Climate Change:

Assessing the Adaptive Capacity of Community Forests

by

Eleanor Furness

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

(Forestry)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

June 2012

Abstract

Community Forests Organizations (CFOs) have been developed in British Columbia (BC) to manage forests according to the needs and desires of local communities and First Nations in forest dependent regions, in order to maximise the economic, social and environmental benefits of forestry. The effects of climate change in many of these regions are expected to be significant, and likely to have a detrimental effect on the health of the forests and communities. However, there are practical steps that CFOs can take which may improve their ability to cope with future conditions such as planting different species, practicing different silvicultural techniques and increasing monitoring and observation of the forest . This study is concerned with what CFOs need to have in place to take these steps. 'Adaptive capacity' is a term used to describe an ability to adjust to change. According to the Intergovernmental Panel on Climate Change (Adger et al. 2007), adaptive capacity depends upon access to natural, physical, economic, human and social capital, as well as enabling guiding values. This study aims to measure and describe each of the components of adaptive capacity in the CFOs in order to ascertain which of these factors are present in more adaptive organisations and may reveal something about the process of adaptation. Describing the nature of adaptive capacity in CFOs could inform policy development in climate change adaptation by both assessing what current capabilities exist in the sector and suggesting potential areas for development.

Preface

Versions of Chapters 1 and 5 have been developed for a report commissioned by Natural Resources Canada and a synopsis of the research has been developed for the British Columbia Community Forest Association (BCCFA).

Eleanor (Ella) Furness identified the research problem and methodologies and developed the research design under the guidance of Dr. Nelson. Dr. Kozak suggested the use of Likert scales used in the questionnaire and Dr. Harshaw provided in depth feedback on the development and structure of the questionnaire. Dr. Nelson made the initial contact with the British Columbia Community Forest Association which was then developed by Ella. Ella completed all the data collection and analysis and wrote all the documents. Drs. Nelson, Kozak, and Harshaw made valuable contributions in critiquing the methodology during the development of the research.

This research was approved by the UBC Behavioural Research Ethics Board (Certificate Number H11-01458).

Table of Contents

List of Tables

List of Figures

Acknowledgements

Talk is cheap, we talk, but if it costs money we don't do it. (CFO 8)

I would like to thank the community forest organisations who spent their valuable time answering my questions, Susan at the BCCFA for help in developing the project and giving me the opportunity to present the research at the BCCFA's AGMs in 2011 and 2012, as well as collaborating on three funding applications to support the work. I'd like to thank the Peter Wall Solutions Initiative for providing funding for the research and Tim Williamson and Kendra Isaac of Natural Resources Canada for their support and feedback during the research process. I'd also like to thank the UBC International Partial Tuition Scholarship fund, the Ralph M and Elizabeth E Cochran Scholarship fund and the Donald S McPhee Fellowship fund which also made the project possible. I'd like to offer my warm appreciation to Drs. Nelson, Harshaw and Kozak for their time and thoughts, particularly for trawling through endless iterations of the questionnaire as well as for their humorous encouragement and wry reflections on my work and errant trains of thought. I'd like to thank Neil Hughes RPF and Satnam Manhas RPF of Ecotrust Canada, and Ken Day RPF of the Alex Fraser Research Forest for their time trialling the questionnaires. I raise a pint of Québécois Maple syrup, a Bill Reid sculpture and a hockey stick to Phillip Grace for enabling my education in Canada's rich cultures, and a frond of *Thuja plicata* to Eirlys Rhiannon for patiently holding my bag while I learnt what a *Thuja plicata* was.

1 Introduction

The introduction below gives an overview of the theme of the research and how it will be presented, first looking at the relevant areas of literature: the physical impact of climate change in forests in British Columbia, the role of community forest organisations (CFOs) and the theoretical background of adaptive capacity. Secondly the research questions and hypotheses are presented, along with a brief outline of the methodology.

1.1 The impacts of climate change on forests in British Columbia

Canada's forests are already impacted by climate change, with increases in the large scale disturbance patterns of drought, insect attack, disease and fire (Williamson et al. 2009; Daniels et al. 2011). These increases in disturbance are likely to persist, putting pressure on local communities by affecting timber quality and production, watersheds and water availability, and increasing risk to health from smoke and fire. The impact of the mountain pine beetle epidemic has been partially caused by climate change, (Carroll et al. 2006, Cudmore et al. 2010, Woods et al. 2010), and gives us an indication of some of the impacts which forest dependent communities will need to contend with in the future. Specifically forests in British Columbia can expect to see increased biotic damage and disease, as well as an increased frequency and intensity of droughts in the southern interior, species migration, and loss of habitat in high-elevation forests. How forest managers anticipate and respond to these changes will affect the future of forestry in BC and have significant impact on rural forest dependent communities (Williamson et al. 2009). Whether forest managers adapt or not, the only certainty is that the future landscape of British Columbia will differ significantly from its current state (Hamann and Wang 2006). As the climate in BC is changing and community forests are or will be strongly affected by these changes, how they plan for and respond to change could have a significant influence upon whether they avoid or reduce the negative impacts of climate change on their organisations and communities (Ogden & Innes 2009).

1.2 Community forests and adaptation to climate change

CFOs are of particular interest in terms of assessing how best communities can address the impacts of climate change. Top-down, rigid and centralized processes have been shown to be limited in their ability to deal with the impacts of local environmental change, and there are suggestions that local participatory governance structures such as community forests may be more effective in building resilience in face of stressors such as climate change (Ostrom et al. 1999, Brondizio et al. 2009, Eakin et al. 2009). Run by voluntary boards for the benefit of the whole community, CFOs could play a lead role in helping forest dependent communities in BC adapt to climate change by improving the adoption of adaptation strategies (Ogden & Innes 2009, Chapin et al. 2010). However, research also shows that communities and organizations vary widely in their ability to adapt to changing conditions, and that community forests are far from a panacea (Bradshaw 2003; Reed & McIlveen 2006; Bullock & Hanna 2007, Bullock et al. 2009). This research aims to contribute to our knowledge about the adaptive capacity of CFOs, looking at how adaptive their organisations are currently and what factors seem to be enabling that adaptation.

1.3 Measuring community capacity to adapt

In order to contribute to understanding of the ability of community forests to adapt to changing conditions this research scrutinizes what is referred to as the 'adaptive capacity' of the organization. Probably the most widely used definition of adaptive capacity to climate change is used by the Intergovernmental Panel on Climate Change (IPCC), who used the following description in their Fourth Assessment Report in 2007.

> "Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change, and includes adjustments in both behaviour and in resources and technologies. The presence of adaptive capacity has been shown to be a necessary condition for the design and implementation of effective adaptation strategies so as to reduce the likelihood and the magnitude of harmful outcomes resulting from climate change". (Adger et al. 2007 p. 727)

Adaptive capacity as a concept has evolved in the climate change literature over the last two decades; early on adaptive capacity was seen as being primarily determined by access to economic, physical and natural resources. More recently a larger role for human and social capital and the values held by a community have been theorised or demonstrated by research. In terms of adapting to climate change, there are a range of impacts that may be of particular relevance to CFOs: flooding, landslides or slope instability, a reduction in the size of annual snow packs and more precipitation falling as rain, fire increase, an increased incidence of insect attack and disease, exotic pests or invasive plants, drought, changes in the structure of the forest or changes in the species composition (Williamson et al.2009). There are ways that CFOs can potentially adapt to the changing conditions, using techniques such as thinning to reduce moisture stress during drought, reducing regeneration delays after harvesting, and increasing their forest fire management. Organisations could also consider increasing their ecological monitoring and involvement in research, changing what species are planted, changing their seed provenance, as well as increasing the diversity of species they plant and the diversity of income sources derived from the forest. This research is concerned with identifying whether these adaptation techniques are being researched and adopted (whether the organisations are demonstrating adaptive capacity), and what characteristics are present in those CFOs that are adapting. In this way the research aims to look at what theoretical determinants need to be in place for a CFO to adapt; be it economic and physical capital, natural capital, social capital, and human capital, or the type of values held by CFOs. In the wider context the research attempts to establish what are the most important determinants of adaptive capacity to enable the targeting of resources and maximum benefit to communities.

1.4 The approach of the research

The project studied active members of the British Columbia Community Forest Association (BCCFA) using a survey approach to explore their current adaptive capacity. The survey measured CFOs' access to resources and documented how they are governed, and catalogued their values to compose a detailed description of the organizations. In addition to this, it detailed organizations' awareness of and response to climate change, as well as any adaptation

techniques they have embarked upon. This project has been in collaboration with the BCCFA. Susan Mulkey, the Communication and Extension Officer of the BCCFA has provided a link with the organisations and assisted in confirming that the research was relevant to the needs of community forest organisations. At the June 2011 Community Forests Conference in 100 Mile House, BC the research was presented to the membership who - through the BCCFA – have ensured that the research is as applied and practical as possible.

1.4.1 Research questions

In response to a recent observation on the study of adaptive capacity, the research aims both to characterize the adaptive capacity present in the CFOs and to that give an indication of the level of adaptive capacity present in the organisations.

> "Most studies to date have focussed on characterizing adaptive capacity. While these efforts are important to the field, they offer little opportunity for advancing a deeper understanding of the determinants and dynamics of adaptive capacity. Research that attempts to measure and characterize adaptive capacity in the same study can offer both theoretical and policy applicable contributions." (Engle 2011, p. 653)

To do this the research assessed the amount of adaptive capacity the organizations had at a given time (between November and January 2012) by measuring the extent to which they were researching, planning, and acting to adapt to the impacts of climate change that they had already observed or expected to observe. To measure and characterise that adaptive capacity a survey was used to collect information about the CFO's access to natural, human, financial, physical, and social capital as well as their motivating values, and attitude to climate change. In order to do this, the study collected data on the adaptive capacity (dependent variable) and the theoretical determinants of adaptive capacity (independent variables) in BCCFA members who hold a Provisional or Full Community Forest Agreement or other Forest Licence (the population of interest).

The study is framed by the following research question:

> Which determinants of adaptive capacity to climate change suggested by the literature are positively associated with greater adaptive capacity in Community Forest Organizations in British Columbia?

A number of sub-questions were then derived from the theoretical and applied literatures which were also used to guide the research.

1. Do CFOs with greater natural capital have greater adaptive capacity to climate change?
2. Do CFOs with greater economic capital have greater adaptive capacity to climate change?
3. Do CFOs with greater physical capital have greater adaptive capacity to climate change?
4. Do CFOs with greater human capital have greater adaptive capacity to climate change?
5. Do CFOs with greater social capital have greater adaptive capacity to climate change?
6. Are particular values held by CFOs associated with their adaptive capacity to climate change?

The research looks primarily at the *social* limits to adaptation (Adger et al. 2007), concentrating in particular on the way the CFOs are organized, the values they hold, the knowledge they have access to, and the relationships which exist between individuals and organizations. Although the research recognises the real impact that physical, natural and economic limitations can have on adaptive capacity, it predominantly interrogates how social adaptive capacity to climate change is constructed, placing the locus of control of adaptive capacity within the CFOs rather than outside them.

1.4.2 Hypotheses

To focus the research a series of hypotheses derived from the research questions were developed which will be examined in more detail in Chapter 5.

H1. CFOS with greater natural capital have greater adaptive capacity.

H2. CFOS with greater economic capital have greater adaptive capacity.

H3. CFOS with greater physical capital have greater adaptive capacity.

H4. CFOs with greater human capital have greater adaptive capacity.

H5. CFOs with greater social capital have greater adaptive capacity.

H6. CFOs with greater adaptive capacity hold distinctly different values from those with less adaptive capacity.

1.4.3 Data collection

In order to obtain a broad overview of the population of CFOs a survey approach was used, being well respected by practitioners in the rapidly evolving adaptive capacity field (Posey 2009, Engle 2011). Case studies were considered as an alternative, but would not provide data which could be generalized across the CFO population of interest, or give more broadly applicable data. The population size is small enough (38 organisations) that the survey could be conducted by telephone and elements of case study techniques (eg. semi-structured interviews) were employed within the survey to allow respondents to emphasise points were particularly salient to them, and add anything else that they thought relevant to the topic.

1.5 Overview of the thesis structure

This study gives an insight into CFOs in BC, and their access to resources, values, and attitudes to climate change. To do this it gives an overview of climate change, community forest management and adaptive capacity as well as details of the survey results, analysis and conclusions.

Chapter 2 gives an overview of climate change, focussing on BC, and looking at the impacts to forest health as well as potential adaptations that forest manager could make.

Chapter 3 looks at community management of common pool resources, the rise of community forests as a management approach and their development in BC.

Chapter 4 looks at adaptation and how adaptive capacity as a concept has developed from the resilience and vulnerability schools of thought before being incorporated into research

specifically on the impacts of climate change. It defines the main determinants of adaptive capacity that have been established by previous studies.

Chapter 5 presents the empirical examination of the adaptive capacity of CFOs and details the methodology used for the research

Chapter 6 gives a summary of the outcomes and analysis of the research, detailing the adaptive capacity and resources of CFOs.

Chapter 7 looks at the implications of the research, and synthesises it within the field as well as discussing how the results can suggest ways forward for the BCCFA and inform the wider policy environment.

2 The impact of climate change on forests in British Columbia

2.1 Global climate change

The Intergovernmental Panel on Climate Change was set up in 1988 by the United Nations to synthesise the research of the world's foremost climate experts. It released its most recent assessment of the state of knowledge about climate change in 2007 which stated that to the best of scientific knowledge the climate is warming due to a build-up of greenhouse gases in the atmosphere mainly caused by human activity. Greenhouse gases such as carbon dioxide, methane, and nitrous oxide are released into the atmosphere by fossil fuel combustion, deforestation, agriculture, and industrial activity, as well as through naturally occurring processes. Once released, these gases increase the amount of heat trapped in the atmosphere which has an impact on air and ocean temperature, precipitation, ocean currents, wind, and evaporation, as well as existing processes, cycles and ecosystems.

2.2 Observed climate change in BC

In British Columbia climate variation is affected by the Pacific Decadal Oscillation (PDO) and the El Niño/Southern Oscillation (ENSO) which give BC an already highly variable climate. The PDO is not very well understood but is thought to have a cycle of warmer and cooler periods over a period of 50 to 60 years, each lasting between 20 to 30 years. The ENSO has periods where winters are cooler than usual with above average precipitation and then warmer than usual with lower precipitation which alternate every few years. These two processes further complicate the already unpredictable and uncertain future effects of climate change in BC.

Taking this variation into account, existing data shows that the climate in BC has warmed significantly since the 1950s. The average global warming trend over the last 50 years was 0.13 ± 0.03ºC per decade, giving a total increase of 0.65 ± 0.15ºC for the period (Solomon et al. 2007). In British Columbia, both the average annual increase in mean temperature of 0.30 ± 0.04ºC per decade and the total increase of 1.5ºC during the last 50 years are slightly higher than the global average. This is consistent with IPCC reporting, which shows that warming at

higher latitudes has been greater than the global average (Solomon et al. 2007). Overnight minimum temperatures are showing the greatest increases, with lessening of frosts and increasing of the length of the growing season; the rate of change has varied across the province, with the North West showing the greatest variation. There has been a loss of snow pack by 25% on average during the last 50 years, though variability from year to year and region to region is large. Glacier loss has been at the rate of 22.48 ± 5.53 Km^3 per year. Spring run off has advanced on average 10-30 days where run-off is dominated by snow melt, and in places that have lost glacier influence stream flow has decreased. The Pacific Ocean is warming along the BC coast with all 7 data stations showing a warming of 0.5 to 1.0°C over the last 50 years. Eleven of the last twelve years rank among the warmest years on record since 1850 (Solomon et al. 2007).

2.3 Projected climate change in BC

Although techniques are constantly improving, there are still considerable sources of uncertainty in projecting regional climate change (Solomon et al. 2007). This uncertainty is due to range of factors: topography has a significant impact on local conditions; the interaction of different processes at the local scale are very hard to pinpoint with accuracy; and spatial resolution that can be achieved with current computer models is limited, there is a lack of historical data for BC, and few repeated model runs focused on the predicting impacts specific to BC. However, the observations in BC of the last 100 years do give researchers some solid historical data with which to build models, and there is consensus among researchers as to how climate in BC is changing and that trends in BC reflect the predictions of the IPCC's global climate models as a whole.

Regardless of the emission scenario used, all IPPC climate model projections suggest significant warming for the province by 2050 (Solomon et al. 2007). The projected trends are that by 2050 BC will have warmed on average 1.7°C compared with the period between 1951 and 1990, which is slightly higher than the global average expected warming. Predictions show winters will continue to warm faster than summers, which will reduce contrast between seasons;

though summers are still projected to warm with much of the province having summers 2–3°C warmer by 2050 than occurred in the period 1961 to 1990. The Northern half of the province is projected to see a greater change with winters warmer by 3–5°C (Rodenhuis 2009). Hydrological processes are harder to predict, though it is suggested that glacier loss is expected to continue at a similar rate as has been observed (22.48 ± 5.53 Km^3 per year), precipitation is expected to increase slightly (an average of 6%), with a comparatively large increase in winter precipitation and a contrasting increase in summer droughts; overall the snow pack is expected to decline by 55%. The continued influence of the ENSO will ensure that these changes are highly variable, with extremes of temperature, precipitation, wind and drought being likely and hard to predict (Rodenhuis 2009).

These observed and expected changes are likely to lead to droughts in the interior of BC, increased fire (a 74-118% increase on current levels by 2100 across Canada, particularly in the west), extreme events like windstorms becoming more frequent, along with increases in tree stress, pathogens and insect attack (Williamson et al. 2009). Many of the more gradual impacts of climate change are likely to be most noticeable at the transitions between ecological units (ecotones) like the edges where grasslands and forest meet (Hebda 1998). The multiple effects of interacting combinations of stress and pathogens (abiotic and biotic factors) are likely to increase in hard to predict ways (Sturrock 2011). Variations in temperature, moisture, and nutrient availability as well as the concentration of atmospheric CO_2 will affect the photosynthesis, respiration, phrenology, reproduction, growth and mortality of trees (Williamson et al. 2009). The combination of these factors: the 'predisposing' abiotic factors and the 'inciting' biotic factors, are the conditions which lead to overall decline of species, as evidenced by Yellow cedar (*Callitropsis nootkatensis*) which has died back throughout the last 100 years or so on the BC coast (Daniels et al. 2011, Sturrock et al. 2011). As locally adapted genotypes increasingly become maladapted to their environment there will be changes in the structure, species distribution and age class composition of forests. In previous historical periods of climate change adaptation has been delayed by hundreds of years in most tree species, a phenomena known as 'adaption lag', during this lag period trees are weak and susceptible to pathogens. In the current period of flux climate change is expected to progress

with unprecedented rapidity and forest managers have been warned to expect unanticipated impacts in forests and that change will be continuous and unremitting (Aitken et al. 2007, Williamson et al. 2009).

2.4 Impacts on forest health in BC

The scientific literature predicts that increases in the frequency and severity of forest pathogens will be one of the first observable impacts of climate change, and this forecast appears to be playing out in BC (Carroll et al. 2006, Woods et al. 2010). Forest pathogens include fungi, oomycetes, bacteria, phytoplasmas, parasitic higher plants, viruses and nematodes (Sturrock et al. 2011). The most striking example of this increase in BC has been the mountain pine beetle (MPB) (*Dendroctonus ponderosae* Hopkins). MPB damage over the last decade has been substantial; by 2010 14 million hectares of forest had been killed by MPB in BC (Woods et al. 2010). This is an exceptional epidemic which has arisen due to the culmination of perfect conditions (mature even aged forests) created by harvesting and silivicultural practices over the previous 100 years and further exacerbated by climate change. To date the epidemic has killed 50% of harvestable Lodgepole pine (*Pinus contorta*) in the province (Carroll et al. 2004, Cudmore et al. 2010, Woods et al. 2010). The role that climate change has played in the epidemic is supported by evidence that the MPB epidemic has not been limited in its spread by the lack of host trees for it to migrate to, but by a lack of favourable climate. As the climate has changed, the habitat available to MPB has increased; during the latter half of the 20th Century there has been an increase in both climatically *benign* habitat (northwards and at higher elevations), and *optimal* habitats which have expanded in south-central and south-eastern British Columbia, representing an increase in optimal habitat of 75% since the 1970s (Carroll et al. 2006). There is also evidence that changing climates are allowing MPB to spread into previously unaffected areas (Carroll et al. 2006), where they attack 'naïve' trees which have lower resistance and seem to offer more favourable conditions for more prolific reproduction of the beetle resulting in booms in insect population and creating the level of reproductive success associated with epidemics (Cudmore et al. 2010). The characteristics of range expansion and reproductive success in naïve trees of found in the

MPB example provides forest managers with an indication of how other forest pathogens are likely to spread in a rapidly changing climate.

The scale and severity of attack by pathogens is not only seen in the MPB, trees in BC are seeing an increasing diversity and quantity of many different pathogens (Woods et al.2010). Previously Dothistroma (*Dothistroma septosporum* Dorog. M. Morelet) needle blight has never been severe enough to kill mature native Lodgepole pine in BC; however the severity of recent infestations has resulted in the complete failure of 9% of pine plantations (Woods et al.2010). Stem rusts and fungi are also very responsive to environmental conditions, and though ideal conditions vary from species to species, warmth and increased precipitation are generally advantageous to this group of pathogens and consequently frequency of infection has increased in some parts of BC (Woods et al. 2010). The pressure upon forests from pathogens seems to be increasing in line with predictions (Sturrock et al. 2011), with trees increasingly stressed and unable to repel the assaults.

2.4.1 Stressed tree population

Drought stress, temperature variability and freeze–thaw events can reduce vigour and increase stress in all trees, and warming combined with drought has increased the susceptibility of many species to increasingly virile pathogens; climate change induced decline has been seen in Paper Birch (*Betula papyrifera*.), Sub Alpine Fir (*Abies lasiocarpa*), Red-cedar (*Thuja plicata*) which has seen die off in the drier areas of the coast and Southern interior, and Yellow-cedar decline which has happened in part as a result of declining snow depth at lower elevation and increased susceptibility of fine roots to late season frost (Woods et al. 2010, Daniels et al. 2011). Over the last two to three decades climate induced tree mortality rates in old forests of western North America have doubled (Daniels et al. 2011).

2.4.2 Species migration

These examples of climate change induced decline are likely to increase as time passes. Local populations facing rapid environmental change have three options: adapt where they are

(evolve), migrate to areas where the climate is more favourable, or die (extirpate or become extinct) (Aitken 2004). Geneticists suggest that in situ adaptation has played an important part in the persistence of tree populations in the past; pollen records show that trees have undergone migration, and the fossil record shows that many species have become extirpated or extinct in response to climate change. However, predicting what will occur in the future is far harder, as the past only provides very incomplete proxies of what we can expect to see: the speed of climate change that is currently occurring and is very likely to occur in the future is far faster than at any other time. In addition, landscapes have become fragmented by human activity on an unprecedented scale, meaning species adaptation and migration will be unable to keep pace with change (Aitken 2004, Aitken et al. 2007). With this in mind, current research suggests that tree species with large populations spread over wide unfragmented areas which have high fecundity and long dispersal ranges may migrate successfully, whereas species in small populations with low fecundity and dispersal (often found in high elevation and late successional species) will suffer significant adaptation lag (signified by high susceptibility to pathogens, low rates of growth, and mortality) (Aitken et al. 2007).

2.4.3 Species and biodiversity

Biodiversity is usually thought of as the amount of different species within a particular area, whether that is genetic diversity or species diversity, and research suggests that this will be affected by climate change on the individual, population, species and ecosystem levels (Gayton 2008). The future landscape of British Columbia will differ significantly from its current state. Some of the most economically important conifers in BC are expected to lose a large proportion of their suitable habitat, with White spruce, (*Picea glauca*) Engleman spruce (*Picea englemanii*,) Black spruce (*Picea marianna*, and Lodgepole pine (*Pinus contorta*) all likely to decline (Hamann and Wang 2006), though fossil records suggest this will not happen predictably. The future changes in BC's forests are likely to be erratic and stuttering changes catalysed by extremes; unprecedented decline in species like Yellow-cedar, and pest outbreaks like MPB may just be the very beginning (Woods et al. 2009). The ecological space created by stressed, morbid, dying and dead trees will be colonized by invasive plants, posing a threat to

biodiversity (Hamman and Wang 2006, Gayton 2008). Although it may be tempting to redraw the map of BC, and visualise, for example, the Coastal Western Hemlock Biogeoclimatic ecological classification (BEC) zone as a whole moving up the west coast as temperatures increase, ecosystems are unlikely to move as preorganized groups of species. Each organism will respond at the species level, with existing ecosystems experiencing the loss of some species and the introduction of new ones (Gayton 2008).

2.4.4 Abiotic changes

Fire is expected to increase in future conditions, both due to climate change and a recent history of fire suppression in BC. It is thought that low severity fires used to be frequent at low elevation, where they influence the composition and structure of low elevation grasslands and forest. At higher elevations fire was less frequent and more severe resulting in the destruction and regeneration of whole stands. There was large variation in the fire cycles with fires either caused by varying climatic conditions or First Nations' forest management techniques. The suppression of fire over the last 70 – 100 years has paradoxically resulted in a build-up of dead wood in many forests which increase the likelihood of large scale fire events, and these conditions in combination with climatic warming trends mean the fire season is expected to increase in the future (Gayton 2008, Daniels et al. 2011). Research indicates that fire regimes, insect attack and hydrology interact; with the presence of high volumes of insect killed dead trees in forests providing fuel for fires and altering hydrological volumes and magnitude (Rodenhuis et al. 2009, Daniels et al. 2011).

2.5 Uncertainty

Modelling future climate is inherently uncertain; atmospheric circulation and interactions between sea and land as well as ocean currents are complex and critical thresholds are unknown or highly speculative. Global climate models (GCMs) are considered robust in their predictions of temperature change for the first half of the 21st century, particularly at the continental scale and above (Soloman et al.2007); different models tend to predict the same

direction of change with varying magnitude. Precipitation is more uncertain since precipitation events often occur on scales that are smaller than the scales at which GCMs currently are able to operate. Particularly in mountainous regions elevation and topography play important roles in the patterns of precipitation. Consequently modelling precipitation is more difficult and models more inconsistent in their outputs. Modelling at larger scales is less reliable than at the global scale; however, taking into account local features, atmospheric circulation, topography, rainfall and seasonal patterns it is possible to dynamically downscale GCMs. To do this it is necessary to choose models for these predictions carefully as different models can have diverse emphases and strengths. The chosen models can then be validated against previous records for the region by 'hindcasting' and comparing the accuracy of the model outputs to the actual records which were recorded for the period (Rowland et al. 2011) although in many situations the available records are not complete enough to do this well (Rodenhuis et al. 2009) which can be a hindrance when attempting to obtain accurate predictions upon which to base forest management decisions at the stand scale.

2.6 Adaptations

Given the difficulties in producing accurate predictions of future climate and its impact upon forests in BC, it is hard to create robust prescription for adaptation. However, there are some potential adaptations that could be made; while some are in areas of research and technology, at the policy level, or require landscape scale co-ordination, others are adaptations that could be made by community forest managers. For example in the area of operations managers may need to be prepared to increase the amount of salvage logging they are carrying out in the future and expect a reduced winter harvest due to difficulties in accessing trees in non-freezing conditions (Williamson et al. 2010), and there is enough evidence of the probability of increasing fire risk to develop increasingly 'fire-smart' landscapes and communities (Williamson et al. 2010). Managers should expect to see an increasingly variable timber supply and begin to include changing climate variables in their growth and yield models and long term timber supply analysis. They could also be adopting risk assessment and adaptive management principles into their planning and day to day management decisions and including climate

change considerations when planning, constructing, or replacing infrastructure (Williamson et al. 2010). In terms of research managers could expand their ecological monitoring and pathogen surveillance (Papadopol 2000), and at the stand level managers can employ a variety of techniques depending on their particular location and expected impacts. For example, CFOs could use thinning to reduce moisture stress in trees and increase the growth of residual trees. They could also shorten rotations and reduce regeneration delays which can maintain or re-establish the CO_2 sequestration capacity of the land as well as reducing erosion where it is a problem (Papadopol 2000). In addition, organisations could develop and maintain a mosaic of species and age classes to try to spread the risk associated with dependency on only one or two commercial species (Cudmore et al. 2010), or experiment with planting alternative genotypes or new species in anticipation of future climate (Papadopol 2000, Aitken et al. 2007).

3 The evolution of community forests

This chapter discusses recent theory of community management of natural resources and looks at changing trends in how favourably community management is viewed in policy. It explores the increasing popularity of community forests globally and the development of the community forest agreement in BC.

3.1 The contested legitimacy of community management in natural resources

The last 50 years have seen huge changes in thought regarding the ability of communities to self-organise in order to use natural resources sustainably. The next section gives a brief description of how assumptions and approaches have evolved from the late 1960s until the present day.

3.1.1 Community management as tragedy

Although community forestry was recognised in the last quarter of the 20th Century as a potential approach for achieving sustainability in rural areas (Pagdee et al. 2006), Hardin's influential 1968 article 'The tragedy of the commons' strongly suggested that individuals benefit more in the short run from overexploiting a common pool resource than by using it sustainably, and that community managed common pool resources would inevitably be depleted. Hardin suggested that top down socialist style government regulation or free market privatization were the only ways that common pool resources could be managed for the long term excluding community management as an option. Reflecting the politics of the time, privatization grew to be seen as the most efficient way to govern natural resources. In the 1990s and 2000s Hardin's proposal has been consistently questioned (Berkes et al., 2006; Ostrom et al. 1994, 1999) with scholars offering increasing evidence that communities have successfully developed and maintained systems to share common pool resources over centuries (Ostrom et al. 1999).

While it is important not to be complacent, and to acknowledge that there are certainly examples where the ‘tragedy of the commons’ has taken place (Berkes et al. 2006), it is also

the case that Hardin's original article painted a particularly pessimistic picture of the human ability to self-organise in order to maintain a common pool resource. Hardin discussed a particular set of conditions under which common pool resources would become depleted (assuming all users were rational actors). Hardin's set of conditions were that users of the resource did not know each other, were not able or inclined to communicate with each other about the resource, had characters which predisposed them to be selfish and place their needs above others and only have short term gain as their goal. While certainly there are people in any group who are predisposed in these ways, and there are sets of conditions which encourage this type of behaviour in people who are less naturally inclined to selfish myopia (Berkes et al. 2006), the opposite is also true. Hardin himself found fault with his original conclusions, acknowledging and agreeing with many of these critiques and published some clarifications in the late 1990s (Hardin 1998). There are favourable conditions which allow people to self-organise to manage common pool resources and enable a more optimistic view of human potential for organisation; it is these conditions which will determine the success or failure of community management of natural resources and climate change adaptation.

Common pool resources have a wide variety of characteristics, and Hardin's warnings are particularly salient when discussing global resources such as fisheries, where users are often unable to communicate and are in precarious situations. Sometimes over-harvesting a seemingly inexhaustible resource seems like the only option for people who are locked into resource dependence (Berkes et al. 2006). The likelihood of successful community based self-governance can also improve with a range of design principles, which have been shown to be more effective in comparison with both external government regulation and privatization (for examples see Ostrom et al. 1999). In fact, in direct contrast to Hardin's advice, devolution of natural resource management to local communities has recently been seen a something of a panacea to deal with problems of over-exploitation of resources, poverty and inequality (McCarthy 2006; Bartley et al. 2008).

3.2 Community management of forests and adaptation to climate change

It is very hard to generalize about the success or otherwise of community management in recent years as in practice examples have been “patchy, varying from place to place, and often relying on local politicians and government officials to deal with newly devolved responsibilities” largely unsupported with varying levels of success (Bartley et al. 2008 p. 165). Despite the difficulty in gaining a universal assessment, there is enough evidence for the Intergovernmental Panel on Climate Change (IPCC) to conclude that local management of resources and participation in the adaptation process is of critical importance (Adger et al. 2007). Indeed, much of Ostrom et al.'s 1999 case study based rebuttal of Hardin's ‘tragedy’ has been recently reconfirmed in the context of community management of forests by a large sample study carried out in 2010 by Van Laerhoven that looked at comparable data of 250 community forests in 15 different countries. Van Laerhoven found that the favourable conditions for successful long term management seem to be the development of agreed on rules among the user groups concerning the utilisation and monitoring of the resource and the existence of active community involvement in maintaining the resource.

Current thinking certainly supports community governance as an essential tool to increase adaptive capacity to climate change (Finan & Nelson 2009), and given the substantial uncertainty of the localised impacts of climate change, there is a compelling argument for concentrating policy interventions on improving the adaptive capacity of communities alongside efforts in the physical sciences towards identifying specifically how that community’s environment may be affected (Agrawal & Perrin 2009). Advancements in understanding and observations of climatic response to global warming may be able to deliver superior predictions within the coming decades, but unless community adaptive capacity is increased, (and along with it our understanding of how best to contribute to this through policy), this knowledge may come too late for communities to respond confidently to the impacts of climate change.

3.2.1 The conditions for successful community management

Much of the literature which has been developed dealing with adaptive capacity of communities can be applied directly to CFOs, in particular, much of what Van Laerhoven (2010) has found can be useful. The characteristics of the governing groups and community are important; for example, user group size can have a significant effect on sustainable use (in bigger groups individuals experience greater costs to organizing and monitoring, it takes longer and it is more laborious to co-ordinate larger groups of people). Factors associated with social capital like mutual trust, dense social networks and close proximity can also make it much easier for groups to self-govern with minimal cost to themselves (Van Laerhoven 2010). Social learning and experience can help communities overcome problems, and salience or dependence on the resource can also contribute towards the maintenance of the shared resource (Ostrom et al. 1999; Van Laerhoven 2010). Leadership was found to be important when establishing a group, and less important for its maintenance, and there is some indication that homogeneity in terms of shared interests improves the likelihood of success (Van Laerhoven 2010). Forest management has some advantage over other resource management in terms of how straightforward it is to self-govern because it is uncomplicated to effectively monitor forest health with simple low cost techniques. The characteristics of the forest in terms of its size, spatial distribution, predictability of production and general condition are all important in terms of its how successful community management is, and in addition secure property rights, tenure and clearly defined boundaries are important. The relationship of the management group to external government was important, with Van Laerhoven (2010) finding that self-organised groups needed to have sufficient autonomy and legitimacy to be successful. However, external government and institutions can have a favourable supportive role, particularly in providing assistance with conflict resolution, supportive external sanctions and compensation for the costs of conservation (Van Laerhoven 2010).

Practical experience seems to indicate that community control is mostly likely to work when local stakeholders and also local officials have clear incentives and motivation to support effective community management of natural resources. At the local, national and international levels governing institutions and elites (corporate or governmental) can have a significant impact on the context in which local communities are managing their resource, and the pressures which face them. This wider institutional setting can either support or undermine community based resource management (Brondizio et al. 2009), irrespective of the ability of a local self-determined group to manage their natural resources.

3.3 The British Columbian context

There are community forests all over the world, and they are all very specific to the context that they have evolved in: they have different aims and objectives, ecosystems, communities, and economic and land ownership characteristics. Globally, community forests are very diverse, and there is not a one size fits all model; in British Columbia (BC) this diversity is reflected. Community forests as a way of managing the land were first mentioned in a government document as part of the Royal Commission of 1945 which gave recommendations for the future of forestry (95% of BC's forested land is owned by the government). Since then 39 community forests holding a probationary or full Community Forest Agreement (a type of tenure agreement administered by the provincial government) have developed. An additional fifteen communities are engaged in the process of obtaining an agreement. Currently community forests cover a total 1,172,238 hectares of land (Ministry of Forests 2011). The BC government instituted community forests by creating the Jobs and Timber Accord (JTA) of 1997, which was an agreement between the government and industry to increase jobs, equity, social justice, ecological and cultural sustainability within the forest industry, which lead to the 1998 development of 'pilot' community forests. Today, British Columbia's community forest program is one of the most developed in the world (McCarthy 2006).

3.3.1 Community management as panacea

The development of community forest organisations in British Columbia can be seen as part of the general trend in the 1990s towards devolution of resource management to local communities (Berkes 2010), embracing the idea that decisions about local common resources should be taken by those who are most directly affected, and reflecting the ascension of Ostrom's collection of evidence in defence of self-organisation. Within community forests in BC, this commitment to self-organisation and community based decision making is the most dominant shared feature in a very diverse collection of organizations. Community forests in BC are charged with a myriad of responsibilities, amongst them increased employment, the development of value added products, conflict mitigation over valuable environmental resources and homelands, community empowerment, the implementation of ecologically based forestry, and the restoration of community links with the environment (Bullock et al. 2009; Berkes 2010). This wide range of expectations has been criticised as unrealistic and undeliverable (Bradshaw 2003), indeed, community forests are expected to provide for many different and competing needs, including those of government, industry, community and First Nations stakeholders (Bullock et al. 2009). Community forests also attempt the incorporation of timber and non-timber values (environmental, recreational, and non-timber forest products), different worldviews, and different types of knowledge into their management of forest ecosystems, something which to a great extent is not expected from their competitors in the forest industry. Adaptation to climate change is yet another demand upon the resources of these small organisations which represent only a very small part of BC's forest industry as a whole.

4 Adaptive capacity

This chapter looks at the development of adaptive capacity as a tool for assessing the ability of a system to deal with change. To do this it looks at the development of adaptive capacity in different areas of thought: resilience, vulnerability and climate change; it then discusses in detail the different determinants of adaptive capacity and what they can explain about the process of change.

4.1 The need for developing adaptive capacity to climate change

As discussed in chapter 2, Climate change is uncertain and both emission scenarios and the results of predictive models vary. As time passes, the emissions scenarios become less uncertain; since the Copenhagen climate summit in 2009 and subsequent international negotiations it is clear that due to a combination of political, behavioural and technological inertia (Marechal & Lazaric 2010) warming is very unlikely to be less than two degrees as a global average, and that areas over land will likely warm twice as much as this average (Soloman et al. 2007, Friedlingstein et al. 2011, New et al.2011). Climate modelling is also becoming more developed and accurate, and monitoring and understanding of atmospheric cycles is becoming more advanced (Soloman et al. 2007). Despite these advances there is still considerable uncertainty at the local level and future climate is best conceptualised as a series of probabilities (Agrawal & Perrin 2009); consequently there is a strong argument that policy interventions will be more efficient and effective if they improve a population's ability to adapt to changing conditions (their 'adaptive capacity') rather than focussing solely on attempts to identify exactly how a particular village or district will be affected by climate change (Agrawal & Perrin 2009). Without precluding the importance of research in the physical sciences, there is a critical need to increase the adaptive capacity of populations, and to learn more about how this can be done (Adger et al. 2007).

4.2 Theoretical background

The theory of adaptive capacity was established in sociology, organizational and business disciplines, where it was developed to improve understanding of the ability of an organisation or community to plan for and cope with change. In the last 10 years the concept of adaptive capacity has been developed by scholars looking at climate change to further understanding of what factors enable communities to adjust. In part because the adaptive capacity concept has developed in multiple schools, there are many contradictory assertions and details within the model which scholars have sought to reconcile (Gallopin 2006, Engle 2011). Rather than in consensus, the field is at a stage where almost every scholar has a different interpretation of what adaptive capacity really means, and in particular what factors are essential for it to be present. For example adaptive capacity has been approached in terms of what institutions (in the broadest sense) and social arrangements exist (Brondizio et al. 2009); or deconstructed into a list of social and ecological functions which scholars frame as forms of capital (human, social, institutional, physical and natural) in order to assess their purposes within the relationship humans have to their environment, or as many scholars call it, the 'social-ecological system' (Adger 2006, Adger et al. 2007, Williamson et al. 2010).

4.2.1 Adaptive capacity in the resilience literature

Resilience Theory grew out of the ecological sciences; it is a type of systems thinking which was developed originally to describe how ecosystems respond to big changes such as rapidly changing climate conditions or influxes of pollution (known as 'shocks'). Humans are seen as part of this system, hence the use of the term 'social-ecological system' which refers not only to ecosystems, but incorporates the analysis of human relationships into an all-encompassing structure. The application of resilience theory to human organisation is not universally accepted as a useful development in improving sociological understanding of societal response to risk because it downplays the substantial role of human agency (Davidson 2010, Daedlow et al. 2011), but it has been used extensively in theoretical discussions to analyse and better understand the adaptive capacity of social-ecological systems (Engle 2011). In terms of its contribution to practice, resilience theory is perhaps most significant because it conceives of a

system not as something which can be retained in a steady state, but as something that is inevitably subject to fluctuations over time. Holling's (1973) original article in which he proposed the theory explains this difference in a way which is salient for scholars seeking to understand adaptation to the uncertainties of climate change today. Holling suggested that a management approach stemming from resilience thinking would emphasise:

> "… the recognition of our ignorance; not the assumption that future events are expected, but that they will be unexpected. The resilience framework can accommodate this shift of perspective, for it does not require a precise capacity to predict the future, but only a qualitative capacity to devise systems that can absorb and accommodate future events in whatever unexpected form they may take" (Holling 1973 p.21).

In resilience thinking adaptive capacity is the ability of a social-ecological system to adapt to change without experiencing a shift in its function, structure, identity, and feedbacks (Walker et al. 2004) and an ability to remain in a desirable state rather than an undesirable state or annihilation (Carpenter et al. 2001, Folke 2004 & 2006). The resilience literature is extensive, and refers to different examples, often where an ecosystem has an identifiable 'threshold' within which it is capable of absorbing a certain amount of change, beyond which it will experience a sudden alteration or shift, known as a 'regime shift' (Folke 2004). For example: in the case of spruce budworm outbreaks in North American forests, the pathogen largely co-exists with other species within the ecosystem, but every 30 to 100 years there is an outbreak catalysed by warm weather and mature forest. If the conditions are favourable enough for budworm reproduction to outstrip predation rates there will be an outbreak which can rapidly spread over thousands of square kilometres. When this happens the damage is such that there is die back of mature softwoods and the ecosystem shifts typically from one dominated by spruce and fir to one dominated by early succession birch and aspen. This has consequences throughout the social-ecological system with impacts on hydrology, soil, and all the other species, including humans; fundamentally altering the relationships between the components

within the system (Folke et al. 2004). In resilience theory, part of the 'adaptive capacity' of the forest in this case is the capacity for its relationships and processes to persist before a transformation occurs and a threshold is crossed, factors such as the resistance of the trees to predation, the structure of the forest which supports an accumulation of the budworm, and the presence of predators which feed on the budworm.

In human societies, resilience theory describes adaptive capacity in terms of how change is dealt with through complex processes like social learning, institutional inertia, and interactions across scales (Holling 2001, Folke 2006); seeking to theorise why some societies persist in their 'primary state', or continue functioning without large declines in the well-being of people in the face of change and others do not (Holling 2001, Chapin et al. 2010). There are difficulties with applying resilience theory onto human societies indiscriminately, as while humans are indeed part of a wider social-ecological system, they are not the same as other actors within that system; non-human adaptation is reactive whereas humans have the capacity to use both anticipatory and reactive actions to respond to climate change (Adger et al. 2007). Humans also have the ability make normative decisions about what state is most desirable to them, and (as humans can control their environment to some extent) unlike other agents within the system they can choose whether to pursue increasing adaptive capacity; this difference is in part why the application of resilience theory to the practical challenges of social adaptive capacity remains only loosely developed. There is no framework within resilience thinking that explains how humans can navigate change onto more desirable routes (Chapin et al. 2010). As a consequence resilience is perhaps best seen as a perspective which has enabled a shifting of emphasis away from the singular pursuit of the prediction of physical events and towards a greater understanding of a system's ability to adjust to those events, as well as a metaphor to explain events, rather than a fully developed theory for the study of social adaptive capacity (Deadlow et al. 2011).

4.2.2 Adaptive capacity in the vulnerability literature

Vulnerability is characterized as the opposite or 'flip side' of resilience (Fikret 2007); it looks at the social-ecological relationship in terms of its susceptibility to harm, rather than its ability to resist harm, and has been developed in the fields of hazard and risk management (Eakin & Luers 2006, Engle 2011). The idea of vulnerability has been used to develop frameworks to assess the extent that ecosystem and communities will be, or are, impacted by climate change (Burton et al. 2002). The outcomes of these assessments indicate that in some ecosystems, species and human communities appear more vulnerable than others (Gonzalez et al. 2010). The definition used by the IPCC in 2001 has been used in most subsequent work and describes vulnerability as follows:

> "The degree to which a system is susceptible to or unable to cope with adverse effects of climate change, including variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity." (White et al. 2001 p.21)

The approach to the study of adaptive capacity in the vulnerability literature is more pragmatic than that of resilience, with the aim of most research being to understand the extent which a specific ecosystem or community (or both) are vulnerable to the effects of climate change. Most research prioritises praxis by building matrices and frameworks to enable the identification of common determinants of vulnerability, which can then be used to inform policy. First generation vulnerability assessments looked primarily at the potential effects of climate change, and second generation assessments tend to emphasise the possibilities of adaptation to these effects (Fussel & Klein 2006, Adger et al. 2007). Developments in understanding about vulnerability have often been derived from grounded research which is reflected in the absences of a unifying framework which can be overlaid onto all situations for their assessment; instead there are many tailor made frameworks with common themes within them (Parkins & MacKendrick 2007, Ostry et al. 2010). Examples include the United Nations

Development Program's 'Mapping climate change vulnerability impact scenarios' (2010) and Natural Resource Canada's 'Framework for assessing vulnerability of forest based communities to climate change' (Williamson et al. 2007).

4.2.3 Adaptive capacity in the climate change literature

The evolution of adaptive capacity in the climate change literature broadly falls into three cohorts: the first group conceptualised the determinants of adaptive capacity as primarily practical, emphasising the roles of technology, science, effective institutions, human capital, effective networks to maximise trust, mechanisms to disseminate knowledge, and an awareness of climate change as an issue (Smit et al. 2001, Yohe & Tol 2002). The second generation wondered why communities that had all these elements still were not adapting (Naess 2004), and looked more specifically into governance and institutional factors which influence change (Folke 2005, Engle & Lemos 2009, Eakin et al. 2009), whether different determinants of adaptive capacity could be substituted for each other (Tol & Yohe 2007), and questioned the role of economics in predicting the adaptability of communities (Adger et al. 2007). More was learned about local and traditional knowledge, indicating that both played as important a role as science and technology (Adger et al. 2007). The third development emphasised the role of internal values, social factors and cognition. The importance of social factors in adaptive capacity has been recognised since the 1990s as being of significant importance in adaptation (Smithers & Smit 1997), but in depth examinations of how social factors such as values, cognition of risk, ethics, knowledge and culture influence adaptation are relatively recent (for example Adger et al. 2009). Explorations of role of values and cognition in adaptation are in their infancy, and there very few examples of research, but the importance of values in climate change adaptation are widely recognised and the need for further research in this area has been requested (O'Brien 2009, O'Brien & Wolf 2010).

4.2.4 Deconstructing adaptive capacity

The process of agreeing exactly what factors enable greater adaptive capacity is on-going. Studies aiming to identify the determinants have been carried out at different scales; the national (Brooks et al. 2005, Eakin et al. 2009), the community (Daniels et al. 2011), and the

individual (Bolnick et al. 2003). It is clear that determinants have different influences at different scales (Smit et al. 2001), and consequently there will be differences in what makes a nation respond to climate change and what makes an individual respond to climate change, though the two scales will interact (Brondizio et al. 2009). Disentangling the determinants of adaptive capacity is difficult as authors use often different terms to refer to the same or significantly overlapping concepts, and may be writing from different perspectives or traditions (Engle 2011). Measuring adaptive capacity and developing systematic indices to do so is notoriously difficult, since the influence of changes in adaptive capacity are not direct or clear and there are many competing variables that may work together, eclipse or mask the effects of one another, or substitute one another (Smit et al. 2001, Smit and Wandel 2006, Gupta et al. 2010, Engle 2011).

4.2.4.1 Natural capital

Both terms 'natural capital' and 'natural resources' are used interchangeably throughout the literature; natural capital is used to quantify the provision of 'ecosystem services' like storm and flood protection, erosion control, clean water, plant and animal habitat, trees and other harvestable plants, as well as recreation and cultural services (Constanza et al. 1997, Wackernagel et al. 1998). The availability of natural resources can have a significant impact on the adaptive capacity of a community (Adger et al. 2007), and access to a wealth of natural resources could give CFOs different options to consider if a particular avenue became untenable due to the impacts of climate change.

4.2.4.2 Financial capital

In broad terms economic wealth increases social adaptive capacity, however, in combination with other factors, the strength of economic determinants is contested. In 1997 the IPCC stated that adaptive capacity was correlated with GDP per capita, though subsequent studies suggested that this overlooked the role of local knowledge in enabling people to adapt to changing and variable environments over generations in places as marginal as the Sahel and the Arctic (Adger 2006).

An over-reliance on financial capital has meant that adaptive capacity has been lost in cases where local knowledge is underused in favour of economic 'fixes' and the relative importance of access to economic resources varies with context (Jennings 2009). With these caveats, economic determinants play a valuable part in spreading the risk imposed by a changing climate, this is apparent in our British Columbian context, where economic diversity could play a large role in increasing adaptive capacity (Joseph & Krishnaswamy 2010).

4.2.4.3 Physical capital

Physical capital is a physical object that makes a person more productive than he or she otherwise would be, a bicycle or a screwdriver is physical capital (Putnam 2003) and so are buildings and equipment (Goode 1959). Physical capital can also be infrastructure like the provision of electricity, roads or transport systems which mitigate isolation (Smit et al. 2001, Smit & Wandel 2006). It is not necessarily the case that 'more is better' in terms of access to physical capital, as an excess of something can become a liability. For example to cut down a tree one chainsaw will suffice, 10 chainsaws would not make the job any easier, and would be a drain, in that they would need to be stored and maintained. In terms of adaptive capacity, lack of access to physical capital is best seen as a potential limit to adaptation.

4.2.4.4 Human capital

Human capital is the state of education and knowledge, skills and experience (as well as health, punctuality and various other qualities) of people that contribute to a shared project (Goode 1959, Becker 1994), it is widely accepted as being an important determinant of adaptive capacity (Yohe & Tol 2002, Adger et al. 2007, Williamson et al. 2010). There needs to be some analytical or experiential understanding of a problem within an organisation or community before it can be solved, as well as information available to communities enable them to look at different options. This information can be scientific or it can be traditional or local: derived from oral traditions, historical knowledge or anecdotes developed through generations of people with the experience of living in a particular place (Duffield et al. 1998, Adger 2006). Human capital also creates organizations which are more innovative and more likely to adapt (Adger et al. 2009, Joseph and Krishnaswamy 2010, Allen & Holling 2010).

4.2.4.5 Social capital

The concept of social capital is multifaceted in part because it has developed from different proponents such as Bourdieu (1988), Coleman (1988) and Putnam (2003). Most recently Putnam defines social capital as “the social norms and networks that enhance people's ability to collaborate on common endeavours” (2003 p. 135). Sociology has developed social network theory, which examines the type and amount of relationships (or ‘ties’) people and groups have with each other, and the impact of these ties on 'influence and information, mobility opportunity, and community organization' (Granovetter 1973, p. 1360). However social capital is defined, it remains a complex quantity to measure, and there are a huge range of approaches taken by researchers. There is a need for a consistent approach to enable the comparison of adaptive capacity (Pelling & High 2005), and work has been done by the World Bank and OECD as well as many governments to develop this (Franke 2005). Adger (2003) defines social capital as a description of a “relationship of trust, reciprocity and exchange; the evolution of common rules; and the role of networks.” (p. 389). Social capital plays an important role in communities’ ability to adapt to risks related to climate change and it has long been recognised that empirical studies on social capital enable greater understanding of collective management of environmental resources (Adger 2003, Adger et al. 2007). In community forest management evidence indicates that when the majority of community members participate in a management program it is more successful (Pagdee et al. 2006), and that social capital is a necessary ‘glue’ for adaptive capacity to climate change; enabling communities to organise despite lack of access to other resources such as money and access to equipment, and maximising the benefits of these resources if they are present (Adger 2003).

4.2.4.6 Values

The rationale for applying a “values-based approach to climate change” (O'Brien & Wolf 2010 p. 232) is compelling, with recent research demonstrating that “distinct values systems drive different types of inquiries of the changing climate, its consequences and responses to them” (O'Brien 2009, O'Brien & Wolf 2010). Defining what values are is an ongoing process, and the scholars in the field of value measurement each have slightly different explanations (for examples see Rohan (2000) and further discussion in chapter 5). Perhaps the simplest is the

definition that values express a belief about a desired end, which guides individual action (de Vries 2009), although values are not only applicable to individuals and can be associated with groups, institutions, organizations and cultures (O'Brien and Wolf 2010). Values have been variously conceptualized as intrinsic and extrinsic (concerned with social contribution and personal growth versus concerned with status and appearance), or materialist and post-materialist (O'Brien and Wolf 2010). The idea of values as a competitive list is also well established, and in this case values are prioritized, and form a hierarchy which can characterize the holder of them (Schwartz 2006) and be adjusted according to the situation the holder is in (Inglehart & Baker 2000, O'Brien 2009). This constant reprioritizing indicates that values themselves often do not translate directly into action, and are better seen as a foundation from which attitudes or behaviours stem, as they are influenced by experience, habits, and the norms of wider society. The role of a hierarchy from which firstly attitudes and secondly behaviours originate from core values is well evidenced by research into environmental actions (Thorgersen 1997). As values are so fundamental to choices made by communities they are likely to play an important role in change adaptation. In In the last 5 years there have been developments that suggest that although a community may have sufficient adaptive capacity in the form of social, cultural, human, physical and economic capital; it may not begin a process of adaptation. This had led to research concluding that communities are restricted in their adaptation to climate change by social limits: their attitudes and values (Naess et al. 2005, Adger et al. 2009, O'Brien 2009).

5 Method

This Chapter presents the organization of the empirical examination of the adaptive capacity of CFOs. As outlined in Chapter 1, this study examined the adaptive capacity of community forests using a survey of the members of the BCCFA. To do this the study collected information on the governance of the CFOs, quantified their adaptive capacity and sought to characterise the determinants of adaptive capacity. To frame the exploration an initial broad research question was devised from which a series of four sub-questions was developed and six subsequent hypotheses developed. These sub-questions were then used to guide the structure of the survey and the open ended responses of the participants.

5.1 Approach of the research

As outlined in the Introduction, the project has been designed in collaboration with the BCCFA, the aim is to provide information for policy development which enables CFOs and their communities to better contend with a changing climate. To do this, questions were deduced from the literature on adaptive capacity and its determinants in order to quantify their presence in CFOs, and to enable the investigators to reason upon the nature of adaptive capacity in CFOs (this deductive approach is outlined in detail in Babbie (2010).

5.1.1 Research questions and hypotheses

Principal research question:

> Which determinants of adaptive capacity to climate change suggested by the literature are positively associated with greater adaptive capacity in Community Forest Organizations in British Columbia?

Table 1 Research questions and associated hypotheses

Research Sub-questions	Associated hypotheses
1. Do CFOs with greater natural capital have greater adaptive capacity to climate change?	H1. CFOS with greater natural capital have greater adaptive capacity.
2. Do CFOs with greater economic capital have greater adaptive capacity to climate change?	H2. CFOS with greater economic capital have greater adaptive capacity.
3. Do CFOs with greater physical capital have greater adaptive capacity to climate change?	H3. CFOS with greater physical capital have greater adaptive capacity.
4. Do CFOs with greater human capital have greater adaptive capacity to climate change?	H4. CFOs with greater human capital have greater adaptive capacity.
5. Do CFOs with greater social capital have greater adaptive capacity to climate change?	H5. CFOs with greater social capital have greater adaptive capacity.
6. Are particular values held by CFOs associated with their adaptive capacity to climate change?	H6. CFOs with greater adaptive capacity hold distinctly different values from those with less adaptive capacity.

5.1.2 Population and sample considerations

For the survey all organisations that were members of the BCCFA and had an active tenure agreement with the BC Ministry of Forests were included in the sample (see Figure 1). Sixteen members of the BCCFA do not have a tenure agreement and are in the early stages of forming a community forest organisation, meaning they are not yet actively managing a forest. Eight holders of Community Forest Agreement holders in BC are not members of the BCCFA and were not approached in this research; consequently the findings are not generalizable beyond the membership of the BCCFA and further research may be beneficial in this area (see Appendix B for breakdown of the organisations in BC, and their position in terms of activity,

BCCFA membership and location). The sample frame was obtained through the BCCFA; with contact telephone numbers accessed through a record of their membership database (as it stood in November 2011). This gave a population of 38 organisations all of which were included in the sample.

Community forest organisations in B.C.

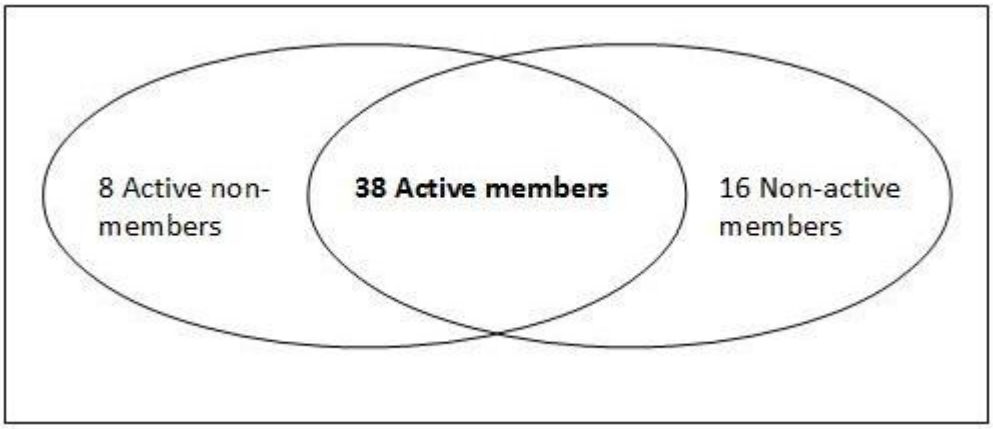

Figure 1 CFOs in BC: 62 organisations; 46 have active operations and 54 are members of the BCCFA, 38 are members with active operations.

5.1.3 Survey design

The survey was designed for maximum efficiency in order to get the best quality of data, with the maximum use (analysis) of the data collected and "without the respondent finding the questionnaire too costly in terms of time or effort" (Dillman 1978, p. 15). In order to achieve this, the survey has been designing according to Dillman (1978) and Dillman et al. (2002) using the Total Design Method (TDM).

5.1.4 Data collection

The telephone survey method enabled the study to obtain a high response rate (100% of the population) at the least inconvenience to the CFOs (whose time and resource constraints can be significant). The telephone method had advantages over mail and Internet in that it offered the opportunity to pursue emerging avenues during the conversation, minimise non-response error, and maximise the clarity of the questions posed in order get the best data possible. In

the initial stages of designing the research an internet questionnaire was considered, as it can also be a convenient method for respondents. However, it became apparent that a 2011 internet based survey carried out with the same population by the BCCFA themselves had yielded considerable non-response for some questions, which led to some doubt about the appropriateness of the internet approach. In enquiring why non-response was prevalent, the advice from some of the original respondents was that seeking clarification about ambiguities was too time consuming by email and it was less costly to simply skip the question and submit an incomplete questionnaire. As an attempt to avoid item non-response the telephone approach was used, which enabled the researcher to pursue particular points, and also allowed respondents to emphasise points were particularly salient to them. The data was triangulated with the information from the aforementioned BCCFA 2011 in-house survey to corroborate any ambiguities, and where necessary transcripts of the telephone interviews were sent to respondents to ensure that details could be substantiated by additional people within the organisation as well as the primary respondent. A summary of the initial results was also presented to the BCCFA before data analysis was completed so that any mistakes or inconsistences were found and resolved.

5.1.5 Minimizing the limitations of the method

The risk associated with a telephone survey is the lack of primary contextual information that will be observed by the researcher. Contributing factors which may be obvious 'on the ground' may not be visible without face-to-face contact, and lead to the researcher remaining oblivious to important additional information. To minimize the risks associated with the methodology the data collected in the survey was triangulated with the help of constitutional and policy documents obtained via the BCCFA for each CFO. With something as topical and potentially emotive as climate change there is also a risk of data being skewed by 'social desirability bias' (SD bias), where the respondent feels subconsciously that they should express certain socially acceptable opinions over what they really perceive (Randall & Fernandes 1991, Babbie 2010). Whereas face to face interviews can suffer from substantial SD bias, the use of telephone questionnaires mitigates this, with some studies showing that telephone questionnaires

removed as much bias as self-administered surveys (Dillman 1978). However, due to the self-reported nature of the data, the possibility of SD bias should be borne in mind when viewing the results.

5.2 Quantifying the variables

Each of the independent and dependent variables were quantified by deriving a set of four questions from a list of four associated statements derived from the literature. This section explains how each of the variables was developed.

5.2.1 Quantifying adaptive capacity

This study used the IPCC's definition of adaptive capacity that framed the Fourth Assessment Report; for context the full extract is quoted in section 1.3; below is the part of the extract most salient to this study:

> As the ability or potential of a system to respond successfully to climate variability and change, including adjustments in both behaviour and in resources and technologies (Adger et al. 2007, p.727).

Assessing adaptive capacity to climate change is challenging, primarily because adaptive capacity is a latent characteristic (Engle 2011). The latency aspect of adaptive capacity has meant that research has largely been carried out by using earlier events as ‘stress tests’, after which it is possible to evaluate a system’s response and recovery. In these studies the events themselves do not need to be directly associated with climate change in order to give a good proxy for how a system may respond to future impacts of climate change. However, this approach is contested as climate change is likely to have an unprecedented impact on a far greater scale and severity than anything that has been previously documented, meaning the use of past proxies may give unrealistically optimistic outcomes in research using the method (Engle 2011). In addition, not all impacts of climate change are associated with extreme events and easily characterized by a 'before' and an 'after' which can then be compared; in fact many

climate impacts likely in forests in BC involve gradual change in the short term. These slow changes do not lend themselves to examination in the form of a stress test and may be further complicated by their interaction with extreme events such as wildfire or epidemics. Consequently, it is important to acknowledge that an organization's adaptive capacity needs to contend with gradual changes and fluctuation (which have always occurred but are more likely to arise at an exceptional rate in the future) as well as extreme events like fire or epidemics; and that concepts of adaptive capacity to climate change must incorporate both.

With this in mind the study used current evidence of CFOs researching, planning and acting on climate change as a positive proxy for adaptive capacity (see Table 2) using four associated statements and asking respondents to rate their level of agreement on a Likert scale of one to five.

Table 2 The measurement of adaptive capacity with associated statements

Extent of research carried out	1. As an organisation we have begun to research adaptations we may be able to make to minimize some of the likely impacts of climate change on our CFO.
Extent of planning carried out	2. As an organisation we have begun to put plans into place for what we may be able to do to minimize some of the likely impacts of climate change on our CFO.
Extent of adaptations already integrated into work	3. As an organisation we have already begin to make adaptations to our work to minimize some of the likely impacts of climate change on our CFO.
Overall organisational response to climate change	4. As an organisation we have yet to do anything to minimise the impacts of climate change.

In analysing the results, organizations that were participating in adaptive research were referred to as Stage 1 Adaptors, and organisations that were engaged in adaptation actions were categorised as Stage 2 Adaptors; those that were not participating in these activities were categorised as Non-Adaptors (see Figure 9, p. 47). This technique is developed from Posey's (2009) work in which he aimed to establish the determinants of vulnerability and adaptive capacity at the municipal level in the United States using degrees of municipal engagement in floodplain management programs as a proxy for adaptive capacity. It is also used by Beier

(2011) in his work examining the factors influencing adaptive capacity in the reorganization of forest management in Alaska where he "considers evidence of adaptation to change as a positive proxy of adaptive capacity" (Beier 2011, p3).

5.2.2 Quantifying the determinants of adaptive capacity

As touched on in Chapter 1 , and explored in Chapter 4, previous research has suggested a wide range of determinants of adaptive capacity, but only a selection of them are relevant to the scale and unique situation of CFOs as the determinants of adaptive capacity vary according to context (Adger & Vincent 2005, Smit & Wandel 2006). From the many determinants cited in the literature six were developed for this research which concentrated primarily on the social sphere of adaptive capacity. All of these were measured in the same way as adaptive capacity; with a Likert scale measuring a level of agreement with associated statements, (Appendix A contains the full survey text for reference). A summary of how each determinant was measured is given in the following section.

5.2.2.1 Natural, economic and physical capital

Ecological and environmental limits to adaptation can of course be fundamental; in fact this is what the phenomenon of rapid climate change exposes (Mc Afee et al. 2010). Natural capital can increase adaptive capacity, in that a greater diversity of natural resources can provide more options for livelihoods in changing circumstances, and may play a role increasing the resilience of the ecosystem. In addition to the benefits of natural capital, access to physical resources can create options for adaptation which would otherwise be unavailable (Yohe & Tol 2002, Adger at al. 2007), and economic capital can also create flexibility in terms of how the CFO approaches adaptation. Figure 2, 3 and 4 show how natural, physical and economic capital were quantified in the survey with each determinant broken into four associated measurements for which statements were developed (see Appendix A for full details).

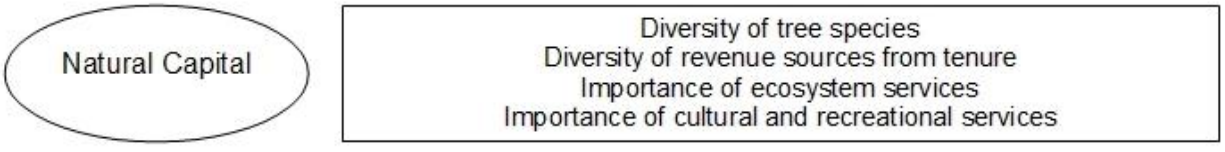

Figure 2 Associated measurements for natural capital

Figure 3 Associated measurements for economic capital

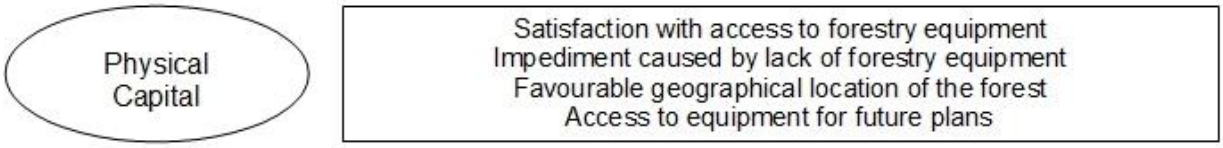

Figure 4 Associated measurements for physical capital

5.2.2.2 Human capital

Knowledge has been identified as a determinant of adaptive capacity to climate change, from experiential local knowledge based on previous weather and climate, to expert skills to provide technical help with a specific problem (Adger et al. 2009). Communities with higher levels of human capital have been shown to be more able to solve problems (Joseph and Krishnaswamy 2010). The associated measurements in Figure 5 were used to quantify human capital.

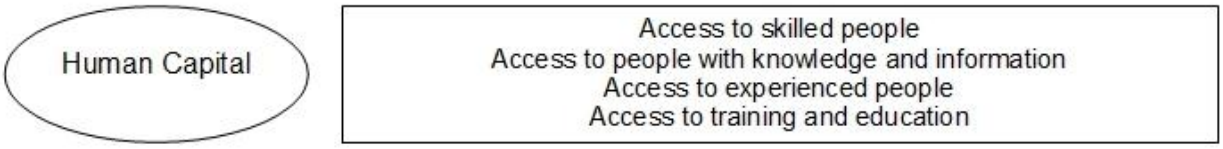

Figure 5 Associated measurements for human capital

5.2.2.3 Social capital

Social capital can be thought of as the sum of the information, communication, support or increased integration that a person or organization can both benefit from and contribute towards. Trust also plays an important role in public opinion of organisational change; as if people have positive expectations of an organisation they are more likely to be supportive of its direction and innovation (Telwel et al. 2008). The associated measurements in Figure 6 were used to quantify social capital.

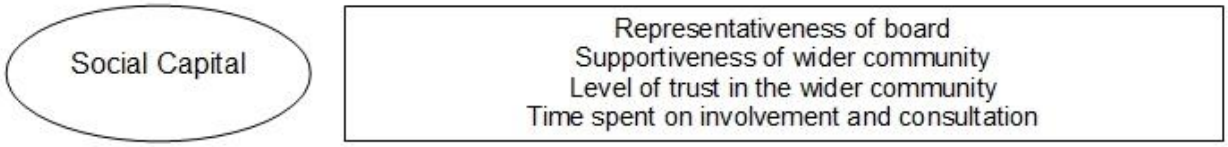

Figure 6 Associated measurements for social capital

5.2.2.4 Values

The survey measured the organisations' values in a number of ways to try to capture how they prioritised multiple values when faced with decisions, in particular to capture the 'actual' values rather than the 'espoused' values of the organisation (Berkhout & Rowlands 2007). The actual organisational values have been shown to be critical indicators of what an organisation will act on, whereas the espoused values are the ones they say they hold. There has been very little research into values and climate change adaptation, and there is very little information on which to base a directional hypothesis, for this reason values were measured in three different ways: as normative values, transcendence values and opportunity values in order to collect as much information as possible to discern a picture.

To do this, the survey again used three Likert scales (see Figure 7), firstly to measure the organisation's normative beliefs, secondly to measure the balance that the organisation had between identifying with 'public serving' and 'organisation serving' motives. These motives are conceptualised as 'self-transcendence' by Schwartz (2006); but are perhaps better understood as 'outward looking' versus 'inward looking' (Nilsson et al. 2004, Telwel et al.2008). Thirdly, in addition to normative and transcendence values, organisations can also value climate change as an opportunity (Burch 2009), opportunity values can be measured is along an opportunity-organisation dimension (Rohan 2000, Schwartz 2006) which can help predict organisational responses to novelty or change: with an 'opportunity focussed' organisation identifying with innovation and progressive exploration rather than conformity and security, and therefore being more likely to act.

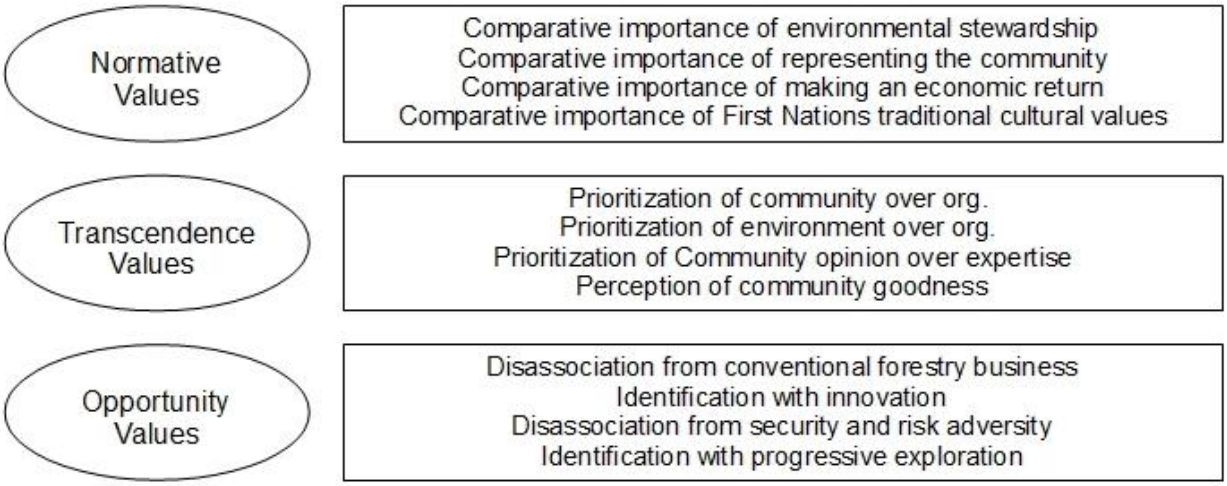

Figure 7 Associated measurements for values

5.2.2.5 Attitudes, observations and expectations of climate change

It is theorised that values and wider social norms combine to influence attitudes and in turn these attitudes translate into behaviour (Tindall et al.2010), the survey explored this by collecting data about respondents attitudes to climate change generally as well as their expectations and understanding of the potential impacts and risk reduction (see Figure 8).

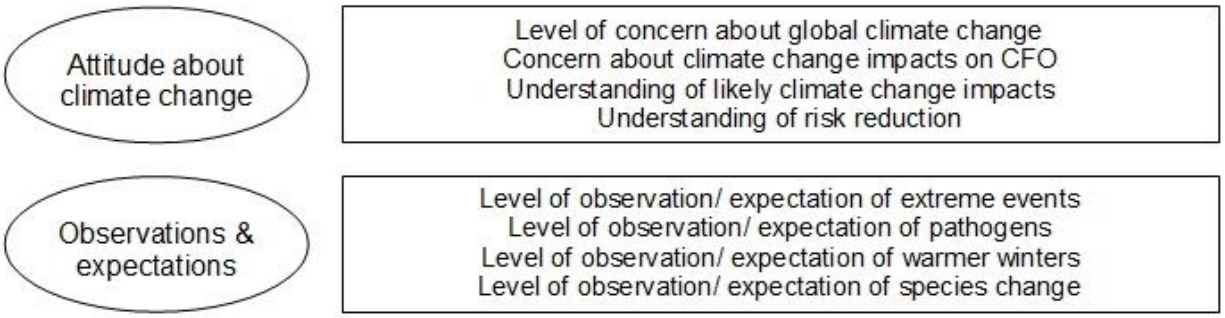

Figure 8 Associated measurements for attitudes, expectations and observations of climate change

5.2.3 Data analysis

As there was a 100% response rate to the survey and as the aim of the research was to characterise the sample rather than infer to any wider population there was little need to use any inferential statistics. The results were summarised and aggregated in three main ways.

Firstly, the Likert scale results were used to split the data into three datasets based on adaptive capacity (the Stage 1 Adaptors, Stage 2 Adaptors and Non-Adaptors); the mean and mode scores for each of the variables were compared which gave a general overview of possible differences between the datasets. Secondly Pearson's Correlations were used to look for associations between the variables for the sample set as a whole. Finally, numerous cross tabulations were run for all the variables that showed any likely significant relationships. Since the sample is quite small it was possible to look in detail at any individual outlier organisations to see if they suggested contradictory trends or characteristics which would otherwise be overlooked at the smaller scale. The text obtained from the open ended question "Is there anything else you would like to say about how climate change is affecting your CFO or what you feel are blocks to you adapting your practices to deal with it?" was compiled and key words were collated to identify any frequently occurring themes arising in the comments. Chapter 6 presents the analysis of the results obtained from the method in detail.

6 Results and analysis

This section presents a descriptive summary of the organisations that were surveyed (all of the active CFOs in BC which are members of the BCCFA). It then presents and gives some analysis of their responses to the questions which sought to quantify and characterise the nature of CFO's access to the determinants of adaptive capacity: natural, economic, physical, human, and social capital, as well as their values and attitudes to climate change, working through the six associated hypotheses in order to do so. Subsequently it gives an overview of the most notable comments that respondents made in the open-ended section of the survey.

6.1 Summary

A brief description of the 38 organisations in the population is given in Section 6.1 to give some contextual background to the results. Of the 38 organisations surveyed a 100% response rate was obtained which allows a good overview, in addition Appendix B lists the organisations and their locations in BC to give an indication of the spatial extent of the groups.

6.1.1 Respondents

Just over three quarters of the respondents to the survey had a formal forestry qualification (Registered Forest Technician or Registered Professional Forester), the average length of time working since qualification was 13 years. The remaining respondents were mainly from forestry backgrounds (but were not formally qualified), had worked in related industries, such as environmental stewardship or land and resource management, were elected representatives or managed the administrative side of the organisation.

6.1.2 Age of the organisations

97% of the CFOs surveyed were established in their current form since 1993, and 79% of these have been established since 2000.

6.1.3 Governance

Usually Community Forest Organisations (CFOs) are founded through an existing decision-making structure, which will hold the majority of the shares (and therefore the financial and decision-making responsibility). A Municipality or First Nation may be the founders, or a structure may be established by individuals; often Non-Governmental Organisations (NGOs) such as local civic organisations, residents associations, watershed management groups, local environmental groups or small businesses may organise and found a CFO in response to a local desire to increase decision making over resources or retain a greater proportion of the benefits of forestry locally. Table 3 details the types of entities represented in the population of concern.

Table 3 Entities holding the shares or membership of the CFOs

Entities holding the shares or membership of the CFOs	Frequency	Percent
Municipality/ies	16	42.1
First Nation/s	6	15.8
Municipality/ies and First Nation/s collaborations	6	15.8
Municipalities, NGOs, businesses and individual collaborations	6	15.8
NGO/s	2	5.3
First Nation/s and NGOs collaborations	1	2.6
Municipality/ies, First Nation/s and NGO/s collaborations	1	2.6
Total	38	100.0

Each entity or collaborative group usually establishes a legally recognised structure for the formal administration of the tenure (see

Table 4), the tenure may be held by this body, or one of the entities above.

Table 4 Legally recognised structures used to administer the CFO

Legally recognised structures used to administer the CFO	Frequency	Percent
Corporation	22	57.9
Society	6	15.8
Co-operative	3	7.9
Limited Partnership	3	7.9
Municipality	3	7.9
Total	37	97.4
Missing	1	2.6
Total	38	100.0

The management boards of the organisations have on average 6 or 7 members. Additional advisory boards are used by approximately half of the organisations. The amount of people on management boards, the presence of advisory boards and the amount of members of the organisation do not have any association with the organisation's adaptive capacity.

6.1.4 Tenure and timber

Of those surveyed, 25 held a Community Forest Agreement, 10 held a Provisional Community Forest Agreement, and 2 held a Tree Farm Licence and one had a volume-based tenure. The annual allowable cut varied between 1,000 M^3 and 86,000 M^3, 60% of CFOs had a tenure between 15,000 M^3 and 40,000 M^3, with 12 at 20,000 M^3). The area of the CFOs varied between 418 ha and 120,000 ha, with most area based tenures between 5,000 and 20,000 ha.

6.2 Adaptive capacity

The respondents had a broad spread of adaptive capacity, with some of them being very much focussed on climate change and its likely impacts and some of them rejecting the concept entirely. A third of organisations had begun integrating climate change adaptation into their work, just under half had carried out research and just over half had not taken any clear action in response to the possible future impacts of climate change. The list below and Figure 9 give an overview of the adaptive capacity of the population.

- 21 (55%) of the CFOs have done 'something' to minimise the impacts of climate change on their CFO.
- 17 (45%) of the CFOs have carried out research into climate change adaptation (the Stage 1 adaptors).
- 13 (34%) of the CFOs have begun planning climate change adaptation.
- 12 (32%) of the CFOs have begun integrating climate change adaptation into their work (the Stage 2 adaptors).

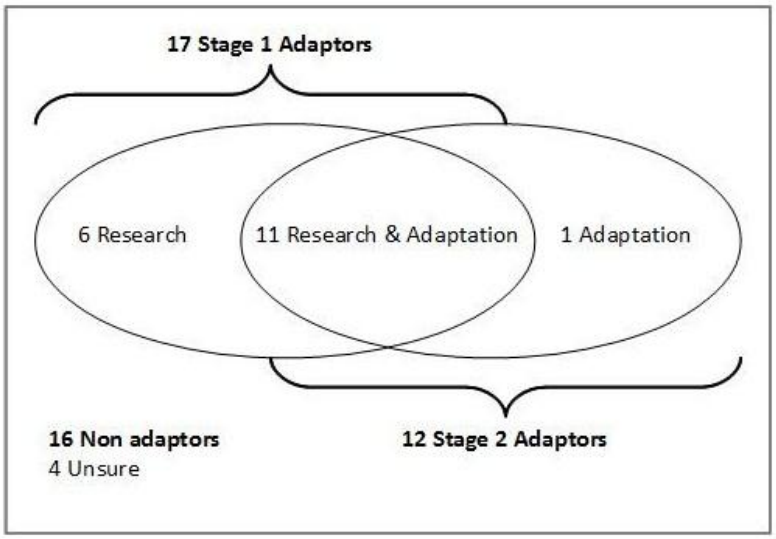

Figure 9: Adaptive capacity among organisations in the population

For the population as a whole, 16 of the organisations were definitely not engaged in research, planning or integration, and these are termed the Non-adaptors, 4 organisations were 'not sure', and felt they were 'doing something', though in these cases it wasn't clear what this might have been. The three groups that showed the most informative data were the 16 'Non-adaptor' organisations , the 17 'Stage 1 Adaptors' and the 12 'Stage 2 Adaptors' (see Figure 9); and these three groups form the majority of the comparative analysis in section 6.3.

6.2.1 Operationalizing adaptive capacity

As explained above, the analysis was carried out by taking all the organisations who had *not* carried out any type of adaptation, whether that was researching climate change or potential adaptations, planning how adaptations could be integrated into future work, or currently integrating adaptations into everyday work and labelling them as 'Non-Adaptors'. In the same way all the organisations that had begun researching climate change or potential adaptations were labelled as 'Stage 1 Adaptors, and all the organisations which were currently integrating adaptations into their everyday work were labelled 'Stage 2 Adaptors'. This approach has the advantage that it is very simple, the three groups are divided by one attribute and the analysis of the results is very easily traceable back to the raw data, meaning it is very transparent. However, because many organisations are both researching and currently integrating adaptations into everyday work, there is large overlap between the Stage 1 and 2 groups, meaning that 11 of the organisations are counted both as Stage 1 and Stage 2 adaptors.

Another way of operationalizing adaptive capacity would have been to separate the organisations into the Non-adaptors (the 17 organisations detailed above); groups which were researching and not adapting (6 organisations); groups which were both researching and adapting (11 organisations); and groups which were adapting and not researching (1 organisation). This would have had the advantage that each group is mutually exclusive. However, this route was not chosen because initial scrutiny of the one organisation which was adapting and not researching and the 6 organisations that were solely researching did not yield any particularly illuminating information. The overlap itself is also an interesting feature of the results, which suggests that the process of adaptation is an iterative one, rather than a linear

one, in which research continues to be important within the more advanced stages of adaptation.

6.3 The Determinants of adaptive capacity

The three groups (the Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors), had distinct characteristics which suggest factors that enable the process of adaptation. Stage 1 Adaptation is associated primarily with the organisation's attitude towards global climate change and their perception of the impacts of climate change on the forest, as well as the presence of pro-environmental values, community investment and trust, and access to financial resources and training. In Stage 2 Adaptors, access to resources seemed more important than pro-environmental values and concern about the direct impacts of climate change on their forest; they had overall observed less of the likely impacts of climate change than Stage 1 Adaptors. However, concern about global climate change as well as community investment and trust remained important features in Stage 2 Adaptors and as a group they invested more time and trust in the community (see Figure 10)

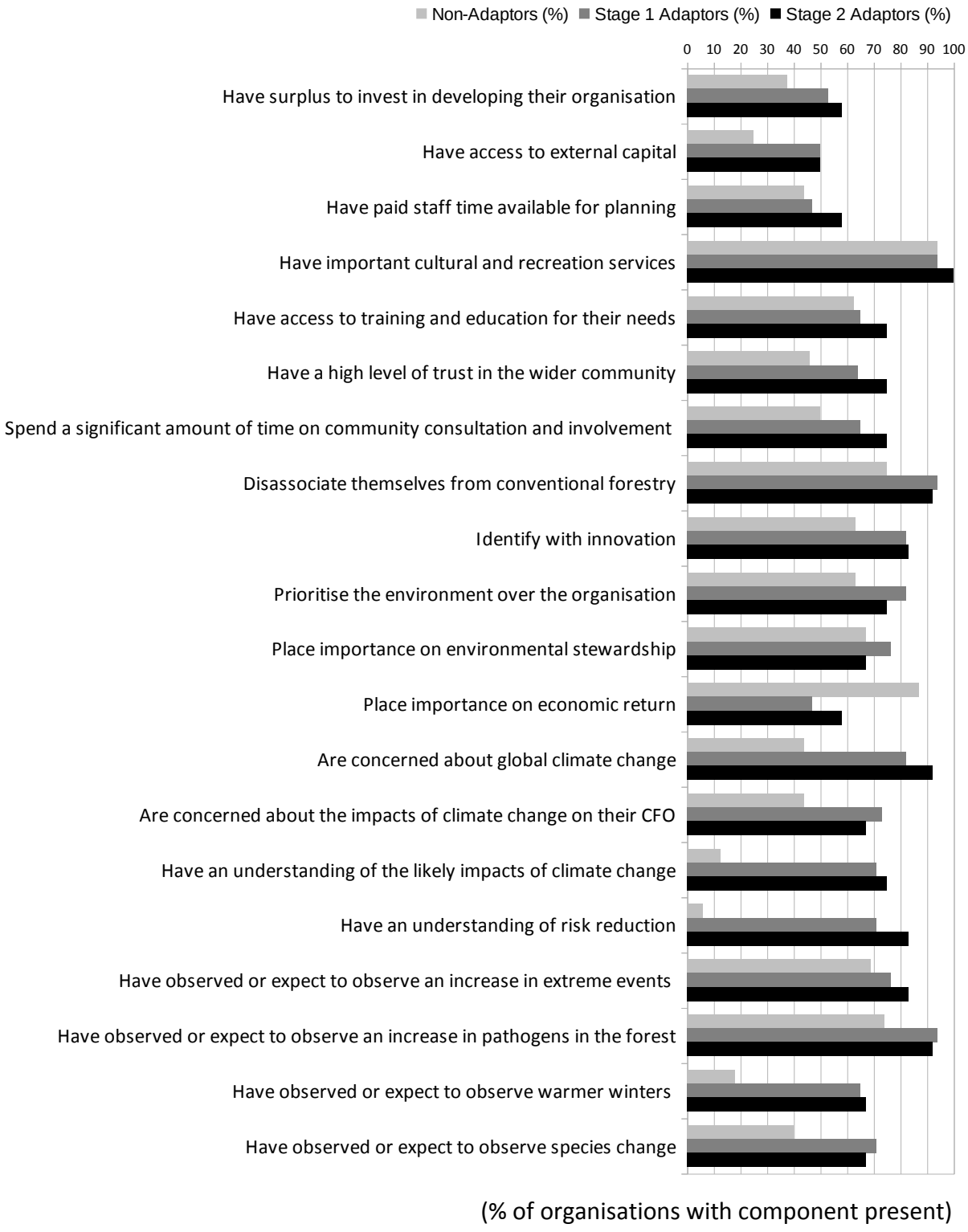

Figure 10: Overview of the presence of the determinants of adaptive capacity in CFOs

6.3.1 Natural capital

The results indicated that CFOs in general had significant natural resources available to them, playing a large role both as custodians of ecosystem services, and providing access to and managing cultural and recreational services, although two thirds are dependent on cutting timber as their sole source of income derived from the tenure. CFOs were very limited in the other options available to them to sustain a livelihood and faced the same resource dependent commodity market trap that seems so prevalent in the undiversified forest industry in BC.

H1. CFOS with greater natural capital have greater adaptive capacity

There was little variation in organisations' access to natural capital, meaning there is little to draw a conclusion from (see Table 5). However, the size of the tenures was raised as an issue, some respondents pointed out that community forests are so small that their decisions have comparatively little impact on the landscape, so whether or not they begin to try to adapt to climate change has little real implication for forests or communities as a whole. Some suggested larger community forests as a solution to this, or the development of partnerships between CFOs, government and industry, some CFOs already had experience of creating partnerships with industry for research.

> *"We have been involved in a study with [a large logging company] looking into underplanting with Douglas fir, researching erosion control and increasing evapotranspiration on an old Mountain Pine Beetle site."* (CFO 36: Stage 2 Adaptor)

> *"When talking about scale of impacts the community forest is 'small potatoes', they only control 5% of the surrounding area."* (CFO 24: Non-Adaptor)

6.3.2 Economic capital

Access to economic capital for CFOs overall was poor. Just over half of CFOs do not have financial surplus to reinvest into developing the organisation, only a third believe they would be able to access grants or loans if necessary, and only seven felt it would be possible develop

other sources of income. Just over half of CFOs have paid staff time to spend on developing future plans. The lack of diversity of income sources suggested in the natural capital figures was echoed here, with only 20% of CFOs reporting as having diverse income sources.

H2. CFOS with greater economic capital have greater adaptive capacity

In terms of economic capital, CFOs with higher adaptive capacity had more self-generated financial surplus, more paid staff time for planning, more access to external capital such as grants and loans, and more diverse sources of income than CFOs with low adaptive capacity. In terms of physical capital, CFOs with higher adaptive capacity were more satisfied with their access to equipment than CFOs with low adaptive capacity. In particular, as shown in Table 5 below, more Stage 1 Adaptors had surplus to invest in their organisation (though at 53% of the organisations this is still low), perhaps more significantly 50% of Stage 1 Adaptors had access to external capital, compared to only 25% of Non-Adaptors. Overall, the more adaptive organisations tended to have greater access to resources than less adaptive organisations, but for the earlier stage of adaptation these differences were quite small, and for most of the remaining measures for natural, economic and physical capital the figures were similar for all levels of adaptive capacity (see Figures 2, 3 and 4).

Table 5 Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors: access to resources

Non-Adaptors (16 CFOs)	**Stage 1 Adaptors (17 CFOs)**	**Stage 2 Adaptors (12 CFOs)**
6 (37.5%) have surplus to invest in developing their organisation	9 (53%) have surplus to invest in developing their organisation	7 (58%) have surplus to invest in developing their organisation
4 (25%) have access to external capital	8 (50%) have access to external capital	6 (50%) have access to external capital
7 (44%) have staff time for planning	8 (47% have staff time for planning	7 (58%) have staff time for planning
15 (94%) have important cultural & recreation services	16 (94%) have important cultural & recreation services	12 (100%) have important cultural & recreation services

The survey found that access to external funding and the ability to generate a revenue surplus that could be reinvested into developing the organisation were more common in organisations which were adapting to climate change (see Table 5). This signals that availability of financial capital could be an enabling factor for adaptation, and it is also well accepted that CFOs have

usually suffered from a lack of funds to pursue their work (Bullock et al. 2009). However, the relationship between access to financial resources and adaptive capacity is not necessarily simple, as of 18 organisations that usually have enough financial surplus to invest in developing their organisation, nine (50%) have no understanding of risk reduction and of those who do not have a surplus, four (34%) have no understanding of risk reduction.

The presence of this negative association suggests that access to financial surplus does not have a clear enabling role in the first stages of adaptation, but may prove important once an organisation has a certain level of understanding. Self-generated finance is important to CFOs, and fluctuations in log markets, and associated economic difficulties which forest dependent communities face have been well documented (Flint & Luloff 2005). This precarious existence can mean that organisations become stuck in a cycle of running to stand still, with little will to step outside their situation and systematically assess risk or develop capacity, and this did appear to be a characteristic of less adaptive organisations. The difficulties experienced by CFOs in trying to diversify their income sources were frequently mentioned as something that kept organisations locked into one way of working, when they said they would rather spread the risk, as is reflected in the comments below.

> "*We're in survival mode, our sawmill shut down; there are low prices for wood…"* (CFO: 8 Non-Adaptor)

> "We're *too busy with heavy harvesting of pine. In two years we've harvested 400,000 M^3, our hands are full."* (CFO 32: Non-Adaptor)

> "*You need to make money to keep in business, and you have to get the volume of cut out to ensure the government will buy into it. They [the government] have to see that the community forest is making money."* (CFO 18: Stage 2 Adaptor)

> "*We're trying to be more resilient, we've been to workshops on climate change, it's part of daily thinking and activities, the main block to change is financial, we've lots to do but no money to do it with. We need to diversify our business, diversify the local economy for timber to go into. The government should put money into wildfire planning for tenants, rather than fighting fires*." (CFO 29: Stage 2 Adaptor)

Of course, money can buy time, and management can choose to spend that time on certain activities; 20 of the 38 CFOs (53%) made staff time available to develop future plans, considering the industry they are working in, where trees planted decades later, this is low. Often lack of time in addition to money was seen as a block to adaptation:

> "*The biggest block, as we only have one admin worker and one forester, is time*." (CFO 10: Stage 2 Adaptor)

> "*We are interested in climate change adaptation but blocked by time and money*." (CFO 4: Non-Adaptor)

> "*Time is the main block to adaptation, as are clear recommendations.*" (CFO 21: Stage 2 Adaptor)

6.3.3 Physical capital

Access to physical equipment for approximately two-thirds of CFOs was satisfactory, for both present and future needs. Just over half of the organisations had a favourable geographical location, indicating that the organisation felt that they were not impeded by their location. For those that were impeded, the impediment was self-defined and could be anything from being in an urban environment, meaning that vandalism was a problem (people setting fire to woody debris that had been kept for habitat) and having to be very conscious of visual impacts or the opposite: coping with extreme remoteness, with a 10 hour journey to a mill, or a tenure area that is a distance away from the community itself). Those who wanted equipment to pursue future plans wanted tools to enable them to diversify their income, for example by developing a sawmill, or for equipment specific to monitoring, for example weather stations, more accurate stream monitoring or mapping software and training.

H3. CFOS with greater physical capital have greater adaptive capacity

Access to equipment was a limiting factor for a third of CFOs, although it was less critical than financial support:

> "*We would also like equipment specific to climate change - weather stations and more accurate stream monitoring, sample plots.*" (CFO 16: Stage 2 Adaptor)

"*We would like mapping equipment, but then we would need the skills to use it*." (CFO 22: Stage 2 Adaptor)

6.3.4 Human capital

Previous studies have reported a lack of human capital in community forests (Bullock et al. 2009), in contrast this study found self-reported access to human capital overall to be high: 79% of CFOs had access to skills, 97% had access to knowledge and information, 87% had access to experience, and 66% had access to training and education to meet their needs.

H4. CFOs with greater human capital have greater adaptive capacity

As reports of each variable were consistently high, there is not much variation to draw conclusions from. However, organisations with higher adaptive capacity do have more to training and education (Table 6).

Table 6 Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors: human capital

Non-Adaptors (16 CFOs)	**Stage 1 Adaptors (17 CFOs)**	**Stage 2 Adaptors (12 CFOs)**
10 (62.5%) have access to training and education for their needs	11 (65%) have access to training and education for their needs	9 (75%) have access to training and education for their needs

Despite the high level of human capital among the population studied, only 40% of CFOs had an understanding of the likely impacts of climate change on their forest and only 37% had an understanding of risk reduction. This gap in understanding suggests that there is a clear lack of appreciation of the impacts and potential adaptations that could be made to minimise vulnerability to climate change. Targeting this knowledge requirement may enable CFOs to better adapt, in fact there were suggestions directly from respondents about the role that education and training may be able to play in increasing the adaptive capacity of CFOs (see below). Clear recommendations for actions that could spread the risk or minimise the impacts of climate change are essential, with 63% of organisations not knowing what to do.

"*A high education among the population here means that people are aware of climate change."* (CFO 1: Stage 1 Adaptor)

"*We have a heightened knowledge and interest in climate change because of a conference here put on by a graduate student from Simon Fraser University*."
(CFO 12: Stage 1 Adaptor)

"*A lack of cold snaps has increased the spread of the Mountain Pine Beetle - 70% of our pine is dead. We're thinking about climate change, but we have a lack of understanding about what to do about it*." (CFO 8: Non-Adaptor)

6.3.5 Social capital

H5. CFOs with greater social capital have greater adaptive capacity

Not all measurements for social capital had enough variation from which to draw conclusions, but results did indicate that organisations with greater adaptive capacity often have more trust in their community and invest more time into consultation and involvement than those with lower adaptive capacity. Just over half of respondents thought that there was a high level of trust within the community which allowed people to work together and trust is higher in the Stage 2 Adaptors than Stage 1 Adaptors and Non-Adaptors (see Table 7 below).

Table 7 Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors: social capital

Non-Adaptors (16 CFOs)	**Stage 1 Adaptors (17 CFOs)**	**Stage 2 Adaptors (12 CFOs)**
7 (46%) have high level of trust in their wider community	11 (64%) have high level of trust in their wider community	9 (75%) have high level of trust in their wider community
8 (50%) spend significant time on community consultation and involvement	11 (65%) spend significant time on community consultation and involvement	9 (75%) spend significant time on community consultation and involvement

Over three quarters of the CFOs felt their board was representative of the wider community, with some of the boards being elected representatives. Of those that were not thought of as representative, some thought of their boards had specialised expertise or said the board was 'heavy to loggers', others said their community was 'siloed' and that only one of those silos was really represented on the board. That only 76% felt that the community was supportive of their work is perhaps surprising, given their status as community organisations, as is the fact that only two thirds spent a significant amount of time on community involvement and consultation. It was noted by some respondents that putting work into consultation was a lot

of work for little feedback. The type of governance structure used by the CFOs do not seem to vary with adaptive capacity, but the organisations that are more directly involved in the community seem to also have greater adaptive capacity. Organisations with greater adaptive capacity employ more staff directly, give higher estimates for the amount of people they consult with, and organise more social events.

Adaptive capacity shows no noteworthy association with the type of entity (Municipality, First Nation, etc.) behind the CFO or the type of governance structures used to administer the organisation (Corporations, Societies, Co-operatives etc.). Some differences in the governance and structural arrangements of the Adaptor and Non-Adaptors also suggested an influential role for social capital, giving an indication that older organisations that were more thoroughly embedded in the local community had greater adaptive capacity:

- The Stage 2 Adaptors are on average 4 years older, and the Stage 1 Adaptors are on average two years older than the Non-Adaptors.
- Adaptors gave higher estimates of the amount of people who participate in consultation annually, an average of 48 a year, compared with 30 for Non-Adaptors.
- Adaptors held more social events with 65% holding them at least annually, whereas only 31% of the Non-Adaptors held them annually.
- Stage 2 Adaptors employ more people directly, with only one of the 12 contracting everything out - whereas 10 of the 16 Non-Adaptors contract everything out.

6.3.6 Values

Values were measured in three ways derived from the literature; as normative standards, along a 'transcendence' scale, and an opportunity scale. Each of these value dimensions are examined in the sections below.

6.3.6.1 Normative values

When asked to rank to what extent four potentially competing values were of 'primary importance' (see Figure 7), nine respondents ranked all four values the same, explaining that different values are prioritised at different times, or that it was a matter of balance: that each decision was balanced with others. Others ranked one or two ahead of others, or had one particular priority. Overall, all of the normative values all scored highly, indicating that all are important, with community representation being the priority shared by 30 CFOs, environmental stewardship by 26, and both economic return and First Nations traditional cultural values by 23.

6.3.6.2 Transcendence values

Respondents were asked to make trade-offs to indicate to what extent their normative values guided their everyday practical choices (see Figure 7). When asked to judge to what extent they valued the interests of their organisations over other interests (the wider community or the environment). Environmental values were upheld, with 27 organisations prioritising the environment over the organisation, contrary to their normative values, only 14 prioritise the interests of the community over their organisation, and only 3 CFOs did not ultimately prioritise their own expertise over that of the community, although as some were elected to do so, it is not unreasonable that they should. However, almost all respondents agreed or strongly agreed that their community members were essentially good.

6.3.6.3 Opportunity values

Most CFOs saw themselves as innovators, being different than conventional forestry businesses, with three quarters identifying as innovative, progressive and interested in new ways of working, and two thirds taking risks sometimes (though many were keen to point out that these were 'calculated' or 'considered' risks)

.

H6. CFOs with greater adaptive capacity hold distinctly different values from those with less adaptive capacity

Stage 1 Adaptors tend to pursue different values than Non-Adaptors; they were more pro-environmental as they prioritised the environment over their organisation, and placed more importance on environmental stewardship. They are more innovative, and less interested in financial return, and tend to disassociate from conventional forestry more than Non-Adaptors (Table 8). However, for the most adaptive organisations this was slightly less pronounced; Fewer Stage 2 Adaptors were concerned with pro-environmental values. It appears as though values emphasising the environment are important in the earlier stages of adaptation, but less so in the later stages, where access to finance seems to be a greater enabler.

Table 8 Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors: values

Non-Adaptors (16 CFOs)	**Stage 1 Adaptors (17 CFOs)**	**Stage 2 Adaptors (12 CFOs)**
12 (75%) disassociate themselves from conventional forestry	16 (94%) disassociate themselves from conventional forestry	11 (92%) disassociate themselves from conventional forestry
10 (63%) identify with innovation	14 (82%) identify with innovation	10 (83%) identify with innovation
6 (40%) prioritise the community over the organisation	7 (41%) prioritise the community over the organisation	5 (42%) prioritise the community over the organisation
10 (63%) Prioritise the environment over the organisation	14 (82%) Prioritise the environment over the organisation	9 (75%) Prioritise the environment over the organisation
10 (67%) place importance on environmental stewardship.	13 (76.5%) place importance on environmental stewardship.	8 (67%) place importance on environmental stewardship.
13 (87%) place importance on making an economic return	8 (47%) place importance on making an economic return	7 (58%) place importance on making an economic return

6.3.7 Attitudes, observations and expectations of climate change

6.3.7.1 Attitude to climate change

Two-thirds of the CFOs were concerned about global climate change, half were concerned about the impact of climate change directly on their forest, 40% had an understanding of the likely direct impacts of climate change and 37% had an understanding of risk reduction. Stage 2 Adaptors are most often concerned about *global* climate change, although fewer are concerned about the direct impacts of climate change on their CFO, and more have an understanding of the likely impacts of climate change or the possibilities for risk reduction (see Table 9 below).

Table 9 Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors: attitude to climate change

Non-Adaptors (16 CFOs)	**Stage 1 Adaptors (17 CFOs)**	**Stage 2 Adaptors (12 CFOs)**
7 (44%) are concerned about global climate change	14 (82%) are concerned about global climate change	11 (92%) concerned about global climate change
3 (19%) not concerned about global climate change	1 (6%) not concerned about global climate change	1 (8%) not concerned about global climate change
7 (44%) are concerned about the impacts of climate change on their CFO.	12 (73%) are concerned about the impacts of climate change on their CFO.	8 (67%) are concerned about the impacts of climate change on their CFO
2 (12.5%) have an understanding of likely climate change impacts	12 (71%) have an understanding of likely climate change impacts	9 (75%) have an understanding of likely climate change impacts
10 (62.5%) have *no* understanding of likely climate change impacts	2 (12%) have *no* understanding of likely climate change impacts	2 (17%) has *no* understanding of likely climate change impacts
1 (6%) has an understanding of risk reduction	12 (71%) have an understanding of risk reduction	10 (83%) have an understanding of risk reduction
13 (81%) have no understanding of risk reduction	4 (23.5%) have no understanding of risk reduction	2 (17%) have no understanding of risk reduction

6.3.7.2 Observations and expectations of climate change impacts

As might be expected in BC, forest pathogens were the most commonly experienced or expected climate change impact (82% of CFOs overall), extreme events were also frequently observed or expected, and species changes and warmer winters less so.

Table 10 Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors: observation and expectation of climate change

Non-Adaptors (16 CFOs)	**Stage 1 Adaptors (17 CFOs)**	**Stage 2 Adaptors (12 CFOs)**
11 (69%) have observed or expect to observe an increase in extreme events.	13 (76.5%) have observed or expect to observe an increase in extreme events	10 (83%) have observed or expect to observe extreme events
12 (74%) have observed or expect to observe an increase in pathogens in the forest.	16 (94%) have observed or expect to observe an increase in pathogens in the forest.	11 (92%) have observed or expect to observe an increase in pathogens in the forest.
3 (18%) have observed or expect to observe warmer winters	11 (65%) have observed or expect to observe warmer winters	8 (67%) have observed or expect to observe warmer winters
9 (56%) have *not* observed and do not expect to observe warmer winters	3 (18%) have *not* observed and do not expect to observe warmer winters	2 (17%) have *not* observed and do not expect to observe warmer winters
6 (40%) have observed or expect to observe species change	12 (71%) have observed or expect to observe species change	8 (67%) have observed or expect to observe species change

Stage 1 Adaptors tend to pursue different values to Non-Adaptors; they were more pro-environmental: prioritising the environment over their organisation, and placing more importance on environmental stewardship. They are more innovative, and less interested in financial return, and tend to disassociate from conventional forestry more than Non-Adaptors. However, for the most adaptive organisations this was less pronounced; Stage 2 Adaptors were less concerned with pro-environmental values. It appears as though values emphasising the environment are important in the earlier stages of adaptation, but less so in the later stages, where access to finance seems to be a greater enabler.

Attitude towards climate change was substantially different among Non-Adaptors and Adaptors, with the Adaptors more concerned about global climate change, and more likely to have observed or expected to observe the impacts of climate change, some of the attitudes about climate change are illustrated by the comments below:

> "*The older group (on our board) haven't bought into climate change; it's not a high concern, although we don't plant cedar anymore because it dries out."*
> (CFO 34: Non-Adaptor)

"*Climate change is too uncertain; it's based on opinions, not knowledge."*
(CFO 30: Non-Adaptor)

"*Climate change all boils down to what side you're on. We haven't talked about climate change*." (CFO 26: Non-Adaptor)

"*Climate change is something way off on the horizon and worrying about it is premature. It is not driving decision-making*." (CFO 23: Stage 2 Adaptor)

"*In general people don't connect Mountain Pine Beetle with climate change, the board are not thinking about it, though the area based tenure is a huge incentive to plant for the future*." (CFO 5: Stage 1 Adaptor)

6.4 Open-ended responses

There were some salient points made by respondents in the open-ended section of the survey which relate to their adaptive capacity; and although the points weren't anticipated in the study design, it seems important not to disregard them. Firstly, the anthropogenic nature of the concept of climate change adaptation was seen as problematic by some respondents and challenges the underlying assumptions of the research. Secondly, some respondents perceived a tension between local and regional priorities in terms of future planning. Thirdly, the level of experience that CFOs have in facilitating community consultation and engagement as well as mitigation of conflict was noteworthy and reflected in some of the comments made by respondents.

6.4.1 Anthropocentric conceptualisations of climate change

For some CFOs the idea of 'managing for climate change' is deeply suspect, not necessarily because they do not believe that the climate is changing, but they do not believe the notion that humans can control the natural world. To some CFOs the notion of 'management' of 'natural resources' legitimizes an idea of human ownership of the natural world, and excludes alternative conceptualisations (often indigenous in origin) of human-environment relations (Bradshaw 2003).

"*Man is part of the ecosystem, we're too anthropocentric. Population growth is a bigger concern than climate change. We expect there to be more drought and grassland - but there was more grassland before we stopped fire anyway. The way we value things - climate change - is skewed, we try to stop wildfire, but there has always been fire. Men believe they can control so many things and control nature; they try to remove themselves from nature. We need to remove our anthropocentric lens*."
(CFO 14: Non-Adaptor)

For these CFOs real adaptation to climate change requires a radical rethink of human interaction with nature within 'western' culture as a whole.

6.4.2 Local and regional tensions

The survey indicated that there can be tension between local and regional concerns which could hamper climate change adaptation:

"We ended up with an area which is the cast off, the worst bit of land - because we don't pay so much stumpage [tax on trees cut on government land]. It's political, Victoria bureaucrats don't want local self-determination, they want taxes to go to Victoria, rather than revenue being generated locally and then spent on what local people perceive to be priorities, they want the money to go to the cities." (CFO 2: Non-Adaptor)

It was also common for CFOs to defer to government expertise, especially if lacking the time or money to invest in their own research, but it was also common for CFOs to complain about standards that government had imposed:

"*With our stocking standards we default to the government standards, we expect them to inform us on climate change, as they have been researching it. The major impacts are planting the wrong stuff - but really it's up to the Province, they are modelling it. We only have an AAC of 20,000M^3. We can't afford scientists - start-up costs are expensive*.
(CFO 31: Non-Adaptor)

"*The Ministry of Forests needs to loosen up the preferred species*."
(CFO 17: Non-Adaptor)

"*We're limited by silvicultural rules, we can't be as experimental as we'd like."*
(CFO 19: Non-Adaptor)

"*There's no way to adapt, provincial stocking standards mean it's not possible to change."*
(CFO 34: Non-Adaptor)

"*We're constrained by prescribed species*." (CFO 35: Stage 2 Adaptor)

"Based on how the area has been hit now [by Mountain Pine Beetle], it is hard to plan for the future, BC Timber Sales [a government department which sets cost and price benchmarks for timber harvested from public land in British Columbia] have hampered progress, and law changes have not helped, overall the laws are not helpful."
(CFO 38 Non-Adaptor)

These tensions across scales between local and regional concerns could play an important role in the ability of CFOs to adapt to climate change in the future.

6.4.3 Community consultation

Some CFOs struggle with attracting people and getting them involved, as can be seen in some of their comments highlighting time pressure and lack of engagement in communities:

"*There's a lack of time commitment, […] does all the work, and local people don't have much time, it's a small town*." (CFO 3: Non-Adaptor)

"*Despite us putting considerable effort into community consultation (a public meeting each month, at least one large social event each year), there is very little feedback from the community - unless there is an issue. Is lack of interest implied trust or apathy or both*?" (CFO 5: Stage 1 Adaptor)

Despite these difficulties, CFOs are usually focussed on their communities using a diversity of approaches to create community benefit:

Fostering partnership: "*We want to do partnerships with ranchers […], we're interested in doing things that are different from 2x4s. There's no challenge in that. We want genuine broad community involvement, there are not many people who can participate in logging, but there are other things (that we can do in the forest) that more people can participate in*." (CFO 13: Stage 1 Adaptor)

Philanthropy: *"Our CFO gives money to the community, we want to be able to say 'yes, we're logging, but look at where the money is going.' A lot of money has gone to projects locally, creating goodwill throughout the town*." (CFO 26: Non-Adaptor)

Mitigating conflict: "*The community forest is in the most contentious area in town. Every group has a very different view and everyone projects their opinions on the community (assumes that everyone shares their view). The most vocal are often the extremes and it very important to represent the quieter people who may not make their opinions known. It's worth getting at the grey in between.*"(CFO 36: Stage 2 Adaptor)

Developing community cohesion: *"The community forest has created community interaction and friendship between us and white people".* (CFO 8: Non-Adaptor)

"[*The community forest has developed] a really good relationship with local First Nations*." (CFO 13: Stage 1 Adaptor)

Overall the results indicate that the three groups, the Non-Adaptors, Stage 1 Adaptors and Stage 2 Adaptors have distinct characteristics. In these CFOs greater adaptation is associated with the organisation's attitude towards global climate change and their perception of the impacts of climate change on the forest. The presence of pro-environmental values, community investment and trust, as well as access to financial resources and training were more frequent in organisations that were beginning adaptation. In organisations that have progressed beyond research and had already integrated adaptation into their work (Stage 2 Adaptors), access to resources could be more important than pro-environmental values and concern about the direct impacts of climate change on their forest. In addition to improved access to resources, concern about global climate change as well as community investment and trust remained important features in the most adaptive organisations. The open-ended comments highlighted some unexpected characteristics of CFOs which may influence their adaptive capacity: how they conceptualise their relationship as humans with the forest, the tension across scales from local to regional which dictate the options available to CFOs in adaptation, and the CFO's high level of experience in facilitating community interaction. The implications of these results collected both with the structured Likert scale and the 'open ended' comments are further explored in the conclusion.

7 Conclusion

The conclusion firstly explores where this research sits within the wider field of adaptive capacity as it has developed in response to climate change in the last decade or so; looking at how the outcomes of the hypotheses contribute to the improvement of understanding. It also looks specifically at how the research can be used to help support community forests in BC prepare for climate change, and at how future research can enable adaptation to progress as the impacts of climate change become more apparent over the coming century.

7.1 The findings in the context of previous research

The findings of this research reflect the evolution of adaptive capacity in the climate change field (detailed in Section 4.2.3). This evolution started from a foundation which recognised the importance of natural, economic and physical capital in enabling adaptation, progressed to include human capital, and has more recently recognised the importance of social capital and the possibility of supporting values playing a strong role. Access to natural capital was universally high in this population and was not perceived as a limiting factor for the organisations themselves in adapting, but the small footprint of community forests at the landscape level limits the consequences of their adaptation choices when considering BC's forests as a whole (H_1). This research implies that economic capital does seem to play a role in enabling adaptation, being more often present in the CFOs which are adapting, but it is clearly not essential, since just under half of the adapting organisations do not have access to self-generated capital to reinvest or external capital to call on if needed (H_2). The role of physical capital was somewhat uncertain, but it was not usually a limiting factor unless the CFO was very geographically isolated (H_3). Human capital plays an unclear role too; access to training and education are more widespread in adapting organisations, but this access to knowledge and information was not reflected in CFOs understanding of the impacts of climate change or risk reduction (H_4). In terms of social capital both trust and time spent on community involvement and consultation seemed to play an strong enabling role in adaptation, as did the amount of rooted involvement in the community evidenced through much higher direct employment of people through CFOs with higher adaptive capacity - irrespective of their

ownership or governance arrangements (H_5). It is difficult to ascertain how these different determinants of adaptive capacity interact, and this research does not give information which would allow us to conclude anything about their substitutability. However, it does indicate that the values (and the attitudes derived from those core values) held by adaptive CFOs are strikingly different in the adaptors and the non-adaptors (H_6). Pro-environmental values, identification with innovation, and a disassociation from the conventional forest industry were all important characteristics of adaptive CFOs, as were the most highly differentiated indicators: their attitude to global climate change and their concern and understanding about its local impacts.

This research supports the IPCC's findings that although economic development may give greater access to resources, it is not a "necessary or sufficient indicator of the capacity to adapt to climate change" (Adger et al. 2007 p728), and the observation that the existence of capacity itself is not a guarantee that it will be used (Burton et al. 2002). It also indicates that social indicators are important, and that values play an influential role. This pivotal role played by values is frustrating in terms of prospects for policy development, since values are far more complex and slow to change than access to resources and it is unclear what institutions could do in order to encourage more enabling values. Conservatism, inertia and slowness to react to change, especially in rural areas in BC (Williamson et al. 2005) entrenched in culture and psychological investment represents a significant subjective limit in communities' adaptation to climate change (O'Brien 2009, Adger et al. 2009). The importance of values in the issue of climate change is not only a problem for CFOs, but a problem on the global scale, as the lingering values of Modernity are simply inappropriate to deal with the challenge of climate change. Modern values can be characterised as prioritising power, achievement and self enhancement (O'Brien 2009) as well as "industrialisation at almost any price" (Inglehart and Baker 2000). By contrast postmodern worldviews may emphasise values that are more orientated towards ideas of self-transcendence, such as universalism and benevolence (O'Brien 2009). It seems that the values of postmodernity may be more likely to enable a practical reassessment of the price of industrialisation, which is perhaps, ultimately, what climate change demands. The sidelining of climate change as an 'environmental problem' is

similarly problematic in that it allows a universal phenomenon to be thought of as a niche interest that many people do not engage with due to the cultural or social values they hold. The framing of climate change as the concern of 'environmentalists' has in some ways prevented a more pragmatic assessment of the challenge by society more broadly, as suggested by Davidson in her work in Northern Canada (Davidson et al. 2003, Adger et al. 2007).

7.2 Application of the research findings

The research gives some suggestions for ways that community forests could be further enabled to adapt to climate change. Maximising access to some of the determinants which seem to play the strongest role in adaptation (human capital, and social capital and enabling values), could empower CFOs to take a greater proactive role in adaptation. Human capital could be increased with targeted training. Research carried out with Swedish foresters suggests that information on risk reduction may be more important than information on the possible impacts of climate change (Blennow and Pearson 2008); although needs may be different in BC and further research could be beneficial to confirm that any programs were addressing the needs of CFOs. In the survey adaptive CFOs reported positive training experiences, with staff and board members attending workshops and seminars on climate change provided by government bodies, universities or other research initiatives as well as working alongside external organisations to improve their adaptive capacity, this research indicates that continuing and widening these initiatives could increase the adaptive capacity of CFOs.

It has been argued that learning and trust are interlinked, that well developed networks of people learn more from past events, identify new information and develop capacity to cope with change (Pelling & High 2005) by exchanging ideas and knowledge. Information conversations and social learning is important in adaptation (Adger et al. 2007, Gupta et al. 2010) and can provide a safety net in cases where other resources are unavailable. There is perhaps an increased role here for the BCCFA in facilitating dialogue between community forests (who are spread over a large geographical area) about climate change adaptation, as

well as the possibility of face to face seminars or conferences, which CFOs could participate in, or online resource hubs with message boards that may increase the sharing of ideas and information between the organisations.

As has been touched on, values are probably the hardest thing to change, and they may well be one the most deep seated barriers to adaptation (O'Brien 2009). However, they do change over time and sometimes radically in quite short periods, though not always in a way that increases adaptive capacity (Adger et al. 2007, Folke et al. 2005). There is the possibility, which has not really been explored explicitly in climate change adaptation, that some values are more enabling in climate change adaptation. The literature stops short of being prescriptive, and no one set of values are overtly privileged above another, it but does acknowledge that there are profound value conflicts about what adaptation should be. Simply put, traditionalists would like to keep the things as they were, modernists would like to maintain the optimum conditions for economic growth and postmodernists would like to promote well-being, equity and ecological health (O'Brien 2009). This impasse in the adaptation literature is a silent echo of the failure of climate change mitigation, where modernist values currently have the floor.

Folke (2005) recognises that there are particular values associated with higher adaptive capacity and social learning and those may be promoted by leadership, and in this case he is talking about pro-environmental values. Outside the adaptation literature, but writing about climate change, Kasser (2011) talks openly about the need to emphasise the benefits of intrinsic values (which place worth on ecological concerns) over extrinsic values (which place worth on materialism, status and wealth) to enable social change, and draws from the same theoretical values basis that O'Brien (2009) used in her work on values and adaptation. Unless scholars within adaptation begin to really discuss and research which values enable adaptation (and this small study gives an indication of where this could begin) the field is destined to go round in circles busily avoiding the controversial finding that one set of values is of better use than another in humanity's current situation.

7.3 Suggestions for future research

Previous to beginning this study it was unclear whether any organisations would be adapting to climate change, having established that a significant minority are, it would be very interesting to approach this research using Rogers' (1983) theory of the diffusion of innovation as a way of operationalizing organisation's levels of adaptation. Rogers uses a diffusion curve (which resembles a normal curve) to explain how innovations (in this case adaptation to climate change) are adopted within a population. He suggested that this is done first by a small (2.5%) group of the population termed the Innovators, secondly by a larger proportion (13.5%) termed the Early Adopters, and progressively an Early Majority (34%), a Late Majority (34%) and eventually Laggards (16%). Rogers' extensive research in this area suggested descriptions for each group: for example Innovators are defined as being willing to take risks, having good access to finances, being very social and having access to scientific sources, and well as interaction with other innovators (Rogers 1962). This conceptualisation of the adoption of innovation overlaps substantially with the concept of adaptive capacity, and perhaps gives a more developed theoretical structure upon which to ground research.

Adaptation itself is limited by biological boundaries, and there is no guarantee whatsoever that planting different seeds, growing a wider variety of trees or similar actions that can be undertaken by CFOs now will offer any protection from the impacts of climate change in the future. The biophysical properties of ecosystems may shift in ways that create large magnitude change, and the speed at which increases in long lived greenhouse gases (LLGHGs) have occurred and are progressing mean that it is probable that the rate of climate change will be unlike any other change that has occurred in the last 10,000 years (Soloman et al. 2007). By contrast, Europeans have been practicing forest management (planting trees as well as cutting them) in BC for less than 100 years, which is much less than the natural lifespan of many species native to region. Any realistic assessment of our state of knowledge and ability to adapt to the coming changes would have to conclude that the possibility of us doing so in any controlled way is fairly slim (Narasimhan 2007, Nelson 2009). This brings us back to values.

Values, as the root of our attitudes, play a large role in forming our expectations of forests and how they should sustain us; given the magnitude of likely climate change, adaptation may be less about how we can control the world by 'managing' it and more about changing these expectations. To adapt, we need to radically reassess our relationship with the natural environment and begin a transformational shift in values to enable this (Nelson 2009). Adaptation research has progressed from its mechanistic roots where economic, physical and human resources were seen as the exclusive enablers, along a path which acknowledged the role of social capital and social learning as well as traditional knowledge, and it has arrived at the role of values as its destination. Thinking more widely, adaptation is only part of the picture, it is a process of coping with changing conditions that are themselves 'extremely likely' to be anthropogenic in nature (Soloman et al. 2007 p 81); humans are simultaneously contributing to climate change and are threatened by it. There is both profit and damage when we burn fossil fuels, but there is no explicit global cost benefit analysis being kept. Consequently, there is a dissonance of values in which competing interests co-exist with eventual loss to both groups, and in which the two groups are actually composed of the same people (foresters in BC with pensions that invest in the oil sands in Alberta for instance). Reflecting this example, climate change can be thought of an "*internal* crisis of *values"* (Kasser 2011 p 89); perhaps this is where the enduring work on adaptation will really take place and what new research should explore (Nelson 2009). Learning can be thought of as being single or double loop (Argyris 1977, Folke 2005); double loop learning stimulates a conflict of underlying assumptions and values, it is the process in which we begin to, in the most literal use of the word, re-evaluate. This re-evaluation is perhaps how we can begin a complete process of adaptation to climate change, whether we do so, and how we can, is in part a question of future research.

Bibliography

Adger, W.N. 2003, "Social capital, collective action, and adaptation to climate change", *Economic Geography,* vol. 79, no. 4, pp. 387-404.

Adger, W.N. & Vincent, K. 2005, "Uncertainty in adaptive capacity", *Comptes Rendus Geoscience,* vol. 337, no. 4, pp. 399-410.

Adger, W.N. 2006, "Vulnerability", *Global Environmental Change-Human and Policy Dimensions,* vol. 16, no. 3, pp. 268-281.

Adger, W.N., Agrawala, S., Mirza, M.M.Q., Conde, C., O'Brien, K., Pulhin, R., Pulwarty, R. & Smit, B and Takahashi, K. "Assessment of adaptation practices, options, constraints and capacity. Climate Change 2007: Impacts, Adaptation and Vulnerability" in *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)*, eds. M.L. Parry, O. Canziani F, J.P. Palutikof & van der Linden P.J and Hanson, C.E., Cambridge University Press, Cambridge, UK., pp. 717-743.

Adger, W.N., Dessai, S., Goulden, M., Hulme, M., Lorenzoni, I., Nelson, D., Naess, L., Wolf, J., Wreford, A. 2009 "Are there social limits to adaptation to climate change?" Climatic Change 93: 335-354.

Agrawal, A. & Perrin, N. 2009, "Climate Adaptation, local institutions and rural livelihoods" in *Adapting to Climate Change*, ed. Adger, N., Lorenzoni, I., O'Brien, K., First edn, Cambridge University Press, UK, pp. 350.

Aitken, S.N. 2004, "Genecology and adaptation of forest trees" in *The Encyclopedia of Forest Sciences*.

Aitken, S.N., Yeaman, S., Holliday, J.A., Wang, T. & Curtis-McLane, S. 2008, "Adaptation, migration or extirpation: climate change outcomes for tree populations", *Evolutionary Applications,* vol. 1, no. 1, pp. 95-111.

Allen, C.R. & Holling, C.S. 2010, "Novelty, Adaptive Capacity, and Resilience", *Ecology and Society,* vol. 15, no. 3, pp. 24.

Argyris, C. 1977, "Double Loop Learning in Organizations", *Harvard business review,* vol. 55, no. 5, pp. 115-125.

Babbie, E. 2010, *The Practice of Social Research,* Wadsworth Publishing.

Bartley, T., Andersson, K., Jagger, P. & Van Laerhoven, F. 2008, "The contribution of institutional theories to explaining decentralization of natural resource governance", *Society & Natural Resources,* vol. 21, no. 2, pp. 160-174.

BC Partnership Act [RSBC 1996] Chapter 348. Available at: http://www.bclaws.ca

Becker, G. 1994, *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education,* University of Chicago Press, Chicago, IL, USA.

Beier, C. 2011, "Factors Influencing Adaptive Capacity in the Reorganization of Forest Management in Alaska", *Ecology and Society,* vol. 16, no. 1, pp. 40.

Berkes, F., Hughes, T.P., Steneck, R.S., Wilson, J.A., Bellwood, D.R., Crona, B., Folke, C., Gunderson, L.H., Leslie, H.M., Norberg, J., Nystrom, M., Olsson, P., Osterblom, H., Scheffer, M. & Worm, B. 2006, "Ecology - Globalization, roving bandits, and marine resources", *Science,* vol. 311, no. 5767, pp. 1557-1558.

Berkes, F. 2010, "Devolution of environment and resources governance: trends and future", *Environmental Conservation,* vol. 37, no. 4, pp. 489-500.

Berkes, F. 2007, "Understanding uncertainty and reducing vulnerability: lessons from resilience thinking", *Natural Hazards,* vol. 41, no. 2, pp. 283-295.

Berkhout, T. & Rowlands, I.H. 2007, "The voluntary adoption of green electricity by Ontario-based companies - The importance of organizational values and organizational context", *Organization & Environment,* vol. 20, no. 3, pp. 281-303.

Blennow, K. & Persson, J. 2009, "Climate change: Motivation for taking measure to adapt", *Global Environmental Change-Human and Policy Dimensions,* vol. 19, no. 1, pp. 100-104.

Bolnick, D.I., Svanback, R., Fordyce, J.A., Yang, L.H., Davis, J.M., Hulsey, C.D. & Forister, M.L. 2003, "The ecology of individuals: Incidence and implications of individual specialization", *American Naturalist,* vol. 161, no. 1, pp. 1-28.

Bourdieu, P. 1988, *Homo Academicus,* (English translation) edn, Polity Press, Cambridge.

Bradshaw, B. 2003, "Questioning the credibility and capacity of community-based resource management", *Canadian Geographer-Geographe Canadien,* vol. 47, no. 2, pp. 137-150.

Brondizio, E.S., Ostrom, E. & Young, O.R. 2009, "Connectivity and the Governance of Multilevel Social-Ecological Systems: The Role of Social Capital", *Annual Review of Environment and Resources,* vol. 34, pp. 253-278.

Brooks, N., Adger, W.N. & Kelly, P.M. 2005, "The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation", *Global Environmental Change-Human and Policy Dimensions,* vol. 15, no. 2, pp. 151-163.

Bullock, R. & Hanna, K. 2008, "Community forestry: Mitigating or creating conflict in British Columbia?" *Society & Natural Resources,* vol. 21, no. 1, pp. 77-85.

Bullock, R., Hanna, K. & Slocombe, D.S. 2009, "Learning from community forestry experience: Challenges and lessons from British Columbia", *Forestry Chronicle,* vol. 85, no. 2, pp. 293-304.

Burch, S. 2010, "Transforming barriers into enablers of action on climate change: Insights from three municipal case studies in British Columbia, Canada", *Global Environmental Change-Human and Policy Dimensions,* vol. 20, no. 2, pp. 287-297.

Burton, I., Huq, S., Lim, B., Pilifosova, O. & Schipper, E.L. 2002, "From impacts assessment to adaptation priorities: the shaping of adaptation policy", *Climate Policy,* vol. 2, no. 2-3, pp. 145-159.

Carpenter, S., Walker, B., Anderies, J. & Abel, N. 2001, "From metaphor to measurement: Resilience of what to what?" *Ecosystems,* vol. 4, no. 8, pp. 765-781.

Carroll, A.L., Taylor, S.W., Regniere, J. & Safranyik, L. 2004, *Effects of climate change on range expansion by the mountain pine beetle in British Columbia*, Natural Resources Canada Canadian Forest Service, Ottawa; Science Branch, Ottawa, Ontario K1A 1G5, Canada.

Chapin, F.S., Carpenter, S.R., Kofinas, G.P., Folke, C., Abel, N., Clark, W.C., Olsson, P., Smith, D.M.S., Walker, B., Young, O.R., Berkes, F., Biggs, R., Grove, J.M., Naylor, R.L., Pinkerton, E., Steffen, W. & Swanson, F.J. 2010, "Ecosystem stewardship: sustainability strategies for a rapidly changing planet", *Trends in Ecology & Evolution,* vol. 25, no. 4, pp. 241-249.

Coleman, J. 1988, "Social Capital in the Creation of Human Capital", *American Journal of Sociology,* vol. 94.

Costanza, R., d'Arge, R., deGroot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., ONeill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. & vandenBelt, M. 1997, "The value of the world's ecosystem services and natural capital", *Nature,* vol. 387, no. 6630, pp. 253-260.

Cudmore, T.J., Bjorklund, N., Carroll, A.L. & Lindgren, B.S. 2010, "Climate change and range expansion of an aggressive bark beetle: evidence of higher beetle reproduction in naive host tree populations", *Journal of Applied Ecology,* vol. 47, no. 5, pp. 1036-1043.

Daedlow, K., Beckmann, V. & Arlinghaus, R. 2011, "Assessing an Adaptive Cycle in a Social System under External Pressure to Change: the Importance of Intergroup Relations in Recreational Fisheries Governance", *Ecology and Society,* vol. 16, no. 2, pp. 3.

Daniels, L.D., Maertens, T.B., Stan, A.B., McCloskey, S.P.J., Cochrane, J.D. & Gray, R.W. 2011, "Direct and indirect impacts of climate change on forests: three case studies from British Columbia", *Canadian Journal of Plant Pathology-Revue Canadienne De Phytopathologie,* vol. 33, no. 2, pp. 108-116.

Davidson, D.J., Williamson, T. & Parkins, J.R. 2003, "Understanding climate change risk and vulnerability in northern forest-based communities", *Canadian Journal of Forest Research-Revue Canadienne De Recherche Forestiere,* vol. 33, no. 11, pp. 2252-2261.

Davidson, D.J. 2010, "The Applicability of the Concept of Resilience to Social Systems: Some Sources of Optimism and Nagging Doubts", *Society & Natural Resources,* vol. 23, no. 12, pp. 1135-1149.

De Vries, B.J.M. & Petersen, A.C. 2009, "Conceptualizing sustainable development An assessment methodology connecting values, knowledge, worldviews and scenarios", *Ecological Economics,* vol. 68, no. 4, pp. 1006-1019.

Dillman, D. A, Eltinge, J., Grove, R.M., Little, R. J. A. 2002, "Survey Nonresponse in design, data collection and analysis" in *Survey Nonresponse*, ed. Grove, R.M., Dillman, D. A, Eltinge, J., Little, R. J. A., Wiley Interscience, New York.

Dillman, D., A. 1978, *Mail and telephone surveys: The total design method,* John Wiley and Sons, New York.

Duffield, C., Gardner, J.S., Berkes, F. & Singh, R.B. 1998, "Local knowledge in the assessment of resource sustainability: Case studies in Himachal Pradesh, India, and British Columbia, Canada", *Mountain Research and Development,* vol. 18, no. 1, pp. 35-49.

Eakin, H., Eriksen, S., Eikeland, P. & Oyen, C. 2011, "Public Sector Reform and Governance for Adaptation: Implications of New Public Management for Adaptive Capacity in Mexico and Norway", *Environmental management,* vol. 47, no. 3, pp. 338-351.

Eakin, H. & Luers, A.L. 2006, "Assessing the vulnerability of social-environmental systems", *Annual Review of Environment and Resources,* vol. 31, pp. 365-394.

Engle, N.L. 2011, "Adaptive capacity and its assessment", *Global Environmental Change-Human and Policy Dimensions,* vol. 21, pp. 647.

Engle, N.L. & Lemos, M.C. 2010, "Unpacking governance: Building adaptive capacity to climate change of river basins in Brazil", *Global Environmental Change-Human and Policy Dimensions,* vol. 20, no. 1, pp. 4-13.

Finan, T.J. & Nelson Donald R. 2009, "Decentralised planning and climate adaptation: towards transparent governance" in *Adapting to Climate Change*, ed. Adger, N., Lorenzoni, I., O'Brien, K., First edn, Cambridge University Press, UK, pp. 313.

Flint, C.G. & Luloff, A.E. 2005, "Natural Resource-Based Communities, Risk, and Disaster: An Intersection of Theories", *Society & Natural Resources,* vol. 18, no. 5, pp. 399 — 412.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L. & Holling, C.S. 2004, "Regime shifts, resilience, and biodiversity in ecosystem management", *Annual Review of Ecology Evolution and Systematics,* vol. 35, pp. 557-581.

Folke, C., Hahn, T., Olsson, P. & Norberg, J. 2005, "Adaptive governance of social-ecological systems", *Annual Review of Environment and Resources,* vol. 30, pp. 441-473.

Folke, C. 2006, "Resilience: The emergence of a perspective for social-ecological systems analyses", *Global Environmental Change-Human and Policy Dimensions,* vol. 16, no. 3, pp. 253-267.

Franke, S. 2005, *Measurement of Social Capital Reference Document for Public Policy Research, Development, and Evaluation*, Government of Canada Policy Research Institute.

Friedlingstein, P., Solomon, S., Plattner, G.-., Knutti, R., Ciais, P. & Raupach, M.R. 2011, "Long-term climate implications of twenty-first century options for carbon dioxide emission mitigation", *Nature Climate Change,* vol. 1, no. 9, pp. 457-461.

Fussel, H.M. & Klein, R.J.T. 2006, "Climate change vulnerability assessments: An evolution of conceptual thinking", *Climatic Change,* vol. 75, no. 3, pp. 301-329.

Gallopin, G.C. 2006, "Linkages between vulnerability, resilience, and adaptive capacity", *Global Environmental Change-Human and Policy Dimensions,* vol. 16, no. 3, pp. 293-303.

Gayton, D. 2008, *Impacts of climate change on British Columbia's biodiversity*, Forest Research Extension Society, Kamloops, British Columbia, Canada.

Gonzalez, P., Neilson, R.P., Lenihan, J.M. & Drapek, R.J. 2010, "Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change", *Global Ecology and Biogeography,* vol. 19, no. 6, pp. 755-768.

Goode, R. 1959, "Adding to the Stock of Physical and Human Capital", *The American Economic Review,* vol. 49, pp. 147-155.

Granovetter, M. 1973, "The Strength of Weak Ties", *American Journal of Sociology,* vol. 78, no. 6, pp. 1360-1380.

Gunter, J. 2004, *The Community Forestry Guidebook. Tools and Techniques for Communities in British Columbia.* FORREX & BC Community Forest Association.

Gupta, J., Termeer, C., Klostermann, J., Meijerink, S., van den Brink, M., Jong, P., Nooteboom, S. & Bergsma, E. 2010, "The Adaptive Capacity Wheel: a method to assess the inherent characteristics of institutions to enable the adaptive capacity of society", *Environmental Science & Policy,* vol. 13, no. 6, pp. 459-471.

Hamann, A. & Wang, T. 2006, "Potential effects of climate change on ecosystem and tree species distribution in British Columbia", *Ecology,* vol. 87, no. 11, pp. 2773-2786.

Hardin, G. 1968, "The tragedy of the commons." *Science,* vol. 162, pp. 1243–1248.

Hardin, G. 1998, "Extension of 'The Tragedy of the commons'" *Science vol. 280, no. 5364 pp. 682-683*

Hebda, R. 1998, "Atmospheric change, forests and biodiversity", *Environmental monitoring and assessment,* vol. 49, no. 2-3, pp. 195-212.

Holling, C.S. 2001, "Understanding the complexity of economic, ecological, and social systems", *Ecosystems,* vol. 4, no. 5, pp. 390-405.

Inglehart, R. & Baker, W.E. 2000, "Modernization, cultural change, and the persistence of traditional values", *American Sociological Review,* vol. 65, no. 1, pp. 19-51.

Jennings, T. 2009, "Exploring the invisibility of local knowledge in decision making: the Boscastle Harbour flood disaster" in *Adapting to Climate Change: Thresholds, Values, Governance.*, ed. Adger, N., Lorenzoni, I., O'Brien, K., Cambridge University Press, Cambridge, UK.

Joseph, C, Krishnaswamy, A 2010, "Factors of resiliency for forest communities in transition in British Columbia", *Extension Note: BC Journal of Ecosystems and Management,* vol. 10, no. 3, pp. 127-144.

Kahan, D.M., Jenkins, H. & Braman, D. 2011, "Cultural cognition of scientific consensus", *Journal of Risk Research,* vol. 14, no. 2, pp. 147-174.

Kasser, T. 2011, "Cultural Values and the Well-Being of Future Generations: A Cross-National Study", *Journal of Cross-Cultural Psychology,* vol. 42, no. 2, pp. 206-215.

Marechal, K. & Lazaric, N. 2010, "Overcoming inertia: insights from evolutionary economics into improved energy and climate policies", *Climate Policy,* vol. 10, no. 1, pp. 103-119.

Mc Afee, B., de Camino, R., Burton, P., Eddy, B., Lutz, F., Messier, C., Reed, M., Spies, Vides, R., Baker, C., Barriga, M., Campos, J., Corrales, O., Espinoza, L., Gibson, S., Glatthorn, J., Martineau-Delisle, C., Prins, C., Rose, N. 2011, "Managing Forested Landscapes for Socio-Ecological Resilience" in *Forests and Society: Responding to Global Drivers of Change*, ed. Mery, G., Katila, P., Galloway, G., Alfaro, R., Kanninen, M., Lobovikov, M., Varjo, J., International Union of Forest Research Organizations, Vantaa, Finland.

McCarthy, J. 2006, "Neoliberalism and the politics of alternatives: Community forestry in British Columbia and the United States", *Annals of the Association of American Geographers,* vol. 96, no. 1, pp. 84-104.

Ministry of Forests, Mines and Lands 3/2/2011-last update, *Community Forests Home Page*. Available: http://www.for.gov.bc.ca.ezproxy.library.ubc.ca/hth/timber-tenures/community/index.htm.

Naess, L., Bang, G., Eriksen, S. & Vevatne, J. 2005, "Institutional adaptation to climate change: Flood responses at the municipal level in Norway", *Global Environmental Change-Human and Policy Dimensions,* vol. 15, no. 2, pp. 125-138.

Narasimhan, T.N. 2007, "Limitations of science and adapting to Nature", *Environmental Research Letters,* vol. 2, no. 3, pp. 034003.

Nelson, D. 2009, "Conclusions: Transforming the world" in *Adapting to Climate Change: Thresholds, Values, Governance,* ed. Adger, N., Lorenzoni, I., O'Brien, K., Cambridge University Press, .

New, M., Liverman, D., Schroeder, H. & Anderson, K. 2011, "Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications (vol 369, pg 6, 2011)", *Philosophical Transactions of the Royal Society A-Mathematical Physical and Engineering Sciences,* vol. 369, no. 1938, pp. 1112-1112.

Nilsson, A., von Borgstede, C. & Biel, A. 2004, "Willingness to accept climate change strategies: The effect of values and norms", *Journal of Environmental Psychology,* vol. 24, no. 3, pp. 267-277.

O'Brien, K. 2009, "Do values subjectively define the limits to climate change adaptation?" in *Adapting to Climate Change: Thresholds, Values, Governance*, ed. Adger, N., Lorenzoni, I., O'Brien, K., Cambridge University Press, Cambridge, UK.

O'Brien, K.L. & Wolf, J. 2010, "A values-based approach to vulnerability and adaptation to climate change", *Wiley Interdisciplinary Reviews-Climate Change,* vol. 1, no. 2, pp. 232-242.

Ogden, A.E. & Innes, J.L. 2009, "Application of Structured Decision Making to an Assessment of Climate Change Vulnerabilities and Adaptation Options for Sustainable Forest Management", *Ecology and Society,* vol. 14, no. 1, pp. 11.

Ostrom, E, Walker, J Walker, J 1994, *Rules, Games, and Common-Pool Resources,* The University of Michigan Press, Ann Arbor, MI , USA.

Ostrom, E., Burger, J., Field, C.B., Norgaard, R.B. & Policansky, D. 1999, "Sustainability - Revisiting the commons: Local lessons, global challenges", *Science,* vol. 284, no. 5412, pp. 278-282.

Ostry, A., Ogborn, M., Bassil, K.L., Takaro, T.K. & Allen, D.M. 2010, "Climate Change and Health in British Columbia: Projected Impacts and a Proposed Agenda for Adaptation Research and Policy", *International Journal of Environmental Research and Public Health,* vol. 7, no. 3, pp. 1018-1035.

Pagdee, A., Kim, Y.S. & Daugherty, P.J. 2006, "What makes community forest management successful: A meta-study from community forests throughout the world", *Society & Natural Resources,* vol. 19, no. 1, pp. 33-52.

Papadopol, C.S. 2000, "Impacts of climate warming on forests in Ontario: Options for adaptation and mitigation", *Forestry Chronicle,* vol. 76, no. 1, pp. 139-149.

Parkins, J.R. & MacKendrick, N.A. 2007, "Assessing community vulnerability: A study of the mountain pine beetle outbreak in British Columbia, Canada", *Global Environmental Change-Human and Policy Dimensions,* vol. 17, no. 3-4, pp. 460-471.

Pelling, M. & High, C. 2005, "Understanding adaptation: What can social capital offer assessments of adaptive capacity?", *Global Environmental Change-Human and Policy Dimensions,* vol. 15, no. 4, pp. 308-319.

Posey, J. 2009, "The determinants of vulnerability and adaptive capacity at the municipal level: Evidence from floodplain management programs in the United States", *Global Environmental Change-Human and Policy Dimensions,* vol. 19, no. 4, pp. 482-493.

Putnam, R.D. 2001, "Civic disengagement in contemporary America", *Government and Opposition,* vol. 36, no. 2, pp. 135-156.

Randall, D.M. & Fernandes, M.F. 1991, "The Social Desirability Response Bias in Ethics Research", *Journal of Business Ethics,* vol. 10, no. 11, pp. 805-817.

Reed, M.G. & McIlveen, K. 2006, "Toward a pluralistic civic science?: Assessing community forestry", *Society & Natural Resources,* vol. 19, no. 7, pp. 591-607.

Rodenhuis, D (Project Lead), Team: Bennett K.E., Werner A.T., Murdock T.Q. , Bronaugh D. 2009, "Climate Overview 2007 Hydro-climatology and Future Climate Impacts in British Columbia"

Rogers, Everett M. 1962. *Diffusion of Innovations*. Glencoe: Free Press

Rogers, Everett M. 1983. *Diffusion of Innovations*. New York: Free Press.

Rohan, M.J. 2000, "A rose by any name? The values construct", *Personality and Social Psychology Review,* vol. 4, no. 3, pp. 255-277.

Rowland, E.L., Davison, J.E. & Graumlich, L.J. 2011, "Approaches to Evaluating Climate Change Impacts on Species: A Guide to Initiating the Adaptation Planning Process", *Environmental management,* vol. 47, no. 3, pp. 322-337.

Schwartz, S.H. 2006, "A Theory of Cultural Value Orientations: Explication and Applications", *Comparative Sociology,* vol. 5.

Smit, B, Pilifosova, O & Burton, I, Challenger, B, Huq, S, Klein, R.J.T., Yohe, G., Adger, N, Downing, T, Harvey, E, Kane, S, Parry, M, Skinner, M, Smith, J, Wandel, J. 2001 "Adaptation to Climate Change in the Context of Sustainable Development and Equity" in A*daptation and Vulnerability*, ed. Review Editors: Patwardhan, A. and Soussana, J.-F., Intergovernmental Panel on Climate Change, .

Smit, B. & Wandel, J. 2006, "Adaptation, adaptive capacity and vulnerability", *Global Environmental Change-Human and Policy Dimensions,* vol. 16, no. 3, pp. 282-292.

Smithers, J. & Smit, B. 1997, "Human adaptation to climatic variability and change", *Global Environmental Change-Human and Policy Dimensions,* vol. 7, no. 2, pp. 129-146.

Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt, "2007: Technical Summary." in *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Sturrock, R.N., Frankel, S.J., Brown, A.V., Hennon, P.E., Kliejunas, J.T., Lewis, K.J., Worrall, J.J. & Woods, A.J. 2011, "Climate change and forest diseases RID G-9496-2011", *Plant Pathology,* vol. 60, no. 1, pp. 133-149.

Terwel, B., Harinck, F., Ellemers, N. Daamen, D. 2009, "How organisational motives and communications affect public trust in organisations: The case of carbon dioxide capture and storage", *Journal of Environmental Psychology.* No. 29, pp. 290-299.

Thorgersen, J. 1997, Values and attitude formation towards emerging attitude objects: From recycling to general waste minimising behaviour, *Advances in Consumer Research* Vol 24, pp. 182-189. Available at: http://www.acrwebsite.org/volumes/display.asp?id=8040

Tindall, D.B., Harshaw, H, W. and Sheppard, S. R. 2010, "Understanding the social bases of satisfaction with public participation in forest management decision-making in British Columbia", *Forestry Chronicle,* vol. 86, no. 6.

Tol, R.S.J. & Yohe, G.W. 2007, "The weakest link hypothesis for adaptive capacity: An empirical test", *Global Environmental Change-Human and Policy Dimensions,* vol. 17, no. 2, pp. 218-227.

Tyler, S., Ambus, L. & Davis-Case, D. "Governance and management of small forest tenures in British Columbia", *Extension Note: BC Journal of Ecosystems and Management,* [Online], vol. 8, no. 2: 2007, pp. 67–78. Available from: http://www.forrex.org/publications/jem/ISS41/vol8_no2_art6.pdf.

United Nations Development Program 2010, *Mapping Climate Change Vulnerability Impact Scenarios*.

Van Laerhoven, F. 2010, "Governing community forests and the challenge of solving two-level collective action dilemmas-A large-N perspective", *Global Environmental Change-Human and Policy Dimensions,* vol. 20, no. 3, pp. 539-546.

Wackernagel, M, Onisto, L, Bello, P, Callejas, A, Lopez Falfan, I. S., Mendez Garcıa, J, Suarez Guerrero, A. I., Suarez Guerrero, M. G. 1999, "National natural capital accounting with the ecological footprint concept", *Ecological Economics,* vol. 29, pp. 375–390.

Walker, B., Holling, C., Carpenter, S. & Kinzig, A. 2004, "Resilience, adaptability and transformability in social-ecological systems", *Ecology and Society,* vol. 9, no. 2, pp. 5.

Williamson, T.B., Colombo, S.J., Duinker, P.N., Gray, P.A., Hennessey, R.J., Houle, D., Johnston, M.H., Ogden, A.E. & Spittlehouse, D.L. 2009, *Climate Change and Canada's Forests - From Impacts to Adaptation*, Sustainable Forest Management Network and Natural Resources Canada, Edmonton, AB.

Williamson, T.B., Price, D.T., Beverly, J.L., Bothwell, P.M., Parkins, J.R., Patriquin, M.N., Pearce, C.V., Stedman, R.C. & Volney, W.J.A. 2007, *A framework for assessing vulnerability of forest-based communities to climate change*, Canadian Forest Service Northern Forestry Centre, Edmonton, Alberta, Canada.

Williamson, T.B., Parkins, J.R. & McFarlane, B.L. 2005, "Perceptions of climate change forest-based risk to forest ecosystems and communities", *Forestry Chronicle,* vol. 81, no. 5, pp. 710-716.

Williamson, T., Hesseln, H. & Johnston, M. 2010, "Adaptive capacity deficits and adaptive capacity of economic systems in climate change vulnerability assessment", *Forest Policy and Economics,* vol. In Press, Corrected Proof.

Woods, A.J., Heppner, D., Kope, H.H., Burleigh, J. & Maclauchlan, L. 2010, "Forest health and climate change: A British Columbia perspective", *Forestry Chronicle,* vol. 86, no. 4, pp. 412-422.

Yohe, G. & Tol, R.S.J. 2002, "Indicators for social and economic coping capacity - moving toward a working definition of adaptive capacity", *Global Environmental Change-Human and Policy Dimensions,* vol. 12, no. 1, pp. 25-40.

Appendix A: Questionnaire

Hello, my name is Ella, I'm a graduate student in the forestry department at UBC and I'm doing a study with the BC Community Forestry Association about community forests and climate change. As part of the study, I'm carrying out a questionnaire, the questionnaire asks about your organization and how you're thinking about forest management and climate change in order to try to create a picture of climate change adaptation in community forests in BC. The questionnaire takes about **30 minutes**, and needs to be answered by someone who has a good knowledge of your forest management, would this be something you could do? I could run through the questionnaire now or call back whenever you choose.

- **If NO** If **not an appropriate person**, ask when an appropriate person may be available. If the respondent requests a call back. **Make a note on schedule.**

- If **YES Read Consent script below**

Your responses will be kept confidential, securely stored and will only be available to those directly involved in this study. You can refuse to answer any questions or withdraw at any time. At the end of the study the overall findings will be given to the BC Community Forestry Association to feedback to their membership in April 2012. There are no right or wrong answers to any of the questions and the survey is not a test.

Can you confirm that you understand this, and that the results of the questionnaire can be used in this research project?

Yes □ (if yes, ask for name and confirm contact details to send a copy of consent script to respondent.)
No □ **(If no, Terminate questionnaire)**

Name:
Position:
How long have you been practicing in your field?
Name of organization:
Address:
Telephone number:
Email address:

Would you prefer to receive a copy of this information and your questionnaire by mail or email? Email □ Mail □

If you have any future questions about the research you can contact Ella Furness at [redacted] at the Faculty of Forestry, UBC. If you have any concerns about your treatment or rights as a research subject, you may contact the Research Subject Information Line in the UBC Office of Research Services at 604-822-8598.

Ensure that the front sheet is detached from the questionnaire on completion and filed separately.

Social Capital

1.1 How many people do you have on your board?

1.2 How many people are on your advisory committee, if you have one?

1.3 How many permanent members of staff do you have?

1.4 How many formal members or shareholders do you have?

1.5 Approximately how many people participate in consultation annually?

1.6 Approximately how many people participate in social events annually?

2. I'm going to read you a list of statements, please can you tell me if you...
1. = strongly disagree; 2. = disagree; 3. = neither agree nor disagree; 4. = agree; 5. = strongly agree

		1	2	3	4	5
Natural capital	2.1 We have a diverse range of timber species available to us which could give us different harvesting options in changing circumstances.					
	2.2 If we could no longer harvest timber, we could find other ways to derive an income from our tenure.					
	2.3 Our community forest provides important ecosystem services to the community like fresh water, erosion control and wildlife habitat.					
	2.4 Our community forest has important non timber amenities, such as providing fishing, hunting, gathering of plants, and recreation opportunities.					

		1	2	3	4	5
Human Capital	3.1 Our CFO has access to all of the skilled people that we need.					
	3.2 Our CFO can always find someone to help out with knowledge and information if we need it.					
	3.3 We have experienced people to draw upon to help develop our organization.					
	3.4 If we need access to training or education to achieve our goals we can usually find it.					

		1	2	3	4	5
Economic	4.1 We usually have enough financial surplus to invest money into developing our CFO.					
	4.2 All of our staff time is spent trying to cope with day to day operations, we don't have the money to pay people to make future plans.					
	4.3 We could find other sources of financial capital to run our CFO if we really needed them. (E.g. grants & loans.)					
	4.4 We have diverse sources of income, meaning that if one dries up we can develop the others to make up any shortfall.					

		1	2	3	4	5
Physical	5.1 We are satisfied with our access to equipment to carry out forestry operations.					
	5.2 If we had access to all the equipment necessary there is no reason why we couldn't carry out all our forest operations ourselves.					
	5.3 The geographical location of our community forest means we can't do some things we would otherwise like to.					
	5.4 Our lack of access to equipment prevents us from pursuing future plans which we would otherwise carry out.					

		1	2	3	4	5
Social Capital	6.1 Our board membership is representative of our wider community.					
	6.2 The feeling within our organization is that the wider community agrees with our aims as a community forest, and is supportive of what we do.					
	6.3 There is a high level of trust in one another within our wider community that enables people to work together.					
	6.4 As an organization we spend a significant amount of time encouraging community involvement and consultation in our work.					

In this next question I'm going to ask you to give me an idea of which is most important to your organization: environmental stewardship, community representation, economic return or First Nations traditional cultural values. In the same way I will read you four statements and ask you to tell me to what extent you agree or disagree with them.

		1	2	3	4	5
Normative values ('moral commitment on an organizational level')	7.1 Within our organization we care primarily about environmental stewardship.					
	7.2 Within our organization we care primarily about faithfully representing the community.					
	7.3 Within our organization we care primarily about making an economic return.					
	7.4 Within our organization we care primarily about maintaining First Nations traditional cultural values.					

		1	2	3	4	5
Schwartz's value systems Organizational enhancement v transcendence	8.1 We concentrate our efforts on improving our organization and sometimes the wider community just have to be secondary to this.					
	8.2 We prioritise what we think is best for our organization and, as sometimes happens in business, the environment has to be secondary to this.					
	8.3 We do consult with the community but ultimately, as the organization's decision makers, we are the experts and lead the way.					
	8.4 People in our community are essentially good.					

			1	2	3	4	5
schwartz's value systems (opportunity v security)	9.1	We are the same as any other conventional forestry business.					
	9.2	We are original as an organization, the way we have done things has been innovative and different.					
	9.3	We concentrate on ensuring the security of our CFO, we don't take risks.					
	9.4	We are progressive and interested in new ways of working, we're happy to explore novel ways of achieving our aims.					

			1	2	3	4	5
Attitudes about climate change	10.1	Within our organization we are concerned about global climate change in general.					
	10.2	Within our organization we are concerned climate change will have an impact on our ability to achieve our goals as an organization.					
	10.3	Within our organization we have an understanding of the likely impacts of climate change on our community forest.					
	10.4	Within our organization we have an understanding of how we could reduce the risk of the effects of climate change.					

			1	2	3	4	5
Observations and expectations of climate change impacts	11.1	Within our organization we have observed or expect to observe more extreme events like windstorms, floods, droughts and widlfires.					
	11.2	Within our organization we have observed or expect to observe increased incidence of pathogens in the form of insect attack, forest diseases and non native invasive species.					
	11.3	Within our organization we have observed or expect to observe warmer winters, increased landslides and slope instability and a reduction in the size of snow packs.					
	11.4	Within our organization we have observed or expect to observe changes in the species and structure of our forest.					

Adaptive capacity to climate change

			1	2	3	4	5
Adaptive capacity	12.1	As an organization we have begun to research adaptations we may be able to make to minimize the some of the likely impacts of climate change on our CFO.					
	12.2	As an organization we have begun to put plans into place for what we might be able to do to minimize the impacts of climate change on our CFO.					
	12.3	As an organization we have already begun to make adaptations to our work to minimize the likely future impacts of climate change on our CFO.					
	12.4	As an organization we have yet to do anything to minimize the impacts of climate change.					

13 Is there anything else you would like to say about how climate change is affecting your CFO or what you feel are blocks to you adapting your practices to deal with it?

Thank you very much for your contribution to this research

Appendix B: Community forests and their locations in BC

Only Probationary and Full Community Forest Agreement (P/CFA)	Both P/CFA holders or other agreement holders and BCCFA Members	Only BCCFA Members
Chunzoolh Forest Products Ltd. (Prince George)	100 Mile House, District of (100 Mile House)	Babine Lake Community Forest Society (Lake Babine Nation & Municipality of Granisle)
HFN Forestry (Huu-ay-aht)	Alberni Valley Community Forest Corp (Port Alberni)	Boundary Community Forest Association
Klahoose Forestry Limited Partnership (Toba Inlet)	Bamfield Huu-ay-aht Community Forest Society (Bamfield)	Canim Lake First Nation
Lower Similkameen Community Forest Ltd. (Keremeos)	Bella Coola Community Forest Ltd	Cascade Lower Canyon Community Forest Corp
Nuxalk Nation (Bella Coola)	Burns Lake Community Forest	Columbia Headwater
Tanizul Timber (Fort St James)	Cheakamus Com For Ltd Partnership (Whistler)	Fraser Lake, Village Of
Terrace Community Forest Ltd Partnership (Terrace)	Cherry Ridge Management Committee (Cherryville CF)	Little Prarie Community Forest Chetwynd, District Of W Moberly FN, Salteau FN (West Moberly)
Tla'amin Timber (Powell River)	Cheslatta Carrier First Nation Community Forest (Cheslatta Lake)	Lumby Village and Splatsin FN
	Cowichan Lake Community Forest Cooperative	Masset, Village of
	Creston Valley Forest Corporation	Moresby Island Management Committee (Sandspit)
	Dungate Com For Ltd Partnership (Houston)	North Island Community Forest (Triport) (District of Port Hardy, Town of Port McNeill,, Village of Port Alice)
	Dunster Community Forest Society	Northern Rockies Regional Municipality (Fort Nelson)
	Eniyud Community Forest (Tatla Resource Association and Alexis Creek Indian Band) (Tatla Lake)	Squamish, District Of
	Esketemc First Nation: Alkali Resource Management Ltd. (Alkali Lake)	Ucluelet, Disctrict Of and Toquaht FN (Ucluelet)
	Fort St James, District Of	Wells, District of
	Harrop-Procter Community Co-operative	Williams Lake, City of
	Kaslo & District Community Forest Society	

Only Probationary and Full Community Forest Agreement (P/CFA)	Both P/CFA holders or other agreement holders and BCCFA Members	Only BCCFA Members
	Khowutzun Forest Services Limited (Cowichan)	
	Likely Xats'ull Community Forest (Likely)	
	Logan Lake Community Forest Corp (Barriere)	
	Lower North Thompson Community Forest Society	
	Mc Leod Lake-MAckenzie CF Ltd Partnership (Mcakenzie)	
	McBride Community Forest Corp	
	Mission, District of (Tree Farm Licence holder)	
	Nakusp and Area Community Forest	
	Nupqu Development Corporation (Ktunaxa Kinbasket)	
	Powell River Community Forest Ltd.	
	Prince George Community Forest, City of	
	Revelstoke Community Forest Corporation (Tree Farm Licence holder)	
	Slocan Integral Forestry Co-operative (Slocan Valley CF Inititative) SIFCO (Slocan)	
	Sunshine Coast Community Forest (Sechelt, District of)	
	Tumbler Ridge, District Of	
	Valemount Community Forest Company Ltd.	
	Vermillion Forks Princeton and District Community Forest Corporation (Princeton)	
	Wells Gray Community Forest Corporation (Clearwater)	
	Westbank First Nation (Heartland Economics LP.) (West Kelowna)	
	Wetzin'kwa Community Forest (formerly known as Bulkley Valley Community Forest Inc) (Smithers)	
	Xaxli'p Community Forest Corporation (Lilooet)	
Total: 8	**Total: 38**	**Total: 16**

.

Appendix C: Governance models used by community forests in BC

Corporation

It is possible to incorporate under provincial legislation, or federal legislation, under the Canada Business Corporations Act or the Canada Not-For-Profit Corporations Act. Organisations incorporated at the Federal level are required to file by-laws with Industry Canada and such bylaws are subject to Ministry approval. Incorporation limits the liability of a corporation's shareholders. This means that, as a general rule, the shareholders of a corporation are not responsible for its debts.

Co-operative

Co-operatives are collectively owned and democratically controlled by their members; the co-operative is a legally incorporated business that can enter into contracts under its corporate name. Liability for individual co-operative members is limited to the extent of the value of shares held by the member. Each member usually pays a share of $1 or similar nominal cost, and each member has a vote.. Co-operatives are characterized by their "service orientation, concern for community, and commitment to values such as self-help, self-responsibility, equity, and democracy." (Gunter 2004).

Local Government or Municipality

Some Municipalities hold tenures directly without establishing a separate entity to administer the CFO. Local government is the smallest administrative unit to have a democratically elected leadership. Commonly referred to as a city, town, or village, or as a small grouping of them, it is an administrative entity composed of a clearly defined territory and its population. In British Columbia, local government also refers to a municipality or regional district. The elected structure of local government typically includes a mayor and council (Tyler et al. 2007).

Society

A society is a not-for-profit organization that holds all of the powers of a legal individual, but that remains separate and distinct from its members. Societies are incorporated according to the provisions of the Societies Act. Each society requires a constitution and by-laws, a list of directors, and notice of address.

A Partnership

Partnerships may encompass a broad array of arrangements, from informal associations or networks to formal legal agreements. The partnership can be drawn up under the BC Partnership Act and can specify the agreement that the two (or more) parties negotiate. Under BC Law a partnership is a "relation which subsists between persons carrying on business in common with a view of profit" (Partnership Act 1996).