** and **internal constraints** on organizational planning. These indicators were measured using a question asking respondents whether various external and internal factors constrained or enhanced their organization's ability to plan and develop policies and strategies. A third indicator, **organizational coordination,** was measured from a question asking respondents their opinion on the ability of organizations in the community to cooperate and coordinate their respective activities.

Scores for institutional capacity indicators are on a similar scale to the vulnerability scores, with higher scores corresponding to lower capacity, and therefore greater vulnerability. The perceived constraints from external factors are fairly significant with moderate to high scores for this indicator in all study communities. The lowest score is found in Hinton (4.2) and the highest in 100 Mile House (7.8). Similarly, all communities report fairly high scores under internal constraints, particularly for Hinton and Mackenzie. Scores for organizational cooperation, however, are significantly lower, suggesting that in most communities organizations successfully cooperate and coordinate their activities. Scores range from 3.5 in Hinton to 5.9 in Burns Lake.

When total institutional capacity scores are calculated—reported in Table 16— findings indicate that study communities have some limitations on institutional capacity. Most scores fall in the middle of the scale, with a minimum value of 5.4 in Vanderhoof and a maximum of 6.7 in Mackenzie.

Table 16. Institutional capacity scores

	External Constraints Ŧ	Internal Constraints Ŧ	Organizational Coordination Ŧ	**Total Institutional Capacity Score**
100 Mile House	7.8	6.1	4.3	**6.1**
Burns Lake	5.4	7.7	5.9	**6.3**
Cheslatta Carrier First Nation	6.3	7.0	3.6	**5.6**
Mackenzie	6.2	9.3	4.7	**6.7**
Quesnel	6.0	6.4	5.3	**5.9**
Vanderhoof	5.7	6.3	4.1	**5.4**
Jasper	5.1	7.7	3.7	**5.5**
Hinton	4.2	9.0	3.5	**5.6**

Ŧ Measured using an index constructed from a multiple item survey question.

Discussion

Much of the research to date around the mountain pine beetle outbreak in BC has associated community vulnerability with physical exposure to beetle activity, and has subsequently recommended adaptation strategies centred around the management of regional wood supplies and more efficient production of forest products. While recognizing the direct relationship between physical exposure and vulnerability, this study also considers the adaptive capacity element of vulnerability, which is measured by examining community-level political, economic and social factors.

When comparing physical vulnerability with the final vulnerability index scores, one can observe what happens to vulnerability when adaptive capacity is taken into account. In Table 17, the physical dimension scores for these study communities are presented alongside the final vulnerability score, with scores sorted from the highest (most vulnerable) to the lowest (least vulnerable). Under the physical dimension, scores generally fall into three categories. High scores range from 7.8 in the Cheslatta Carrier First Nation to 9.5 in Quesnel. Moderate scores range from 4.5 in Houston to 6.0 in 100 Mile House, and low scores range from 3.4 in Invermere to 3.8 in Mackenzie. Scores in the final vulnerability index similarly fall into three major groupings. High scores range from 7.2 in Quesnel to 7.4 in the Cheslatta Carrier First Nation, and moderate scores range from 5.7 in Cache Creek to 6.5 in Vanderhoof. Low scores range from 4.2 in Invermere to 4.9 in Houston.

Table 17. Comparison of physical dimension scores and final vulnerability index scores

	Physical Dimension Score		Final Vulnerability Index Score		
High	Quesnel	9.5	Cheslatta	7.4	High
	Burns Lake	8.5	Burns Lake	7.3	
	Cheslatta	7.8	Quesnel	7.2	
Medium	100 Mile House	6.0	Vanderhoof	6.5	Medium
	Vanderhoof	5.8	Williams Lake	6.4	
	Williams Lake	5.0	Mackenzie	6.3	
	Houston	4.5	100 Mile House	6.2	
Low	Mackenzie	3.8	Cache Creek	5.7	
	Cache Creek	3.5	Houston	4.9	Low
	Salmon Arm	3.4	Salmon Arm	4.4	
	Invermere	3.4	Invermere	4.2	

There is significantly greater variation in the physical dimension scores compared to the final index scores, largely explained by considerable differences in regional exposure to mountain pine beetle activity. This variation in vulnerability decreases substantially when political, economic and social factors are considered, indicating that these factors are stabilizing the impact of physical exposure on vulnerability. In communities with significant mountain pine beetle activity, such as Quesnel, Burns Lake and the Cheslatta Carrier First Nation, political, economic and social dimensions place downward pressure on overall vulnerability, while in the remaining communities with considerably less physical exposure they place an upward pressure on vulnerability.

This is further illustrated in Figure 7 in Appendix B. Areas where red is visible indicates that the community's physical dimension score exceeds the final vulnerability score. In these regions, although physical vulnerability may be significant, a combination of political, economic and social factors is reducing community vulnerability. In areas where only yellow is visible, physical vulnerability is fairly low but a combination of political, economic and social factors has increased community vulnerability.

When comparing the order (or rank) of communities under the physical dimension with the order of communities under the final vulnerability index scores, we find that they do not always correspond, which again illustrates the considerable influence of political, economic and social factors on vulnerability. Quesnel, for example, has the highest physical vulnerability score, while it has the third highest final vulnerability index score. Mackenzie, in contrast, has one of the lowest physical vulnerability scores, but has a moderately high final vulnerability score. In other words, when political, economic and social factors are considered in addition to physical exposure, vulnerability decreases in Quesnel, while it increases in Mackenzie. In the discussion below this shift in vulnerability for these two communities is explored in more detail.

One of the most significant differences between Quesnel and Mackenzie is the extent of physical exposure to mountain pine beetle activity, with Quesnel's physical vulnerability two and half times greater than Mackenzie's. Perceived impact, nevertheless, is quite similar for the two communities, despite differences in actual physical presence of pine beetle. One explanation for this finding could be that residents in Mackenzie are concerned about a significant future impact from the pine beetle and are also anxious about activity in the interior region as a whole.

Under the political dimension, these two communities receive moderately low scores that are nearly identical. This is not surprising as political scores are fairly similar for all study communities, and therefore this dimension does not appear to explain variation in final vulnerability scores. Low political dimension scores in Quesnel and Mackenzie suggest that political capacity is relatively high in these two communities. Specifically, community members in both locales consider the mountain pine beetle issue of great importance to them personally, believe pine beetle activity to be a significant risk to their community, and are reasonably familiar with basic beetle biology. These factors are more likely to lead to greater community support to local adaptation efforts, thereby lowering vulnerability. Community evaluations of leadership in both these communities are somewhat problematic, however, as residents have low trust in political leaders and moderately low satisfaction with beetle management efforts. These factors contribute to slightly greater vulnerability, particularly with regard to low levels of trust. The importance of trust in facilitating adaptive strategies is discussed in more detail near the end of this section. The political dimension score has a greater effect on Quesnel's final indicator score because this score is substantially lower (4.6) than its physical dimension score (9.5).

Similar to the political dimension, Mackenzie and Quesnel have very similar scores under the economic dimension of the vulnerability framework. These scores are moderately high, explained by high forest dependence and low perceived economic resilience. Quesnel's score is slightly higher than Mackenzie's because of relatively limited availability to alternative forest resources. While the political scores lowered vulnerability for these two communities, the economic scores increase vulnerability, as these communities have economic structures that will be affected by downturns in the forest sector, and in Quesnel's case, may have limited options for restructuring their forestry sector. The effect of this dimension on the final vulnerability score is more pronounced in Mackenzie, as its score under this dimension (6.5) is significantly higher than its physical dimension score (3.8).

Both Mackenzie and Quesnel receive relatively high socio-economic dimension scores, with Mackenzie's score higher than Quesnel's, suggesting that socio-economic factors are increasing vulnerability in these two communities. Similar to the economic dimension, the socio-economic dimension also appears to have a much greater impact on Mackenzie's final vulnerability score. As Mackenzie receives the highest possible score (10.0) this substantially increases its final vulnerability score, whereas in Quesnel, where most dimension scores are already high, its score of 8.0 has little effect on the final vulnerability score.

In summary, the shift in scores between Quesnel and Mackenzie—where Quesnel's vulnerability is lowered when political, economic and social factors are considered, and Mackenzie's is raised—appears to be explained by the influence of the political and economic dimensions in Quesnel, and the economic and socio-economic dimensions in Mackenzie.

As mentioned earlier in this section, scores under trust in government institutions in both Quesnel and Mackenzie, as well as all other study communities, are relatively high, indicating that there is significant community distrust of municipal, provincial and federal government institutions. This finding is worth exploring more carefully, and bringing to the attention of key decision makers in communities affected by mountain pine beetle activity, as institutional trust will influence the successful implementation of adaptation strategies and policies.

Low levels of institutional trust may not be unique to these study communities, and is likely indicative of similar distrust felt by rural communities across Canada. Although not examined in this study, there are several possible explanations for low levels of institutional trust in the study communities. In recent years in British Columbia, provincial government services and offices have been closed or relocated as part of overall government restructuring. In addition, both federally and provincially, there has been a gradual divesting of responsibility to rural communities in such areas as economic development and the provision of social services. Rural community residents tend to view these measures as a lack of government interest in community issues and as a form of disinvestment in their community. At the same time, federal and provincial governments are involved in several large funding initiatives and financial assistance packages around the mountain pine beetle outbreak and the Bovine Spongiform Encephalopathy (BSE) crisis. With these forms of government involvement contrasting with cutbacks in rural government services, communities may view government financial investments in rural regions as sporadic and largely crisis-driven. Another factor that could explain low levels of institutional trust is simultaneous rural economic decline and urban economic growth, where rural communities associate large urban areas with political and economic power, and view their own communities as having little influence on provincial and federal policy decisions. These factors may explain low levels of trust in the provincial and federal government; however, low trust in municipal governments was also found. One explanation for this finding may be that municipal governments are viewed as not been able to influence these larger social and economic trends, and have therefore lost a great deal of trust from rural constituents. In addition, because of economic decline, municipal budgets have been reduced in many communities and these governments are more constrained in their ability to make financial investments in the community.

Limitations

There are several limitations to this study that are worth noting for subsequent vulnerability analyses.

This study considers a limited set of physical impacts from the mountain pine beetle outbreak, namely the presence of beetle activity and eventual declines in timber supply. There are, however, several related impacts from beetle activity that could be examined in future studies, including the potential increase in forest fire hazard, various environmental impacts from large areas of dead timber, and visual impacts on the forest landscape. These factors were not considered in this study, but could be examined in future analyses as specific events contributing to community vulnerability.

A second limitation of the study was in the method of calculating the final index value. Indicators under each dimension, as well as the four dimensions themselves, were all accorded equal weight when calculating the final index scores. The purpose of this weighting scheme was to reflect the relatively equal importance of these concepts to the vulnerability framework. At the community level, however, some factors may have more of an impact than others on vulnerability, and by weighting each factor equally this relative influence is not reflected by the final vulnerability analysis. In future analyses, weighting could be assigned by asking community members to evaluate the importance of each of the factors on community vulnerability and adaptive capacity. Related to this limitation is emerging criticism of social indicators research in general. One recent study by Jackson et al. (2004) found that social indicators work is not as effective as longitudinal case study analyses at explaining the causal factors behind social and economic change. As such, this exploratory study could provide sufficient baseline information to inform a subsequent long-term case study analysis of the social dimensions of vulnerability to the mountain pine beetle outbreak that can provide greater insight into the specific community-level dynamics contributing to vulnerability and adaptive capacity.

Another limitation of the analysis is the regional rather than community relevance of the socio-economic dimension scores. This variable is measured using an index score calculated by BC Stats for Local Health Areas, which include several rural communities and regions within a large area. By assigning a regional score to an individual community, influences on well-being from outside the community are included in the analysis. Another approach may have been to create an index of social and economic well-being using 2001 Census data, which is measured at the community level. This approach was not taken because of the unique variables included in the BC Stats index, such as children and youth at risk, that are not found in Census data. Other regional level data, nevertheless, such as forest resources data, were intended to be measured at the regional rather than community level, because of the structure of the forest industry, where access to timber is from a larger region surrounding the community.

The poor quality of data from the leaders survey is another limitation of the study. The purpose of the leaders survey was to collect data on the political capacity of local institutions and to document the extent to which communities were investing in adaptation strategies. Because of low response rates to the leaders survey, this data was not used in the final vulnerability analysis.

Perhaps the most significant limitation of this study is the format of the final vulnerability analysis, where community vulnerability is represented using a single number. Although useful for identifying areas that require the most attention, the use of a single index value to represent the complex notion of vulnerability can be problematic and misleading. A single number does not reflect the many factors that influence vulnerability, such as political capacity, economic structures and social factors, nor does it reflect the many considerations that went into developing the vulnerability framework. For this reason, a breakdown of scores under each dimension and indicator is given in the report, to illustrate how various elements have influenced vulnerability for each of the study communities. The use of single index value is also somewhat misleading, in that it may be assumed that communities can be ranked relative to one another. In this study, it is difficult to discuss relative vulnerability as each community has a unique set of strengths and weaknesses that influence vulnerability, which cannot be accurately reflected in a ranking or ordering procedure.

CONCLUSIONS

Over the past few decades, scientific and technical risk assessments have come under sharp scrutiny. Assessments that were once undertaken by experts in university or government labs are now giving way to more pluralist approaches to risk assessment. Pluralism in this context involves an expansion of our understanding of what constitutes a risk, how it is characterized and how it is measured. It also involves an expanded array of scientific and alternative sources of knowledge that contribute to improvements in environmental risk decision making.

An expanded understanding of risk is reflected in the operational definition of vulnerability employed in this study. Extending beyond strictly biophysical assessments of risk, the international assessment literature focuses on the coping abilities of natural and human systems and the ways in which these systems can mitigate biophysical risks. Within a human system context, social, political, institutional, and economic factors play key roles. These factors are also prominent in the community assessment literature that seeks to understand the capacity of communities to respond to a variety of shocks, such as natural disasters or economic declines. The theoretical terrain within this literature offers a more pluralist and multi-disciplinary definition of vulnerability and related approaches to assessment.

Consistent with this expanded definition, pluralist approaches to risk assessment draw on significant developments in the fields of civic science and public participation. These developments have opened new opportunities for dialogue between scientists (with their experimental and empirical evidence on one hand) and lay people (with their experiential, localized, and contextualized evidence on the other). These inclusive approaches to environmental decision making provide opportunities for dialogue that are based on more pluralist forms of scientific, social, and cultural arguments. They offer a more even playing field for discussions between lay people and the scientific community.

A pluralist approach to understanding vulnerability is foundational to this study. It offers an opportunity to examine the multi-dimensionality of vulnerability within the context of mountain pine beetle-affected communities. Within the physical dimension, the study reveals high levels of vulnerability in communities like Quesnel, Burns Lake, and the Cheslatta Carrier First Nation. These vulnerability scores are consistent with assessments of exposure to the pine beetle derived from the BC Ministry of Forests. Scores for the political dimension of vulnerability reveal generally high levels of awareness about the mountain pine beetle but low levels of trust in government institutions to manage beetle impacts. Scores within this dimension are fairly consistent across the study communities with the highest levels of vulnerability in Cache Creek and Salmon Arm. Given high levels of forest sector dependence in several communities, the economic dimension of vulnerability varies quite dramatically. The highest levels of vulnerability include Quesnel, Mackenzie, Burns Lake, and 100 Mile House. Finally, the socio-economic scores derived from BC Stats reveal some variation in vulnerability with high scores among many of the study communities.

In developing a more holistic approach to vulnerability assessment, results from this study provide opportunities to gain some understanding of the multi-dimensional nature of risks and vulnerabilities to the beetle epidemic. For some communities, such as Quesnel and Burns Lake, vulnerability represents a high level of physical risk. For other communities, such as Mackenzie or Houston, vulnerability represents a high level of economic risk.

These results point to specific policy challenges for government agencies and corporations tasked with finding ways to support beetle-affected communities. In highly vulnerable locales, the economic engines of today are not likely to be the same economic engines in a post-beetle-salvage era. In this context, both physical and economic dimensions are likely to be compromised, resulting in coping strategies and effective transitions that will rely heavily on the social, political, and institutional capacities. Public perceptions, trust, political leadership, external and internal institutional constraints, and organizational coordination, along with capacities of local residents that are reflected in rates of education attainment and other health and well-being statistics are all crucial components within these transitional economies. Unlike the fixed and long-term nature of natural assets (natural resources) and economic infrastructure (physical infrastructure), these other forms of capital (local assets) are often the most affordable and amenable receptacles for community capacity building. Yet, ironically, they are also the most often neglected forms of community capacity within a natural resource management context.

A holistic approach to addressing vulnerability in beetle-affected communities will require investments within a variety of local and regional institutions. These investments in capacity will require collaborative efforts at all levels of government and across various private and public sectors. Natural resource departments, human health departments, education departments, and economic development departments are all required elements for effective vulnerability reduction in this context.

There are several promising directions for future research. Some research directions may involve addressing some of the limitations of the current study such as: (1) Working with BC Stats to determine socio-economic scores for individual communities, rather than a regional score. (2) Developing more empirical information on the institutional dimensions of vulnerability. In addition, the current study includes eleven communities in the BC interior and two communities in Alberta. The vulnerability framework and assessment approach could be scaled up to a larger number of affected communities in the region. Finally, this assessment provides a snapshot of vulnerability that is based on current data. Future research may involve some 'ground truthing' of the assessment tool by following several communities through this transition over the next five to ten years. To what extent does the vulnerability assessment provide insights into the actual outcomes of the communities in question? If empirical observations are not consistent with predictions, is it possible to improve the tool by incorporating new dimensions or new measures? Ongoing research will contribute to our understanding of the multi-dimensional nature of vulnerability and to the impact of policy interventions and strategies to mitigate vulnerability at the community level.

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Contacts:

John Parkins
Senior Sociologist
Canadian Forest Service
5320-122 St
Edmonton, AB T6H 3S5
Tel: (780) 435-7373
Email: jparkins@nrcan.gc.ca

Norah MacKendrick
Sociologist
Canadian Forest Service
5320-122 St
Edmonton, AB T6H 3S5
Tel: (780) 435-7345

Email: nmackend@nrcan.gc.ca

Appendix A: Procedures for Standardizing Indicators and Variables

Table 1. Standardization for physical risk variables, British Columbia

	Current forest susceptibility	Future forest impact	Perceived Impact
Standardization procedure: (Scale from 1 to 10)	Rank communities according provincial distribution of density of susceptible pine. (Measured in m3/ha by Timber Supply Area for 2003.)	Rank communities according provincial distribution of projected density of susceptible pine. (Measured by projected cumulative volume of pine killed (m3/ha) by Timber Supply Area by 2010)	Calculate mean score for survey questions for “perceived degree of impact on community from beetle activity” and nature of perceived impact on community” Apply weighting Calculate average
Weights:	--	--	2.0 for perceived degree of impact 1.4286 for nature of perceived impact

Table 2. Standardization for physical risk variables, Foothills Model Forest

	Percent area highly susceptible to beetle attack	Future forest impact	Perceived Impact
Standardization procedure: (Scale from 1 to 10)	Convert percent area to ten-point value. (Measured by percent area highly susceptible to beetle attack)	Not assessed. Data not available	Calculate mean score for survey questions for “perceived degree of impact on community from beetle activity” and nature of perceived impact on community” Apply weighting Calculate average
Weights:	--	--	2.0 for perceived degree of impact 1.4286 for nature of perceived impact

Table 3. Standardization for community awareness of risk variables

	Personal importance of beetle activity	Basic knowledge and awareness of mountain pine beetle	Perceived risk to community from beetle activity
Standardization procedure: (Scale from 1 to 10)	Calculate mean score for survey question. Apply weighting	Calculate composite index of True False questions. Question 8 (a, b, d, h) Best score = 1.0 (respondent has most answers correct) 1= 90.0% of sample has score of 1.0 5 = 70.0%-89.9% of sample has score of 1.0 10 = Less than 69.9% of sample has score of 1.0	Calculate mean score for survey question. Apply weighting
Weights:	2.0	--	1.4286

Table 4. Standardization for evaluation of community leadership variables

	Trust in government institutions to manage impacts and risk from beetle	Evaluation of community efforts to respond to beetle presence	Satisfaction with local beetle management efforts
Standardization procedure: (Scale from 1 to 10)	Calculate composite index of trust (Question 13(2). Items a, b, c, d) Apply weighting	Calculate mean score for survey question. Apply weighting	Calculate mean score for survey question. Apply weighting
Weights:	1.4286	1.4286	1.4286

Table 5. Standardization for economic dimension variables

	Economic Diversity	Forest Dependence	Availability of non-pine species	Community Assessment of Economic Resilience
Standardization procedure: (Scale from 1 to 10)	Rank communities according provincial distribution of economic diversity values	Convert percentage income from all forest activities to a ten point value	Convert percent pine on Timber Harvesting Landbase to a ten-point value. *(Not assessed for Foothills Model Forest area.)*	Calculate mean score for survey question. Apply weighting
Weights:	--	--	--	1.4286

Table 6. Standardization for socio-economic index, British Columbia

	Socio-economic Index
Standardization procedure: (Scale from 1 to 10)	0.42 to 0.94 (Worst) = 10 0.2 to 0.41 (Second Worst) = 8 -0.08 to 0.19 (Middle) = 6 -0.34 to -0.09 (Second best) = 4 -1.0 to -0.35 (Best) = 1
Weights:	--

Table 7. Standardization for the socio-economic index, Foothills Model Forest

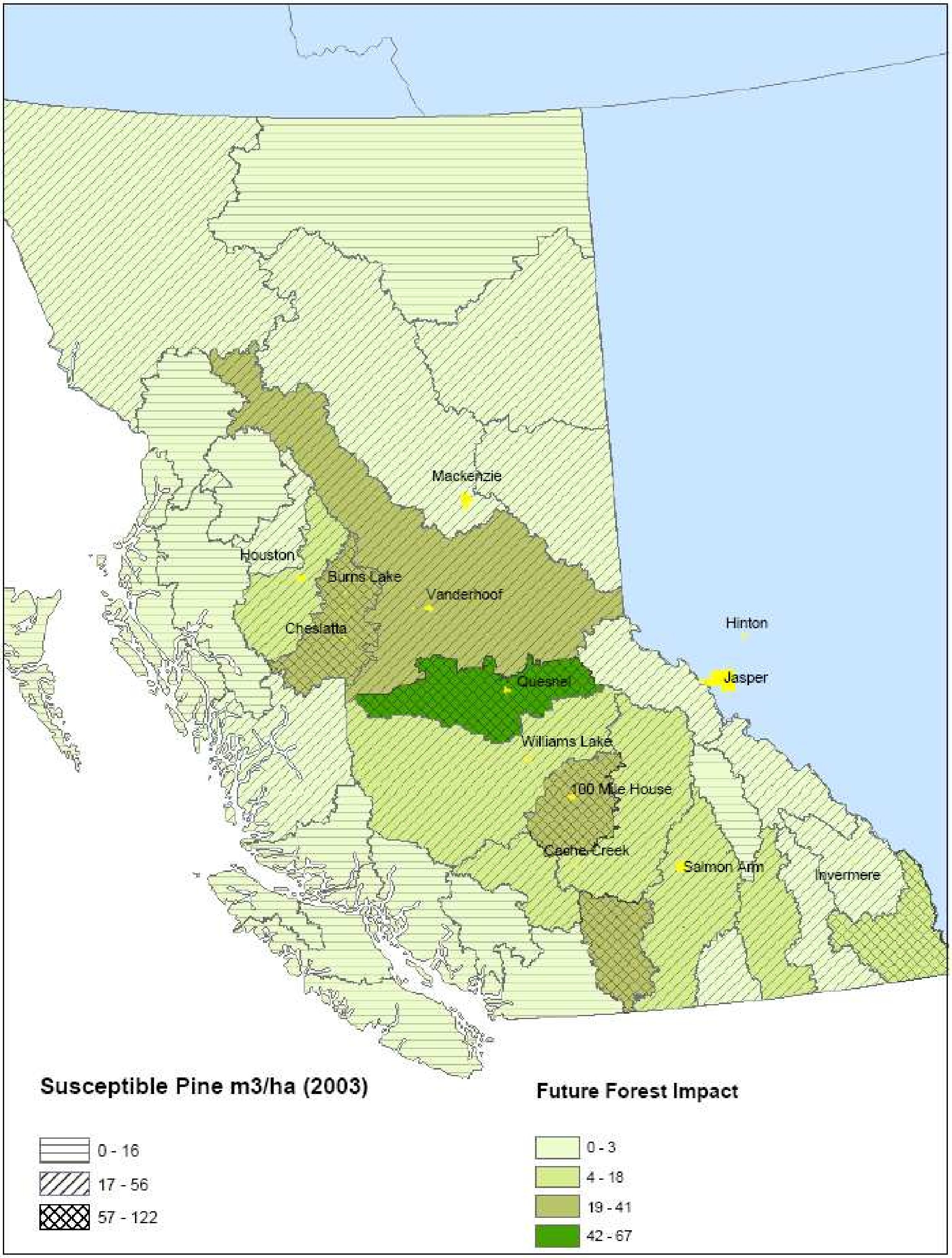
	Socio-economic Index
Standardization procedure: (Scale from 1 to 10)	Rank communities according provincial distribution of values for education attainment and incidence of low income
Weights:	--

Table 8. Standardization for institutional capacity index

	External Constraints	*Internal Constraints*	*Coordination*
Standardization procedure: (Scale from 1 to 10)	Calculate composite index of external constraints using question 13 (Items A, B, D, E F, G, I)	Calculate composite index of internal constraints using question 13 (Items C and H)	Calculate composite index coordination using question 12 (Items A, B, and C).
	Apply weighting	Apply weighting	Apply weighting
Weights:	1.4286	1.4286	1.4286

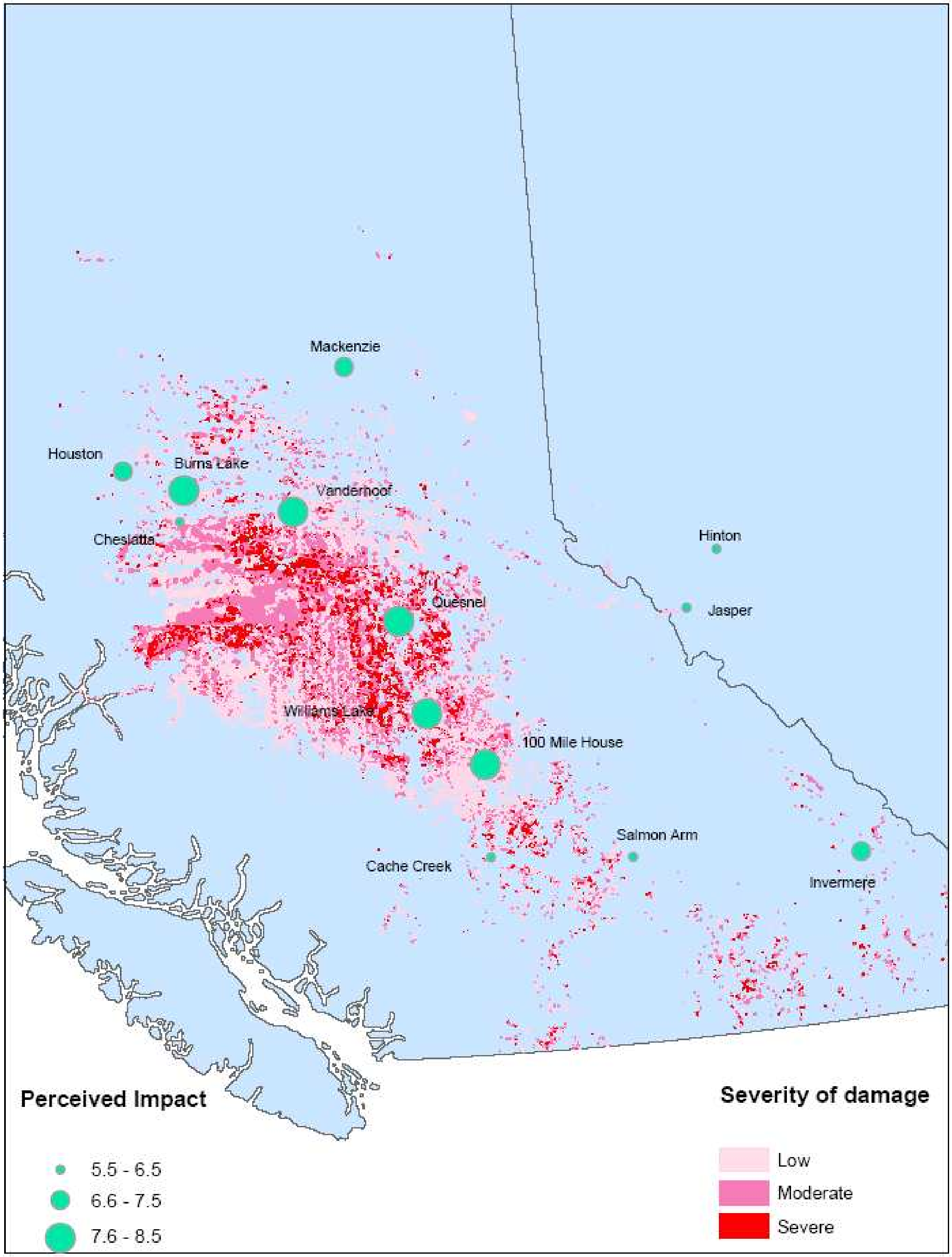
Appendix B: Maps of Vulnerability Indicators and Dimensions

Figure 1. Current Forest Susceptibility and Future Forest Impact



Current susceptibility and future forest impact data provided by BC Ministry of Forests, Research Branch. Timber Supply Area boundaries provided by the Surveyor General Branch, BC. Ministry of Sustainable Resource Management.

Figure 2. Perceived Impact on the Community and Severity of Damage from the Mountain Pine Beetle Infestation



Perceived impact data derived from the household survey.

Figure 3. Perceived Economic Resilience and Forest Dependence

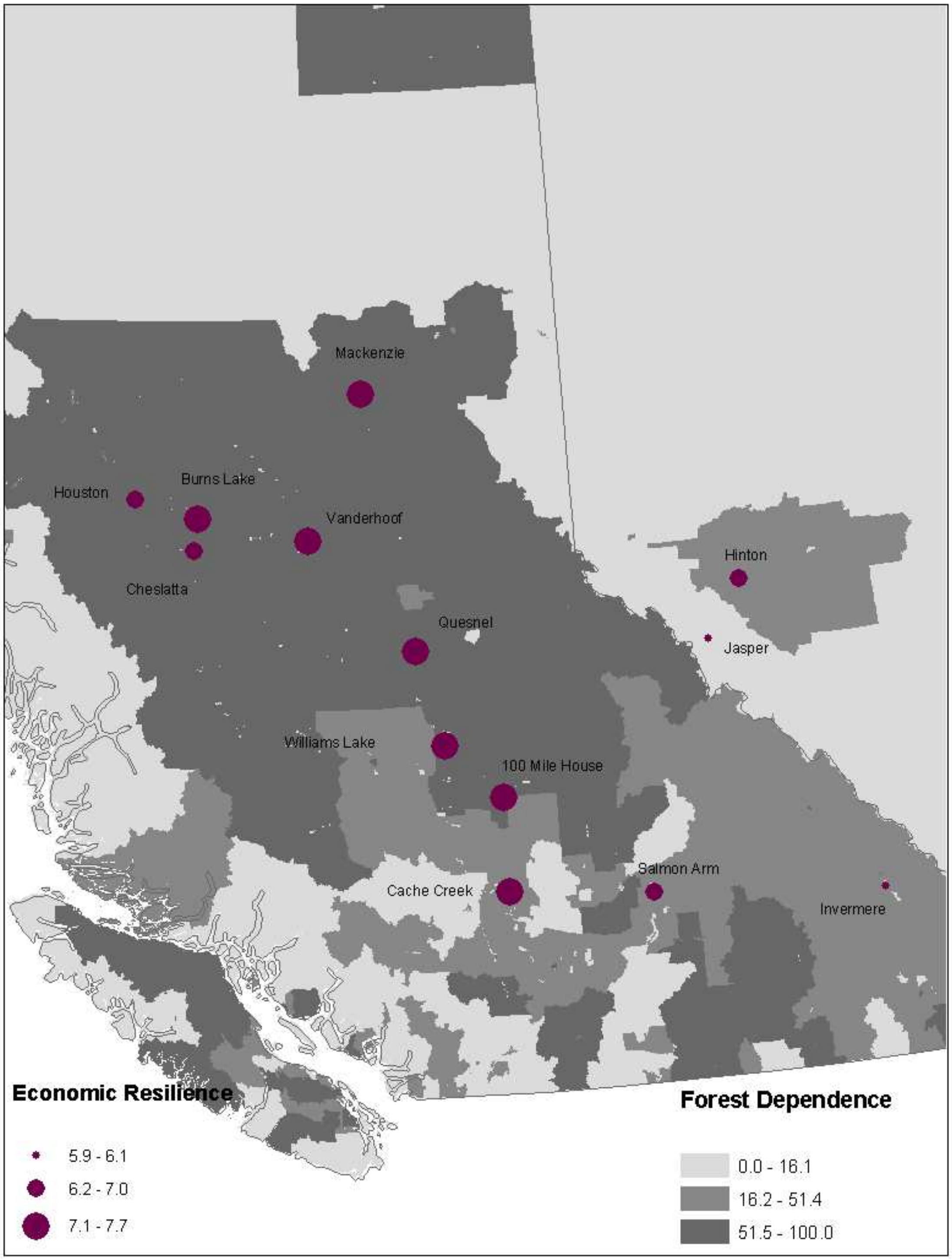


Figure 4. Perceived Economic Resilience and Economic Diversity

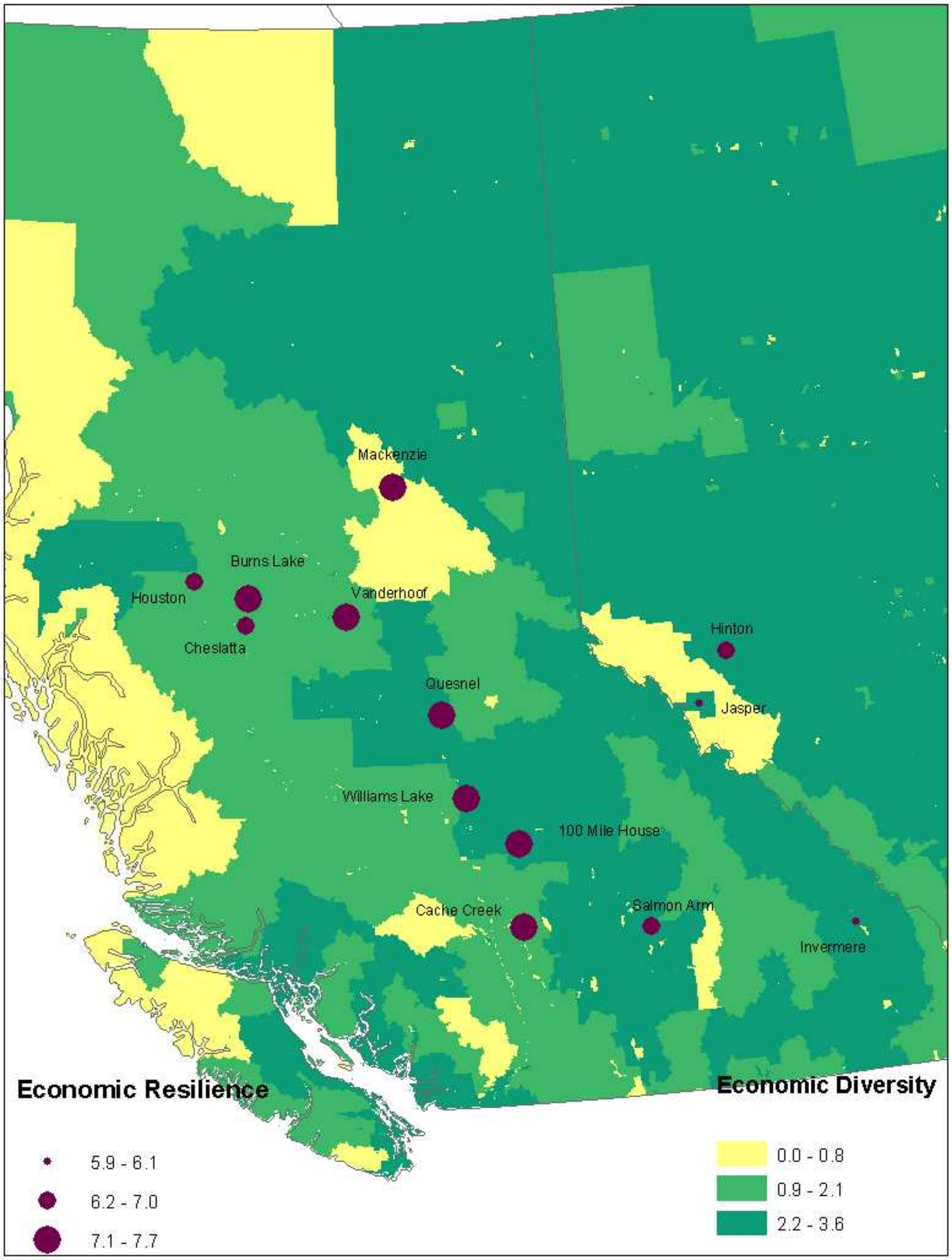
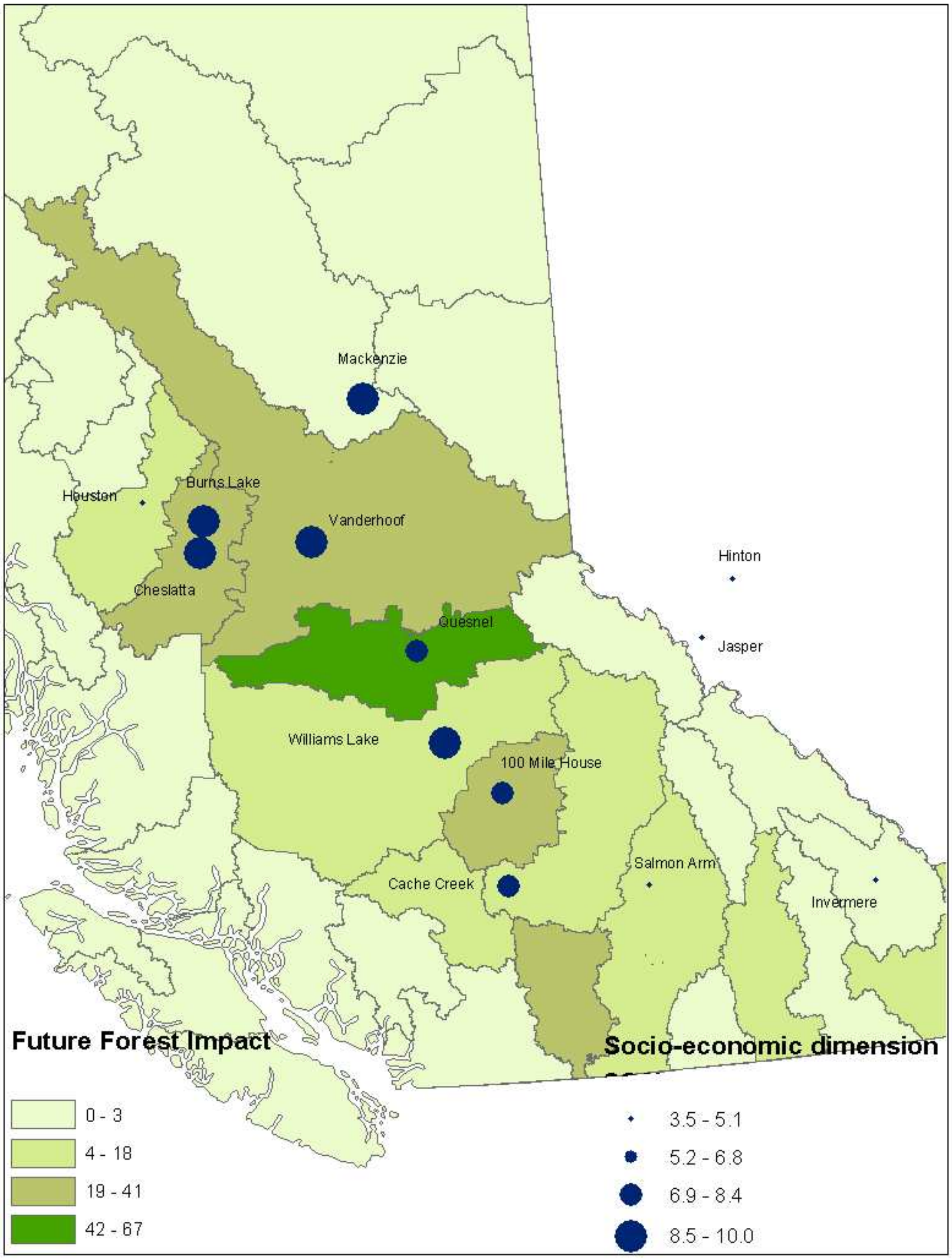


Figure 5. Socio-Economic Dimension Scores and Future Forest Impact



Future forest impact data provided by BC Ministry of Forests, Research Branch.

Figure 6. Vulnerability Index Scores for Study Communities

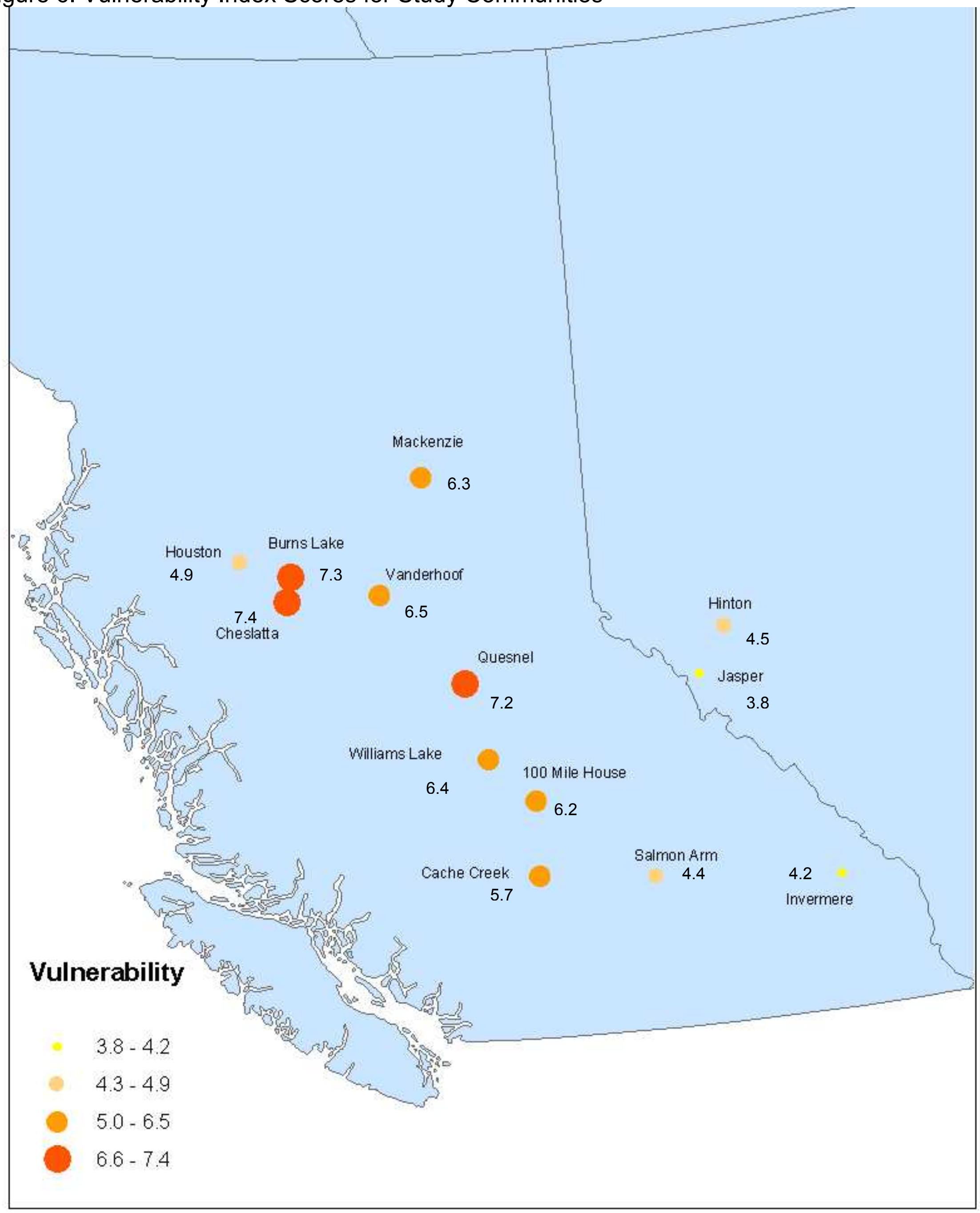
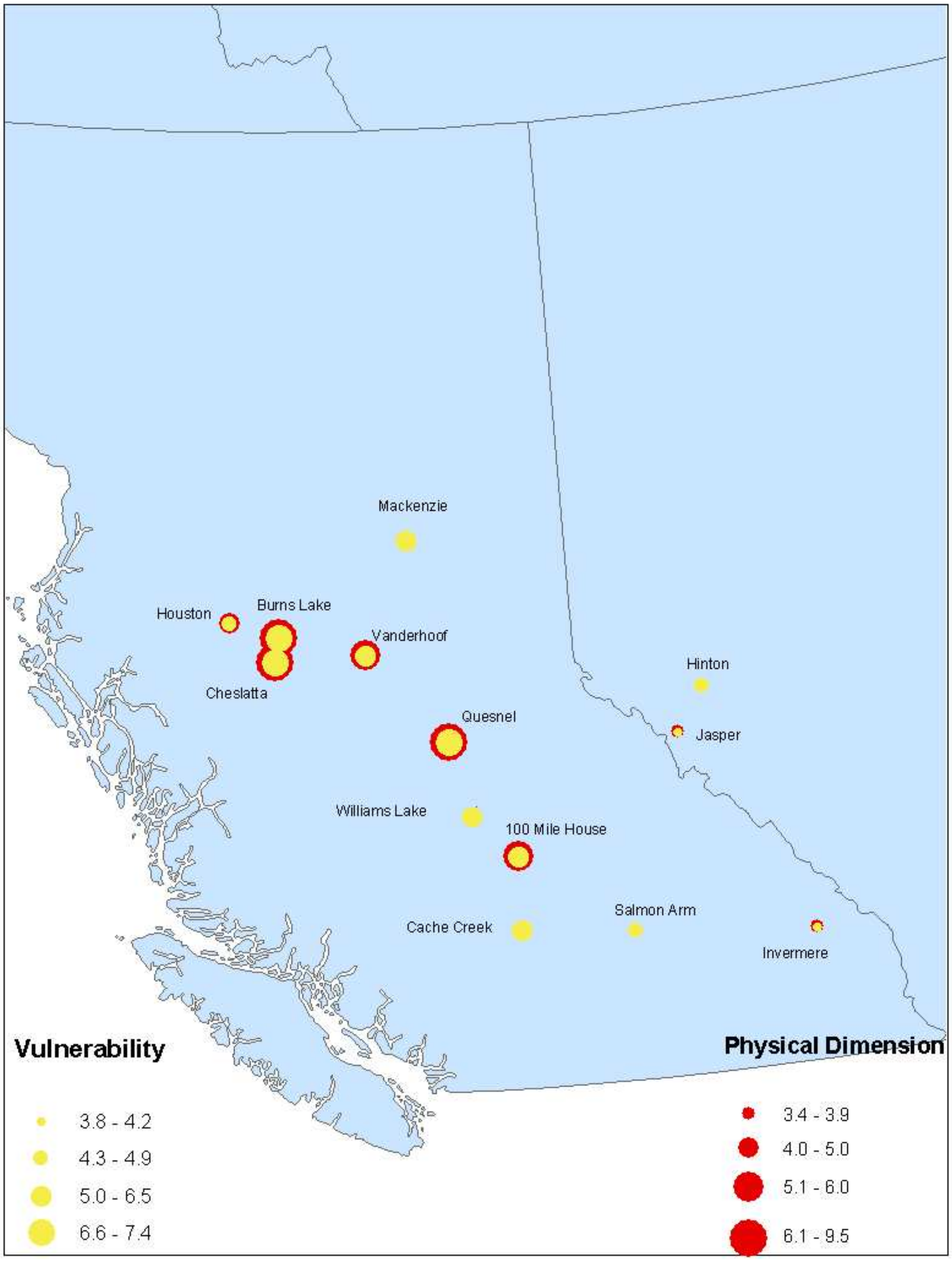


Figure 7. Physical Dimension and Vulnerability Index Scores



Appendix C: Household Survey Instrument

We would ask that the person currently living in the household
over the age of 18 and with the **most recent birthday** complete this questionnaire**.**

Thank you for taking the time to complete this questionnaire. The success of this study depends on your participation.

Please try to answer all of the questions. They can be answered by checking (□) the box, circling the number that best describes your answer, or writing in the space provided. Your participation in completing this questionnaire is voluntary; if there are any questions you do not wish to answer please leave them blank and move to the next question.

All information you provide is anonymous. Your name never appears with your answers. Only a summary of everyone's answers will be made public.

At your earliest possible convenience, please return the questionnaire in the self-addressed, postage paid envelope provided.

If you have any questions or comments regarding this survey, please contact:

Norah MacKendrick, Social Science Research Group, Canadian Forest Service, (780-435-7345), nmackend@nrcan.gc.ca
John Parkins, Social Science Research Group, Canadian Forest Service, (780-435-7373), jparkins@nrcan.gc.ca

SECTION I—YOUR COMMUNITY AND MOUNTAIN PINE BEETLE

First, we would like to know more about the current extent of mountain pine beetle activity in your community and region.

1. We will be asking you a number of questions about **your community.** Regardless of your residential address, to which community do you most strongly identify or associate? Please write the name of your community on the line below.

   Community name:___________________________________

2. How long have you lived in your community? _____________years

3. Does anyone in your household depend upon forestry or mining industries, or a natural resource government agency for their economic livelihood? Please check (Y) your answer. Yes No Don't know

4. Before receiving this survey, had you ever heard of the mountain pine beetle? Yes No

5. How would you describe the level of mountain pine beetle activity (defined as the presence of mountain pine beetles and dying trees) in the forests around your community? (Please check (Y) only one)

1) There has not been any mountain pine beetle activity and it is not likely to happen
2) There has not been any mountain pine beetle activity, but it is likely to happen
3) Mountain pine beetle activity is increasing
4) Mountain pine beetle activity is at its peak or is very active
5) Mountain pine beetle activity is declining or the outbreak is ending
6) Don't Know

6. How important is the mountain pine beetle issue (in your community or region) to you personally? Circle your rating on the scale below. (Please circle only one):

Not at all important		Neither important nor not important		Very important
1	2	3	4	5

7a. How much of an impact has mountain pine beetle activity had on your community?

No impact	Minor impact			Significant impact	Don't Know
1	2	3	4	5	9

(Please go to question 8) *(Please go to question 7b)* *(Please go to question 8)*

7b. What kind of impact has it had on your community?

Very negative			Neither positive or negative			Very positive
1	2	3	4	5	6	7

SECTION II—YOUR KNOWLEDGE OF MOUNTAIN PINE BEETLE

We would like to ask about your familiarity with the mountain pine beetle

8. Please indicate if you think each statement is true or false. Please check (Y) your answer.

	True	False	Not sure
A. The mountain pine beetle is a naturally occurring insect currently found in the interior of region BC and western Alberta			
B. The mountain pine beetle infects wildlife such as deer and elk			
C. A single mountain pine beetle can kill a young tree			
D. The mountain pine beetle causes no visible damage to the trees it infects			
E. The mountain pine beetle is beneficial to some birds			
F. The mountain pine beetle can be carried in firewood from one region to another			
G. Pesticides are the most effective means of killing the mountain pine beetle			
H. The mountain pine beetle is spread mainly by birds carrying it from one tree to another			
I. The mountain pine beetle infects mostly old pine trees			
J. The mountain pine beetle was imported to Canada from Europe			
K. The mountain pine beetle is prone to population fluctuations			
L. The mountain pine beetle is found in most of Canada from Newfoundland to Vancouver Island			

9. Rate, according to your own knowledge of mountain pine beetle, what single factor you think is most responsible for the current outbreak being experienced in your province. (Please check (Y) only one):

(1) Mild winters

(2) Drought

(3) Global warming or climate change

(4) Logging or removal of forest

(5) The suppression or prevention of forest fires

(6) Lack of early response to mountain pine beetle activity

(7) Other (please specify)______________________________

SECTION III—MANAGEMENT AND IMPACTS OF MOUNTAIN PINE BEETLE

We would like to know more about your views on the management of mountain pine beetle activity in your community and region, as well as the impact this activity may be having on your community.

10. Overall, how active has your community been in responding to the presence of mountain pine beetle?
Indicate the level of activity by circling the appropriate number on the scale below. (Please circle only one):

Not Active						Very Active	Don't Know
1	2	3	4	5	6	7	9

11. Overall, how satisfied are you with how mountain pine beetle activity is being managed in your community and larger region?

Very Dissatisfied						Very Satisfied	Don't Know
1	2	3	4	5	6	7	9

12. How much risk do you think each item poses, in terms of its impact on the well-being of your community or region. (Please circle only one number per item):

	Poses no risk						Poses a great risk	Don't Know
A. Climate change or global warming	1	2	3	4	5	6	7	9
B. Naturally occurring fires	1	2	3	4	5	6	7	9
C. Land use development next to parks or natural areas	1	2	3	4	5	6	7	9
D. Mountain pine beetle outbreaks	1	2	3	4	5	6	7	9
E. Young people leaving the community	1	2	3	4	5	6	7	9
F. An increase in the cost of living	1	2	3	4	5	6	7	9
G. Restrictions in trade with the United States	1	2	3	4	5	6	7	9
H. Unemployment	1	2	3	4	5	6	7	9
I. Crime	1	2	3	4	5	6	7	9
J. Reduction in health care services	1	2	3	4	5	6	7	9
K. Retirement of skilled workers	1	2	3	4	5	6	7	9
L. Cutbacks in social assistance	1	2	3	4	5	6	7	9

13. On the scale below, please circle:

1) Whether the following organizations should be responsible for managing impacts and risks from mountain pine beetle activity in and around your community:

AND →

2) How much trust you have in them to properly manage for mountain pine beetle activity:

	Should be responsible? Yes	No	Level of trust: No trust				Complete trust
A. Municipal government	1	2	1	2	3	4	5
B. Provincial government forestry department	1	2	1	2	3	4	5
C. Provincial government parks or protected areas department	1	2	1	2	3	4	5
D. Federal government agencies	1	2	1	2	3	4	5
E. Forestry companies	1	2	1	2	3	4	5
F. Other (please specify):______________________________	1	2	1	2	3	4	5

SECTION IV—THE ECONOMY IN YOUR REGION

These questions ask about your opinion on the economy in the region around your community.

14. In general, the economy in this region is (Please circle only one):

Rapidly Shrinking	Shrinking	Moderately Shrinking	Stable	Moderately Growing	Growing	Rapidly Growing
1	2	3	4	5	6	7

15. Please circle the number that best describes your opinion about each statement. (Please select only one number per item):

	Strongly Disagree			Neutral			Strongly agree
The economy in this region will be able to adjust to external influences, such as forest insects and fires.	1	2	3	4	5	6	7
The economy is able to bounce back from shocks quickly.	1	2	3	4	5	6	7

16. In your opinion, what kind of impact will natural disturbance (such as forest insects or fires) have on the economy:

	Very Negative			No Impact			Very Positive
in the short-term (1 to 5 years)?	1	2	3	4	5	6	7
in the long-term (over 5 years)?	1	2	3	4	5	6	7

SECTION V—ABOUT YOU

These last few questions are about you.

17. What was your age on your last birthday? ____________years

18. Are you: Female Male

19. Are you married or living with a partner? Yes No

20. Do you consider yourself to be an Aboriginal person? Yes No
(Status Indian, non-status Indian, Inuit, Métis)

21. Do you live on an Indian reserve? Yes No

22. How many children (under age of 18) live in your household? ________children

23. Are you (Please check (Y) only <u>one</u>):

(1) Employed
(2) Self-employed
(3) Retired
(4) Student
(5) Unemployed
(6) Outside the workforce to care for family or home
(7) Other (please specify): ____________________________________

YOU HAVE NOW COME TO THE END OF THE QUESTIONNAIRE. THANK YOU FOR PARTICIPATING IN THIS SURVEY.

If you would like to include any additional comments, please note them in the box below.

Appendix D. Leaders Survey

LEADERS SURVEY: MOUNTAIN PINE BEETLE SOCIO-ECONOMIC STUDY

Thank you for taking the time to complete this questionnaire. The success of this study depends on your participation.

The mountain pine beetle is an insect that infests and eventually kills mature pine trees. The outbreak of this insect is a key forestry issue in British Columbia and Alberta. Forests along the western edge of Alberta are being affected by this insect, while British Columbia is currently experiencing the largest outbreak of this insect in its recorded history. The information from this survey will help us understand the impact of the mountain pine beetle outbreak on human communities in this region.

The survey should take only about 15 minutes to complete. **Your responses are anonymous**; they will never be associated with your name.

We would ask that you respond to this survey **according to your own perspective, using your experience and knowledge as a representative of your organization**. Note that we will not take your response to represent your organization's official position or mandate on the issues addressed in this survey, and all individual survey responses will remain confidential.

If you have any questions or comments regarding this survey, please contact:

Norah MacKendrick, Social Science Research Group, Canadian Forest Service, (780-435-7345), nmackend@nrcan.gc.ca
John Parkins, Social Science Research Group, Canadian Forest Service, (780-435-7373), jparkins@nrcan.gc.ca

SECTION I—YOUR COMMUNITY AND MOUNTAIN PINE BEETLE

First, we would like to know more about the current extent of mountain pine beetle activity in your community and region.

1. This survey will ask you questions based on your experience as a current representative or employee of a community organization. We are interested in knowing more about the role you play in this organization. Please indicate whether you are a: (Please check (Y) only <u>one</u> of the following):

7) Mayor

8) Municipal government council member

9) Employee of a government organization

10) Employee of a non-government organization

11) Other
Please specify:____

1b. What is the name of the organization that you currently represent? Name:____________________________

2a. Does your organization serve or represent (Please choose only <u>one</u> of the following):

1) One community ⟶ Please go to the next question (2b)

2) More than one community ⟶ Please go to question 2c

3) An entire district or region ⟶ Please go to question 2c

2b. What community does your organization serve or represent?

Name: __________________________________ (⟶ Please go to question 3)

The following survey questions will ask you about the community you have indicated here. Please keep this in mind as you complete the survey.

2c. Below is a list of communities involved in our study. Please indicate which community your organization serves or represents. N.B. If your organization represents more than one of the communities listed below, please select only **one** (the one with which you are most familiar). **Please use this community as your point of reference for the remainder of the survey.**

1. Hinton, Alberta
2. Jasper, Alberta
3. 100 Mile House, BC
4. Burns Lake, BC
5. Cache Creek, BC
6. Cheslatta Carrier First Nation, BC
7. Houston, BC
8. Invermere, BC
9. Mackenzie, BC
10. Quesnel, BC
11. Salmon Arm, BC
12. Vanderhoof, BC
13. Williams Lake, BC

SECTION II—YOUR KNOWLEDGE OF MOUNTAIN PINE BEETLE

We would like to ask about your familiarity with the mountain pine beetle

3. Before receiving this survey, had you ever heard of the mountain pine beetle? Yes No

4. Please indicate if you think each statement is true or false. Please check (Y) your answer.

		True	False	Not sure
M.	The mountain pine beetle is a naturally occurring insect currently found in the interior of region BC and western Alberta			
N.	The mountain pine beetle infects wildlife such as deer and elk			
O.	A single mountain pine beetle can kill a young tree			
P.	The mountain pine beetle causes no visible damage to the trees it infects			
Q.	The mountain pine beetle is beneficial to some birds			
R.	The mountain pine beetle can be carried in firewood from one region to another			
S.	Pesticides are the most effective means of killing the mountain pine beetle			
T.	The mountain pine beetle is spread mainly by birds carrying it from one tree to another			
U.	The mountain pine beetle infects mostly old pine trees			
V.	The mountain pine beetle was imported to Canada from Europe			
W.	The mountain pine beetle is prone to population fluctuations			
X.	The mountain pine beetle is found in most of Canada from Newfoundland to Vancouver Island			

5. According to your own knowledge of mountain pine beetle, what single factor you think is most responsible for the current outbreak being experienced in your province. (Please check (Y) only one):

(1) Mild winters
(2) Drought
(3) Global warming or climate change
(4) Logging or removal of forest
(5) The suppression or prevention of forest fires
(6) Lack of early response to mountain pine beetle activity

(7) Other (please specify):____

SECTION III—MANAGEMENT AND IMPACTS OF MOUNTAIN PINE BEETLE

We would like to know more about your views on the management of mountain pine beetle activity in your community and region, as well as the impact this activity may be having on your community.

6. Please rate how much risk you think each item poses, in terms of its impact on the well-being of the community or region. For this question and the questions below, please note that we are interested in your assessment of the community that your organization serves or represents. (Please circle only one number per item):

	Poses no risk						Poses a great risk	Don't Know
M. Climate change or global warming	1	2	3	4	5	6	7	9
N. Naturally occurring fires	1	2	3	4	5	6	7	9
O. Land use development next to parks or natural areas	1	2	3	4	5	6	7	9
P. Mountain pine beetle outbreaks	1	2	3	4	5	6	7	9
Q. Young people leaving the community	1	2	3	4	5	6	7	9
R. An increase in the cost of living	1	2	3	4	5	6	7	9
S. Restrictions in trade with the United States	1	2	3	4	5	6	7	9
T. Unemployment	1	2	3	4	5	6	7	9
U. Crime	1	2	3	4	5	6	7	9
V. Reduction in health care services	1	2	3	4	5	6	7	9
W. Retirement of skilled workers	1	2	3	4	5	6	7	9
X. Cutbacks in social assistance	1	2	3	4	5	6	7	9

7. How would you describe the level of mountain pine beetle activity (defined as the presence of mountain pine beetles and dying trees) in the forests around the community? (Please check (Y) only one)

1) There has not been any mountain pine beetle activity and it is not likely to happen
2) There has not been any mountain pine beetle activity, but it is likely to happen
3) Mountain pine beetle activity is increasing
4) Mountain pine beetle activity is at its peak or is very active
5) Mountain pine beetle activity is declining or the outbreak is ending
6) Don't Know

8a. How much of an impact has mountain pine beetle activity had on the community?

No impact	Minor impact			Significant impact	Don't Know
1	2	3	4	5	9

(Please go to question 9) — 1

(Please go to question 8b) — 2 to 5

(Please go to question 9) — 9

8b. What kind of impact has it had on the community?

Very negative			Neither positive or negative			Very positive
1	2	3	4	5	6	7

9. To the best of your knowledge, which of the following activities are taking place in the community and larger region in response to mountain pine beetle activity? (Please check (Y) all that apply)

1) No activities
2) Large-scale logging operations
3) Property owners have removed pine trees from their property
4) Local protests against logging as a form of mountain pine beetle management
5) Prescribed burning
6) Public forums or information meetings
7) Clearing of trees around community to reduce fire hazard
8) Local protests against the processing of local beetle wood in outside regions
9) Written documentation (policies or plans) to address mountain pine beetle issues
10) Subsidies or grants to address mountain pine beetle issues
11) Other
   Please specify:____

10. Overall, how active has the community been in responding to the presence of mountain pine beetle?
Indicate the level of activity by circling the appropriate number on the scale below. (Please circle only one):

Not Active						Very Active	Don't Know
1	2	3	4	5	6	7	9

11. Overall, how satisfied are you with how mountain pine beetle activity is being managed in the community and larger region?

Very Dissatisfied						Very Satisfied	Don't Know
1	2	3	4	5	6	7	9

SECTION IV. ORGANIZATIONS IN THE COMMUNITY

Questions in this section ask about organizations in the community and your own organization.

12. To what extent do you agree or disagree with the following statements about organizations in the community?
(Please circle only one number per item)

	Strongly Disgree			Neutral			Strongly Agree	Don't Know
A. Organizations do not coordinate their efforts when working on similar issues in the community.	1	2	3	4	5	6	7	9
B. When stressful events happen in the community, organizations cooperate with each other to help the community recover.	1	2	3	4	5	6	7	9
C. Organizations in this community operate as a tightly knit and cooperative network.	1	2	3	4	5	6	7	9

SECTION V. YOUR ORGANIZATION'S ACTIVITIES

The next few questions address your organization's involvement in mountain pine beetle management and response. To ensure that we are aware of all community efforts around MPB issues, we would like to know about any written documents and spending from your organization that address mountain pine beetle issues.

16a. Are there any documents (e.g. reports, plans or policies) from your <u>own</u> organization that are directed at managing <u>local</u> pine beetle activity, or helping to prepare the <u>local</u> community to deal with impacts from the pine beetle? (Include documents released or scheduled to be released during this calendar year: January 1, 2004 to December 31st, 2004).

Yes	No	Don't know
↓	↓	↓
Please go to the next question	Please go to question 17a	Please go to question 17a

16b. If yes, please specify name of the documents and how to locate it using the entry fields below.

Name of document 1: ______________________________

Location of document 1: ______________________________

Name of document 2: ______________________________

Location of document 2: ______________________________

Name of document 3: ______________________________

Location of document 3: ______________________________

Name of document 4: ______________________________

Location of document 4: ______________________________

Name of document 5: ______________________________

Location of document 5: ______________________________

17a. To the best of your knowledge, are there any organizations in this community <u>other than your own</u> that have prepared documents directed at managing <u>local</u> pine beetle activity, or helping to prepare the <u>local</u> community to deal with impacts from the pine beetle? (**Please do not include documents from the provincial government**)

Yes	No	Don't know
↓	↓	↓
Please go to the next question	Please go to question 18a	Please go to question 18a

17b. Below, please list the names of the organizations responsible for the document:

Organization 1: ______________________________
Organization 2: ______________________________
Organization 3: ______________________________
Organization 4: ______________________________
Organization 5: ______________________________

18a. Is your organization currently directing any <u>money</u> toward managing <u>local</u> pine beetle activity, or helping to prepare the <u>local</u> community to deal with impacts from the pine beetle? (Include money already allocated or scheduled to be allocated during this calendar year: January 1, 2004 to December 31st, 2004).

Yes	No	Don't know
↓	↓	↓
Please go to the next question	Please go to question 19a	Please go to question 19a

18b. If yes, please specify the purpose and amount of spending below.

Purpose of spending: ______________________________
Amount ($): ______________________________

19a. To the best of your knowledge, are there any organizations in this community <u>other than your own</u> that are directing money toward managing <u>local</u> pine beetle activity, or helping to prepare the <u>local</u> community to deal with impacts from the pine beetle? (Please do not include spending from the provincial government)

Yes	No	Don't know
↓	↓	↓
Please go to the next question	Please go to question 20a	Please go to question 20a

19b. If yes, please list the organizations below:

Organization 1: ______________________________
Organization 2: ______________________________
Organization 3: ______________________________
Organization 4: ______________________________
Organization 5: ______________________________

20a. To the best of your knowledge, is your organization planning to release any documents in the future toward the management of local pine beetle activity, or helping to prepare the local community to deal with impacts from the pine beetle?

Yes	No	Don't know
↓	↓	↓
Please go to the next question	Please go to question 21a	Please go to question 21a

20b. If yes, when do you expect these documents to be ready?

2005 2006 2007 After 2007

21a. To the best of your knowledge, is your organization planning to direct any funding in the future toward the management of local pine beetle activity, or helping to prepare the local community to deal with impacts from the pine beetle?

Yes	No	Don't know
↓	↓	↓
Please go to the next question	Please go to question 22	Please go to question 22

21b. If yes, when do you expect this funding to be available?

2005 2006 2007 After 2007

SECTION VI—ABOUT YOU

These last few questions are about you.

22. What was your age on your last birthday? ____________years

23. Are you: Female Male

24. Does anyone in your household depend upon forestry or mining industries, or a natural resource government agency for their economic livelihood? Please check (Y) your answer. Yes No Don't know

25. If you would like to include any additional comments, please note them in the box below.

Thank you for completing this survey

This publication is funded by the Government of Canada through the Mountain Pine Beetle Initiative, a program administered by Natural Resources Canada, Canadian Forest Service (web site: mpb.cfs.nrcan.gc.ca).

Contact:

For more information on the Canadian Forest Service, visit our web site at:
www.nrcan.gc.ca/cfs-scf

or contact the Pacific Forestry Centre
506 West Burnside Road
Victoria, BC V8Z 1M5
Tel: (250) 363-0600 Fax: (250) 363-0775
www.pfc.cfs.nrcan.gc.ca