Adapting conservation policy to the impacts of climate change: an integrated examination of ecological and social dimensions of change

by

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ABSTRACT

Recognition of the impacts of climate change has prompted re-assessment of existing conservation policy frameworks (here thought of as collections of means and objectives that reflect values, beliefs and expectations of control). The concern is that changing temperature and precipitation regimes will alter an extensive range of biological processes and patterns. These system dynamics are at odds with long-established conservation policies that are predicated on assumptions of stable biodiversity targets (e.g. species or ecosystems), and that seek to protect these targets by means of static protected areas. Efforts to address this challenge have so far originated from the fields of ecology and biogeography and include the core adaptive strategies of expanding protected areas and implementing migration corridors. The purpose of this research was to reach beyond these disciplines to integrate across a set of ecological *and* social insights to develop a more holistic understanding of challenge of adapting conservation policy to the impacts of climate change. Two overarching questions guided this research: 1) do the impacts of climate change necessitate a different set of means, objectives and expectations than are indicated by current conservation adaptation proposals (i.e. proposals that include new protected areas and migration corridors as the primary adaptive strategy); and 2) if there is evidence that this is so, what are the barriers to implementing a policy framework with new means, objectives and expectations?

Using a combination of case study, expert elicitation, and ethnographic methods, the results of this thesis provide empirical evidence that the impacts of climate change are seen by many experts to implicate the need for changes in conservation policy that include consideration of interventions such facilitating species distributions through disturbance, assisted migration, revised objectives, and triage-like priority setting. Yet simultaneously there is evidence of a public precautionary ambivalence towards these alternative elements of a potentially new policy framework, combined with durable more preservationist (less engineering) conservation values. It is contended that these value-based commitments have in part, shaped the adaptive response so far. Combined, these results highlight that policy adaptation within "science-based" conservation is a tangle of social dynamics, including durable preservationist-type values and related resistance to anticipated difficult trade-offs implicit in a more transformative decision framework.

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GLOSSARY

This thesis draws insights from across disciplines. In effort to towards clarity in terminology and usage, a short glossary is provided below.

Adaptation: The process of change amongst individuals, groups and governments in response to evolving socio-cultural and biophysical forces. The focus in this thesis is on *policy* adaptation to the impacts of climate change. Only when specifically indicated does adaptation refer to the process of change in non-human species (for example, micro-evolutionary, adaptive, responses to biophysical change).

Assisted Migration: Deliberately moving species to sites where they do not currently occur or have not been known to occur in recent history in response to the impacts of climate change.

Assisted Colonization: See also *Assisted Migration*.

Climate Change: 'A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods' (UNFCCC, Article 1).

Conservation: The meaning of this term has changed over time, but it currently represents a collection of means (management strategies) designed to achieve the current articulated fundamental objective of protecting and perpetuating the Earth's biological diversity across scales.

Conservation Adaptation: Used in the ecology and biogeography literature to describe a set of established conservation strategies designed to respond to the impacts of climate change. Key proposed strategies include: the expansion of new protected areas, implementing migration corridors and making managed (non-protected areas) landscapes more hospitable for biodiversity.

Conservation Prioritization: Priority-setting schemes used to identify conservation priorities amidst social and spatial constraints (e.g. the siting of protected areas or the listing of endangered species). Schemes vary with scale and criteria. At the species level, prioritization can be considered on the basis of "keystone" or "umbrella" species, or phylogenic diversity. At the landscape scale, common criteria include so-called "hotspots" or "coldspots". Current prioritization schemes are not the same as *Conservation Triage* because they do not include an explicit framework for loss, either in the absence of action, or given potential repercussions of interventions.

Conservation Triage: Nascent ideas for a decision framework that would include the *explicit* decision to allocate resources away from species or ecosystems assessed to be non-viable (by some criteria) given the impacts of climate change interacting with other drivers, in favor of other species or ecosystems assessed as being more viable. Thus triage for species or ecosystems involves assessment of viability at a given place, point in time, and with some degree and type of *active* intervention. It may further include explicitly acknowledging the potential loss of one (or more) species as a consequence of active interventions (e.g. introducing species into new locales).

Decision Constitution: *See Policy Framework*.

Expert: An individual with specialized knowledge (in this case on topics relating to the impacts of climate change on biodiversity pattern and process), with demonstrated experience and involvement in climate-change related projects and/or publications.

Human-ecological (H-E) systems: See *Social-ecological systems*.

Ideas: collections of assumptions, evidence, experience, morality and held values that form conceptions of how the world works, or ought to work. Different terms are used in other literatures to describe a similar concept. In the risk and decision-sciences, "ideas" as seen here are termed "mental models". In political ecology, ecological anthropology and cultural geography, a more power-infused equivalent is "discourses".

Irreducible Uncertainties: Uncertainties that are perpetuated by the properties and dynamics of linked social-ecological systems.

Means objective: See *Policy Means*.

Policy Adaptation: The process of change in policy frameworks in response to new information, impacts, changing values and expectations of control.

Policy Framework: longstanding collections of objectives and means that reflect values, beliefs, knowledge and expectations of control at a given point in time. Policy frameworks (and the means and objectives embedded therein) are prone to change over longer time periods as forces from different domains (e.g. technological, biophysical, social, political) change through time.

Policy Means: The specific methods or management strategies designed to achieve a specific objective (desired endpoint). Policy means answer the question of "how" to achieve a specific end.

Policy Objective: A statement of a fundamental desired end-point. Objectives are the "things that matter" to the actors in a given decision context. Policy objectives answer the question of "why" achieving a given endpoint is important.

Social-ecological systems (SES): Complex systems of coupled social and ecological dimensions interacting across scales.

Trade-offs: Decisions about what to do, where, and over what time period, as exercised within a given policy framework/constitution. Trade-offs imply that achieving one objective comes at the cost of another objective. These decisions arise from constraints on resources including space, and cost, interacting with the beliefs and expectations that support and are reinforced by a given framework/constitution.

Uncertainty: A statement of limited knowledge. For any decision context, there are numerous sources of uncertainty that include: *parametric uncertainties* (the result of measurement error,

natural variation, and subjective judgment of parameter values); *model uncertainty* (the result of not identifying or misidentifying key interactions and mechanisms between variables within a system), *linguistic uncertainty* (the result of vague language and imprecise terminology – vague terms are by definition difficult to quantify and therefore yield uncertainties); and *value uncertainties* (the result of evolving values over time).

Values: Held beliefs and preferences about what is desirable and important.

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For Brodie and his grandkids Madelyn and Jackson

CO-AUTHORSHIP STATEMENT

In all five of the following research papers my contributions include a) identification and design of research, b) performance of research activities, c) data analysis and d) manuscript preparation.

Paper I (Chapter 2): *Climate change and biodiversity conservation: impacts, adaptation strategies and future research directions*

In this chapter I conducted the literature review, identified the outline and wrote the manuscript. Kai Chan provided comments for revisions and contributed to the manuscript preparation.

Paper II (Chapter 3): *Propositions for conservation in an era of change*

In this chapter, I conducted the literature review, conceived of the structure and wrote the manuscript. Hadi Dowlatabadi was central to the conceptual development and provided comments for revisions. Kai Chan and Terre Satterfield provided comments for revision.

Paper III (Chapter 4): *History of conservation policy in BC*

In this chapter, I identified, designed and performed the research and wrote the manuscript. Hadi Dowlatabadi and Terre Satterfield contributed conceptual insights into the early development of the structure of this paper and provided comments for revisions.

Paper IV (Chapter 5): *Expert views on conservation policy*

In this chapter, I designed and performed the research and wrote the manuscript. Hadi Dowlatabadi, Terre Satterfield and Tim McDaniels contributed insights into the survey design and provided comments for revision.

Paper V (Chapter 6): *Conservation adaptation at the WCC*

In this chapter, I designed and performed the research and wrote the manuscript. Terre Satterfield was instrumental in facilitating my invitation to participate in this larger event ethnography study. Terre Satterfield and Hadi Dowlatabadi provided comments for revisions.

1. INTRODUCTION

1.1. PROBLEM STATEMENT

The impacts of climate change have prompted re-assessment of existing conservation policy frameworks (here thought of as collections of means and objectives and the attitudes and social norms embedded therein). The concern is that changing temperature and precipitation regimes (IPCC 2007) will alter an extensive range of biological processes and patterns (Thomas et al. 2004). Bearing out these projections is a growing body of empirical evidence that documents a range of climate-attributed impacts including altered species distributions (Rinnan et al. 2007; Parmesan 2006; Lenoir et al. 2008). These system dynamics are at odds with the well-established biodiversity conservation framework that is predicated on assumptions of stable biodiversity targets (e.g. species or ecosystems), and that seeks to protect these targets from proximate drivers (forces acting on biodiversity at local or regional scales) by means of static protected areas. However, the consequence of distal drivers (forces operating at broader global scales) interacting with proximate drivers, is that some conservation targets will no longer be viable in reserve areas created for their protection.

The current response to this challenge originates from the disciplinary domains of ecology and biogeography within the field of conservation biology more broadly. Scholars working from these perspectives commonly advocate the expansion of protected areas including connectivity corridors as the central adaptation response (Hannah et al. 2002a; Hannah 2008), as well as managing matrix areas for biodiversity values (Noss 2001; Hannah et al. 2002b). Other less established, more controversial strategies include, spatially dynamic protected areas (Bengtsson et al. 2003; Rayfield et al. 2007) and assisted migration of imperiled species (McLachlan et al. 2007; Hoegh-Guldberg et al. 2008). Pioneering scholars working on this challenge have stated:

> Collaboration across disciplines is necessary to plan conservation responses to climate change adequately. Biogeography and ecology provide insights into the effects of climate change on biodiversity that have note yet been fully integrated into conservation biology and applied conservation management (Hannah et al. 2002a).

However, formulating an adaptive response to the impacts of climate change requires integration of insights in addition to the realms of ecology and biogeography. The purpose of this research was to reach beyond these disciplines to integrate across a set of ecological *and* social insights in effort to develop a more holistic understanding of the challenge of adapting conservation policy to the impacts of climate change. In doing so, two central questions arise and guide this research: 1) do the impacts of climate change necessitate a different set of means, objectives and expectations than indicated by current conservation adaptation proposals designed to respond to the impacts of climate change (i.e. proposals that include new protected areas and migration corridors as the primary adaptive strategy); and 2) if there is evidence that this is so, what are the barriers to implementing a conservation policy framework with new means, objectives and expectations?

This thesis does not consider all possible responses to the challenge of climate change for conservation, but rather limits examination to potential *adaptive*, *in situ* ("on site", within natural habitats) conservation strategies only. Thus related *mitigation* strategies such as Reducing Emissions from Deforestation and Degradation (REDD), or *ex situ* ("off-site") strategies such as gene banking or captive breeding are not considered here.

1.2. RESEARCH STRATEGY

To structure this integration, and to maintain a focus on policy implications, insights were drawn from integrated assessment (IA). Across its various formations, IA approaches share a set of core "elements" (Rotmans and van Asselt 2000), which are used here as a general guide to structuring this work. These elements include: 1) a focus on interdisciplinarity (placing the problem in broader context - both over time and beyond disciplinary borders), 2) identification of uncertainties (which aids in identifying what we can, and can't know within a decision context, which together 3) can provide integrated insights for decision-making. In this thesis, an IA approach is used to examine the broader social context within which conservation policy is currently being negotiated across a range of institutions (IA is not applied to a specific decision process rooted in a specific agency or institution for a given jurisdictionally defined problem here in this thesis).

1.3. CLIMATE CHANGE AND CONSERVATION POLICY ADAPTATION: SELECTED CONCEPTS

This dissertation is located at the nexus of three broad literatures whose concepts are mutually coherent: complex adapting human-ecological (H-E) systems; decision-making under uncertainty; and human dimensions of protected areas (Figure 1.1). Key concepts from these domains as they apply to the challenge of understanding conservation *policy* adaptation are briefly outlined below. In the chapters that follow, these concepts sometimes a) inform the analysis b) are applied in a new domain or c) are extended/modified by the empirical data.

1.3.1. History, policy frameworks and linked human-ecological systems

Understanding interactions between humans and the biophysical world requires recognition that human and ecological dimensions are co-produced, perpetually dynamic entities. This perspective has been articulated by scholars working from various perspectives of integrated change dynamics in complex adaptive systems, and has yielded the synonymous terms linked human-ecological systems (H-E) (Reynolds et al. 2007), coupled social-ecological systems (SES) (Walker et al. 2004), and socioecological systems (Crumley 1994). Common features include that changes in human and ecological dimensions of coupled systems are governed and mediated by interactions between slow (e.g. soil development, loss of soil fertility; socio-cultural change) and fast variables (e.g. flood, forest fires, market collapse), from biophysical (e.g. climate, vegetation, topography) and social domains (e.g. cultural norms, interests, institutions, geopolitical events) (Berkes et al. 2003; Walker 2006; Folke 2006) across scales. Combined, these attributes lead to non-linear, episodic, perpetually co-adapting systems with no single equilibrium (Crumley 1994; Gunderson and Holling 2002; Walker et. al. 2004).

While humans and the biophysical environment have always existed as co-produced dimensions (Crumley 1994; Balée 1998), the complexity, scale and rate of change of the interrelationships has increased in recent centuries and decades (Turner et al. 1990; Goudie 2000). Land use change, genetically modified organisms, global (and immediate) communication networks, geo-political events, transmission of disease, distal accumulation of toxic compounds, the consumption patterns and impacts of 6.6 billion people, and climate change provide a few

examples. This has prompted focused attention within the relatively new field of climate change adaptation on the ways in which human societies respond to new conditions (e.g. Adger 2005). [1]

Policy frameworks for governing landscapes serve to mediate human interactions with ecological elements of complex adaptive systems. These frameworks (termed *constitutions* by economists) prevail for lengthy periods of time and reflect values, knowledge and expectations of control and outcome at the time of their design. Within these frameworks, decisions are made that reflect the divergent interests and values of the actors who are involved. Over time, changing forces from different domains (e.g. technological, biophysical, social) can trigger a new decision framework (with new means, objectives, expectations and norms) (Buchanan 1987). With this change comes a new set of rules where previously unacceptable values, actors, strategies or alternatives become newly acceptable. The central point is that policy frameworks and their attendant objectives and means that were suitable for one set of human and ecological conditions at one point in time can become ineffective, untenable, unethical or undesirable in the longer view (Buchanan 1987).

1.3.2. Irreducible uncertainty and decision-making

Because of the co-adapting properties of H-E systems, many uncertainties relating to projecting species and ecosystem responses to the impacts of climate change are perpetual and irreducible. Adopting the categories of Morgan and Henrion (1990) we can identify a range of parametric, model and value uncertainties that combine to limit what we can know of future patterns of biodiversity in an era of climate change. These uncertainties include biotic interactions such as competition, facilitation, predation and mutualisms (Pearson and Dawson 2003; Guisan and Thuiller 2005); dispersal dynamics (Pearson 2006); colonization dynamics (Carmel and Flather 2006; Ibanez et al. 2006) and "rapid evolutionary change" (Gienapp et al. 2008). Model uncertainties relating to so-called 'unknown unknowns' of key processes that are not yet recognized, understood or incorporated into model structure, or as parameters, represent an additional source of uncertainty. Moreover, there are uncertainties relating to the global climate scenario models (e.g. future patterns of land use and how the climate will actually change) that influence the outputs of models that seek to project species responses to climate change. Lastly, there are critical socio-political uncertainties (in values, impacts, responses and feedbacks).

[1] Policy adaptation in this dissertation is viewed more broadly in the context of adaptive change through time.

These uncertainties are irreducible because they emerge from and perpetuate the dynamics (e.g. thresholds and feedbacks) of linked human-ecological systems over time and across scales. Over time, further research will yield a more nuanced understanding of these dynamics and resolve some current modeling challenges. However, new research and insights may raise more questions, and even increase uncertainty (cf Yohe 2006) within timescales relevant for decision-making. Therefore, while efforts to reduce ecological uncertainties will represent a key contribution to the biological literature, we simultaneously need to develop conservation approaches that are robust to irreducible uncertainties.

In the mid 1980's, the concept of adaptive management was conceived in recognition of linked H-E dynamics and perpetual uncertainties, and as a process to make resource management decisions under uncertainty (Walters 1986). Adaptive management is "a structured process of learning by doing", where policies are viewed as questions and management actions are viewed as experiments (Walters 1986). Over the past two decades, the concept of adaptive management has inspired a range of structured adaptive decision-analytic processes more broadly (e.g. Failing et al. 2004; McDaniels and Gregory 2004). Adaptive decision frameworks share in common a set of iterative steps that in principle allow for learning, reevaluation and revision of objectives and means as indicated by new evidence over time. The steps typically include: problem definition; information on impacts and consequences; identification and evaluation of alternatives; policy implementation; evaluate effectiveness; reassess policies through time (changing means and objectives where indicated).

However as many scholars have noted, the process of *implementing* adaptive decisions (actually realizing an adaptive response to some assessment – however complete and insightful the assessment may be) is often hampered by institutional capacity, agency constraints, interests and objectives of key actors, histories of use, trust, perception and political dimensions (e.g. Gunderson 1999; Gregory et al. 2006). These observations highlight the perpetual challenge of completing the adaptive decision-making feedback loop, even when evidence indicates that a given decision framework including objectives are in need of revision.

1.3.3. Human dimensions of conservation: ideas, values and practice

The third literature drawn from in this thesis comes under the broad category of the human dimensions of conservation. Two related foci are distinguished. The first topic concerns the role of ideas and beliefs in determining the features of policy and practice (and so links to the discussion above on values). Specifically, environmental historians and anthropologists have shown that ideas, values (or the more power-infused term discourses) about and of nature change over time and have material consequences (Cronon 1996; Slater 1996; Slater 2000). The material consequences arise because these ideas and values render specific alternatives visible, possible and just, while other alternatives remain invisible (Sundberg 1998; Brosius 1999; Neumann 2004). Brosius (1999) states: "discourse matters" because they "define various forms of agency, administer certain silences, and prescribe various forms of intervention" (Brosuis 1999). [2]

Directly related is the second topic which concerns the social impacts of protected areas. Scholars in the social sciences and humanities have shown that protected areas implementation can incur a range of impacts on social practices (West et al. 2006) including the alteration of livelihoods through changes in access, the exacerbation of prior social conflicts, or the enhancement of vulnerability within particular populations (Harper 2002; Neumann 2004; Timko and Satterfield 2008). As a consequence, key areas of inquiry and critique have focused on addressing land entitlement and rights (e.g. prior consent and compensation) (Brockington et al. 2006), protected areas access, governance process (Wilshusen et al. 2003), and governance structure (e.g. co-management and adaptive co-management) (e.g. Brechin et al. 2003; Brosius, 2004; Olsson et al. 2004).

Yet few of these social concerns or critical points have been examined in light of, or in response to climate change initiatives to adapt to the impacts of climate change.[3] They are however particularly salient to the land-use management and the protected area adaptation proposals listed above because, among other means, conservationists have argued in the context of climate

[2] Discourses are not static – as Brosius notes, "environmental debates are not merely shifting zones of contestation but zones of constantly shifting positionality" (1999)

[3] The topic/challenge covered in this dissertation sits within a dynamic field of research that is evolving now daily. On February 3rd, 2009 the MacArthur Foundation, WWF and IUCN announced an initiative for integrating understanding of biodiversity, adaptation and livelihoods – the Ecosystems, Livelihoods and Adaptation Network (ELAN). The problem framing and research presented here pre-dates these more recent developments, which I will follow for future research.

change that protected areas boundaries "should be expanded regardless of political boundaries" (Li et al. 2006). This proposition is both socially and politically naïve and could result in considerable social unrest and biological consequence (Chan and Satterfield 2008). Given the pressing, near and far term consequences of climate change, these social concerns must be integrated into future policies. [4]

1.4. RESEARCH PURPOSE AND CONTRIBUTION

The overall purpose of this research is to advance understanding of the linked ecological and human dimensions of adapting conservation policy to the impacts of climate change by *integrating* these insights under a common conceptual (IA-inspired) framework. The sub-objectives of this research which are addressed in individual chapters are to:

- Review the impacts of climate change on biodiversity pattern and process, existing strategies and identify key topics to be resolved (CHAPTER 2).

- Synthesize, integrate and extend insights from multiple domains (outlined above) to develop an interdisciplinary conceptual framework for understanding the challenge of adapting conservation policy to the impacts of climate change (CHAPTER 3).

- Examine the history of change in conservation policy in a specific case to provide insight into potential future dynamics of policy change under uncertainty (CHAPTER 4).

- Elicit the views of experts on the necessary attributes (means, objectives and expectations) for an adaptive conservation policy framework (CHAPTER 5).

- Examine the nature and evolution of the debates on adapting conservation policy to the impacts of climate change in a specific policy-setting context (CHAPTER 6).

[4] As a consequence of how this dissertation work developed, this thesis addresses the first issue of human dimensions of conservation but not the second (e.g. livelihoods, rights, governance) in any substantive way. See the concluding chapter for discussion on future research.

The methodological, theoretical and topical contributions that result from this effort are indicated in the dissertation outline below.

1.5. STRUCTURE AND OVERVIEW OF DISSERTATION

This is an interdisciplinary, manuscript-based, mixed-methods thesis. The dissertation is comprised of this introductory chapter, 5 core (research) chapters, and a synthetic concluding chapter (Figure 1.2). The 5 research papers (Chapters 2-6) are written and presented as stand-alone manuscripts that are in various stages of review, or have already been published (indicated at the outset of each chapter). As per a thesis of this kind, the specific concepts and methods relevant to addressing the specific objectives for each manuscript are presented within the individual chapters (unlike a monograph-based thesis). Moreover, each chapter has a slightly different voice as suits the target journal (also indicated at the outset of each chapter).

Chapter 1 provides the context for this research, situates the work within the literature, outlines the objectives and the main findings of the individual research chapters, and briefly summarizes the combined results of the dissertation as a whole.

Chapter 2 presents a succinct overview of climate impacts and implications for policy. It is written as a brief report for a biology audience.

Chapter 3 synthesizes a set of established insights from a range of disciplines and applies them to the problem domain of conservation adaptation. This effort adopts the structure and approach of integrated frameworks of change in other domains (e.g. Reynolds et al. 2007). Key insights from resilience theory, environmental history and ecological anthropology are reviewed to synthesize an integrated set of principles relevant to the challenge of adapting conservation policy to the impacts of climate change. The principles are then used as a basis to examine current and potential alternative conservation objectives and means, and to offer a list of preliminary propositions. The propositions engage with topics including re-calibrating conservation objectives, conservation triage, and new conservation means such as facilitating ecological transitions. The propositions are speculative, and outline potential avenues for further empirical research and refinement. In the spirit of adaptation, their revision is expected. This

chapter represents a methodological contribution by way of bringing together previous disparate literatures to re-frame the challenge of conservation adaptation.

Chapter 4 presents the case study of the history of conservation and forest policy change in British Columbia since 1850. The objective was to examine the historical dynamics of change in this system so as to gain insight into potential future pathways for change such as outlined in Chapter 3. The following question guided this analysis: How has a set of system attributes changed over time, and what drivers contributed to change when it occurred? The relationship between scientific uncertainties and policy change in this system over time was of particular interest. The foundations of this analysis include integrative perspectives on change in linked human-ecological systems (Gunderson et al. 1995; Gunderson and Holling 2002; Walker 2004) with additional insight provided by the concept of punctuated equilibrium as applied to policy adaptation and change.

Results showed that decision-relevant uncertainties prevailed as a constant backdrop during all phases of change in the system. In contrast, the objectives and values of key actors (in this case the forest industry and the Province) were influential both in triggering change in the face of substantive uncertainties (e.g. implementing sustained yield in the face of scarce inventory data), and impeding change in the face of substantive evidence (e.g. delayed artificial regeneration despite a half century of evidence indicating failed natural regeneration). This paper contributes to the scholarly literature on dynamics of policy change in linked social-ecological systems with a specific contribution on the roles and non-roles of uncertainties in policy adaptation and change.

Chapter 5 presents the empirical results of 21 in-depth interviews with biodiversity and climate change adaptation experts on the implications of climate change for conservation policy. The purpose was to synthesize the diversity of current thinking on this topic. The findings reveal active engagement among experts with some more controversial policy means and objectives (including active interventions, disturbance and facilitation of species range shifts, revised objectives and evolving standards of conservation success, and conservation triage), despite a comparative silence on these topics in the published literature.

These findings indicate that many experts are considering the possibility for new means and revised objectives and expectations for adaptive conservation frameworks beyond that which are represented by conventional proposals for expanding protected areas. At the same time, this study reveals resistance to such change, because the triage-type decisions and interventions that would accompany a new set of means, objectives and expectations pose a fundamental challenge to the current values and objectives of some experts. This elicitation provides new information on the views of experts on addressing the challenge of adapting conservation to the impacts of climate change that has thus far not been expressed in the scholarly literature.

Chapter 6 examines the evolution of discussions concerned with adapting conservation policy to the impacts of climate change as they unfolded at the 4th World Conservation Congress (WCC) of the International Union for Conservation of Nature (IUCN). The interview and ethnographic-based analysis reveals two key findings: 1) during interviews, many experts acknowledged the need for new interventions (new means), and revised objectives in anticipation of changing species processes and distributions, however 2) no equivalent acknowledgement, or consideration was delivered in the public setting of the meeting itself (e.g. in workshops or panel presentations on adaptive conservation), and active avoidance of these apparent realities was observed on the few public occasions that these topics were raised from the audience. Consequently, the conventional set of means (e.g. expand protected areas) and objectives (e.g. maintain *a priori* biodiversity targets) have continued to be upheld, even within so-called adaptive conservation policy proposals.

It is argued that these observations can at least partly be explained by value-based commitments to current conservation frameworks, and more importantly to an understandable resistance to the difficult trade-offs (species for species and perhaps land-base for land-base) implied by new frameworks. This paper contributes to an understanding of the social context within which "science-based" conservation decisions are made. Specifically it shows how the prevailing values of key actors including experts can act as a barrier to substantive policy change even when dimensions of that change are acknowledged to likely be necessary.

Chapter 7 concludes the dissertation with a synthesis of the combined significance of the results of the individual manuscripts. It summarizes the key findings and identifies the contributions to

broader fields as well as policy implications. It further includes discussion of the anticipated and actual outcomes of this research as well as the strengths and weakness of the research. Finally, it outlines a future research agenda that flows from this work.

1.6. CONCLUSION

The purpose of this research was to integrate insights from complex adapting linked human-ecological systems; decision-making under uncertainty; and the human dimensions of conservation to develop a more holistic understanding of the challenge of adapting conservation policy to the impacts of climate change. Two overarching questions guided this research: 1) do the impacts of climate change necessitate a different set of means, objectives and expectations than indicated by current conservation adaptation proposals designed to respond to the impacts of climate change (i.e. proposals that include new protected areas and migration corridors as the primary adaptive strategy); and 2) if there is evidence that this is so, what are the barriers to implementing a policy framework for conservation with new means, objectives, expectations and norms?

Each of the individual research chapters contributes specific pieces of insight into the broad challenge outlined above, and the two questions more specifically. Collectively, the papers in this dissertation underscore that the impacts of climate change do implicate the need for a constitutional change in conservation policy (new means, objectives, expectations and norms) beyond that which is proposed by conventional adaptive proposals (Chapter 3 and 5). Further, this research demonstrates the complex interplay between science, uncertainty and the held values of experts that has so far tended to reinforce the existing decision constitution (Chapter 6). (Figure 1.3).

Four synthetic points are emphasized in this brief concluding synthesis: 1) the feedback loop that would inform and allow for change and policy adaptation is mediated by social dimensions 2) this has led to policies that are adaptive in name, but not substantively different from the means and objectives associated with the conservation framework of the past four decades (i.e. maintaining *a priori* identified species and ecosystems by means of protected areas with minimum preferred intervention) 3) the features of an alternative set of means and objectives

exist in expert conversation, but these have not yet found traction in either scientific or policy realms and 4) innovation and change when it occurs will likely come from outside the current actors.

For the most part, scientists and stakeholders recognize and agree on the potentially transformative impacts of climate change for conservation (Chapter 2,3). And yet after decades of discussion in expert spheres, and a more recent concentrated five - year period of discussion in policy spheres, the leading-edge proposals for conservation adaptation are largely consistent with longstanding conservation means and objectives (maintain *a priori* conservation targets by means of protected areas) (Chapter 6). In other words, the feedback loop that would prompt revision considering an awareness of climate change impacts has not been completed. Why? As shown in Chapter 4, uncertainty has not been a barrier to conservation policy change in past, and most experts agree that it need not be for conservation adaptation now (Chapter 5). In contrast, as shown in Chapters 5 and 6, the values and objectives of key actors, conservation NGOs and in some cases scientists themselves, have mediated the degree of change that has occurred. The results are "adaptive" conservation proposals that employ the same sets of means in the hope of achieving the same objectives as past efforts and thus are adaptive in name only. Combined, these results highlight that policy adaptation within "science-based" conservation, as it is often referred to, is a tangle of social dynamics, including value-based commitments to conventional preservationist ideals of static, pristine nature. This has in part, resulted in resistance to consideration of new means, objectives and expectations, given the anticipated difficult trade-offs that they would impose.

Just as change was triggered from the outside of the system boundaries in the context of BC conservation policy (Chapter 4), it is cautiously speculated that this will be the case for adaptive conservation policy as well. There is little evidence in practice (at this point in time) that the traditional actors, including the big conservation NGOs will easily revise their stated objectives – there may be little incentive for them to do so. At the same time, expert interviews and observed moments of questioning at the World Conservation Congress (Chapters 5 and 6) indicate that perspectives are changing. Additionally, there is evidence of similar discussions emerging from within the grey literature including government reports and assessments (Baron et al. 2008; Dunlop and Brown 2008). For those agencies that are willing and able the research gaps

identified in the expert assessment (Chapter 5) will make a useful contribution to designing future efforts. In other cases, actors will likely continue in their efforts to maintain current frameworks with adaptive-looking proposals that do not pose a challenge the pursuit of their interests and preferences.

The UBC Behavioural Research Ethics Board Certificate of Approval for the research conducted in this thesis is found in Appendix A.

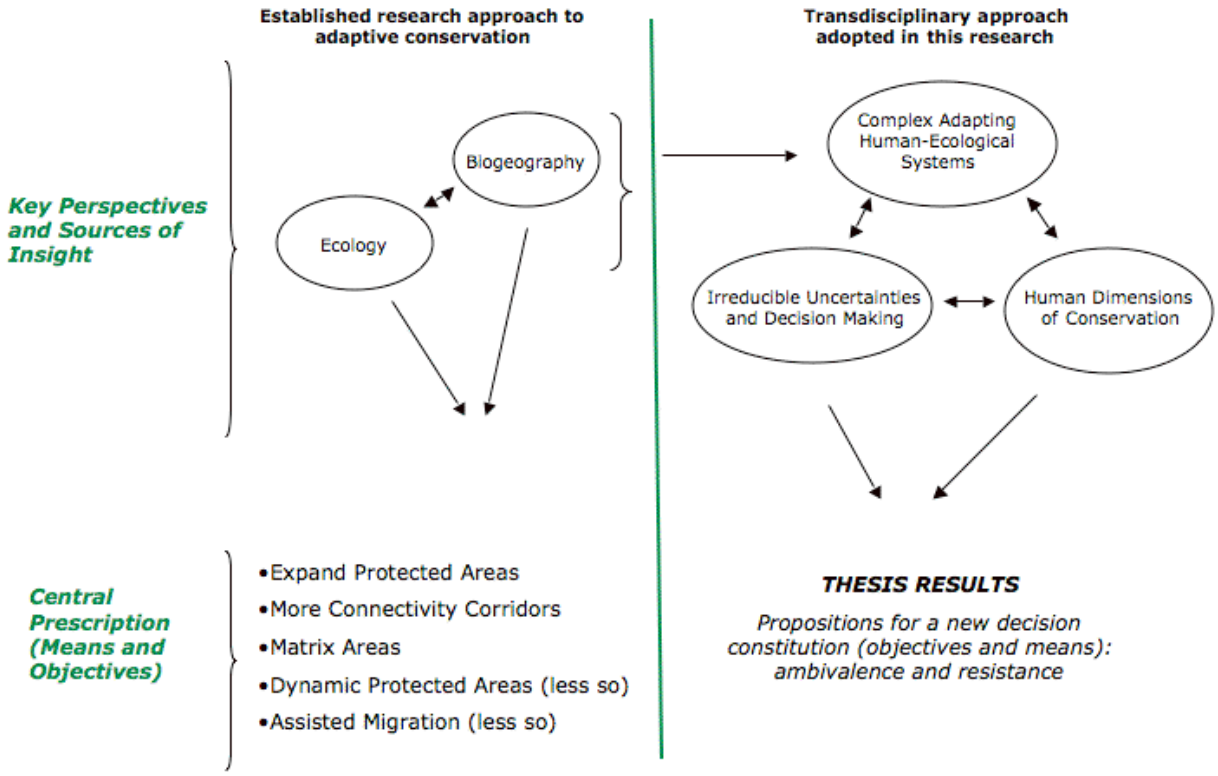

Figure 1.1 Disciplinary and transdisciplinary (this research) approaches to understanding adapting conservation policy to the impacts of climate change.

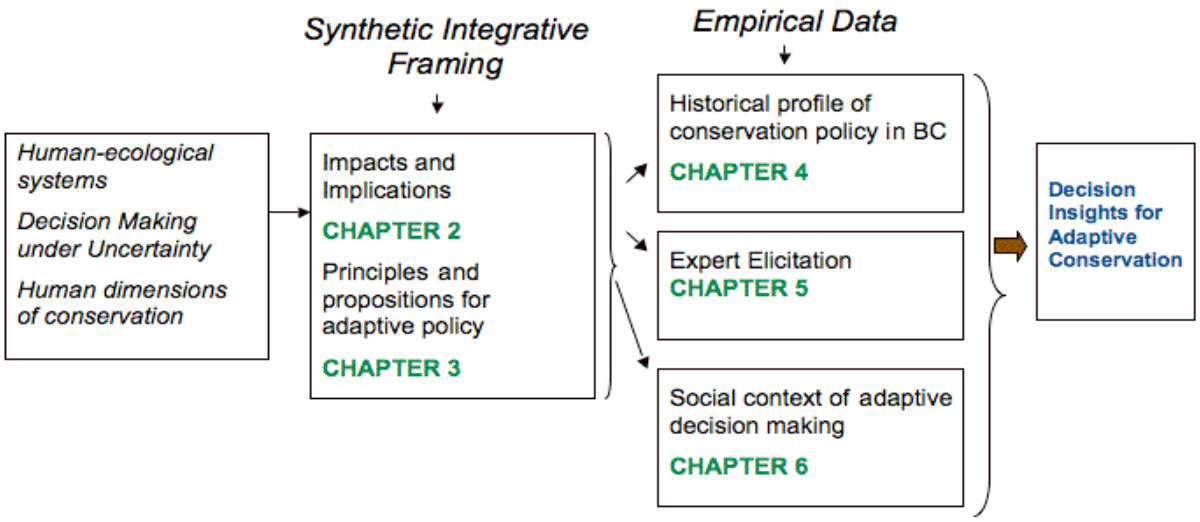

Figure 1.2. Summary of research strategy, and organization of dissertation chapters.

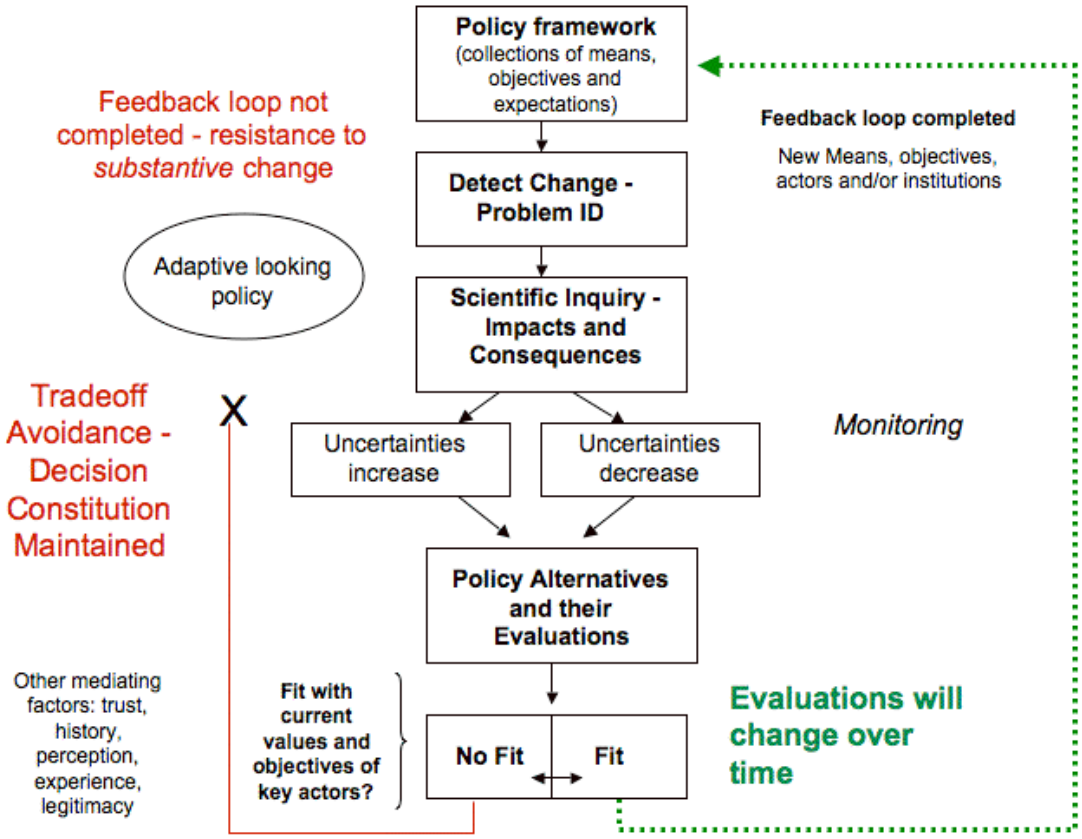

Figure 1.3. Understanding current efforts to adapt conservation policy to the impacts of climate change.

1.7. REFERENCES

Adger, N., 2005. Adapting to climate change: perspectives across scales. Global Environmental Change 15, 75-76.

Balee, W., 1998. Advances in Historical Ecology.

Baron, J.L., Joyce, L.A., Kareiva, P., Keller, B.D., Palmer, M.A.,Peterson, C.H. and Scott, J.M., 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A report by the US Climate Change Science Program and the Subcommittee on Global Change Research. 873.

Bengtsson, J., Angelstam, P., Elmqvist, T., Emanuelsson, U., Folke, C., Ihse, M., Moberg, F.,Nystrom, M., 2003. Reserves, resilience and dynamic landscapes. Ambio 32, 389-396.

Berkes, F., Colding, J. and Folke, C., 2003. Navigating social-ecological systems. 393.

Brechin, S.R., Wilshusen, P.R.,Fortwangler, C.I. and P.C. West, 2003. Contested nature: Promoting international biodiversity with social justice in the twenty-first century.

Brockington, D., Igoe, J. and K. Schmidt-soltau, 2006. Conservation, human rights, and poverty reduction. Conservation biology 20, 250.

Brosius, J.P., 2004. Indigenous peoples and protected areas at the World Parks Congress. Conservation biology 18, 609.

Brosius, J.P., 1999. Analyses and Interventions: Anthropological Engagements with Environmentalism. Curr.Anthropol. 40, 277-309.

Buchanan, J.M., 1987. The relatively absolute absolutes. Draft paper prepared for presentation at SEA meeting

Carmel, Y., Flather, C., H., 2006. Constrained range expansion and climate change assessments. Frontiers in Ecology and the Environment 4, 178-179.

Chan, K.M.A. and T. Satterfield, 2008. Justice, equity and biodiversity. In: S. Levin and Daily, G.C. and Colwell, R.K. (Ed.), The Encyclopedia of Biodiversity. Oxford, Elsevier Ltd.,

Cronon, W., 1996. Uncommon Ground: Rethinking the human place in nature. 561.

Crumley, C.L., 1994. Historical Ecology: Cultural knowledge and changing landscapes. 284.

Dunlop, M. and Brown, P.R., 2008. Implications of climate change for Australia's National Reserve System: A preliminary assessment. Report to the Department of Climate Change,

Failing L., Horn G. and P. Higgins, 2004. Using expert judgement and stakeholder values to evaluate adaptive management options. Ecology and Society 9, 13.

Folke, C., 2006. Resilience: the emergence of a perspective for social-ecological systems analyses. Global Environmental Change 16, 253-267.

Gienapp, P., Teplitsky, C., Alho, J.S.,Mills, J.A. and Merila, J., 2008. Climate change and evolution: disentangling environmental and genetic responses. Molecular Ecology 17, 167-178.

Goudie, A., 2000. The human impact on the natural environment. MIT Press, Cambridge, Massachusetts.

Guisan, A., Thuiller, W., 2005. Predicting species distribution: offering more than simple habitat models. Ecology letters 8, 993-1009.

Gregory, R., Ohlson, D. and J. Arvai. 2006. Deconstructing adaptive management: criteria for applications to environmental management. Ecological Applications 16, 2411-2425.

Gunderson, L., 1999. Resilience, flexibility and adaptive management - - antidotes for spurious certitude? Conservation Ecology 3, 7.

Gunderson, L.H., Holling, C.S., 2002. Panarchy: understanding transformations in human and natural systems.

Gunderson, L.H., Holling, C.S.,Light, S.S., 1995. Barriers and Bridges to the Renewal of Ecosystems and Institutions. 593.

Hannah, L., 2008. Protected Areas and Climate Change. Annals of the New York Academy of Sciences 1134, 202-212.

Hannah, L., Midgley, G.F.,Millar, D., 2002a. Climate change-integrated conservation strategies. Global Ecology and Biogeography 11, 485-495.

Hannah, L., Midgley, G.F., Lovejoy, T., Bond, W.J., Bush, M., Lovett, J.C.,Scott, D. and F.I. Woodward, 2002b. Conservation of biodiversity in a changing climate. Conservation Biology 16, 264-268.

Harper, J., 2002. Endangered species: Health, Illness and Death Among Madagascar's People of The Forest. Carolina Academic Press, Durham, North Carolina.

Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P.,Thomas, C.D., 2008. Assisted Colonization and Rapid Climate Change. Science 321, 345-346.

Ibanez, I., Clark, M.C., Feeley, K., Hersh, M., LaDeau, S., BcBride, A., Welch, N.E.,Wolosin, M., 2006. Predicting biodiversity change: outside the climate envelope, beyond the species-area curve. Ecology 87, 1896-1906.

IPCC, 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 104.

Lenoir, J., Gegout, J.C., Marquet, P.A., de Ruffray, P.,Brisse, H., 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320, 1771.

Li, M.H., Krauchi, N.,Gao, S., 2006. Global warming: Can existing reserves really preserve current levels of biological diversity? Journal of integrative plant biology 48, 255-259.

McDaniels, T., Gregory, R., 2004. Learning as an objective within a structured risk management decision process. Environmental science technology 38, 1921-1926.

McLachlan, J.S., Hellmann, J.J.,Schwartz, M.W., 2007. A framework for debate of assisted migration in an era of climate change. Conservation Biology 21, 297-302.

Morgan, M.G. and M. Henrion, 1990. Uncertainty: A guide to dealing with uncertainty in quantitative risk and policy analysis. Cambridge University Press, Cambridge.

Neumann, R.P., 2004. Moral and discursive geographies in the war for biodiversity in Africa. Political Geography 23, 813-837.

Noss, R.F., 2001. Beyond Kyoto: Forest management in a time of rapid climate change. Conservation biology 15, 578-590.

Olsson, P., Folke, C.,Berkes, F., 2004. Adaptive comanagement for building resilience in social-ecological systems. Environmental management 34, 75.

Parmesan, C., 2006. Observed Ecological and Evolutionary Impacts of Contemporary Climate Change. Annual Reviews of Ecology and Systematics 37, 637-669.

Pearson, R.G., Dawson, T.P., 2003. Predicting the impacts of climate change on the distribution of species: are bioclimate envelope models useful? Global Ecology and Biogeography 12, 361-371.

Pearson, R.G., 2006. Climate change and the migration capacity of species. Trends in Ecology and Evolution 21, 111-113.

Rayfield, B., James, P.M.A., Fall, A.,Fortin, M., 2008. Comparing static versus dynamic protected areas in the Quebec boreal forest. Biological Conservation 141, 438-449.

Reynolds, J.F., Stafford Smith, M.D., Lambin, E.F., Turner II, B.L., Mortimore, M., Batterbury, S., Downing, T.E., Dowlatabadi, H., Fernandez, R., et al, 2007. Global desertification: Building a science for dryland development. Science 316, 847-851.

Rinnan, R.A., Michelsen, A.,Baath, E. and Jonasson, S., 2007. Fifteen years of climate change manipulations alter soil microbial communities in a subarctic heath ecosystem. Global Change Biology 13, 28-39.

Rotmans, J. and M. van Asselt, 2000. Integrated Assessment Modelling. In: Martens, P. and J. Rotmans. (Ed.), Climate Change: An Integrated Perspective. Kluwer Academic Publishers, New York,

Slater, C., 2000. Justice for whom? Contemporary images of amazonia. In: C. Zerner. (Ed.), People, plants and justice: the politics of nature conservation. Columbia University Press, New York, pp. 67-82.

Slater, C., 1996. Amazonia as edenic narrative. In: Anonymous (Ed.), Uncommon ground: rethinking the human place in nature. W.W. Norton and Co., New York, pp. 114-159.

Sundberg, J., 1998. NGO landscapes: conservation in the Maya Biosphere Reserve, Peten Guatemala. The Geographical Review 88, 388-412.

Thomas, C., D., Cameron, A., Green, R., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siqueira, M.F., Grainger, A., et al, 2004. Extinction risk from climate change. Nature 427, 145-148.

Timko, J.A. and T. Satterfield, 2008. Seeking social equity in national parks: experiments with evaluation in Canada and South Africa. Conservation and Society 6, 1-17.

Turner, B.L., Clark, W.C., Kates, R.W., Richards, J.F., Matthews, J.T.,Meyer, W.B., 1990. The earth as transformed by human action: global and regional changes in the biosphere over the past 300 years. 713.

Walker, B., Gunderson, L., Kinzig, A., Folke, C.,Carpenter, S. and Schultz, L., 2006. A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems. Ecology and Society 11,

Walker, B., Holling, C.S., Carpenter, S.R.,Kinzig, A., 2004. Resilience, adaptability and transformability in social-ecological systems. Ecology and Society 9, June 12, 2005.

Walters, C., 1986. Adaptive management of renewable resources. McMillan, New York, USA.

West, P., 2006. Conservation is Our Government Now: The politics of ecology in Papua New Guinea (New Ecologies for the Twenty-First Century). Duke University Press, Durham, USA.

West, P., Igoe, J.,Brockington, D., 2006. Parks and peoples: the social impact of protected areas. Annual Review of Anthropology 35, 251-277.

Wilshusen, P.R., Brechin, S.R., Fortwangler, C.,West, P.C., 2003. Contested Nature: Conservation and development at the turn of the twenty-first century. In: Steven R. Brechin. (Ed.), Contested Natures: promoting international biodiversity conservation with social justice in the twenty-first century. State University of New York Press, Albany, pp. 1-22.

Yohe, G.W., 2006. Representing dynamic uncertainty in climate policy deliberations. Ambio 35, 89-91.

2. CLIMATE CHANGE AND BIODIVERSITY CONSERVATION: IMPACTS, ADAPTATION STRATEGIES AND FUTURE RESEARCH DIRECTIONS [5]

2.1. INTRODUCTION

Changing temperature and precipitation regimes (IPCC 2007) are expected to interact with other drivers to impact a range of biological processes and influence species distributions (Thomas et al. 2004; Parmesan 2006) (Figure 2.1). In the past 5 years, a growing body of empirical evidence has documented climate-change-attributed changes in processes, including phenology (Root et al. 2003; Parmesan and Yohe 2003; Menzel et al. 2006), and species interactions (Suttle et al. 2007). Changes in species distributions have also been observed in both above-ground (Walther et al. 2002; Parmesan 2006; Pounds et al. 2006; Lenoir et al. 2008) and below-ground communities (Rinnan et al. 2007).

This situation poses fundamental challenges to existing approaches for biodiversity conservation because targets (for example, species) are currently managed within spatially and temporally static reserves (Peters and Darling 1985; Halpin 1997; Hannah et al. 2002; Araujo et al. 2004; Hannah et al. 2007; Pressey et al. 2007). As a result of changing species distributions, some populations and species will no longer be viable in reserves created for their protection. Additionally, altered disturbance regimes may enhance the ability of invasive species to colonize reserves more easily (Hobbs and Huenneke 1992).

Thus, a central unresolved question in conservation biology is: how can we manage for biodiversity objectives in an era of accelerated climate change? In this report we provide a brief overview of a current suite of proposed adaptation approaches, and identify some future challenges and key issues to be resolved. Both mitigation and adaptation strategies are crucial to respond to climate change. Although reserves can play a role in carbon storage and sequestration - for example, through initiatives such as reducing emissions from deforestation and degradation (one aspect of climate change mitigation) - here we focus solely on adaptation strategies.

[5] A version of this chapter has been published. Hagerman S.M. and K.M.A. Chan: Climate change and biodiversity conservation: impacts, adaptation strategies and future research directions. *F1000 Biology Reports* 2009, 1:16.

2.2. MAJOR RECENT ADVANCES

Below we highlight four commonly proposed adaptation strategies for biodiversity conservation given climate change. In this overview report we focus on a selection of commonly proposed *in situ* adaptation strategies in response to the impacts of climate change. For a journalistic overview of *ex situ* strategies, such as captive breeding, seed and gene banking, in the context of responding to climate change, the reader is referred to Marris (2008). The first three approaches seek to reduce extinction risk primarily by addressing the effects of climate change on species distributions (the pattern), and in part by passively influencing mediating drivers (for example providing corridors for movement). The last considers a more controversial interventionist option (Table 2.1).

Managing the matrix as a buffer should both protect core populations (but often not in the matrix, rather by insulating reserves) and also facilitate shifts across a landscape; new and dynamic reserves function primarily by protecting core populations and also by accommodating (rather than facilitating) target movement.

2.2.1. New reserves and corridors

The most common proposed approach for conservation adaptation is to expand linked networks of protected areas including migration corridors (Noss 2001; Hannah et al. 2002; 2007; Pressey et al. 2007; Hannah 2008; Phillips et al. 2008). These researchers argue that the existing network does not provide enough area to allow for organisms to respond autonomously to changing climatic conditions.

The principal purpose of new protected areas is to mitigate the risk of extinction by providing the potential for species distributions to shift; a secondary contribution is that they may also enhance micro-evolutionary potential through enhanced population size and diversity. Therefore, corridors may reduce extinction risk by enabling the passive shifting of some species to new geographic ranges, and by reinforcing species distributions (in a metapopulation context).

A crucial challenge for this approach is determining where to site corridors and new reserve areas. The current state-of-the-science is to use species distribution models or bioclimate

envelope models to generate projections of future species' responses to various climate scenarios (Midgley et al. 2002; Thuiller et al. 2005; Lawler et al. 2006; Thuiller et al. 2008). Many view this information as providing essential insight into the strategic siting of new protected areas (Williams et al. 2005). At the same time, myriad uncertainties impact the validity of these projections (Davis et al. 1998; Pearson and Dawson 2003; Pearson et al. 2006; Araujo and Guisan 2006; Heikkinen et al. 2006; Ibanez et al. 2006). Efforts to address these uncertainties are ongoing (Araujo and New 2007; Thuiller et al. 2008), but many uncertainties may remain (or even increase) within decision-making time frames nonetheless.

Schemes for siting new areas may be more robust to uncertainties by incorporating coarse scale environmental gradients, such as edaphic and elevational ranges (for example, Noss 2001).

2.2.2. Matrix as buffers

As a complement to protected areas expansion, many researchers highlight the importance of matrix areas (Franklin 1993) or the wider managed landscape, as being particularly crucial for biological adaptation in an era of change (Noss 2001; Hannah et al. 2002). For example, some land uses, such as forestry or agro-forestry, may provide a spatial buffer for populations as they respond to climate change and move outside core reserves. In order for this proposal to be effective, matrix areas must be of sufficient size, and landowners must be willing to adjust their activities as monitoring indicates (Noss 2001). Incentives may increase the viability of this proposal. The logic of this approach is similar to new protected areas and corridors: more benign matrix areas may passively facilitate species shifts by promoting movement across land- and seascapes; they may also reinforce species distributions at fine scales (around reserves).

2.2.3. Dynamic reserves

The management of matrix areas for biodiversity objectives further supports a third proposal. Dynamic reserves implemented on managed landscapes (or seascapes) are areas whose locations and levels of protection change through time and space (Bengtsson et al. 2003; Pressey et al. 2007; Hannah 2008; Rayfield et al. 2008). This approach may be particularly important in areas

where there is little spatial opportunity available for new core protected areas. At the same time, the issue of ownership and property rights requires further examination in different contexts in order to more fully understand the implementation challenges of this potential approach in particular localities. This approach involves the future passive facilitation of shifting species distributions in response to future conditions, rather than prediction of conditions.

2.2.4. Assisted colonization

More controversial is the interventionist proposal for 'assisted migration' (McLachlan et al. 2007; Hunter 2007) or 'assisted colonization' (Hoegh-Guldberg et al. 2008). Both describe a management option in which species are deliberately introduced into an area where they have not existed in recent history for the purpose of achieving a conservation objective. This proposal has emerged in response to the mounting evidence that some species may not be able to track changing climatic conditions quickly enough (Parmesan 2006; Midgley et al. 2006), or because there are natural or human barriers in the way. This approach would involve actively shifting species distributions.

The assisted colonization proposal is at odds with current reserve management in which substantial efforts are directed at keeping non-native species out. It also carries with it substantial risks because introduced species may become invasive and displace other valued ecosystem elements. Nevertheless, assisted colonization may be seen as a necessary last resort in some cases. In anticipation of this, Hoegh-Guldberg et al. (2008) proposed a framework for decision-making within which the costs, benefits and risks of the translocation event could be evaluated. Other researchers have inferred the risk of potential invasion of assisted colonization from comparisons of intra-continental and inter-continental past invasions (Mueller and Hellman 2008).

2.3. FUTURE DIRECTIONS

In this last section we identify a collection of key challenges to be resolved for reserve management suited for an era of change. We divide these challenges into five categories: focus on processes, projections and uncertainties, monitoring, implementation, and norms and expectations.

2.3.1. Focus on processes

In the main, conservation activities have focused on maintaining biodiversity patterns and indirectly enabling natural processes: for example, by protecting space for species to exist (represented by the first three categories referred to above). As climate change influences mediating drivers, the attributes that make certain places conducive to species flourishing (critical habitat) will change, and in some cases disappear. For species whose critical habitat changes dramatically or disappears, it will be increasingly necessary to consider approaches that involve the active management of mediating drivers.

Restoration activities have long involved management of disturbance regimes, ecosystem function, and species interactions. Adapting to the impacts of climate change may require more such active management, including assisted colonization, and other interventions, such as enhancement of evolutionary adaptation (Bell and Collins 2008), and active maintenance of processes and conditions.

2.3.2. Projections and uncertainties

A key area of future research is to improve our capacity for forecasting species responses to changing climate - for example, by incorporating biotic interactions in bio-climate models (Araujo and Luoto 2007), and refining species-specific process-based models (Morin et al. 2008). Other areas include the longstanding scientific challenge of understanding when a given species will become invasive in a given context (Mueller and Hellman 2008). Efforts to reduce the ecological uncertainties just mentioned will represent a key contribution to the literature on adaptive reserve management.

In addition to ecological uncertainties, there are various parametric and model uncertainties relating to species distribution models. This includes uncertainties relating to so-called ‘unknown unknowns’; where key processes are not yet recognized, understood or incorporated into model structure, or as parameters. Yet such processes may play critical roles in ecosystem dynamics nonetheless. Moreover, there are uncertainties relating to the climate scenario models that

influence the outputs of envelope models (Beaumont et al. 2008). Lastly, there are critical socio-political uncertainties (in values, impacts, responses and feedbacks).

Thus, a second key area of future research is the development of conservation approaches that are robust to uncertainty, recognizing that many of the above uncertainties are irreducible. As ecological and social systems co-adapt, non-linear dynamics will lead to perpetually surprising outcomes (Gunderson and Holling 2002). Therefore, even with the best scientific research and most comprehensive models, species responses may surprise us. Indeed, uncertainties may also increase with new research and insights (Yohe 2006). Thus, the implementation of safe-to-fail adaptive management policies may be as or more important than efforts to reduce uncertainties.

2.3.3. Monitoring

In many ways, conservation adaptation requires recognition of what is changing and where (for example, assisted migration, dynamic reserves). Thus, there is an urgent need for monitoring of impacts. While existing monitoring programs could be adapted and used for this purpose, programs specifically targeted to assessing the impacts of climate change would support the most effective adaptation responses possible under highly uncertain circumstances.

2.3.4. Implementation

So far, the adaptation proposals outlined above have focused primarily on biological dimensions. This effort has provided a critical foundation, but land-use decisions, including reserves, are social decisions made in the context specific places. Therefore, a key area of future research is to identify through applied case studies the factors that determine the relative receptivity or resistance of communities to new and additional conservation measures. This effort will provide crucial insights by which conservationists can foster socially sustainable conservation action.

2.3.5. Changing norms and expectations for reserve management

To date, core protected areas have been managed with a preferred minimum intervention (with exceptions for active management including controlled burns, programs to limit grazers, and

efforts to minimize the impacts and distributions of invasive species, for example). Proposals for more widespread intervention, including assisted colonization, raise many unanswered questions. When do we intervene and to what extent? To what extent and under what circumstances are we willing to sacrifice the persistence of one species to save another? Who decides? And by what decision process? Addressing these questions, including latent and even more controversial proposals for conservation triage (Bottrill et al. 2008), will be a key challenge moving forward.

Ultimately, one of the biggest challenges to fostering biological adaptation may be a willingness across stakeholders, scientists and managers to re-calibrate existing expectations of nature and reserves in responding to an era of global change.

Table 2.1. Selection of central current proposed adaptation approaches for conservation mechanisms and types of intervention for minimizing extinction risk given climate change.

Approach	**Main role**		**Timing**		**Type of Intervention**	
	Protect Cores	*Facilitate Movement*	*Now and Over Time*	*Specific Points Through Time*	*Passive*	*Active*
New Reserves	√		√		√	
Matrix as Buffers	√	√	√		√	
Dynamic Reserves	√			√	√	
Assisted Colonization		√		√		√

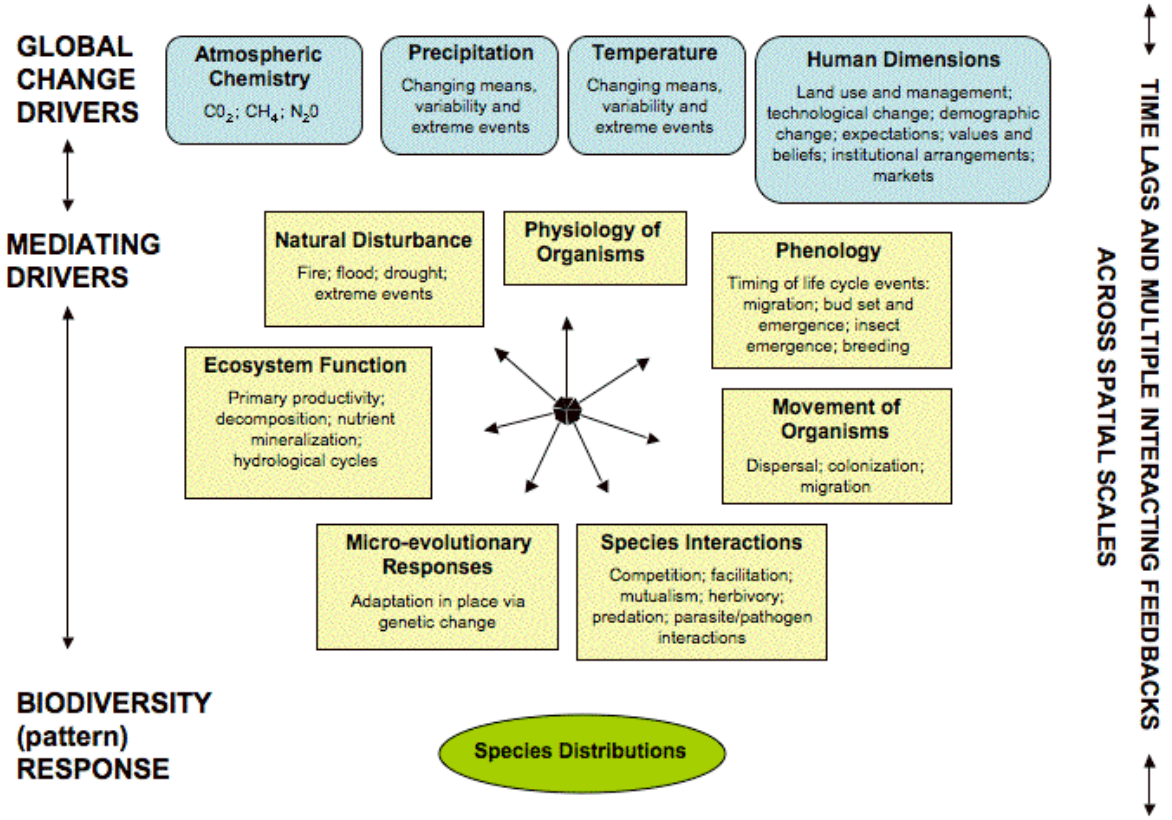

Figure 2.1. Diagrammatic representation of some of the global change drivers, mediating drivers and biodiversity (pattern) responses in terrestrial ecosystems. Within and between each of the three levels, the global change drivers, mediating drivers and responses can interact and feed back to each other.

2.4. REFERENCES

Araujo, M.B. and Luoto, M., 2007. The importance of biotic interactions for modelling species distributions under climate change. Global Ecology and Biogeography 16, 743.

Araujo, M.B., Guisan, A., 2006. Five (or so) challenges for species distribution modelling. Journal of Biogeography 33, 1677-1688.

Araujo, M.B., Cabeza, M., Thuiller, W., Hannah, L.,Williams, P.H., 2004. Would climate change drive species out of reserves? An assessment of existing reserve-selection methods. Global Change Biology 10, 1618-1626.

Beaumont, L., Hughes, L. and A.J. Pitman, 2008. Why is the choice of future climate scenarios for species distribution modelling important? Ecology Letters 11, 1135-1146.

Bell, G. and S. Collins, 2008. Adaptation, extinction and global change. Evolutionary Applications 1, 3-16.

Bengtsson, J., Angelstam, P., Elmqvist, T., Emanuelsson, U., Folke, C., Ihse, M., Moberg, F.,Nystrom, M., 2003. Reserves, resilience and dynamic landscapes. Ambio 32, 389-396.

Bottrill, M.C., Joseph, L.N., Carwardine, J., Bode, M., Cook, C., Game, E.T., Grantham, H., Kark, S., Linke, S., et al, 2008. Is conservation triage just smart decision making? Trends in Ecology and Evolution 23, 649-654.

Franklin, J.F., 1993. Preserving biodiversity: Species, ecosystems or landscapes? Ecological Applications 3, 202-205.

Gunderson, L.H., Holling, C.S., 2002. Panarchy: understanding transformations in human and natural systems.

Halpin, P.N., 1997. Global climate change and natural-area protection: management responses and research directions. Ecological Applications 7, 828-843.

Hannah, L., 2008. Protected Areas and Climate Change. Annals of the New York Academy of Sciences 1134, 202-212.

Hannah, L., Midgley, G.F., Andelman, S., Araujo, M.B., Hughes, G., Martinez-Meyer, E., Pearson, R.,Williams, P., 2007. Protected area needs in a changing climate. Frontiers in Ecology and Environment 5, 131-138.

Hannah, L., Midgley, G.F.,Millar, D., 2002. Climate change-integrated conservation strategies. Global Ecology and Biogeography 11, 485-495.

Heikkinen, R.K., Luoto, M., Araujo, M.B., Virkkala, R., Thuiller, W.,Sykes, M.T., 2006. Methods and uncertainties in bioclimatic envelope modelling under climate change. Progress in Physical Geography 30, 751-777.

Hobbs, R.J., Huenneke, L.F., 1992. Disturbance, diversity and invasion: implications for conservation. Conservation Biology 6, 324-337.

Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P.,Thomas, C.D., 2008. Assisted Colonization and Rapid Climate Change. Science 321, 345-346.

Hunter, Malcolm L. Jr., 2007. Climate Change and Moving Species: Furthering the Debate on Assisted Colonization. Conservation Biology 21, 1356-1358.

IPCC, 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 104.

Lawler, J., White, D., Neilson, R.P.,Blaustein, A.R., 2006. Predicting climate-induced range shifts: model differences and reliability. Global Change Biology 12, 1568-1584.

Lenoir, J., Gegout, J.C., Marquet, P.A., de Ruffray, P.,Brisse, H., 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320, 1771.

Marris, E., 2008. Bagged and boxed: it's a frog's life. Nature 452, 394-395.

McLachlan, J.S., Hellmann, J.J.,Schwartz, M.W., 2007. A framework for debate of assisted migration in an era of climate change. Conservation Biology 21, 297-302.

Menzel, A., Sparks, T.H., Estrella, N., Koch, E., Aasa, A., Ahas, R., Alm-Kubler, K., Bissolli, P., Braslavska, O., et al, 2006. European phenological response to climate change matches the warming pattern. Global change biology 12, 1969.

Midgley, G.F., Hughes, G.O.,Thuiller, W. and Rebelo, A.G., 2006. Migration rate limitations on climate change-induced range shifts in Cape Proteaceae. Diversity and Distributions 12, 555-562.

Morin, X., Viner, D. and I. Chuine, 2008. Tree species range shifts at a continental scale: new predictive insights from a process-based model. Journal of ecology 96, 784.

Mueller, J. and Hellmann, J., 2008. An assessment of invasion risk from assisted migration. Conservation Biology 22, 562-567.

Nemani, R.R., Keeling, C.D., Hashimoto, H., Jolly, W.M., Piper, S.C., Tucker, C.J.,Myneni, R.B. and Running, S.W., 2003. Climate-driven increases in global terrestrial net primary production from 1982-1999. Science 300, 1560-1563.

Noss, R.F., 2001. Beyond Kyoto: Forest management in a time of rapid climate change. Conservation biology 15, 578-590.

Parmesan, C., 2006. Observed Ecological and Evolutionary Impacts of Contemporary Climate Change. Annual Reviews of Ecology and Systematics 37, 637-669.

Parmesan, C., Yohe, G., 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421, 37-42.

Pearson, R.G., Dawson, T.P., 2003. Predicting the impacts of climate change on the distribution of species: are bioclimate envelope models useful? Global Ecology and Biogeography 12, 361-371.

Peters, R.L., Darling, J.D.S., 1985. The greenhouse effect and nature reserves: Global warming would diminish biological diversity by causing extinctions among reserve species. BioScience 35, 707-717.

Phillips, S.J., Williams, P.,Midgley, G. and A. Archer, 2008. Optimizing dispersal corridors for the Cape Proteaceae using network flow. Ecological Applications 18, 1200-1211.

Pounds, J.A., Bustamante, M.R., Coloma, L.A., Consuegra, J.A., Fogden, M.P.L., Foster, P.N., La Marca, E., Masters, K., Merino-Viteri, A., et al, 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439, 161.

Pressey, R.L., Cabeza, M., Watts, M., Cowling, R.M.,Wilson, K.A., 2007. Conservation planning in a changing world. Trends in Ecology and Evolution 22, 583-593.

Rayfield, B., James, P.M.A., Fall, A.,Fortin, M., 2008. Comparing static versus dynamic protected areas in the Quebec boreal forest. Biological Conservation 141, 438-449.

Rinnan, R.A., Michelsen, A.,Baath, E. and Jonasson, S., 2007. Fifteen years of climate change manipulations alter soil microbial communities in a subarctic heath ecosystem. Global Change Biology 13, 28-39.

Root, T.L., Price, J.T., Hall, K.R., Schneider, S.H., Rosenzweig, C.,Pounds, J.A., 2003. Fingerprints of global warming on wild animals and plants. Nature 421, 57-60.

Suttle, K.B., Thomsen, M.A. and Power, M.E., 2007. Species interactions reverse grassland response to changing climate. Science 315, 640-642.

Thomas, C., D., Cameron, A., Green, R., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siqueira, M.F., Grainger, A., et al, 2004. Extinction risk from climate change. Nature 427, 145-148.

Thuiller, W., Albert, C., Araujo, M.B., Berry, P.M., Cabeza, M., Guisan, A., Hickler, T., Midgley, G.F., Paterson, J., et al, 2008. Predicting global change impacts on plant species' distributions: Future challenges. Perspectives in plant ecology, evolution and systematics 9, 137.

Thuiller, W., Lavorel, S., Araujo, M.B., Sykes, M.T.,Prentice, C., 2005. Climate change threats to plant diversity in Europe. Proceedings of the National Academy of Sciences of the United States of America 102, 8245-8250.

Walther, G., Post, E., Convey, P., Mensel, A., Parmesan, C., Beebee, T.J.C., Fromentin, J., Hoegh-Guldberg, O.,Bairlein, F., 2002. Ecological responses to recent climate change. Nature 416, 389-395.

Williams, P., Hannah, L., Andelman, S., Midgley, G.F., Araujo, M.B., Hughes, G., Manne, L., Martinez-Meyer, E.,Pearson, R., 2005. Planning for Climate Change: Identifying Minimum-Dispersal Corridors for the Cape Proteaceae. Conservation Biology 19, 1063-1074.

Yohe, G.W., 2006. Representing dynamic uncertainty in climate policy deliberations. Ambio 35, 89-91.

3. PROPOSITIONS FOR CONSERVATION POLICY SUITED TO AN ERA OF CHANGE: AN INTEGRATED SYNTHESIS OF ECOLOGICAL AND SOCIAL INSIGHTS [6]

3.1. INTRODUCTION

Conservation policies have changed over time (e.g. Wynn 2004; Loo 2006), as have policies for resource management more generally. [7] These changes are the result of interacting social-cultural and biophysical drivers (e.g. Light et al. 1995; Gunderson and Holling 2002). Consider British Columbia (BC) as one representative example. At the turn of the last century and for decades afterwards, parks were set-aside for tourism and recreation objectives. Their purpose was to provide public "pleasure grounds" (Province of BC, 1911), their value was measured in terms of number of park visits, and their boundaries were prone to alteration when mining, logging, or hydroelectric operations promised to deliver greater potential immediate economic benefits (Chapter 4). In the mid 1960's, the objectives of parks expanded to include ecological values by means of set-asides for which the "main purpose of its designation is the preservation of its particular atmosphere, environment or ecology" (Park Act 1965, Province of BC).

This broadening of conservation objectives to include ecological values occurred in tandem with the inception and growth of the discipline of conservation biology more generally. Today, conservationists view the fundamental objective of conservation biology as "the protection and perpetuation of the Earth's biological diversity" (Meine et al. 2006). In the last three decades, the primary means to achieve this end has been to establish protected areas that separate valued ecosystem attributes from proximate (spatially adjacent) anthropogenic stressors. By this current approach, management objectives (or means objectives), seek to achieve the representation and persistence of *a priori* identified biodiversity targets (e.g. species or ecosystems) within and between networks of static protected areas boundaries (Margules and Pressey 2000).

[6] A version of this chapter has been submitted for publication. Hagerman, S.M., Dowlatabadi, H., Chan, K. and T. Satterfield. Propositions for conservation policy suited to an era of change: an integrated synthesis of ecological and social insights.

[7] The meaning of the word "conservation" has in itself changed over time. In the late 1800s it referred to the rational use of natural resources for the greatest public benefit. In the context of forests, conservation meant logging, fire protection and the perpetuation of the resource by technical management. "Conservation" at this time was seen as the antithesis to preservation movements.

Considering the increasing scale and complexity of global change drivers and impacts (Turner et al. 1990; Foley et al. 2005), further adaptations on conservation frameworks appear imminent. The impacts of climate change are particularly salient. For example, changing temperature and precipitation regimes (IPCC 2007) are projected to interact with other drivers (e.g. land conversion), to impact a range of biological processes and influence species distributions (e.g. Thomas et al. 2004). Indeed, in the past five years a growing body of empirical evidence has documented climate change-attributed changes in biological processes including phenology (Root et al 2003; Parmesan and Yohe 2003; Menzel et al. 2006), and species interactions (Suttle et al. 2007). Changes in species distributions have also now been observed (Parmesan 2006; Rinnan et al. 2007; Lenoir et al. 2008).

Because conservation planning of the past three to four decades has been predicated on assumptions of relatively static species ranges, the implications of these dynamics are that some conservation targets will not be viable in conservation areas created for their protection (Peters & Darling 1985; Halpin 1997; Hannah et al. 2002; Araújo et al. 2004). In response, conservation biologists and ecologists have proposed a suite of adaptive conservation strategies (conservation means). These include the expansion of linked networks of protected areas and migration corridors (Hannah et al. 2002; Hannah et al. 2007; Pressey et al. 2007); management of human-dominated matrix areas for biodiversity objectives (e.g. Noss 2001); dynamic reserves (e.g. Bengtsson et al. 2003; Rayfield et al. 2007), and more interventionist alternatives such as the assisted migration of imperiled species (e.g. McLachlan et al. 2007).

In addition to emerging climate change-conservation perspectives from the biological sciences, key insights for conservation more generally have emerged from disciplines spanning the social sciences and humanities. Although the focus of this collection of work has not been climate change, insights pertaining to dynamics in linked human-ecological systems, governance and potential social impacts are all directly relevant to understanding and responding to the challenge of climate change for conservation. For example, historical ecologists and environmental historians have shown that landscapes including protected areas are the dynamic, co-produced outcomes of cultural preferences, human actions and biophysical attributes (e.g. Crumley 1994; Heckenberger 2007). Common property scholars and anthropologists have shown that because protected areas change property rights, they can incur a range of impacts on social practices

(reviewed by West et al. 2006) including the alteration of livelihoods through changes in access or by exacerbating prior conflicts (Harper 2002; Neumann 2004). As a result, topics of concern in this research domain include the distribution of benefits (e.g. Brockington et al. 2006); access (Ribot and Peluso 2003); and legitimate forms of governance (Wilshusen et al. 2003) including co-management and adaptive co-management (e.g. Berkes 2004; Brosius, 2004; Olsson et al. 2004).

So far, the insights and advances from the biological and human-dimensions of conservation fields as outlined above have not been integrated and applied to understanding the challenge of adapting conservation policy in an era of climate change. The purpose of this paper is to review and synthesize insights from non-equilibrium ecology, resilience theory, environmental history and ecological anthropology to create an integrative framework for understanding the multiple dimensions of the challenge of conservation in an era of change. In doing so we identify some challenges to be resolved and offer a set of propositions for key policy-relevant questions including: *Which* species or ecosystems should we protect, where and with how much effort? What are the social and ecological trade-offs? Who should decide? And on what basis? Are the current management objectives of conservation tenable in an era of change? What new conservation means might be used to respond to increasingly complex and possibly urgent circumstances? And what social and political factors need to be considered in the development of such alternatives?

The basis and organization of this paper is as follows. First, we outline and review an integrated set of principles relevant to the development of conservation strategies adapted to an era of complexity and change. We then consider the implications of the principles for existing and potential alternative conservation objectives and means, and offer a set of preliminary propositions. The propositions are speculative, not programmatic. They raise numerous scientific, social and ethical questions that require further consideration and empirical testing in case studies. In the spirit of adaptation, we expect their revision and refinement.

3.2. PRINCIPLES

Below, we outline a set of four integrated principles (derived from the literature outlined below) relevant to adapting conservation policies. The principles are integrated both in the sense that their dynamics are interconnected, and because they are derived from disciplines from the natural and social sciences.

1) Landscapes are the dynamic product of biophysical and socio-cultural drivers that interact across scales.
2) Our knowledge of future species distributions is incomplete
3) Any management regime will be good for some species and bad for others
4) Human values change over time

3.2.1. Landscapes are the product of biophysical and socio-cultural drivers that interact across scales

Landscapes are linked social-ecological systems (SESs) systems (Berkes and Folke 1998; Reynolds 2007). They are co-produced entities whose social and ecological dimensions interact across temporal and spatial scales (Crumley 1994; Gunderson and Holling 2002; Walker et. al. 2004). The dynamics and patterns of SES are driven by slow (e.g. soil development; cultural change) and fast variables (e.g. forest fires; market collapse), from biophysical (e.g. climate, vegetation, topography) and social domains (e.g. cultural norms, interests, institutions, geopolitical events) (Walker 2006; Folke 2006). These dynamics lead to non-linear, episodic, and inherently unpredictable system behavior. Thus landscapes are perpetually co-adapting with no single equilibrium.

Landscapes (including protected areas), are also path-dependent with historical determinants, that are both ecological and social. For example, the present configuration of a given landscape is the consequence of abiotic conditions, stochastic disturbance events, histories of specific land-use practices (including species introductions), access relations, and in some cases colonial legacies (e.g. Neumann 1998; Harper 2002; Nelson 2003). The linked, path dependent and co-evolving dynamics of SES have been demonstrated in numerous case studies (e.g. Gunderson et al. 1995; Kinzig et al. 2006). To highlight one of many examples, Abel et al. (2006) show how

ecological and social triggers including drought, markets, legislation, livestock numbers and disease and human rights movements have interacted at different times to shape the ecological and social attributes of four social-ecological systems in Zimbabwe and Australia.

3.2.2. Knowledge of future species distributions is and will continue to be incomplete

The non-linear, non-equilibrium dynamics of SES create irreducible system uncertainties relating to species and ecosystem patterns. These uncertainties are irreducible because they emerge from and perpetuate the dynamics (e.g. thresholds and feedbacks) of linked human and ecological systems over time and across scales. Thus the second principle is that knowledge of future species distributions has been in the past, and will always be, incomplete.

The impacts of climate change confound and amplify existing system uncertainties. They do so in ways that are directly relevant to conservation objectives as currently articulated (i.e. the protection of *a priori* species and ecosystems). For example, efforts to project the impacts of climate change on future species distributions are constrained by uncertainties relating to biotic interactions (Pearson and Dawson 2003; Guisan and Thuiller 2005); dispersal (Thuiller et al. 2005; Pearson 2006); colonization dynamics (Carmel and Flather 2006; Ibanez et al. 2006); rapid evolutionary change (Gienapp et al. 2008); and interactions between the dynamics across scales. In addition, future patterns of land use, changing carbon dioxide concentrations, and how the climate will actually change, adds additional layers of uncertainty to predictions of future species distributions.

Further research will improve our understanding of these dynamics and resolve some current modeling challenges. However, new research and insights may raise more questions, and even increase uncertainty (cf Yohe 2006). Because SES are linked, dynamics and co-adapting systems, uncertainties are inherent and perpetuating. Even with the state-of-the-science in modeling and long-term monitoring, species responses may surprise us. Therefore, while efforts to reduce uncertainties will represent a key contribution to the biological literature, we simultaneously need to develop conservation approaches that are robust to uncertainty, recognizing that many of the above uncertainties are irreducible.

3.2.3. Any management decision will be good for some species and bad for others

The non-equilibrium, non-linear dynamics of linked SES described in Principle 1 also underpins this third principle. Hobbs and Huenneke (1992) state that because "nearly all systems are likely to be nonequilibrial in the future; we must be activists in determining which species to encourage and which to discourage. We cannot just manage passively, or for maximal diversity, but must be selective and tailor management to specific goals". This position is closely related to the views of some resilience scholars who note that there is no single resiliency across all scales for all valued attributes and to all stressors (Walker and Abel 2002).

Because managing for one species or one objective may occur at the expense of another, it is not particularly helpful to call generally to build resiliency of species, ecosystems, or landscapes to climate change. A clearly defined management purpose (and temporal scale) is required (Walker and Abel 2002). Attention to temporal scale is important because a given configuration of key variables and processes can lack resilience (i.e. change to a configuration of a different set of variables and processes) at shorter temporal scales but have considerable resilience at longer ones. Asking *which* species and *which* ecosystems to manage and protect brings the issue of conservation triage to the fore, and contrasts with the view that no species should be forsaken in order to better protect others (Pimm 2000).

3.2.4. Human values change over time

The fourth and last principle derives from and feeds back to the previous three. It has two parts: 1) ideas and valued attributed of landscapes have material consequences and 2) these ideas and values change over time. This principle derives from the work of environmental historians and anthropologists who have shown that ideas and perceptions of the value of nature are shaped within a particular social-cultural and biophysical context at a particular point in time (Cronon 1996; Slater 1996; Slater 2000). In interaction with other social and ecological factors, ideas (and discourse) contribute to shaping the nature of change when it occurs. They do so by implicating or justifying certain policy options, and simultaneously obfuscating or discrediting others (e.g. Brosius 1999). For example, ideas of stable, pristine (non-human influenced) ecosystems have underpinned protected areas policies that seek the maintenance of species in place over time and that restrict human activities.

Secondly, we know, from environmental historians (e.g. Cronon 1996; Loo 2006), and economists (Buchanan 1987) that ideas, and their expression in policy objectives that were suitable for (or reflective of) the social, ecological and technological context of one time period, may be either ill-suited, not desired or untenable in a different time period and context. Buchanan invokes the concept of "relatively absolute absolutes" to describe the reality that the ideas norms and values that represent a given "constitution" of alternatives at a given time are stable in the short term, but prone to change in the long term (Buchanan 1987).

3.3. IMPLICATIONS AND PROPOSITIONS

In this section, we use the principles as a guide to examine emerging and potential alternative conservation strategies suited for an era of accelerated change. The discussion is organized by considering the implications of the principles for conservation management objectives and the means for achieving the fundamental objectives of the perpetuation of as much biodiversity as possible in the long term. The implications are presented in combination with a set of research/policy propositions (Table 3.1). The propositions are intended to be speculative, to generate discussion, and suggest potential avenues for further empirical research.

3.3.1. Implications and propositions for conservation objectives

Re-calibrating objectives

Non-linear system dynamics, including changing values, lead to irreducible uncertainties relating to future species distributions (Principles 1, 2 and 4). Adoption of this perspective implicates decision-relevant constraints on predictive powers across all levels of biodiversity (genetic, population, species and ecosystem). Yet, many proposals for conservation given climate change are based on approaches that seek to project future species distributions for the purpose of providing insight into the future locations of conservation areas (Hannah et al. 2002; Williams et al. 2005). For example, the outputs of bioclimate models, which are based on correlations between observations of species in a given geographic area and various subsets of environmental variables (e.g. climate, soils and topography) (Guisan and Zimmermann 2000), including data

from general circulation models (GCMs) are used to project future environmental envelopes and infer future species (and ecosystem) distributions given climate change (Thuiller et al. 2005; Saxon et al. 2005; Malcolm et al. 2006). The application of this approach would maintain the current management objectives of protecting *a priori* identified species, just transferred to a new spatial location.

Many researchers highlight the uncertainties and limitations of bioclimate models (e.g. Pearson and Dawson 2003; Guisan and Thuiller 2005; Araújo & Guisan 2006; Heikkinen et al. 2006; Ibanez et al. 2006). At the same time, numerous governmental, non-governmental and academic agencies are using them as an approach to think through conservation responses to climate change. For example, a recent biodiversity assessment in the UK (known as the MONARCH assessment), used the bioclimate envelope approach to project potential future suitable climate space through time for a range of species under different climate scenarios (Walmsley et al. 2007). The authors state that the objective was to inform the development of conservation policy, including discussions about future targets for regional species and habitat protection planning. In BC, there are similar efforts within regional conservation non-governmental organizations (NGOs) and government agencies to adopt a methodological framework of projecting future species distributions to be used as a source of insight for both ecoregional planning, and forest and biodiversity resource management (Hamann and Wang 2006).[8]

Given the ecological uncertainties outlined above, and differences in life history strategies, the strategic siting of new protected areas will likely be more helpful to some species than for others. Moreover, it is unclear the extent to which the protection of specific species and ecosystems can be targeted through time. The researchers involved in the MONARCH project acknowledge many of the constraints that these uncertainties place on predicting future species ranges (Walmsley et al. 2007). In so doing they hint at the limits of species-specific policy objectives in the context of global change. This is not to say that protected areas expansion should not be considered as one of a number of adaptive strategies to ameliorate the impacts of climate change. Indeed, new protected areas may successfully achieve other conservation objectives such as limiting the extraction of resources or stemming land conversion. Rather, it is to propose that

[8] For example the Nature Conservancy of Canada climate change program for the central interior of BC, and the BC Ministry of Forests recent efforts to project future distributions of biogeoclimatic zones for the purpose of informing conservation and timber management (e.g. Future Forests Ecosystem Initiative).

management objectives based on *a-priori* identified targets may be mismatched with the uncertainties that are relevant to achieving those objectives.

Proposition: Recalibrating objectives

Future conservation policies may include a re-calibration of management objectives (and expectations) to match conditions characterized by limited predictive capacities and deterministic control.[9] Examples of potential recalibration may include a shift away from maintenance and persistence objectives to objectives that emphasize functional diversity, facilitating flows of desired ecosystem attributes, and explicit acknowledgment of potential population or species losses.

Proposition: Coarse-scale features

Management objectives based on "physical templates" (e.g. topographic gradients such as elevation, aspect, latitude and edaphic regimes) offer a potential alternative (or complimentary input) to site-selection methods based on projected species distributions. These "physical templates" (Urban et al. 2000) are relatively permanent and therefore more amenable to prediction regardless of how the impacts of climate change unfold. This proposition is similar to Noss (2001) who suggests more broadly that a viable approach to locating future conservation areas could be to follow gradients of relatively stable landscape features.

Scientific uncertainties are always present

We have noted above the constraints that scientific uncertainties relating to future species distributions place on species-specific conservation policy objectives. We have also noted that uncertainties are inherent properties of dynamic SES generally, and therefore of species and ecosystem management more specifically. Three decades ago we didn't have prior confirmatory evidence that systematic protected areas would achieve species persistence objectives. In some cases restricting natural disturbance, for example through fire suppression in fire-adapted

[9] A closely related view has recently been developed independently by Dunlop and Brown (2008). In their recent assessment of climate change impacts on reserve areas in Australia these authors similarly make the argument that we need to calibrate conservation objectives with uncertainties and predictive capacities. This perspective is one that we have been developing in earlier versions of this work (e.g. Hagerman et al. 2007). The ideas and language are coincident and independent.

systems, has contributed to altering the diversity of endemic species (e.g. MacDougall et al. 2004).

Proposition: Uncertainties and adaptation

Ecological uncertainties have always been present in conservation decision-making. Their presence is not in and of itself, a barrier to adaptation. Irrespective of the particular conservation approaches that come to take the place of conventional frameworks, they will occur amidst a backdrop of uncertainties, as previous approaches have in the past. More interesting are the ways in which certain proposals are advocated or discredited despite of or because of uncertainties.

Proposition: Safe-to-fail policies

We will not know in advance of trying alternative conservation means if they will be more successful at achieving a specific set of objectives than conventional methods. This implicates the need for an adaptive management approach and a "safe-to-fail" philosophy.

Triage

The principles relating to the dynamics of linked social-ecological systems (notably multi-scalar drivers), limited predictive control and no universal resilience (Principles 1-3), together invite consideration of a model of conservation triage. In medicine, triage is a form of priority setting used in urgent situations when it is not possible to save all patients due to resource limitations (time, supplies, medical personnel, intervention alternatives) at a given point in time. Insofar as conservation priorities are set amidst social and spatial constraints, conservation activities (e.g. the siting of protected areas or the listing of endangered species) are ranked and prioritized all the time (Margules and Usher 1981; Vane-Wright et al. 1991; Marris 2007). [10]

But prioritization is not the same as triage. Triage includes the explicit decision not to treat a given individual (protect a given species), knowing that a lack of effort will likely lead to

[10] Current prioritization schemas vary by scale and concept. Some researchers have proposed that species-level conservation be prioritized based on the concept of redundancy (discussed by Walker 1992; Naeem 1998). In practice, the basis for species-level prioritization includes taxonomic or phylogenetic distinctness (Vane-Wright et al. 1991; Moritz 2002; Forest et al. 2007), keystone species (Paine), or focal species (Lambeck 1997). At the landscape scale, common prioritization schemes include hotspots (Myers 2000); consideration of cold-spots (Kareiva and Marvier 2003), or cost-benefit analysis over time (Wilson et al. 2006).

death/possible extinction. Triage for ecosystems involves making an assessment of the viability of a given species or ecosystem at a given place, point in time, and with some degree and type of active intervention. It means explicitly diverting resources away from targets assessed to be non-viable (by some criteria), in favor of efforts that are focused on targets assessed as being more viable given a set of conditions and interventions at a given point in time. Therefore, triage for conservation has implications both for conservation objectives (because some targets would be protected and others would not) and conservation means (because a triage framework requires that decisions be made regarding the extent and type of intervention in a given place and time). There are at least four key issues to consider in thinking towards operationalizing a model of conservation triage.

The first issues relates to criteria. On what basis should triage assessments be made? The uncertainties and interactions across scales (Principles 1 and 2) pose tremendous challenges to determine that efforts to conserve species X are futile (and that its absence in a system will have minimal consequences), and that efforts to protect species Y by some type and degree of intervention are more likely to succeed. As noted by Kareiva and Levin (2003), we may be able to identify un-expendable species, but determination of an expendable species is near impossible given biotic interactions and impacts across scales. On the other hand, Principle 2 reminds us that uncertainties are inherent and in many cases, irreducible. Perhaps because of these species-level uncertainties, most triage proposals have been focused at the ecosystem or landscape scale (e.g. Baron et al. 2008). In the conservation and restoration triage proposal outlined by Hobbs and Kristjanson (2003), triage assessment is based on two ecological dimensions: the level of threat to a given landscape, and the likelihood of persistence or recovery.

The second issue concerns the management interventions side of a triage assessment. Consider a hypothetical case in which a given area is assessed in a triage framework to be of high priority for conservation, and that the chosen intervention is a new protected area or connective corridor (arguably the most common conservation adaptation proposal). Because social and ecological systems are inextricably linked (P1), social dimensions must also be considered in a triage assessment. Common property scholars have developed a strong empirical foundation for understanding the ecological and social variables that can influence dynamics and outcomes in linked SES. Insights from this work could provide a basis for identifying the types of systems in

which triage (by various conservation interventions) may feasibly be applied (and where certain interventions may be more likely to be met with resistance). Key variables could include examination of property rights; actors; number of actors; governance; history of resource use; conflict; norms and mental models; and resource dependence (Agrawal 2003; Ostrom 2008).

The third issue concerns the crucial question of who decides? And by what process? Triage in medicine is rule-based, expert driven and requires rapid decision-making. However for many conservation initiatives (particularly on public lands) decisions are the result of a shared decision-making processes (that also involves expert input and framing) that can take upwards of a decade to negotiate. These processes are not necessarily rule-driven, or rapid. For example, the designation of conservation areas for the central and north coast of BC, took *10 years* to achieve, with implementation negotiations ongoing. These differences indicate a potential mismatch in rates of potential ecological change and participatory conservation decision-making. They also raise important issues for engagement and governance (discussed in the next section on conservation means).

The fourth issue relates to variable constraints on resources. In medicine, triage is applied in discrete, urgent situations where resources are fixed within a given crisis event. For conservation, the challenge is continuous and resources are not necessarily fixed. In some cases, the possibility exists that the availability of resources may increase with perceived crises (as the result of people being willing to pay more) (Tisdell et al. 2007). For conservation NGOs, there may be little benefit to publicly write-off a given species/system given that doing so may detract from their ability to raise funds and lobby for change. In contrast, the adoption of a triage framework may be more likely in the context of decision-making for public lands where trade-offs between economic, ecological and social objectives are negotiated for a given area (such as occurs for public lands in BC). Because trade-offs are constantly being made in this context, triage may offer additional points of leverage in negotiation.

Triage-like proposals are currently contentious in the conservation community (e.g. Noss 1996). Almost by definition, many individuals in the conservation community hold strong views that conservation management must defend the right of all species to exist, regardless of their perceived functionality, likelihood of survival, or other metric. More, a preference for a

minimum intervention approach to conservation will likely continue to shape the acceptability of conservation management for a period of time. We say for a period of time, because there is evidence that a "save everything" view is being questioned within the conservation community itself (despite how much this outcome may be desired). If with reluctance and trepidation, the question of triage almost inevitably comes up at conservation conference sessions and conservation planning workshops (prelim. data). Increasingly, it is also referred to in agency reports (e.g. Baron et al. 2008; Dunlop and Brown 2008), journalistic pieces (Marris 2007), and peer-reviewed publications (Parmesan 2008).

Proposition: New management objectives: triage?

Given climate change (and other drivers), adaptation for conservation policy may include triage for management objectives that would explicitly divert resources away from specific conservation targets (species or ecosystems) in favor of other targets assessed to be more viable by some degree/type of intervention.

Proposition: Variation in the acceptability of conservation interventions

A range of social variables will influence the relative acceptance of the interventions that flow from a triage approach. Using these variables (examples in text above), it may be possible to develop typologies of intervention amenable/resistant systems, which could be used as a decision-making heuristic under potential urgent circumstances and irreducible uncertainty.

Proposition: Acceptability of new objectives and means and time

Ideas of conservation and valued ecosystem attributes change over time. Over longer temporal scales, these changes will impact both the acceptability of a triage framework itself in a given context, the value of the ecological elements being triaged within the framework, and the means (interventions) that are acceptable.

3.3.2. Implications for policy means

An estimated 6 million km ^{2} of protected areas worldwide restrict human access (West et al. 2006) (e.g. IUCN strict Nature Reserve) and are valued as "unmodified land" that retains it's "natural character" (IUCN Category 1b Wilderness Areas). In light of climate change interacting

with other stressors (e.g. land conversion), future conservation means may need to adapt existing restrictions on human interventions in core conservation areas in order to achieve the perpetuation of as much biodiversity as possible. Ideas along the lines of the "gardenification of nature" (Janzen 1998) or "gardening in the wild" (Janzen 2000) may provide a useful guide. For Janzen, efforts to protect biodiversity include natural disturbance and human activity in the form of non-damaging use. The fundamental objective of conservation is still to protect as much biodiversity as possible, but since the time scale of interest is the long term, actions that permit localized short term (or even permanent) losses may be acceptable.

Acknowledging that this is a potentially contentious topic, a key question moving forward is not should we intervene in (previously minimally managed) conservation areas, but to what extent and by what means? We consider this question below in the context of the four principles and their implications.

Disturbance processes are integral to species distributions – and for facilitating transitions

Stochastic disturbance events are key processes that determine the dynamics and shape the patterns of linked social-ecological systems (Principle 1). Examples include fire, grazing, wind, floods, soil disturbance and fluctuating nutrient regimes. Depending on the frequency, intensity and interactions with other drivers, disturbances maintain certain patterns of species and ecosystems (Hobbs and Huenneke 1992). Fire, for example, is required for the perpetuation of some native grasses that would otherwise face encroachment by woody tree species. In some cases, the absence of these types of disturbances has reduced the diversity of endemic species (Cowling et al. 1986; Puerto et al. 1990). For these reasons, many conservation management plans include provisions for controlled burns, invasive species management and the use of grazers (e.g. BC Parks).

However, the role of disturbance in biodiversity conservation goes beyond perpetuation of specific species in particular places. Disturbance is also a key mechanism for facilitating species transitions. In the most recent era of conservation management, species transitions have been something to be avoided due to concerns that non-native species may become invasive and incur ecologically and socially undesirable outcomes. However in the context of climate change, facilitating species transitions may be exactly what is desired; either by passive means (e.g. as

species potentially migrate through networks of protected areas in response to changing climatic conditions) or by active interventions (e.g. assisted migration). The assisted migration proposal refers to the deliberate introduction of a species into a region where it hasn't previously existed in recent history (McLachlan et al. 2007). This alternative has come under consideration for species that may not be able to track changing climatic conditions quickly enough, or because there are natural or human barriers in the way. Because transitions to new species assemblages often occur following disturbance, this proposal may require the additional step of making the ecological niche space available (i.e. by initiating some type of disturbance).

Putting aside for the moment the prospect of initiating disturbance, there are risks related just to the facilitated movement of species. Although the vast majority of species introductions fail to establish in new locations (reviewed by Mack et al. 2000), relocating species in new locations may result in localized or even widespread losses of non-target species if introduced species become invasive. A prime example is the extinction of endemic fish species in Lake Victoria that followed the introduction of the Nile perch. But, because not all species become invasive, there has been a great deal of interest in determining the factors that predispose a given species to become invasive in general (e.g. Kolar and Lodge 2001) and in response to climate change in particular (Hoegh-Guldberg et al. 2008; Mueller and Hellman 2008). Determining invasibility has proven challenging due to interactions between species traits and different habitats, but some potential key factors have been identified. These include resource availability, natural enemies, abiotic factors (Shea and Chesson 2002), the number of release events, whether of not the taxon has a history of invasion, and mode of reproduction (Kolar and Lodge 2001).

Considering that species transitions are often mediated by disturbances invites consideration of another even more controversial medical metaphor; namely determining a state of "brain death" (where the recovery of an individual is assessed to be impossible), for the purpose of enabling organ transplantation and anticipated survival of another individual patient. In the context of managing transitions of species on the landscape, a resident (donor) population is assessed to be beyond recovery given changing climate at one location, in order to provide the ecological niche space (the organ-equivalent) for (potentially assisted) in-migrating species (the recipient).

This is a negatively evocative metaphor and we raise it with hesitation. But consider a few examples. This metaphor would apply to interventions that could include the active use of small-scale fire to remove some plant populations, release nutrients and expose a mineral seed-bed to aid in the colonization of a new (for that area) plant species. It could also mean taking advantage of human disturbances such as logging. Recently logged areas for example, could be candidate locations for the attempted establishment of new plant species assessed to be more suited to changing conditions. Alternatively, policy-makers and managers could take a passive approach and capitalize on opportunities created by naturally occurring disturbance events. For example, fire or insect disturbance could prompt re-consideration of which plant species to encourage in "restoration" efforts.

Whether active or passive, the management of ecological transitions carries substantial risks. The prospect of triggering undesirable states [11] is worrisome (Walters 2006). But calculated risk taking (and the potential loss of some species) may become acceptable in order to encourage the long-term persistence of other valued species that would be imperiled in the absence of intervention (Hoegh-Guldberg et al. 2008). In other cases, the potential risks (to a set of valued attributes) may be assessed as being too great to attempt intervention/relocation. Given the suite of interacting uncertainties noted above, these decisions will only ever be made under high degrees of uncertainty. Thus, potential interventions carry with them the same assessment challenges that apply to a triage model (and similar challenges that have developed alongside the history of conservation efforts more generally).

Our intention in raising the relationship between disturbance and biodiversity pattern is not to advocate the spread of weedy species or widespread disturbance. It is to highlight that natural disturbance plays an important role in the perpetuation of biodiversity, that it is an important process by which species transitions (more specifically, species establishment) may occur, and that the desirability of a given species is a social, not ecological determination.

Proposition: Species transitions and disturbance

New protected areas and migration corridors may be a necessary but insufficient means to achieve the establishment of some populations in new locales. Providing the potential habitat is

[11] Recalling earlier conversations, whether or not attributes of a given social-ecological configuration are deemed desirable or not will differ across stakeholder groups and social context.

clearly essential, but a disturbance event (either anthropogenic or "natural") that opens up the niche space may be required to facilitate colonization and establishment of some species.

Proposition: Passive vs. active intervention

Considering existing preferences for minimum intervention in conservation areas, and the potential costs to valued ecosystem elements, it is most likely that decision-making will err on the side of not actively removing individuals to make room for another in-migrating spaces. Passive application may be more likely. This may change with time.

Integrating human dimensions into the means

In the above we have discussed the need to simultaneously consider ecological and human dimensions of various adaptation proposals for reasons relating to Principle 1 (landscapes are linked SES). Because conservation activities including protected areas alter property rights and access relations (Agrawal and Ostrom 2001), many view the need to integrate human dimensions on the basis of environmental justice and human rights. Brockington et al. (2006) for example, highlight the importance of ensuring fair, timely and appropriate compensation (money, but also, equity, control over livelihoods, etc.) for both indigenous and non-indigenous groups. Other scholars have highlighted the need to recognize heterogeneity in communities (Brosius et al. 1998), noting that benefits from resources tend to be distributed differently across groups (gender, class, ethnicity) within these communities, and that "the burden of coercion tends to fall unequally on those who are less powerful" (Agrawal 2003). Still others highlight the process by which conservation decisions are arrived at, and the importance of designing processes of engagement and participation that are equitable, transparent, and legitimate in a given locality (Wilshusen et al. 2003).

All conservation and sustainable resource management are to some extent exercises of social engineering (Chan and Satterfield 2008), behavioral constraint (Wilshusen et al. 2003), or even coercion (discussed by Agrawal 2003). Therefore key questions that must be asked include: who decides on the form and potential implementation of new conservation proposals, by what process, and how are the costs and benefits distributed across groups and scales? These topics have received a great deal of attention in specific domains of the conservation and political ecology literature. However they have not yet been integrated into discussions of conservation

proposals for climate change, which have thus far tended to focus solely on ecological dimensions. Proposals to expand protected areas "regardless of political boundaries" (Li et al. 2006), therefore may be misguided.

Proposition: Governance
Addressing dimensions of governance (e.g. participation; compensation; co-management) is fundamental to the implementation and success of any new management regime.

3.4. CONCLUSION

In this paper we have synthesized an integrated set of principles to help conceptualize some of the key policy and management challenges facing the future of biodiversity conservation in an era of climate change. From the principles we have outlined a set of propositions about future possible iterations on conservation policy objectives and means. The propositions are not programmatic. Rather they raise numerous scientific, social and ethical questions that require further empirical research (Chapter 5 and 6).

Environmental policy in general and conservation policy in particular will always be a moving target. Past objectives and means were tailored to a specific set of ecological and social conditions and assumptions. As conditions and assumptions change conservation polices will be adapted. This may include re-calibrating conservation policies, along the lines of incorporating recognition of local ecological losses. It may also include more extensive active management such as facilitating the transitions of species using disturbance. New approaches will carry with them their own sets of problems as previous approaches have in the past. Moreover, new conservation means need not occur to the exclusion of past approaches. Indeed, as Ostrom notes (2007), there are no panaceas for environmental challenges, and multiple context specific approaches will be required. While change in conservation policy is a certainty, it remains to be seen which options will be acceptable, and which options will be rejected in the development of this next iteration of conservation policy.

Table 3.1. Principles for adapting conservation policies to an era of climate change, and their implications as expressed as propositions [within parentheses indicates the principle as basis for the proposition].

Principles	Propositions for Conservation Policy in an Era of Change
P1. Landscapes are the dynamic product of biophysical and socio-cultural drivers that interact across scales. **P2.** Knowledge of future species distributions is incomplete **P3.** Any management regime will be good for some species and bad for others **P4.** Human values change over time	**Recalibrating objectives** Future conservation policies may include a re-calibration of management objectives (and expectations) to match conditions characterized by limited predictive capacities and deterministic control [P1, P2, P4].
	Coarse-scale features Management objectives based on "physical templates" (e.g. topographic gradients such as elevation, aspect, latitude and edaphic regimes) offer a potential alternative to site-selection methods based on projected species distributions [P1, P2]
	Uncertainties and adaptation Ecological uncertainties have always been present in conservation decision-making. Their presence is not in and of itself, a barrier to adaptation [P1]
	"Safe-to-Fail" policies We will not know in advance of trying alternative conservation means if they will be more successful at achieving a specific set of objectives than conventional methods. This implicates the need for an adaptive management approach and a "safe-to-fail" philosophy [P1, P2]
	New management objectives: triage? Given climate change (and other drivers), adaptation for conservation policy may include triage for management objectives that would explicitly divert resources away from specific conservation targets (species or ecosystems) in favor of other targets assessed to be more viable by some degree/type of intervention [P1, P2, P3]
	Variation in the acceptability of conservation interventions A range of social variables will influence the relative acceptance of the interventions that flow from a triage approach. Using these variables (examples in main text), it may be possible to develop typologies of intervention amenable/resistant systems, which could be used as a decision-making heuristic under potential urgent circumstances and irreducible uncertainty [P1].
	Acceptability of new conservation objective and means and time Ideas of conservation and valued ecosystem attributes change over time. Over longer temporal scales, these changes will impact both the acceptability of a triage framework itself in a given context, the value of the ecological elements being triaged within the framework, and the means (interventions) that are acceptable [P1, P4]
	Species transitions and disturbance Providing new protected areas and migration corridors may be necessary but insufficient to achieve the establishment of some populations in new locales. Providing the potential habitat is clearly essential, but a disturbance event (either anthropogenic or "natural") that opens up the niche space may be required to facilitate colonization and establishment of some species [P1, P3].
	Passive vs. active intervention Considering existing preferences for minimum intervention in conservation areas, and the potential costs to valued ecosystem elements, it is most likely that decision-making will err on the side of not actively removing individuals to make room for another in-migrating spaces. Passive application may be more likely. This may change with time [P1, P4]
	Governance Addressing dimensions of governance (e.g. participation; compensation; co-management) is fundamental to the implementation and success of any new management regime.

3.5. REFERENCES

Abel, N., Cumming, D.H.M. and Anderies, J.M., 2006. Collapse and reorganization in social-ecological systems: questions, some ideas and policy implications. Ecology and Society 11,

Agrawal, A., 2003. Sustainable Development of Common Pool Resources. Annual Review of Anthropology 32, 243-262.

Agrawal, A., and Ostrom, E., 2001. Collective action, property rights, and decentralization in resource use in India and Nepal. Political Science 29, 495-514.

Araújo, M.B., Guisan, A., 2006. Five (or so) challenges for species distribution modelling. Journal of Biogeography 33, 1677-1688.

Araújo, M.B., Cabezas, M., Thuiller, W., Hannah, L.,Williams, P.H., 2004. Would climate change driver species out of reserves? An assessment of existing reserve-selection methods. Global Change Biology 10, 1618-1626.

Baron, J.L., Joyce, L.A., Kareiva, P., Keller, B.D., Palmer, M.A.,Peterson, C.H. and Scott, J.M., 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A report by the US Climate Change Science Program and the Subcommittee on Global Change Research. 873.

Bengtsson, J., Angelstam, P., Elmqvist, T., Emanuelsson, U., Folke, C., Ihse, M., Moberg, F.,Nystrom, M., 2003. Reserves, resilience and dynamic landscapes. Ambio 32, 389-396.

Berkes, F., 2004. Rethinking community-based conservation. Conservation biology 18, 621-630.

Berkes, F. and Folke, C., 1998. Linking social and ecological systems: management practices and social mechanisms for building resilience.

Berkes, F., Colding, J. and Folke, C., 2003. Navigating social-ecological systems. 393.

Brockington, D., Igoe, J. and K. Schmidt-soltau, 2006. Conservation, human rights, and poverty reduction. Conservation biology 20, 250.

Brosius, J., Tsing, A.,Zerner, C., 1998. Representing communities: histories and politics of community-based natural resource management. Society and Natural Resources 11, 157-169.

Brosius, J.P., 2004. Indigenous peoples and protected areas at the World Parks Congress. Conservation biology 18, 609.

Brosius, J.P., 1999. Anthropological engagements with environmentalism. Current Anthropology 40, 277-288.

Buchanan, J.M., 1987. The relatively absolute absolutes. Draft paper prepared for presentation at SEA meeting

Carmel, Y., Flather, C., H., 2006. Constrained range expansion and climate change assessments. Frontiers in Ecology and the Environment 4, 178-179.

Chan, K.M.A., and Satterfield, T., 2008. Justice, equity and biodiversity. In: S. Levin and Daily, G.C. and Colwell, R.K. (Ed.), The Encyclopedia of Biodiversity. Oxford, Elsevier Ltd.,

Cowling, R.M., Pierce, S.M.,and Moll, E.J., 1986. Conservation and utilisation of South Coast renosterveld, an endangered South-African vegetation type. Biological conservation 37, 363-377.

Cronon, W., 1996. Uncommon Ground: Rethinking the human place in nature. 561.

Crumley, C.L., 1994. Historical Ecology: Cultural knowledge and changing landscapes. 284.

Dunlop, M. and Brown, P.R., 2008. Implications of climate change for Australia's National Reserve System: A preliminary assessment. Report to the Department of Climate Change,

Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., et al, 2005. Global consequences of land use. Science 309, 570-574.

Folke, C., 2006. Resilience: the emergence of a perspective for social-ecological systems analyses. Global Environmental Change 16, 253-267.

Gienapp, P., Teplitsky, C., Alho, J.S.,Mills, J.A. and Merila, J., 2008. Climate change and evolution: disentangling environmental and genetic responses. Molecular Ecology 17, 167-178.

Guisan, A., Thuiller, W., 2005. Predicting species distribution: offering more than simple habitat models. Ecology letters 8, 993-1009.

Guisan, A., Zimmermann, N.E., 2000. Predictive habitat distribution models in ecology. Ecological Modelling 135, 147-186.

Gunderson, L.H., Holling, C.S., 2002. Panarchy: understanding transformations in human and natural systems.

Gunderson, L.H., Holling, C.S.,Light, S.S., 1995. Barriers and Bridges to the Renewal of Ecosystems and Institutions. 593.

Hagerman, S.H., Dowlatabadi, H., Satterfield, T., McDaniels, T. 2007. Biodiversity protection, climate change and decision-making. Poster presented at the annual meeting of the American Association for the Advancement of Science (AAAS) San Francisco, CA.

Hagerman, S.M., Dowlatabadi, H., Satterfield, T., Elements, Determinants and Dynamics of Policy Change: Insights from 150 years of Forest Management in BC. Submitted to Ecology and Society.

Halpin, P.N., 1997. Global climate change and natural-area protection: management responses and research directions. Ecological Applications 7, 828-843.

Hamann, A., and Wang, T., 2006. Potential effects of climate change on ecosystem and tree species distributions in British Columbia. Ecology 87, 2773-2786.

Hannah, L., Midgley, G., Andelman, S., Araujo, M., Hughes, G., Martinez-Meyer, E., Pearson, R.,Williams, P., 2007. Protected area needs in a changing climate. Frontiers in Ecology and Environment 5, 131-138.

Hannah, L., Midgley, G.F.,Millar, D., 2002. Climate change-integrated conservation strategies. Global Ecology and Biogeography 11, 485-495.

Harper, J., 2002. Endangered species: Health, Illness and Death Among Madagascar's People of The Forest. Carolina Academic Press, Durham, North Carolina.

Heckenberger, M.J., Russel, J.C., Toney, J.R.,and Schmidt, M.J., 2007. The legacy of cultural landscapes in the Brazilian Amazon: implications for biodiversity. Philosophical Transactions of the Royal Society B 362, 197-208.

Heikkinen, R.K., Luoto, M., Araujo, M.B., Virkkala, R., Thuiller, W.,Sykes, M.T., 2006. Methods and uncertainties in bioclimatic envelope modelling under climate change. Progress in Physical Geography 30, 751-777.

Hobbs, R.J. and Kristjanson, L.J., 2003. Triage: How do we prioritize health care for landscapes. Ecological Management & Restoration 4, S39-S45.

Hobbs, R.J., Huenneke, L.F., 1992. Disturbance, diversity and invasion: implications for conservation. Conservation Biology 6, 324-337.

Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P.,Thomas, C.D., 2008. Assisted Colonization and Rapid Climate Change. Science 321, 345-346.

Ibanez, I., Clark, M.C., Feeley, K., Hersh, M., LaDeau, S., BcBride, A., Welch, N.E.,Wolosin, M., 2006. Predicting biodiversity change: outside the climate envelope, beyond the species-area curve. Ecology 87, 1896-1906.

IPCC, 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 104.

Janzen, D., 1998. Gardenification of wildland nature and the human footprint. Science 279, 1312-1313.

Janzen, D.H., 2000. Costa Rica's Area de Conservacion guanacaste: a long march to survival through non-damaging biodeveleopment. Biodiversity 1, 122-132.

Kareiva, P. and Levin, S., 2003. The importance of species: Perspectives on expendability and triage. Princeton University Press, Princeton, New Jersey.

Kareiva, P., Marvier, M., 2003. Conserving biodiversity coldspots. American Scientist 91, 344-351.

Kinzig, A.P., Ryan, P., Etienne, M., Allison, H., Elmqvist, T.,Walker, B.H., 2006. Resilience and regime shifts: assessing cascading effects. Ecology and Society 11,

Kolar, C.S., and Lodge, D.M., 2001. Progress in invasion biology: predicting invaders. Trends in ecology evolution 16, 199-204.

Lambeck, R.J., 1997. Focal species: a multi-species umbrella for nature conservation. Conservation Biology 11, 849-856.

Lenoir, J., Gegout, J.C., Marquet, P.A., de Ruffray, P.,Brisse, H., 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320, 1771.

Li, M.H., Krauchi, N.,Gao, S., 2006. Global warming: Can existing reserves really preserve current levels of biological diversity? Journal of integrative plant biology 48, 255-259.

Light, S.S., Gunderson, L.H.,Holling, C.S., 1995. The Everglades: Evolution and management in a turbulent ecosystem. In: L. H. Gunderson, C. S. Holling and S. S. Light. (Ed.), Barriers and Bridges to the Renewal of Ecosystems and Instiutions. Columbia University Press, New York, NY, pp. 103-168.

Loo, T., 2006. States of Nature: Conserving Canada's wildlife in the twentieth century. UBC Press, Vancouver.

MacDougall, A., Beckwith, B.,and Maslovat, C.Y., 2004. Defining conservation strategies with historical perspectives: a case study from a degraded oak grassland ecosystem. Conservation biology 18, 455-465.

Mack, R.N., Simberloff, D., Londsdale, M., Evans, H., Clout, M.,Bazzaz, F.A., 2000. Biotic invasions: Causes, epidemiology, global consequences and control. Ecological Applications 10, 689-710.

Malcolm, J.R., Liu, C., Neilson, R.P., Hansen, L.,Hannah, L., 2006. Global warming and extinctions of endemic species from biodiversity hotspots. Conservation Biology 20, 538-548.

Margules, C., and Usher, M.B., 1981. Criteria used in assessing wildlife conservation potential: a review. Biological Conservation 21, 79-109.

Margules, C.R. and Pressey, R.L., 2000. Systematic conservation planning. Nature 405, 243-253.

Marris, E., 2007. What to let go. Nature 450, 152-155.

McLachlan, J.S., Hellmann, J.J.,Schwartz, M.W., 2007. A framework for debate of assisted migration in an era of climate change. Conservation Biology 21, 297-302.

Meine, C., Soule, M. and Noss, R.F., 2006. "A mission-driven discipline:" the growth of conservation biology. Conservation Biology 20, 631-651.

Menzel, , 2006. European phenological response to climate change matches the warming pattern. Global change biology 12, 1969.

Naeem, S., 1998. Species redundancy and ecosystem reliability. Conservation Biology 12, 39-45.

Nelson, R., 2003. Environmental Colonialism: "Saving" Africa from Africans. The Independent Review VIII, 65.

Neumann, R.P., 2004. Moral and discursive geographies in the war for biodiversity in Africa. Political Geography 23, 813-837.

Neumann, R., 1998. Imposing wilderness: struggles over livelihood and nature preservation in Africa. University of California Press, Berkeley.

Noss, R.F. 1996. Conservation or Convenience? Conservation biology 10, 921-922.

Noss, R.F., 2001. Beyond Kyoto: Forest management in a time of rapid climate change. Conservation biology 15, 578-590.

Olsson, P., Folke, C.,Berkes, F., 2004. Adaptive co-management for building resilience in social-ecological systems. Environmental management 34, 75.

Ostrom, E., Janseen, M.A.,Anderies, J.M., 2007. Going beyond panaceas. Proceedings of the National Academy of Sciences 104, 15176-15178.

Ostrom, E., 2008. Frameworks and theories of environmental change. Global Environmental Change 18, 249-252.

Parmesan, C., 2008. Where the wild things were. Daedalus Spring, 31-38.

Parmesan, C., 2006. Observed Ecological and Evolutionary Impacts of Contemporary Climate Change. Annual Reviews of Ecology and Systematics 37, 637-669.

Parmesan, C., Yohe, G., 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421, 37-42.

Pearson, R.G., Dawson, T.P., 2003. Predicting the impacts of climate change on the distribution of species: are bioclimate envelope models useful? Global Ecology and Biogeography 12, 361-371.

Pearson, R.G., 2006. Climate change and the migration capacity of species. Trends in Ecology and Evolution 21, 111-113.

Peters, R.L., Darling, J.D.S., 1985. The greenhouse effect and nature reserves: Global warming would diminish biological diversity by causing extinctions amon reserve species. BioScience 35, 707-717.

Pimm, S.L., 2000. Against triage. Science 289, 2289.

Pressey, R.L., Cabeza, M., Watts, M., Cowling, R.M.,Wilson, K.A., 2007. Conservation planning in a changing world. Trends in Ecology and Evolution 22, 583-593.

Province of British Columbia, 1911. Statutes of the Province of British Columbia: An Act respecting Strathcona Park. 331-332.

Puerto, A., Rico, M., Matias, M.D.,and Garcia, J.A., 1990. Variation in structure and diversity in mediterranean grasslands related to trophic status and grazing intensity. Journal of Vegetation Science 1, 445-452.

Rayfield, B., James, P.M.A., Fall, A.,Fortin, M., 2008. Comparing static versus dynamic protected areas in the Quebec boreal forest. Biological Conservation 141, 438-449.

Reynolds, J.F., Stafford Smith, M.D., Lambin, E.F., Turner II, B.L., Mortimore, M., Batterbury, S., Downing, T.E., Dowlatabadi, H., Fernandez, R., et al, 2007. Global desertification: Building a science for dryland development. Science 316, 847-851.

Ribot, J.C., Peluso, N., 2003. A theory of access. Rural Sociology 68, 153.

Rinnan, R.A., Michelsen, A.,Baath, E. and Jonasson, S., 2007. Fifteen years of climate change manipulations alter soil microbial communities in a subarctic heath ecosystem. Global Change Biology 13, 28-39.

Root, T.L., Price, J.T., Hall, K.R., Schneider, S.H., Rosenzweig, C.,Pounds, J.A., 2003. Fingerprints of global warming on wild animals and plants. Nature 421, 57-60.

Saxon, E., Baker, B., Hargrove, W.,Zganjar, C., 2005. Mapping environments at risk under different global climate change scenarios. Ecology Letters 8, 53-60.

Shea, K., Chesson, P., 2002. Community ecology theory as a framework for biological invasions. Trends in Ecology and Evolution 17, 170-176.

Slater, C., 2000. Justice for whom? Contemporary images of amazonia. In: C. Zerner. (Ed.), People, plants and justice: the politics of nature conservation. Columbia University Press, New York, pp. 67-82.

Slater, C., 1996. Amazonia as edenic narrative. In: Anonymous (Ed.), Uncommon ground: rethinking the human place in nature. W.W. Norton and Co., New York, pp. 114-159.

Suttle, K.B., Thomsen, M.A. and Power, M.E., 2007. Species interactions reverse grassland response to changing climate. Science 315, 640-642.

Thomas, C., D., Cameron, A., Green, R., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siqueira, M.F., Grainger, A., et al, 2004. Extinction risk from climate change. Nature 427, 145-148.

Thuiller, , 2008. Predicting global change impacts on plant species' distributions: Future challenges. Perspectives in plant ecology, evolution and systematics 9, 137.

Thuiller, W., Richardson, D.M., Pysek, P., Midgley, G.F., Hughes, G.O.,Rouget, M., 2005. Niche-based modelling as a tool for predicting the risk of alien plant invasions at a global scale. Global change biology 11, 2234-2250.

Thuiller, W.L., S., Araujo, M.B., Sykes, M.T.,Prentice, C., 2005. Climate change threats to plant diversity in Europe. Proceedings of the National Academy of Sciences of the United States of America 102, 8245-8250.

Tisdell, C., Swarna Nantha, H.,and Wilson, C., 2007. Endangerment and likeability of wildlife species: how important are they for payments proposed for conservation. Ecological Economics 60, 627-633.

Turner, B.L., Clark, W.C., Kates, R.W., Richards, J.F., Matthews, J.T.,Meyer, W.B., 1990. The earth as transformed by human action: global and regional changes in the biosphere over the past 300 years. 713.

Urban, D.L., Miller, C., Halpin, P.N.,Stephenson, N.L., 2000. Forest gradient response in Sierran landscapes: the physical template. Landscape Ecology 15, 603-620.

Vane-Wright, R.I., Humphries, C.J.,Williams, P.H., 1991. What to protect - Systematics and the agony of choice. Biological conservation 55, 235-254.

Walker, B., 1992. Biodiversity and Ecological Redundancy. Conservation Biology 6, 18-23.

Walker, B., Gunderson, L., Kinzig, A., Folke, C.,Carpenter, S. and Schultz, L., 2006. A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems. Ecology and Society 11,

Walker, B., Holling, C.S., Carpenter, S.R.,Kinzig, A., 2004. Resilience, adaptability and transformability in social-ecological systems. Ecology and Society 9, June 12, 2005.

Walker, Brian and Abel, Nick, 2002. Resilient rangelands: adaptation in complex systems. In: Gunderson, Lance, H. and Holling C.S. (Ed.), Panarchy: Understanding transformations in human and natural systems. Island Press, Washington, pp. 293-313.

Walmsley, C.A., Smithers, R.J., Berry, P.M., Harley, M.,Stevenson, M.J., 2007. MONARCH - Modelling Natural Resource Responses to Climate Change - a synthesis for biodiversity conservation. 1-53.

Walters, J., 2006. "Do no harm". Conservation in Practice 7,

Walther, G., Post, E., Convey, P., Mensel, A., Parmesan, C., Beebee, T.J.C., Fromentin, J., Hoegh-Guldberg, O.,Bairlein, F., 2002. Ecological responses to recent climate change. Nature 416, 389-395.

West, P., Igoe, J.,Brockington, D., 2006. Parks and peoples: the social impact of protected areas. Annual Review of Anthropology 35, 251-277.

Williams, P., Hannah, L., Andelman, S., Midgley, G., Araujo, M., Hughes, G., Manne, L., Martinez-Meyer, E.,Pearson, R., 2005. Planning for Climate Change: Identifying Minimum-Dispersal Corridors for the Cape Proteaceae. Conservation Biology 19, 1063-1074.

Wilshusen, P.R., Brechin, S.R., Fortwangler, C.,West, P.C., 2003. Contested Nature: Conservation and development at the turn of the twenty-first century. In: Steven R. Brechin. (Ed.), Contested Natures: promoting international biodiversity conservation with social justice in the twenty-first century. State University of New York Press, Albany, pp. 1-22.

Woodward, F.I. and Beerling, D.J., 1997. The dynamics of vegetation change: health warnings for equilibrium "dodo" models. Global Ecology and Biogeography 6, 413-418.

Wynn, G., 2004. "Shall we linger along ambitionless?": Environmental perspectives on British Columbia. BC Studies 142/143, 5-67.

Yohe, G.W., 2006. Representing dynamic uncertainty in climate policy deliberations. Ambio 35, 89-91.

4. OBSERVATIONS ON DRIVERS AND DYNAMICS OF ENVIRONMENTAL POLICY CHANGE: INSIGHTS FROM 150 YEARS OF FOREST MANAGEMENT IN BC [12]

4.1. INTRODUCTION

Biophysical and human (socio-cultural) elements of landscapes co-adapt and change over time. By elements we mean a constituent part or component. These changes are the result of social, political and ecological processes that interact across scales (e.g. Gunderson et al. 1995; Gunderson and Holling 2002; Wynn 2004). While humans and the biophysical environment have always existed as a co-produced dialectic (Crumley 1994; Balée 1998), the complexity and scale of the interrelationships have increased in recent centuries and decades (Turner et al. 1990; Goudie 2000). Land use change, genetically modified organisms, geo-political events, transmission of disease, distal accumulation of toxic compounds, the consumption patterns and impacts of 6.6 billion people, and climate change are salient cases in point.

The impacts of climate change in particular, present substantial challenges for resource managers and policymakers. Changing temperature and precipitation regimes (IPCC 2007) are projected to impact natural disturbance dynamics (Dale et al. 2001), interspecific interactions (Araújo and Luoto 2007) primary production (Nemani et al. 2003) and microbial activity (Rinnan et al. 2007). Indeed, climate change has already been linked with changes in species distributions (Root et al. 2003; Parmesan 2006; Lenoir 2008).

These projected and observed changes are in contrast with management policies based on equilibrium assumptions of ecosystem behavior, and that tend to support a "command and control" approach to managing natural resources (Holling and Meffe 1996). As described by these authors, a command and control approach assumes that ecosystems are well-bounded entities, that are governed by linear cause and effect relationships and that are predictable given the right information. Examples of control polices include both the management of forests for a steady and predictable timber supply, and the management of biodiversity for species persistence

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within static protected areas. Although scholars have advocated alternatives to command and control policies for some time, in many cases policies based on assumptions of ecological stability continue to persist in practice.

The incompatibility between non-linear landscape dynamics and control-type policies, in combination with the apparent persistence of these policies, prompts the following question: What factors might eventually contribute to policy change that does incorporate an understanding of dynamic systems, limited control and limited predictive capacities? We use the case of forest management in British Columbia (BC) to examine the history and drivers of past changes in this system. In doing so we propose some likely key factors over time.

The literature on the biophysical and social-political dynamics of BC forests is rich, though relatively discrete with respect to its integration across disciplinary boundaries. On the one hand, natural scientists have contributed to an understanding of the biophysical patterns and processes operating in temperate forests. A selection of this work includes ecosystem classification (Krajina 1965; Pojar et al. 1987); natural disturbance such as fire (DeLong 1998), wind (Lertzman et al. 1996), and insects (Taylor and Caroll 2004); plant-disease interactions (Baleshta et al. 2005); below-ground dynamics (Simard 1997) and net ecosystem productivity (Humphreys et al. 2007).

On the other hand, environmental historians, political scientists and sociologists have examined the human dimensions acting in BC forests. Some have focused on interactions between technology, mechanization and labor (Marchak 1983; Rajala 1998; Rajala 2006), others have sought to explain changes in forest policy at specific times by focusing on various combinations of market pressures, interests, institutions and ideas (Hoberg 1996; Lertzman 1996; Howlett 2001). Still others have focused on the political, scientific and ideological aspects of conservation and environmental movements in BC at various times (Wilson 1998; Wynn 2004), and in Canada more broadly (Gillis and Roach 1986; Loo 2006).

The aim of this paper is to merge insights from these disciplinary perspectives in effort to provide an *integrated* empirical analysis of the biophysical and social elements (components) of change in the regional BC forest system over time. The purpose of using a historical approach

was to better understand the drivers and dynamics of policy change in this system over time in order to extract insights into potential future iterations of change in this system. By drivers we mean key factors and forces (potentially from both biophysical and social domains) for which there is empirical evidence to indicate an important/measurable contribution to a set of observed phenomena. By dynamics we mean patterns of policy change over time (e.g. gradual and incremental dynamics, sudden and episodic, or some combination). In doing so, it is not our intention to seek to identify a single consistent set of causal factors. Rather we are interested in exploring the possibility that there may be commonly observed patterns and key variables contributing to change (or not) in this system over time.

We use the regional provincial boundary (BC) to delineate the system and our analysis. This is the scale of the key forestry and conservation legislation governing management and use in the province. This boundary further serves our purpose of drawing coarse scale insights into the drivers and dynamics of change at a regional scale. Importantly, rules for resource use in the provincial system also include federal legislation, but analysis at that much larger scale does not fit with the analytical objectives of this paper. Nevertheless, in the analysis that follows, we do examine drivers external to this regional boundary that includes consideration of drivers from national and international scales. In the text below, forces external to this boundary setting are referred to as exogenous, those within are referred to as endogenous.

4.2. CONCEPTUAL FOUNDATIONS

Before proceeding, it is necessary to outline and define a set of key concepts that shape the analysis that follows. Broadly, our approach adopts the perspective that social-ecological systems (SES) (Berkes and Folke 1998) are linked, co-produced systems that display multi-scalar, historically contingent, non-linear change dynamics (Crumley 1994; Gunderson and Holling 2002; Berkes et al. 2003; Walker 2004; Reynolds et al. 2007). This view derives jointly from Holling's seminal work on multiple stable states and non-equilibrium behavior of ecological systems (Holling 1973), and related insights on non-linearity, path dependence, and

multiple potential outcomes in complex adaptive systems (CAS) more broadly (e.g. Holland 1995; Levin 1998).[13]

More specifically, this work is situated and interpreted in the context of three broad literatures: 1) resilience theory; 2) theories of policy change; and 3) social theories of science and policy. We discuss each of these in turn below.

Resilience Theory: Resilience theory is an integrative theory of change that examines processes and drivers of change in complex adaptive managed systems (Gunderson and Holling 2002). Resilience theory is "integrative" in that it seeks to draw from and synthesize "partial perspectives" relating to processes and dynamics of change in linked social-ecological systems drawing from the fields of ecology, economics and institutional analysis (Holling et al. 2002:8). In resilience theory, understanding change is organized around the metaphor of the 4-phase adaptive cycle; within which change dynamics may, but not always (discussed by Walker et al. 2006), pass through phases of growth, conservation, release and reorganization (e.g. Allison and Hobbs 2004).

Theories of Policy Change: From the policy sciences, we draw on the decades of scholarship from different approaches into the question of what causes policy change and why. Below, we briefly highlight a *selection* of this scholarship. Our interests lie in understanding the drivers and dynamics of change over time. For this reason, we specifically sought approaches with a commitment to examining the question of what changed and why in historical contexts. In doing so, we find the work of Baumgartner and Jones (1991); Kingdon (1995); Sabatier and Jenkins Smith (1993); Hajer (1995); Pierson (2004); Repetto et al. (2006); and Sabatier (2007) particularly useful for our purposes. These authors and others, have used and described a range of frameworks, theories and approaches to explain or organize thinking about a) drivers and or b) dynamics of policy change over time.

Drivers of Change: Some scholars have worked towards developing alternatives to the analysis of policy change oriented towards institutions and actors. For instance, Sabatier and Jenkins Smith (1993) argue that shared "belief systems" (or value priorities and perceptions of what

[13] Defined as systems in which patterns at higher levels of organization or broader scales emerge from and feed back to processes and interactions occurring at lower levels of organization or smaller scales.

matters), and policy learning through technical debates are key variables in policy change (and resistance to change) over time. Importantly, and related to other perspectives, these authors argue that "core beliefs" are "very resistant to change", particularly, when proponents of the status quo remain in positions of influence (Sabatier 2007). With some similarities, Hajer (1995) uses a constructivist approach to understand environmental policy change. For Hajer, policy-making is understood as an "interpretive activity" (1995: 22) that is shaped by particular discursive understandings of a given environmental "problem". As with Sabatier and Jenkins Smith (1993), Hajer also uses the concept of coalitions (discourse coalitions in the latter case) as important sources towards policy change. However, Hajer highlights the "unstable value positions" of individuals (1995: 71) that are labile and change over time in response to new "story lines" or discourses. Hajer also underscores the observation that people's beliefs and contributions vary in different settings and can, in fact, lend support to multiple coalitions (1995). These approaches further differ in their views on the objectivity of science and its role in achieving policy consensus.

From a slightly different perspective, Kingdon (1995) argues that a number of factors increase the chances of a new proposal surviving the "selection process" and contributing to change. Specifically, Kingdon argues that new proposals need to have gone through a gestation period of "softening up"; they must be ready and feasible; and similar to the perspectives outlined in the preceding paragraph, they must reflect the values of the actors.

Dynamics of Change: Others scholars have argued from a methodological perspective that understanding policy change at a given point in time necessarily requires understanding the history of preceding sequential events and processes (e.g. Pierson 2004). Pierson argues that historical events set path dependent processes and are key factors in shaping outcomes removed in time. Path dependency has been defined as "dynamic processes involving positive feedback, which generate multiple possible outcomes depending on the particular sequence in which events unfold" (Pierson 2004: 20). Key features of path dependency include self-reinforcement (positive feedbacks), and the establishment of trajectories that become entrenched over time. Without attention to dynamics over time, it is argued, analysts may fail to recognize key variables explaining a given phenomenon (Pierson 2004).

Related to the concept of path dependence and the analytical benefits of historical analysis for understanding a given set of observations, is the observation that given the right timing, relatively inconsequential events can result in substantial change. Some scholars have argued that policy change proceeds "incrementally" (Lindblom 1959). And that incremental change occurs for intrinsic (that is the way the world works), and strategic reasons (cf Kingdon 1995). Or with more nuance, that incrementalism applies to some aspects of policy change, such as the generation of new alternatives, but not to the larger process of agenda setting (Kingdon 1995). Other scholars, some adopting Stephen Gould's punctuated equilibrium metaphor from evolutionary biology, have argued that patterns of change are more accurately described as occurring in punctuated spurts of more substantive and infrequent change that follow prolonged periods of relative constancy and stasis (e.g. Baumgartner and Jones 1991; Kingdon 1995; Howlett and Ramesh 2003; Repetto 2006). Reflecting the social variables that are commonly studied within the policy sciences, key contributing factors towards policy change include the role of social movements, ideas, technologies, actors, institutions, market forces, learning, and scientific information.

There are some key similarities and differences between resilience theory, and theories of policy change (selectively outlined above). Similarities and points of convergence include the shared observations that a relatively small set of key variables and relationships underpin complex change dynamics (Holling et al. 2002; Walker et al. 2006; Sabatier 2007); the importance of external events to a given system (however defined) in determining policy change; and the observation that slowly unfolding processes may be critical variables contributing to a given set of observations (Pierson 2004; Walker et al. 2006). This last point further reinforces the benefits historical inquiry. Moreover, in resilience theory, the adaptive cycle predicts similar change dynamics to a punctuated equilibrium model (and carries with it the additional benefit of integrating ecological and social variables). For instance, Gunderson and Holling (2002) describe the dynamics of adaptive cycles as: "cycles of slow accumulation of natural and cultural capital – in an ecosystem, an institution, or a society…interspersed with rapid phases of reorganization where, for transient moments, novelty can emerge to become subsequently entrained."

A key difference between resilience theory and theories of policy change more specifically, is the extent of analytical integration of transdisciplinarity. For instance, while many approaches to

understanding change in the policy sciences seek to bridge disciplines (e.g. economics, institutional analysis, political science, law and sociology), integration across social and natural *domains* to include biophysical drivers of change is much more rare. The position taken in this paper is that integration across social and natural domains is critical to a comprehensive understanding of change.

Social Theories of Science: Lastly, the selected theories of policy change sketched above incorporate in different ways the role of scientific and technical debates as sources of policy change. For this reason we draw (to a lesser extent than the two literatures already described) from insights from social theories of science. Research from this tradition helps to understand the roles and non-roles of science and (ostensibly) scientific debates in decision-making (see Jasanoff 2004; Oreskes 2004; Pielke 2004). Decades of research in this field have shown that the domains of science and society are co-produced and cannot be separated in practice. Rather there are subjective values at play during all phases of knowledge production and application of science in policy (Jasanoff 2004). With respect to the relationship between scientific uncertainty and policy change, research in this field has shown that "scientific proof is rarely what is at stake in a contested environmental….issue". And that in environmental policy, there is "no need to wait for proof, no need to demand it and no basis to expect it" (Oreskes 2004).

Questions and Propositions

Having now established the aim of this paper, and our conceptual foundations, the analysis that follows explores the following questions (*Q.*) and propositions (*P.*), relating to the determinants and dynamics of policy change in a specific SES. As derived from the insights outlined above, we are particularly interested in understanding what changed and why; the role of scientific information and uncertainty; and more broadly, observed patterns of policy change through time. The historical approach and analysis that follows enables us to explore these propositions empirically.

> *Q 1.* How has a selected set of system attributes changed over time? What drivers were key contributors of change when it occurred? From what scale and what domain did these factors originate?

P.1. The degree of influence of different drivers varies with origin (exogenous vs. endogenous to the system), domain (e.g. social, ecological), and over time.

Q.2. In what ways did the presence of scientific uncertainties shape policy responses over time?

P. 2. The presence of decision-relevant uncertainties is not, in-and-of-itself a barrier to the adoption of new policy proposals.

Q. 3. Do the observed patterns of policy change in this system align with any of the established models of change?

P.3. Policy change in this system has proceeded according to a punctuated equilibrium model.

4.3. APPROACH AND DATA

We use an integrated assessment-inspired framework (IA) to organize this analysis and to maintain an integrated focus on historical processes and policy implications. Across its various formations, IA approaches share the following features: a focus on interdisciplinarity (placing the problem in broader context - both in time and beyond disciplinary borders); identification of uncertainties (which aids in identifying what we can, and can't know within a decision context); which together can provide integrated insights for decision-making (Rotmans and van Asselt 2000). Moreover, an IA approach focuses on the multiple drivers acting on a given system and responses to these drivers over time (cf Reynolds et al. 2007). Echoing the themes of the specific literatures described above, key groups of variables for IA include a) agency (who are the actors in the system, what degree of influence do they have on decision making and what are their objectives); b) scale (what are the key social and ecological factors influencing system attributes at different scales) c) uncertainties (what are the various types of uncertainty in the system; what can, and can't we know within a decision context) and d) path dependency and history (how have a selected set of attributes of the system changed over time).

Using an IA-inspired framework as a guide to the variables examined, we collected historical data on the following variables dating from 1850 to present. The variables can be divided into three categories: 1) governance (actors, institutional arrangements, decision-making process); 2) inputs to decision-making (stated policy objectives, scientific uncertainties, technologies, markets, biophysical drivers); and 3) outputs of decision-making (area harvested, area planted, area set-aside as protected) (Table 4.1). These categories are used for analytical purposes, but they are co-produced across scales and domains in practice.

Data collection included a thorough reading of provincial and federal Royal Commissions, and legislation; ministry annual reports; Hansard reports (verbatim records of legislative debates); agency publications; conference proceedings; newspaper articles; industry association publications, Statistics Canada and BC Stats. Secondary sources included scholarly analyses of forest policy in BC.

To assess the impacts of scientific uncertainties on decision-making we selected two core scientific issues in forest management during this period: forest inventory, and forest regeneration. Qualitative accounts of certainty and uncertainty were collected from the documentary materials listed above as well as from inventory reports, and peer-reviewed literature.

This paper proceeds in three parts. We begin with a description of the region of focus. This is followed by a historical profile in which a consistent set of variables is examined through time. In the last section, we discuss the historical analysis in relation to the questions and propositions set forth in the introduction.

4.4. AREA of FOCUS

Bio-physiographic-climatic components

British Columbia spans 11 degrees of latitude and 25 degrees longitude, and occupies a total area of land and freshwater of 95.2 million hectares (Meidinger and Pojar 1991). The provincial

region is influenced by 4 sub-continental climatic regimes (Demarchi 1995), and includes all 9 of the major soil groups found in Canada. Various combinations of physiography, climate, and soils have formed the basis of a number of ecosystem classifications schemes that describe the assemblages of biotic components across this region. Of these, the Biogeoclimatic Ecological Classification (BEC) used by the BC Ministry of Forests delineates 14 regional zones (and 76 subzones) that currently includes ecosystems ranging from deserts, grasslands, wetlands, a diversity of forest types, and alpine tundra (Figure 4.1).

Over 60% of the provincial area (approximately 59 million ha) is classified as forest, which range in type from coastal temperate forests, interior-dry forests and northern boreal forest. A number of natural disturbance processes have influenced the biotic patterns described in the various ecosystem classifications. These vary by ecosystem in frequency, intensity and scale and include fire, pathogens, insect activities, wind-events, drought and flooding (Wong 2004; Daniels and Gray 2006). In addition, human activities including logging, mining, agriculture, settlements, road development, the introduction of non-native species, fire suppression and controlled burns have in the past, and continue to impact observed biotic patterns.

Current forest ownership and governance

The Province owns approximately 93% (55.2 million ha) of the total forest area in this region. Federal and private ownership comprise 1% and 3% respectively. Access to the publicly-owned forest-land in BC (Crown land), is defined by property rights that grant forest licensees the rights to harvest timber on a given parcel of land for a renewable period of 15 or 25 years. In return, forest licensees pay a fee at the time of harvest to the provincial government. This contractual agreement and all forest activities in BC are currently governed by the legislation contained within the Forest and Range Practices Act.

Currently approximately 13.5% of the total provincial area (13 m ha) is set-aside within protected areas, ecological reserves, biodiversity areas, conservancies, or recreation areas. Statistics compiled in 2002 indicate that forested lands comprise approximately 5.75 million hectares of the area under protection (Niemann 2006). Protected areas are currently administered by the Ministry of Environment, and among other regulations, are governed by the Protected

Areas of British Columbia Act, the Park Act and the Ecological Reserves Act. Protected areas and forests are managed under separate administrations, but as the history below indicates, this has not always been the case. Moreover because land use designations are currently considered within a unified sub-regional-level decision-making process, the history and future of forest and biodiversity management in BC is necessarily examined together.

Current socio-economic attributes

Since official records have been kept, the population of BC has grown from a reported 32,000 in 1867 to 4.3 million residents in 2006. Approximately 50% of the population resides in the mostly urbanized southwest corner of the province (Niemann 2006). The forest sector currently accounts for 7% of provincial employment and comprises 15% of economic activity (including indirect and induced activities). Lumber, natural gas and coal are the province's three main exports (Niemann 2006). Other key provincial industry sectors currently include agriculture, construction, mining, and tourism.

4.5. A HISTORY OF CHANGE AND STASIS IN BC'S FORESTS

The timeline of this history of BC's industrial managed forests is presented in five periods. The first division is marked by the inaugural forest act in 1912. The following two divisions are marked by Royal Commissions in 1943 and 1976. The last division is marked by changes in governance in 1992. The reporting of the selected groups of variables (governance, inputs, outputs) in each historical time period lends a consistent structure to the presentation of data in this section.

Industrial beginnings (1843 – 1912)

At the time of European settlement in BC (1843), forests were perceived by colonists to possess no particular value over other landscape types. Timber was cut to clear land, construct settlement buildings and support agricultural progress. Timbered lands were equal in cost to other landscape types and as noted by the federal Commission on Conservation: "…the standing timber was considered of no great value" (Whitford and Craig 1918). Perceptions began to change in the mid

1850's. The end of the fur trade, the discovery of gold on the Fraser River, timber supply disruptions as a consequence of the American Civil War, and the biophysical qualities of Douglas-fir all combined to increased demand for coastal BC timber. By the 1860's BC timber was exported to water-based markets throughout the Pacific Rim including South America, China, Japan, Australia and New Zealand (Whitford and Craig 1918; Gillis and Roach 1986).

Technological changes further transformed the value of timber and the scale of operations. The construction of the railways throughout the1880's was particularly influential. Construction created local demand, opened up eastward rail-based markets, and with rail lines built directly into timber stands, increased access to timber that had previously been unavailable beyond about 5 km from a waterway (Whitford and Craig 1918). Other influential technological changes included the mechanization of forest operations by the steam-powered cable-logging machine (mid-1870's) that served the function that oxen had previously of transporting logs to water or skid road (Figure 4.2).

Private interests accessed Crown timber primarily by a Land Ordinance in which licenses were issued to cut timber for a non-transferable term of one year. There was no regulation as to how much timber could be cut, or in what manner. This particular configuration of social and ecological elements had the following outcomes: The number of sawmills in BC increased from 25 in 1888 to 224 by 1911 (Whitford and Craig 1918; Marchak 1983) and the total volume of timber cut on Provincial lands increased from an estimated 317,551 MBF [14] in 1903 to 1,060,000 MBF in 1911-12 (Whitford and Craig 1918). During this period the population of BC increased 12-fold from an estimated 32,000 (1867) to 393,000 (1911) (BC Stats).

Despite this activity, a perpetual forest industry was not yet envisioned. Agricultural settlement remained the priority use for "timbered agricultural lands" (Province of BC 1913). At the same time, many conservationists (those who promoted the economic development of timbered lands), called for a better understanding of the distribution of trees across the landscape. In 1902, the Commission of Conservation was established to compile a province-by-province inventory of timber resources. Given the area, topography and access throughout BC at the time, it would not be an exaggeration to say that the scale of this task with respect to estimating standing timber

[14] MBF = 1000 board feet.

was enormous. In the end, the authors would note that in most cases, the published estimates were essentially "confined to guesswork" (Whitford and Craig1918).

While conservationists were devising strategies for timber utilization, BC's first provincial park, Strathcona, was established (1911) to satisfy a different set of objectives. The objectives of parks during this period were more narrowly defined that they are today. During this early period, the mandate of parks was to "set apart as a public park and pleasure ground for the benefit and advantage, and enjoyment of the people of British Columbia" (Province of BC, 1911). This mirrored the intent and language of earlier national initiatives. For example the *Dominion of Forest Reserves and Park Act* (1908) similarly states that National Parks are to serve as "…pleasure grounds for the benefit, advantage and enjoyment of the people of Canada".

By the end of this period, increases in land acquisition by private interests driven by international market demand, new technologies and a growing population, triggered concern amongst industrial-focused conservationists over access to land and a lack of ownership agreements. This prompted the first Provincial Royal Commission on BC forests and led to the formalization of the industry.

Formalization (1912 –1943)

The Fulton Commission (1909-1910) led to the first *Forest Act* (1912), and the establishment of the provincial Forest Branch. The Act introduced various mechanisms of leasing Crown land to private companies under the condition that a portion of the revenues would return to the province (the basis of the current stumpage system) (discussed by Marchak et al. 1999). With the contractual agreement now in place, the actors in the BC forest industry were clearly defined: the provincial government (who owned the land and collected rents), and industry operators (who paid a rent to harvest timber on it). This system of property rights satisfied the stated objectives of the province which were to increase provincial revenues through: "timber utilization" and to "increase the annual cut" (Province of BC 1913). The primary objectives of industry operators were to acquire more land, increase the efficiency of operations (e.g. through increased mechanization), and turn a profit. Towards the end of this period, labor organizations took their place as a third actor.

Technological (e.g. gasoline and diesel powered trucks, and the refinement of the power-saw), and market drivers (increased international demand) continued to shape the industry's activities and outcomes on the landscape. Biophysical drivers including the mountain pine beetle, the spruce budworm and fire disturbances also impacted the landscape. The combined impacts of the mountain pine beetle and the western pine beetle were reported to have "destroyed most of the yellow pine occurring in pure stands in the Province" (Mulholland 1937). At the same time, these disturbances and others seemed to have had little impact on the trajectory of harvesting outcomes. It was not uncommon for instance, for the introductory section of the Forest Branch annual report to begin with a paragraph outlining a litany of disturbances such as the "heavy snowfall" that delayed operations, or "unprecedented floods" (Province of BC, 1939) or a "disastrous fire season" (Province of BC, 1938), which was then followed by a statement such as "in spite of these, the year closed with a record log scale" (Province of BC 1939).

Indeed the volume of timber harvested during this period maintained an upward trend with periodic fluctuations correlated with geo-political (e.g. WWI, stock market crash 1929, and the Depression) more than biophysical drivers (Figure 4.3). By the end of this period (1943), the harvested timber volume had nearly tripled (14.64 million m^3) from levels at the beginning of this period. As in the preceding period, there was no regulation of logging methods or the amount cut, and no incentive for operators to ensure the regeneration of a future timber crop on these lands.

Amidst this accelerating logging activity, the Forest Branch considered the perpetuation of the forest industry insofar as it asserted that logging should provide for a second crop of trees on logged lands by means "best obtained by clear-cutting followed by slash burning" (Province of BC 1913), or in the Interior, by natural regeneration. Now, in addition to inventory estimates, knowledge of the dynamics of seedling regeneration was also required for management. Both held substantial uncertainties.

> It is very important, if we are to build up a technique for proper forest management in the widely different forest conditions of the Province, that investigations of systematic character and conducted with scientific accuracy form an important part of the work of the service. At the present time we are severely handicapped by a lack of reliable information … (Province of BC 1921).

From the inception of the industry, there were doubts that commercially-desired species would regenerate naturally. Yet, the Ministry continued to claim that natural regeneration would suffice and that the alternative (artificial regeneration by planting nursery-grown seedlings) was "impracticable" (Province of BC 1914). Meanwhile, evidence was mounting in direct contradiction. In the 1926 annual report, it was reported that broadleaf (hardwood) trees (not desired conifers) were the dominant species regenerating post-logged stands. Ten years later the Forest Branch stated that: "the regeneration of logged lands on Vancouver Island and the adjacent Mainland constitutes the most urgent silvicultural problem facing the Province…" (Province of BC, 1936).

Also at this time, amendments to the Forest Act in 1939 added the administration of new parks to the responsibilities of the Ministry of Forests. The amendment introduced the first classification scheme (inviolate Class A parks to Class C recreation sites) and gave Cabinet authority to "extend, reduce or cancel" Parks. Consistent with the previous period, the value of parks continued to be seen in terms of "pleasure and recreation". By 1945, 52 provincial parks comprised a combined area of approximately 4.4 m hectares (Sloan 1945) (Figure 4.4).

Towards the end of this period, the second provincial inventory was published. It reiterated previous concerns about "unsatisfactory reforestation" and introduced the additional concern of "the rapid expansion of industries" (Mulholland 1937). It was now acknowledged that existing forest practices combined with increasing demand, would soon outstrip the capacity of the available (Coastal) forest supply. Regulation of the cut was required. A second Royal Commission was established "to inquire into all phases of the forest industry of the Province" (Sloan 1945), and specifically, to formalize a means within which "the continuous production may be assured from all our forest land".

"Regulation" (1943 – 1974)

The 1945 Royal Commission introduced the concept of sustained-yield (SY) as a policy solution to the objective of "continuous production". SY was defined as: "a perpetual yield of wood of commercially usable quality from regional areas in yearly or periodic quantities of equal or

increasing volume" (Sloan 1945). This satisfied the objectives of the two major actors. It would achieve the "stability of regional communities" and the economic growth of the province by "…ensuring a perpetual supply of raw material for forest industries with consequent stability of industrial communities and assurance of permanent pay-rolls" (Sloan 1945). SY followed a prescription of "liquidation and conversion" of "static virgin" stands, replacement with the desired "normal forest", and regulation and forest management including forest regeneration thereafter.

SY ideas and proposals to regulate the cut were implemented in the face of explicitly acknowledged uncertainties about the very conditions required for its implementation (e.g. the volume of mature timber in a given area, rates of growth of natural regenerating trees). As stated by the in the Commissioners Report:

> The regulation of the cut – especially during the harvesting of the second rotation crop – depends on a thorough knowledge of forest increment on sites of various yield quality. That information will not be obtainable except through experimentation and research over a considerable period of time (Sloan 1945).

The Commissioner further concluded that in order to achieve regulated forest management, "the presently denuded productive land areas not restocking must be replanted…" (Sloan 1945). Consistent with the previous era, this position was opposed by powerful actors including the Chief Forester and Minister of Forests at the time. As a consequence, SY carried no contractual obligation of industry operators to regenerate logged stands to any standards. This legal responsibility at the expense of licensees would not come until *40 years* later. It is therefore not surprising that from 1945 to 1955 the amount of area classified as "not sufficiently restocking" (NSR) more than doubled on the coast from an estimated 372 thousand ha to 697 thousand ha (Sloan 1957). The total (coastal and interior forests) estimated area of NSR in 1955 was 4.8 million hectares (Sloan 1957).

During this period planting programs did expand beyond experimental studies to include production landscapes as well. But to put these efforts into perspective, the percentage of area planted relative to area logged remained skewed by a fledgling planting program that was outpaced by the rapidly increasing cut. In 1943, at the beginning of this period, approximately 10% of the area of harvested Crown land was replanted (4607 ha planted vs. 43,698 ha

harvested). Over a decade later in 1955 this percentage decreased to 5% as the area harvested nearly doubled while the area planted remained the same (4379 ha planted; 86,466 ha harvested). By 1965, the area planted had increased to approximately 11% of the total harvested area (15,172 ha planted; 129,645 ha harvested).

The demand for timber products increased steadily following World War II as a result of both domestic, and international markets. This occurred in tandem with increased mechanization and the specialization of logging trucks. At this time, the Interior wood-supply was largely unutilized for timber production (comprising only 17% of the total provincial cut in 1943). This meant that sustained-yield posed little challenge to the trajectory of timber cut in the province as a whole, as a operations expanded into the interior (reaching 50% of the total provincial cut by 1974). In fact, the annual volume of timber harvested during this period increased by almost 400%. Rising from 14.64 million m^3 in 1943, to 70.14 million m^3 in 1973. In the year of 1973 alone, the amount of timber scaled increased by 24.2% over 1972 (55.60 million m^3) levels.

From this period onwards, parks became increasingly central to forest land-use decisions. In 1957, after two decades within the Ministry of Forests, parks administration was moved to a separate department. Parks objectives continued to be "the pleasure and recreation of the public" (Province of BC, 1957) for *economic* benefit.

> In harmony with this recreational plan, the park system for example, in time must blanket the Province. In this way all sections of BC will be used and enjoyed by our citizens. A major consideration in implementing the recreational plan is economics (Province of BC 1957).

Less than a decade later, ecological attributes were added to the valued elements of parks. In 1964 Nature Conservancy Areas (NCA) were implemented to give "absolute protection to outstanding areas of scenic, faunal and floral environment" (Province of BC 1964). Ecological objectives were further solidified in the *Park Ac*t (1967) where park categories now included those for which the "main purpose of its designation is the preservation of its particular atmosphere, environment or ecology".

These additions coincided with growing inter-agency tension over land use and growing public discontent with forest practices. In 1969, The Ministry of Forests sought to distance itself from

the past SY era and proclaimed "the start of a new era for the Forest Service with direct involvement with programmes involving multiple-use of Crown wooded land" (Province of BC 1969). However, managing forests for "multiple-uses" was not a new idea. In fact, it can be traced to ministry documents as early as the 1930's.

> It is becoming increasingly apparent that we must value our forests not only as a source of our supplies of timber, but also for their many other uses-as food and shelter for our game and fur-bearing animals, as regulators of the water-flow of the streams in which we fish, and as attractions for the tourist and other recreationists who delight in the great outdoors. Our forest areas must be developed and protected from fire in the interests of these "multiple uses" (Province of BC 1936 MOF).

Similarly, there had been outspoken critics of forest management from the very beginning of the industry (D. Brownstein pers. comm.). Nevertheless, in 1971, the Ministry reported that "steadily mounting public interest and concern over forest-land uses resulted in the firming up of "balanced use" policies…" (Province of BC 1971). Three years later this was explained as follows:

> …the new resource planning system calls for input from all land-use agencies involved before any Crown land is committed to logging or any other form of industrial operation. The system considers fish, wildlife, watersheds, recreation, soils, stream protection and a host of other factors related to the environment (Province of BC 1974).

Balanced, or "integrated forest management" was seen as the replacement to SY. While acknowledging that these were early days for this "new" forest management, discussions relating to "multiple use" in the 1972 annual report were confined to the introductory remarks, and the public relations section: "with continuing public concern over use of forest land, the Service's public relations programme placed heavy emphasis on the "balanced use" concept (Province of BC 1972). No mention was made of actual policies for implementing multiple-use. By 1975 public concern over forest practices, and industry demands for tenure reform prompted a 4th Royal Commission.

Friction and Transition (1976 – 1991)

This was a transitional period for forest management in BC. It began with the report of the Royal Commission in 1976, and amendments to the Forest Act (1979) that posed no substantial

challenge to existing attributes of governance or logging practices. It ended with multiple public protests, mass arrests at logging sites, international media coverage of BC logging practices, new actors in the decision making process, and a "dramatic shift in values" (Forest Resources Commission 1991).

As foreshadowed by events at the end of the last period, the amended Forest Act (1979) included the directive for the Ministry to plan for multiple use. This directive was in response to emerging concerns about the protection of ecological values. It also staked out the Ministry's position that the best approach to managing timbered landscapes was for multiple values and uses (not single uses such as protected areas as we shall see). Attributes of governance including the key actors in the system remained as they had in past, and the stated objectives of the Ministry of Forests continued to be to: "maximum productivity".

Meanwhile, ecological concerns had become a central issue in international agencies (e.g. the UN World Commission on Environment and Development (WCED, 1987)); the UN Convention on Biological Diversity, 1992), academic domains (e.g. the emerging field of conservation biology and associated organizations); and in the media (e.g. articles on BC logging practices including one titles the "Canadian Chainsaw Massacre" The Observer UK, Dec 1, 1991). One of the outcomes of this collective focus was the proclaimed need for more protected areas. As stated by the WCED: "… the total expanse of protected areas needs to be at least tripled if it is to constitute a representative sample of Earth's ecosystems." (WCED 1987). This statement has been interpreted as the 12 % target by 2000, and we will see that it directly influenced protected areas policy in BC.

Proposals for protected areas were at odds with a century of BC forest practices that had singularly prioritized timber production. It was also at odds with conceptions of "multiple-use". Ministry and industry leaders responded by railing against suggestions for "single-use" land designations such as protected areas. Dave Parker (then Minister) stated at the time "I have a personal problem with single purpose use of the land base…Single purpose use in many cases makes very thin soup". (Vancouver Sun June 11, 1988). Speaking at a symposium on BC parks, the president and CEO of the main industry association (Council of Forest Industries) at the time, stated his concern that "accessible, high-value forests" would be "removed permanently and

given over to single uses…". He proposed instead that "integrated resource management such as selective or salvage logging in some parkland could actually enhance recreational and aesthetic values" (Lanskail, in Dooling 1985).

Although the Ministry asserted that there would be "greater emphasis on planning for the full spectrum of resource uses with involvement of other resource management agencies" (Province of BC 1987), the harvesting outcomes for this period indicate that this planning had no measurable impact where timber extraction was concerned. In fact, the conceptual transition from the sustained-yield to integrated resource management eras coincided with successive record volumes in the amount of timber harvested (69.9 million m^3, 1977; 75.2 million m^3, 1978; and 76.2 million m^3, 1979). Production decreased in the early 1980's (reaching a low of 60.94 million m^3 in 1982), due to the downturn in the global economy, reduced US demand; falling lumber prices, and labor strikes. But by the mid 1980's, harvesting volumes had rebounded, breaking records each year (1986, 79.9 million m^3; 1987, 89.05 million m^3, 1987). Towards the end of this period, harvesting levels fluctuated between 86.9 million m^3 in1989 and 74.92 million m^3 in 1991.

Meanwhile, the proportion of area replanted following harvesting increased from approximately 25.6% in 1979 to 50.4% in 1980. However, due to increasing cuts and the backlog of NSR lands, the area of harvested NSR land remained high in the range of 3.9 million hectares (Pearse 1976). Finally, in 1986 (after more than a half a century of expressed concern and evidence indicating the failed regenerative status of many harvested stands), the provincial and federal government announced a commitment to replant NSR lands. At the same time, amendments to the *Forest Act* in 1987 made reforestation to free-growing status a contractual obligation of operators (at their own expense) on Crown land.

At the same time that the Ministry was promoting "multiple use", it was also reassuring the public that it would be consulted on land-use decisions: "Special efforts will be made to ensure that the public has input in resource-use decision-making..." (Province of BC 1987). However the steadily increasing cut prompted many observers to note that consultation efforts amounted to little more than tokenism (Drushka 1999). The phrase "talk and log" (e.g. Wilson 1998), came to represent the view that government and industry were proceeding with decision-making as they had in the past. While there had been logging moratorium studies and community-level

efforts to limit logging in wilderness areas dating back to the early 1970's, it wasn't until the mid -1980's that an increasing number of blockades by individuals, environmental groups, and First Nations were organized across the province in opposition of logging operations. The 1993 blockade in Clayoquot Sound resulted in the largest mass arrest in Canadian history.

Amidst this growing public discontent, the Parks Branch was elevated to its own Ministry (Province of BC 1988), with an "increased emphasis on protection and management of BC natural heritage". This period culminated in a provincial election where the would-be new government campaigned on the promise of forest practices reform and commitments to environmental protection in keeping with WCED recommendations.

Shared decision-making (1992 – present)

By 1992, expanding public values, increased international and regional scrutiny of BC forest practices, commitments to international conventions, and a newly elected provincial government combined to effect changes in the policy configuration of the system. Within a relatively short period, the actors in the system and the decision-making process changed for the first time in the industrial history of the system. This occurred in combination with the implementation of a suite of new initiatives and legislation.

One of the first of these initiatives was a new decision-making process based on a multi-stakeholder, consensus-based planning model (The Commission on Resources and Environment, or CORE, 1992). One year later a similar (sub-regional) process was initiated (Land Resource Management Plans (LRMP). CORE was disbanded after 4 years but the LRMP process has continued as the decision-making framework within which land-use decision at the sub-regional scale are negotiated. With both, environmental NGO's and First Nations were added to the perennial actors in the system (industry and the provincial government). The two new groups gained agency in different ways: ENGO's through international markets campaigns, and First Nations, through the Supreme Court of Canada. Other initiatives and policies occurred in rapid succession and included the Forest Sector Strategy Committee (1993); the the Forest Renewal Act (1994); Forest Practices Code (1995), the Timber Supply Review (1992/93); the Biodiversity Strategy (1992), and the Protected Areas Strategy (PAS) (1993) to name a few.

In particular, the goal of the PAS was to double the amount of protected areas to 12% by 2000. This has now been achieved (Figure 4.4). Between 1991 and 2007 the total area under protection increased from approximately 5.3 to13 million ha. The objectives of the PAS followed in the tradition of the preceding period of Parks legislation in that it included both recreation and ecological values. As for ecological considerations, the PAS viewed an ecosystem as: "an integrated and *stable* association of living and nonliving resources…". (Province of BC 1993 emphasis added).

Recent planning processes have adopted a more dynamic conception of ecological systems and their linkages with human systems. For example, efforts towards ecosystem-based management (EBM) identify maintaining ecological integrity (EI) as a central principle (where EI is defined as: "the abundance and diversity of organisms at all levels, and the ecological patterns, processes and structural attributes responsible for the biological diversity and for ecosystem resilience") (Coast Information Team 2004).

With a stated focus on ecological processes, efforts to foster EI appear to contrast with the static conceptions that underpinned the PAS. However, the extent to which a dynamic view of ecosystem behavior has been incorporated into planning remains ambiguous. Evidence suggests that assumptions of ecosystem stability have continued to shape the EBM objectives for protected areas, which are to: "protect representative samples of all native ecosystems and species…sustain viable populations of native species…" (Coast Information Team 2004). This focus on representing native ecosystems and species is reflective of past approaches, more than it is suggestive of non-linear, evolving, dynamic systems.

A clear and dramatic example of a dynamic, non-linear ecological and social process is currently unfolding across millions of hectares of the interior of the province. As of 2007, the mountain pine beetle (*Dendroctonus ponderosae*) had infested an estimated 13.5 million hectares of Crown forest. Insect and disease are common disturbance agents in temperate forests (Dale et al. 2001), and the endemic mountain pine beetle has reached outbreak levels in this region in the past (Safranyik et al. 1974). However, the current outbreak is larger in area than previously recorded (Safranyik and Carroll 2006). Moreover the ecosystems that will ultimately follow are unclear.

The beetle outbreak has provided justification for an increased cut in some areas. This increase has been explained as an "emergency measure for salvaging and recovering the greatest value possible form beetle attacked timber" (Ministry of Forests and Range accessed September 8, 2008). In 2004, with the "beetle uplift" in place, total cuts were 89.8 million m^3. This highpoint occurred after a period of decreasing cuts in the mid 1990's (1993: 78.01 million m^3; 1998: 67.6). These reductions came on the heels of new structures of governance and legislation. However, market factors are strongly implicated in that temporary decline. Hoberg (1996) has argued that the "high prices and expanded markets for BC wood products" in the early 1990's created a situation that was conducive to regulation. In essence, it became politically feasible for the government to implement regulation and protected areas, and affordable for the industry to concede.

Consistent with the preceding periods, this period was characterized by the presence of scientific uncertainties relevant to the decisions being made. Some of the uncertainties lingered from earlier periods (e.g. inventory):

> Accurate and up-to-date inventories of all forest values are critical to the success of any resource management policy. They form the basis for land use classification decisions and provide the raw materials used to determine the appropriate level of enhanced stewardship called for in the Vision Statement. Without this information, Land Use Planners and forest managers are severely hampered in making intelligent choices and recommendations. Sadly, the state of renewable forest resource inventories in this province is inconsistent at best, and woefully inadequate at worst (CORE 1992).

Other uncertainties became relevant as new management objectives were introduced. For example, the focus on biodiversity and protected areas introduced uncertainties relating to the size, design and location of protected areas. More recently, the impacts of climate change have introduced a barrage of uncertainties relating to future species distributions. These include, uncertainties relating to biotic interactions (Pearson and Dawson 2003; Guisan and Thuillier 2005); dispersal (Pearson 2006); disturbance (Woodward and Beerling 1997); the potential for rapid evolutionary change (Gienapp et al. 2008); and interactions between the dynamics across scales.

Figure 4.3. summarizes the key social and ecological events in the history of forest management in this system.

4.6. DISCUSSION

4.6.1. Attributes and Drivers of Change (What Changed and Why?)

System attributes and outputs

The historical evidence shows that the outputs measured for this system (particularly harvesting levels, and eventually area under protection) changed substantially over time (Figures 4.3 and 4.4). In partial contrast, attributes of governance remained static for the majority of the period examined, with changes occurring relatively recently. Lastly, despite widespread acknowledgement that ecosystems are dynamic systems, a command and control model of resource management has remained unchanged in practice.

A central question of this analysis (*Q1*) is: where change was detected, what were the contributing drivers of change? In the case of harvesting outputs, exogenous drivers (war, technological change, international markets, expanding values and climate) overwhelmingly influenced the cut. Sometimes these drivers pushed the cut downwards, but over time the trend is upwards (Figure 4.3). Exogenous drivers were similarly influential in contributing to changes in the amount of area protected, and, changes in governance. This general observation of the importance of external drivers is supported by theories of adaptive change, which predict that change in managed SES often requires an external force to release "social and political gridlock" (Gunderson and Holling 2002). Other empirical studies have similarly reported the importance of external triggers (e.g. Light et al. 1995; Abel et al. 2006). Additionally, and as outlined in the introduction, scholars in the policy sciences have also observed the importance of external drivers in initiating change (e.g. Sabatier 1997; Repetto 2006).

Of the exogenous drivers noted above, the policy consequences, common origins, and labile quality of ideas are worth highlighting. By ideas we mean collections of assumptions, evidence, experience, morality and cultural norms that form conceptions of how the world works, or ought to work. Different terms are used in other literatures to describe a similar concept. In the risk and

decision-sciences, "ideas" as we see them, are termed "mental models". In political ecology, ecological anthropology and cultural geography, a more power-infused equivalent is "discourses". All make the point that in interaction with other social and ecological factors, ideas have material policy consequences. They can prevent or catalyze change, and they contribute to shaping the nature of change when it occurs. Ideas do so by implicating or justifying certain policy options, and simultaneously obfuscating or discrediting others. For example, in this system, ideas of stable, pristine (non-human influenced) ecosystems have underpinned protected areas policies that seek the maintenance of species in place over time and that restrict human activities.

As to the origins of ideas that spur change, Light et al. (1995) observe that: "…new understanding usually emerges from the periphery, it often appears as hearsay to the prevailing myths and dogma". Thus in the absence of *external* sources of ideas, prevailing beliefs and values held by the status quo can act as powerful barriers to change and entrenchment of the status quo. Here, we similarly find that ideas external to the system were catalyzing drivers of change. For example, while there had been decades of discontent about forest management amongst naturalists in BC (D. Brownstein pers. comm.), measurable changes in policy outputs only came on the heels of international conventions, protests and market campaigns.

Lastly on ideas, we know from environmental historians (e.g. Cronon 1996; Loo 2006), and economists (Buchanan 1987) that ideas, and their expression in policy objectives that were suitable for the social, ecological and technological context of one time period, may be either ill-suited, not desired or untenable in a different time period and context. Buchanan invokes the concept of "relatively absolute absolutes" to describe the reality that the ideas norms and values that represent a given "constitution" of alternatives at a given time are stable in the short term, but prone to change in the long term (Buchanan 1987).

Considering now the issue of exogenous drivers more generally, using "exogenous" as a class of driver requires distinction on at least two issues. The first issue concerns within-class variation. Proposition 1. posits that the relative influence of exogenous drivers varies across domain (e.g. social, ecological), and over time. As for the first part of this proposition, the data indicate that *social*-exogenous drivers have been particularly influential in this system for the majority of the

time profile examined. Technological, geo-political, economic, and cultural (ideas and social movements) factors consistently influenced the outputs in this system. Additionally, the evidence suggests the need for further distinction still because these exogenous social drivers had different rates of change. New technologies, wars, and markets changed system outputs relatively rapidly. In contrast, the emergence of new ideas took decades longer to impact outcomes. Again, this echoes the observations from both resilience and policy change research that has highlighted the eventual importance of slowly unfolding variables (Walker et al. 2006; Pierson 2004).

Combined, the evidence lends *partial* support to the second part of Proposition 1, which is that the relative influence of drivers from different domains changes over time. For the majority of the time period examined, biophysical drivers have not triggered sustained measurable changes in this system. Past insect outbreaks, droughts and fires have been absorbed by the system without long-term impacts on outputs measured at the regional scale. This pattern has recently been broken by the MPB outbreak (ostensibly the impact of an exogenous ecological driver). While the future drivers and dynamics of this system remain undetermined, a proposition for further empirical exploration is that exogenous ecological drivers may become more dominant in this system in terms of determining outputs and change dynamics.

An alternative or additional interpretation is that some ecological factors are simply operating at slower rates of change (e.g. climate change, soil degradation), and that these latent variables have been imperceptibly active for some time (along with the social), but with consequences yet to be perceived. Using this explanation, slow variables again play an important role. Moreover, by this rationale, the exercise of parsing exogenous from endogenous, or the relative influence of domains over time, while analytically tractable, can only ever yield a partial explanation of the system dynamics.

We hasten to highlight a second issue relating to exogenous as an analytical class: namely interactions between exogenous drivers and endogenous conditions. As influential as exogenous drivers (be they social or ecological) have been in *contributing* to change at a given point in time in this system, these catalysts are enabled (or constrained), by endogenous social and ecological conditions and historical contingencies. Put differently, while change in policy attributes or outputs may appear sudden and attributable to a given set of forces operating at the time, the

roots of change run deep. Consider again, the MPB outbreak. This outbreak has occurred on the scale that it has due to a recent spate of successively warmer winters (an exogenous biophysical driver) *in combination* with decades of forest management that has incentivized planting monoculture pine in combination with manual and chemical brushing programs that have eliminated other non-susceptible plant species (creating vulnerable endogenous conditions).

Another example of the role of endogenous conditions is the decades of latent discontent amongst various local groups that preceded the widespread international public outcry that erupted to occupy news headlines, and garner international attention in the 1980's and 1990's. Together, these observations fit predictions that endogenous vulnerabilities are important mediators of change (Gunderson and Holling 2002), and that change dynamics in complex adaptive ecological and social systems are historically contingent, non-linear and with delayed feedbacks (e.g. Levin 1998; Pierson 2004).

Transitions to "new" management regimes

On numerous occasions throughout the 150 years of industrial forest management, "new" policies were proposed, debated and passed into legislation. In some cases, the benefit of hindsight reveals that these proposals represented only incremental changes in practice, or changed aspects of governance (e.g. tenure) that did not impact the trajectory of outputs. Sustained-yield is an example of such a policy. In other cases, new proposals did result in measurable changes in outputs. These include policies relating to land-use in the early 1990's. Whether new policies yielded illusory or measurable changes, decision-relevant ecological uncertainties *perceived at the time* characterized every period of transition to a new management regime. The adoption of sustained yield is a case in point: its implementation depended specifically on technical information that was known to be unavailable.

This observation lends support to Proposition 2 that decision-relevant uncertainties are not in-and-of themselves barriers to the adoption of new policy proposals in particular or adaptation more generally. It also supports the conclusions made by other scholars that: "scientific proof is rarely what is at stake in a contested environmental….issue". And that in environmental policy,

there is “no need to wait for proof, no need to demand it and no basis to expect it” (Oreskes 2004).

If reductions in uncertainty did not impact transitions to new policies, then perhaps evidence of past policy failure did. Clearly, an issue needs to be perceived as a problem before a policy response can be developed. However, as the issue of forest regeneration illustrates, evidence of policy failure was an insufficient ingredient for change. In this case, over half a century passed between recognition of failed regeneration, and the implementation of policies to address the failure. Here, the endogenous conditions of the interests of the industry and ministry, combined with arguments that planting was uneconomical served as a powerful barrier to change - despite the evidence.

The lack of influence of the presence of uncertainties, or awareness of policy failure with respect to policy change in this system is contrasts with what would be expected by a linear model of science and society. A linear model holds that science provides objective facts, or “truths” delivered to political actors (“power”) to be used as a guide to policy. Based on the relationship between “science” (here thought of in terms of both uncertainty and evidence) and decision-making in this system, the role of science is more accurately described as an indeterminate input. In this system, science has been mobilized as both a non-trigger for change and a justification for change. This interpretation fits within the now extensive work on social dimensions of science that has shown that the domains of science and society are co-produced and cannot be separated in practice. Rather there are subjective values at play at all phases of knowledge production and application of science for policy (e.g. Jasanoff 2004).

If reductions in uncertainties or new evidence are not *necessarily* required to initiate policy change, what factors *have been* important in this system? What, in addition to awareness, and external drivers are required to initiate measurable policy change? Kingdon (1995) argues that a number of factors increase the chances of a new policy proposal surviving the “selection process”: new proposals need to have gone through a gestation period of “softening up”; they must be ready and feasible; and they must reflect the values of the actors.

Take the example of the PAS in 1993. The adoption of this proposal met all of these criteria. Proposals for protected areas had become increasingly familiar to the public and had been part of public and agency discussions for over a decade, an articulated proposal was at the ready (e.g. the WCED), and the proposal itself reflected (and reinforced) assumptions of stable and pristine nature. Finally, all of these factors were in place during the "policy window" that opened with the newly elected provincial government, and a swell of changing public values. This perspective is related to the proposition made by Walker et al. (2006) that: "multiple modes of reorganization are possible during phases of release and renewal in a social-ecological system". This also reflects insights from the path dependency literature that many different possible pathways are possible during specific windows of time (e.g. Pierson 2004). To a large extent, the reorganization that occurs during policy windows or phases of renewal will depend on the actors in the system, their values, and the characteristics of new proposals as outlined above.

4.6.2. Dynamics of Policy Change

The historical approach used here enables us to examine a third proposition. Proposition 3 posits that the dynamics of policy change in this system have followed a punctuated equilibrium model. In part, the evidence from the BC forest system supports a punctuated equilibrium pattern of change. For the bulk of the time period examined here, changes in management regimes are best described as incremental. New names were given to policies whose attributes and outcomes were the same as prior eras. For example, sustained-yield and integrated resource management were governed within a system configuration occupied by the same actors, and that had the same trajectory of system outputs (e.g. increasing harvesting levels). These relatively stable periods were "punctuated" by a single (so far) episode of measurable policy change characterized by new actors, institutions, decision-making process and in some cases changed outputs (e.g. increased area under protection).

However, while substantive change in some system attributes has occurred, ideas of well-bounded, predictable ecosystems have prevailed. Most recently, this is exemplified by the approach in some biodiversity conservation proposals to predict future patterns of species distributions in order to plan new protected areas for the future protection of specific species (Williams et al. 2005). In other cases, planners recognize these dynamics, but even the most

sophisticated planning processes are overwhelmed by social negotiations over presumed *stable* (let alone dynamic) ecological targets. Thus, the evidence assembled here indicates that underlying assumptions of ecosystem stability remain in practice – even for newly developing policies. Therefore we would modify Proposition 3 to state that *some* system attributes have followed a punctuated equilibrium pattern of change but whole-scale *paradigmatic* change has not occurred. Further, we wonder if whole-scale paradigmatic change in all domains ever does occur in a given system at once? Or, is a combination of punctuated change in some domains, and incrementalism or stasis in other domains a more typically observed description?

The persistence of ecosystem stability assumptions has important policy implications. As per earlier discussion on the importance of ideas, Kingdon (1995) similarly suggests that in order for new proposals to become acceptable they need to fit within the value frames of the key actors; all of whom at this point appear oriented to the command and control model. This prevailing view or (mental model) undoubtedly constrains the decision alternatives, at least for now. In this way ideas can act as a social basin of attraction (cf Walker et al. 2006). Or put differently, ideas can act as a source of positive feedback, reinforcement and barrier to change. However, given the increasing complexity and scale of biophysical drivers acting on this system (notably climate change), views of predictability and control may eventually become untenable. At that time, alternatives that carry with them policies for dynamic flows of resources (and interventions) may become acceptable. It is likely not a matter of if, but rather a question of when this happens, and what combination of drivers will tip the scales to enable more transformative changes to become established.

4.6.3. What lessons can (and can't) we take from history?

In this analysis we wanted to know what the historical change dynamics might suggest about potential pathways of future policy iterations. This line of questioning contains both possibilities and constraints. The constraints include the fact that the dynamics of SES are idiosyncratic. A particular disturbance that sets a system down a given path at one period of time is unlikely to be repeated in the future, and if it were, it is unlikely to yield the same impacts owing to evolving social and ecological configurations. Thus seeking insights from past dynamics likely tells us more about future potential human behavioral dynamics and general system dynamics of

common patterns rather than future potential biophysical changes and outcomes. On the other had, some patterns beyond idiosyncrasies are suggested by the historical evidence. We focus on these in the list below that outlines the observed system realities over time and relates back to the initial propositions:

- For the time period examined, social, exogenous variables have been key contributors of change in this system. There is evidence that this may be changing and that slow variables from both biophysical (climate change) and social domains (ideas) may be poised for substantive change (*Proposition 1*).

- Prevailing patterns of agency are powerful barriers to change (social basins of attraction), and can result in policies that both maintain and entrench maladaptive policy configurations (*Proposition 1*).

- The reduction of ecological uncertainty (or perceived certainty) is not a requirement for policy change and should not be expected as criteria for change. Scientific information and uncertainty is better understood as a malleable factor of change and non-change that is mobilized or not depending on other variables*. (Proposition 2).*

- Policy change in this system has unfolded according to a *partial* pattern of punctuated equilibrium *(Proposition 3).* Whole scale paradigmatic change across all measured domains was not observed. We wonder if whole scale paradigmatic change across all domains is actually all that common. Or, if determination of punctuated equilibrium behavior reported in the literature would contain more nuance if a wider range of variables from different domains were distinguished?

- The passage of time may be as important as any other variable both in creating a gestation period for new ideas and to allow for changing norms and values. For example, the command-and-control model of resource management remains entrenched in practice in this system, but perhaps will be challenged in the near future by the potentially transformative impacts of climate change (*Proposition 3*).

4.7. CONCLUSIONS

The history above reveals that exogenous factors have been key drivers towards change in this system. The impacts of these factors have been mediated by endogenous conditions, which have been shaped by historical contingencies. The analysis further shows that drivers of change originated from a variety of domains (particularly social) and influenced specific (not all) attributes of the SES configuration (i.e. change in SES configuration was partial – not complete). The pattern of change in this system fits with a nuanced pattern of punctuated equilibrium. However, given the persistence of underlying command and control ideas we would not go so far as to say that paradigmatic change has occurred. That degree of change is yet to come.

Managed SES are complex adaptive systems in which there is no stable end-point - no equilibrium configuration. This system has co-adapted over time and it will continue to do so. Looking ahead in anticipation of future changes we can cautiously speculate from the insights from history that exogenous drivers will be key factors towards change; that biophysical drivers may become more influential than they have in the past; and that innovation will come from outside of existing configuration of actors. The chances of new policy proposals being taken up in the next period of change will be determined by factors including the familiarly of the proposal, the fit of the proposal with the values of the key actors and its readiness for implementation when the time comes. It may well be that a previously eschewed proposal will become acceptable, as time, ecosystems and ideas change.

Table 4.1. Variables examined in through time.

Attributes of Governance	Inputs to Decision-Making	Outputs of Decision-Making
Agency	Stated Synthesis Objectives	Area and Volume Harvested
Institutional Arrangements	Scientific Uncertainties	Area Reforested
Decision-Making Process	Technology	Area of Parks and Protected Areas
	Markets	
	Biophysical Dynamics	

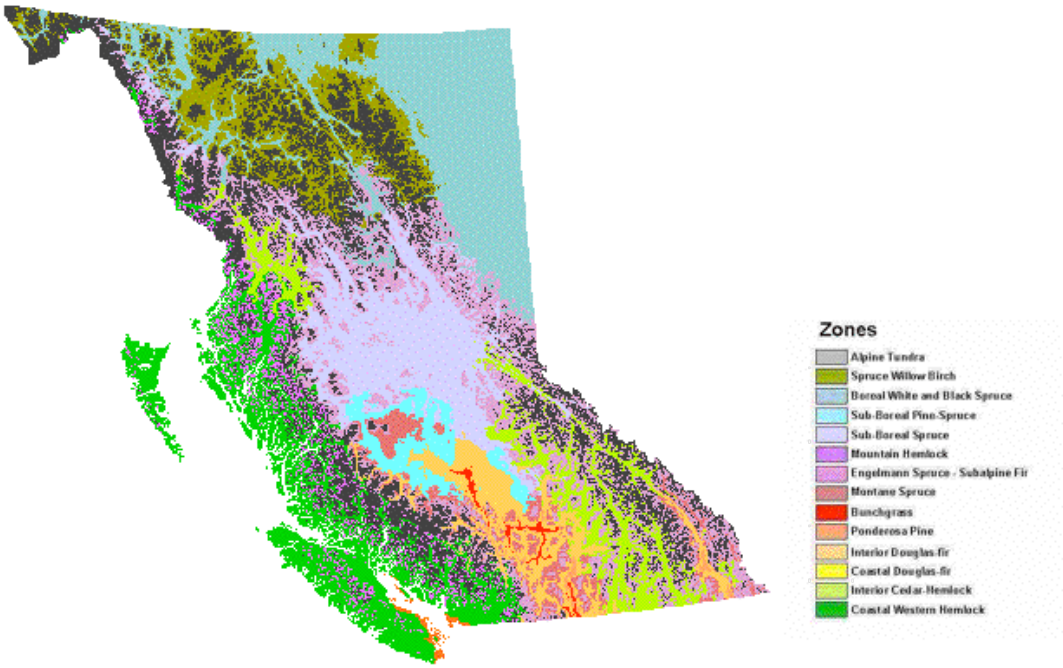

Figure 4.1. Biogeoclimatic zones of British Columbia (BC Ministry of Forests and Range).

A)

B)

Figure 4.2. Logging practices in the early 1900's and currently: A) skid logging on Denman Island circa 1904 (Source: BC Archives Collections – Call Number: A-07086); B) cedar logging on the west coast (Source: BC Ministry of Forests and Range).

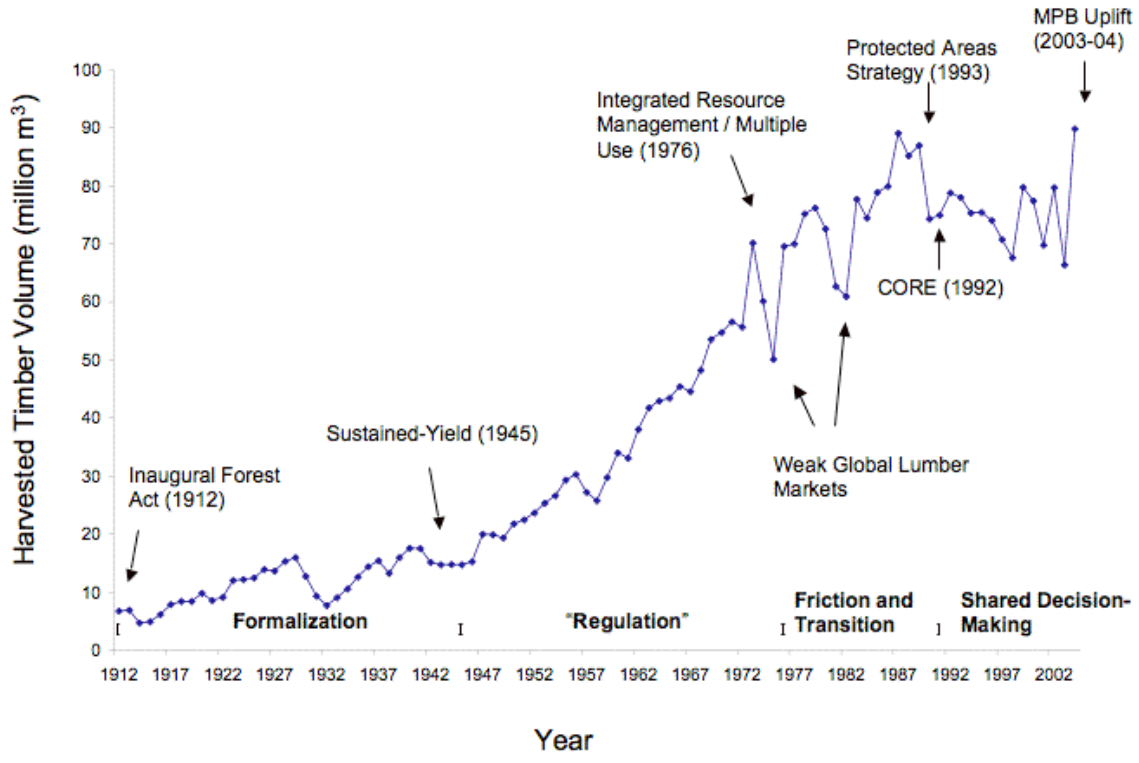

Figure 4.3. Summary of forest management regimes, key events, and harvesting levels in BC over time.

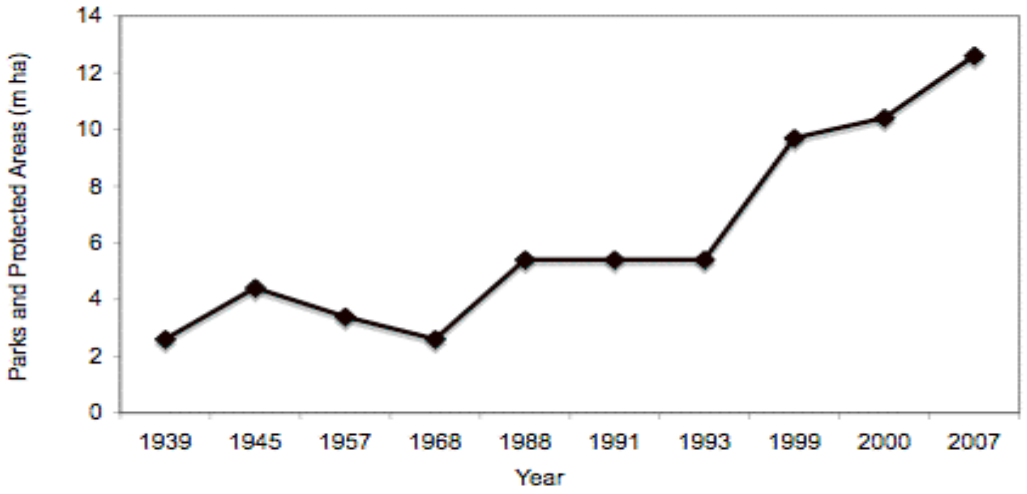

Figure 4.4. Total area of parks and protected areas over time (m ha) (Sources: Ministry of Forest Annual Reports; Department of Recreation and Conservation; State of the Environment 2007).

4.8. REFERENCES

Abel, N., Cumming, D.H.M. and Anderies, J.M. 2006. Collapse and reorganization in social-ecological systems: questions, some ideas and policy implications. Ecology and Society 11:

Allison, H. E., and Hobbs, R. J. 2004. Resilience, adaptive capacity, and the "lock-in trap of the Western Australian agricultural region. Ecology and Society 9:3.

Araújo, M.B. and Luoto, M. 2007. The importance of biotic interactions for modelling species distributions under climate change. Global Ecology and Biogeography 16:743.

Balée, W. 1998. Advances in Historical Ecology. Columbia University Press, New York, NY.

Baleshta, K. E., S. W. Simard, and Guy, R.D. and Chanway, C.R. 2005. Reducing paper birch density increases Douglas-fir growth rate and Armillaria root disease incidence in southern interior British Columbia. Forest Ecology and Management 208:1-13.

Baumgartner, F.R. and Jones, B.D. 1991. Agenda dynamics and policy subsystems. Journal of Politics 53:1044-1074.

Berkes, F. and Folke, C. 1998. Linking social and ecological systems: management practices and social mechanisms for building resilience. Cambridge University Press, Cambridge, UK.

Berkes, F., Colding, J. and Folke, C. 2003. Navigating social-ecological systems. Cambridge University Press, Cambridge.

British Columbia Forest Resources Commission. 1991. The future of our forests. Forest Resources Commission, Victoria.

Buchanan, J. M. 1987. The relatively absolute absolutes. Draft paper prepared for presentation at SEA meeting

Commission on Resources and the Environment. 1992. Report on a Land Use Strategy for British Columbia. Victoria, B.C.

Cronon, W. 1996. Uncommon Ground: Rethinking the human place in nature. W.W. Norton and Company, New York.

Crumley, C. L. 1994. Historical Ecology: Cultural knowledge and changing landscapes. School of American Research Press, Santa Fe, New Mexico.

Dale, V. H., L. A. Joyce, S. McNulty, R. P. Neilson, M. P. Ayres, M. D. Flannigan, P. J. Hanson, L. C. Irland, A. E. Lugo, C. J. Peterson, D. Simberloff, F. J. Swanson, and Stocks, B.J. and Wotton, M. 2001. Climate change and forest disturbances. BioScience 51:723-734.

Daniels, L.D. and Gray, R.W. 2006. Disturbance regimes in coastal British Columbia. BC Journal of Ecosystems and Management 7:44-56.

DeLong, S. C. 1998. Natural disturbance rate and patch size distribution of forests in northern British Columbia: Implications for forest management. Northwest Science 72:35-48.

Demarchi, D. A. 1995. Ecoregions of British Columbia (1:2,000,000). BC Ministry of Environment and Parks, Wildlife Branch, Victoria, Canada.

Dooling, P. J. 1985. Parks in British Columbia.

Drushka, K. 1999. In the Bight. Harbour Publishing, Madeira Park, BC.

Eldridge, N. and Gould, S.J. 1972. Punctuated equilibria: an alternative to phyletic gradualism. Pages 82-115 in T. M. Schopf. , editors. Models in paleobiology. Freeman Cooper San Francisco, CA.

Gienapp, P., C. Teplitsky, J. S. Alho, and Mills, J.A. and Merila, J. 2008. Climate change and evolution: disentangling environmental and genetic responses. Molecular Ecology 17:167-178.

Gillis, R. P. and T. R. Roach. 1986. Lost initiatives: Canada's forest industries, forest policy and forest conservation. Greenwood Press, New York, NY.

Goudie, A. 2000. The human impact on the natural environment. MIT Press, Cambridge, Massachusetts.

Guisan, A. and W. Thuiller. 2005. Predicting species distribution: offerring more than simple habitat models. Ecology Letters 8:993-1009.

Gunderson, L. H. and C. S. Holling, editors. 2002. Panarchy: understanding transformations in human and natural systems. Island Press, Washington, D.C.

Gunderson, L. H., C. S. Holling, and S. S. Light. 1995. Barriers and Bridges to the Renewal of Ecosystems and Institutions. Columbia University Press, New York, NY.

Hajer, M.A. 1995. The politics of environmental discourse. Ecological modernization and the policy process. Oxford University Press, Oxford, New York.

Hoberg, G. 1996. Putting ideas in their place: A response to "learning and change in the British Columbia forest policy sector". Canadian Journal of Political Science 29:135.

Holland, J. 1995. Hidden order: How adaptation builds complexity. Helix Books,

Holling, C. S. 1973. Resilience and Stability of Ecological Systems. Annual Review of Ecology and Systematics 4:1-23.

Holling C.S. and G. K. Meffe. 1996. Command and control and the pathology of natural resource management. Conservation biology 10:328-337.

Holling, C.S., Gunderson, L.H. and D. Ludwig. 2002. In quest of a theory of adaptive change. Pages 3-22 in L.H. Gunderson and C.S. Holling, editors. Panarchy: understanding transformations in human and natural systems. Island Press, Washington, D.C., USA.

Howlett, M. 2001. Canadian Forest Policy. University of Toronto Press, Toronto.

Howlett, M. and M. Ramesh. 2003. Studying Public Policy: Policy Cycles and Policy Subsystems. Oxford University Press, Toronto.

Humphreys, E. R., T. A. Black, K. Morgenstern, and Li, Z. and Nesic, Z. 2005. Net ecosystem production of a Douglas-fir stand for 3 years following clearcut harvesting. Global Change Biology 11:450-464.

IPCC. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.104 IPCC, Geneva, Switzerland.

Jasanoff, S. 2004. States of knowledge: the co-production of science and social order. Routledge, New York, New York.

Kingdon, J. 1995. Agendas, Alternatives and Public Policies. Harper Collins College Publishers, New York, NY.

Krajina, V. J. 1965. Biogeoclimatic zones and biogeocoenoses of British Columbia. Ecology of Western North America 1:1-17.

Lenoir, J., J. C. Gegout, P. A. Marquet, P. de Ruffray, and H. Brisse. 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320:1771.

Lertzman, K. and Rayner, J. and J. Wilson. 1996. Learning and change in the British Columbia forest policy sector: A consideration of Sabatier's advocacy coalition framework. Canadian Journal of Political Science 29:111.

Lertzman, K. P., G. D. Sutherland, and Inselberg, A. and Saunders, S.C. 1996. Canopy gaps and the landscape mosaic in a coastal temperate rainforest. Ecology of Western North America 1254-1270.

Levin, S. A. 1998. Ecosystems and the biosphere as complex adaptive systems. Ecosystems 1:431-436.

Light, S. S., L. H. Gunderson, and C. S. Holling. 1995. The Everglades: Evolution and management in a turbulent ecosystem. Pages 103-168 in L. H. Gunderson, C. S. Holling and S. S. Light., editors. Barriers and Bridges to the Renewal of Ecosystems and Institutions. Columbia University Press New York, NY.

Lindblom, C. E. 1959. The science of "muddling through". Public Administration Review 19:79-88.

Loo, T. 2006. States of Nature: Conserving Canada's wildlife in the twentieth century. UBC Press, Vancouver.

Marchak, M. P., S. L. Aycock, and D. M. Herbert. 1999. Falldown: forest policy in British Columbia. David Suzuki foundation and Ecotrust Canada, Vancouver, BC.

Marchak, P. 1983. Green Gold: The forest industry in British Columbia. UBC press, Vancouver, BC.

Meidinger, D. and Pojar, J. 1991. Ecosystems of British Columbia. Ministry of Forests Research Branch, Victoria, Canada.

Ministry of Forests and Range. Mountain Pine Beetle.2008:

Mulholland,F. D. 1937. The Forest Resources of British Columbia. King's Printer, Victoria, B.C.

Nemani, R. R., C. D. Keeling, H. Hashimoto, W. M. Jolly, S. C. Piper, C. J. Tucker, and Myneni, R.B. and Running, S.W. 2003. Climate-driven increases in global terrestrial net primary production from 1982-1999. Science 300:1560-1563.

Niemann,T. 2006. The State of British Columbia's Forests.1-194 Ministry of Forests and Range, Victoria, Canada.

Oreskes, N. 2004. Science and public policy: What's proof got to do with it? Environmental Science and Policy 7:369-383.

Parmesan, C. 2006. Observed Ecological and Evolutionary Impacts of Contemporary Climate Change. Annual Reviews of Ecology and Systematics 37:637-669.

Pearse,P. H. 1976. Timber rights and forest policy in British Columbia. Canada Royal Commission on Forest Resources,

Pearson, R. G. and T. P. Dawson. 2003. Predicting the impacts of climate change on the distribution of species: are bioclimate envelope models useful? Global Ecology and Biogeography 12:361-371.

Pearson, R. G. 2006. Climate change and the migration capacity of species. Trends in Ecology and Evolution 21:111-113.

Pielke, R. A. J. 2004. When scientists politicize science: making sense of controversy over The Skeptical Environmentalist.7:405-417.

Pierson, P. 2004. Politics in Time: History, institutions and social analysis. Princeton University Press, Princeton, New Jersey.

Pojar, J. and Klinka, K. and Meidinger, D. 1987. Biogeoclimatic ecosystem classification in British Columbia. Forest Ecology and Management 22:119-154.

Province of BC, Department of Lands. 1939. Report of the Forest Branch. Kings Printer, Victoria, B.C.

Province of BC, Department of Lands. 1938. Report of the Forest Branch. Kings Printer, Victoria, B.C.

Province of BC, Department of Lands. 1913. Report of the Forest Branch. Kings Printer, Victoria, BC.

Province of British Columbia. 1993. A protected areas strategy for British Columbia. Queen's Printer, Victoria, B.C.

Province of British Columbia. 1911. Statutes of the Province of British Columbia: An Act respecting Strathcona Park.331-332 King's Printer, Victoria, B.C.

Province of British Columbia, Department of Lands. 1936. Report of the Forest Branch. Kings Printer, Victoria, B.C.

Province of British Columbia, Department of Lands. 1921. Report of the Forest Branch. Kings Printer, Victoria, B.C.

Province of British Columbia, Department of Lands. 1914. Report of the Forest Branch. Kings Printer, Victoria, B.C.

Province of British Columbia, Department of Lands, Forests and Water Resources. 1974. Report of the Forest Service. Queen's Printer, Victoria, B.C.

Province of British Columbia, Department of Lands, Forests and Water Resources. 1972. Report of the Forest Service. Queen's Printer, Victoria, B.C.

Province of British Columbia, Department of Lands, Forests and Water Resources. 1971. Report of the Forest Service. Queen's Printer, Victoria, B.C.

Province of British Columbia, Department of Recreation and Conservation. 1964. Report of the Department of Recreation and Conservation. Queen's Printer, Victoria, B.C.

Province of British Columbia, Department of Recreation and Conservation. Report of the Department of Recreation and Conservation. Queen's Printer, Victoria, B.C.

Province of British Columbia, Ministry of Forests and Lands. 1987. Annual report of the Ministry of Forests and Lands. Queen's Printer, Victoria, B.C.

Province of British Columbia, Ministry of Parks. 1988. Annual Report of the Ministry of Parks. Queen's Printer, Victoria, B.C.

Rajala, R. A. 2006. Up-Coast: Forests and industry on British Columbia's North Coast, 1870-2005. Royal BC Museum, Victoria, Canada.

Rajala, R. A. 1998. Clearcutting the Pacific Rain Forest: production science and regulation. UBC Press, Vancouver, BC.

Repetto, R. 2006. Punctuated Equilibrium and the Dynamics of U.S. Environmental Policy. Yale University Press, New Haven.

Reynolds, J. F., M. D. Stafford Smith, E. F. Lambin, B. L. Turner II, M. Mortimore, S. Batterbury, T. E. Downing, H. Dowlatabadi, R. Fernández, J. E. Herrick, E. Huber-Sannwald, H. jiang, R. Leemans, T. Lynam, F. T. Maestre, and Ayarza, M. and Walker, B. 2007. Global desertification: Building a science for dryland development. Science 316:847-851.

Rinnan, R. A., A. Michelsen, and Bååth, E. and Jonasson, S. 2007. Fifteen years of climate change manipulations alter soil microbial communities in a subarctic heath ecosystem. Global Change Biology 13:28-39.

Root, T. L., J. T. Price, K. R. Hall, S. H. Schneider, C. Rosenzweig, and J. A. Pounds. 2003. Fingerprints of global warming on wild animals and plants. Nature 421:57-60.

Sabatier, P.A., editor. 2007. Theories of the Policy Process. Westview Press, Boulder, Colorado, USA.

Sabatier, P.A. and Jenkins-Smith, editors. 1993. Policy change and learning: an advocacy coalition approach. Westview Press, Boulder, Colorado, USA.

Safranyik, L. and Carroll, A.L. 2006. The biology and epidemiology of the mountain pine beetle in lodgepole pine forests. Pages 3-66 in Safranyik, L. and Wilson, B., editors. The mountain pine beetle: a synthesis of its biology and management in lodgepole pine. Natural Resources Canada, Canadian Forest Service Victoria, B.C.

Safranyik,L. and Shrimpton, D.M. and Whitney, H.S. 1974. Management of lodgepole pine to reduce losses from the mountain pine beetle. Natural Resources Canada, Canadian Forest Service, Victoria, Canada.

Simard, S. W., D. A. Perry, M. D. Jones, and Durall, D. and Molina, R. 1997. Net transfer of carbon between ectomycorrhizal tree species in the field. Nature 388:579-582.

Sloan,G. M. 1945. Report of the commissioner, the Honourable Gordon McG Sloan, Chief Justice of British Columbia relating to the forest resources of British Columbia. Victoria, BC.

Sloan, G. M. 1957. Report of the commissioner Honourable Gordon McG. Sloan, Chief Justice of British Columbia relating to the forest resources of British Columbia. Victoria, BC.

Taylor, S.W. and Carroll, A.L. 2004. Disturbance, forest age, and mountain pine beetle dynamics in BC: a historical perspective.41-55 Mountain pine beetle symposium: Challenges and solutions. Natural Resources Canada, Canadian Forest Service, Victoria, Canada.

Turner, B. L., W. C. Clark, R. W. Kates, J. F. Richards, J. T. Matthews, and W. B. Meyer. 1990. The earth as transformed by human action: global and regional changes in the biosphere over the past 300 years. Cambridge University Press with Clark University, Cambridge.

Walker, B., L. Gunderson, A. Kinzig, C. Folke, and Carpenter, S. and Schultz, L. 2006. A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems. Ecology and Society 11:

Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social-ecological systems. Ecology and Society 9:June 12, 2005.

Whitford, H.N. and R.D. Craig. 1918. Forests of British Columbia. Commission of Conservation Canada, Ottawa.

Williams, P., L. Hannah, S. Andelman, G. Midgley, M. Araújo, G. Hughes, L. Manne, E. Martinez-Meyer, and R. Pearson. 2005. Planning for Climate Change: Identifying Minimum-Dispersal Corridors for the Cape Proteaceae. Conservation Biology 19:1063-1074.

Wilson, J. 1998. Talk and Log: Wilderness Politics in British Columbia, 1965-1996. UBC Press, Vancouver.

Wong,C. and Sandmann, H. and Dorner, B. 2004. Historical variability of natural disturbances in British Columbia: A literature review. FORREX-Forest Research Extension Partnership, Kamloops, BC.

Woodward, F.I. and Beerling, D.J. 1997. The dynamics of vegetation change: health warnings for equilibrium "dodo" models. Global Ecology and Biogeography 6:413-418.

World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press, Oxford, UK.

Wynn, G. 2004. "Shall we linger along ambitionless?": Environmental perspectives on British Columbia. BC Studies 142/143:5-67.

5. EXPERT VIEWS ON BIODIVERSITY CONSERVATION IN AN ERA OF CHANGE[15]

5.1. INTRODUCTION

Conservation policy has undergone significant evolution through time - shifting for example from a focus on preserving iconic places, to preserving biodiversity across scales. Today, the impacts of climate change prompt consideration of further iterations on policy and practice. By "policy" we mean collections of objectives and means that reflect values, beliefs, knowledge and expectations of control at a given point in time. By "objectives" we mean statements of a fundamental desired end-point, or things that matter to the actors in a given decision context. By "means", we refer to the specific methods or management strategies designed to achieve a specific objective or desired endpoint. Of primary recent concern is that changing temperature and precipitation regimes (IPCC 2007) will alter a wide range of biological processes and patterns (Thomas et al. 2004). Indeed a growing collection of empirical evidence has documented a range of climate change-attributed biological impacts (Parmesan and Yohe 2003), including altered species distributions (Parmesan 2006; Rinnan et al. 2007; Lenoir et al. 2008). These system dynamics are at odds with established conservation approaches, which are commonly predicated on assumptions of stable biodiversity targets and that seek to protect these targets within static protected areas (e.g. Margules and Pressey 2000). The consequence and recognized challenge is that some target species or ecosystems will no longer be viable in reserve areas created for their protection (Peters and Darling 1985; Hannah et al. 2002; Araujo et al. 2004; Pressey et al. 2007).

In response, conservation scientists have proposed a range of adaptive strategies and solutions, including proposals for dynamic protected areas [16] (Bengtsson et al. 2003; Rayfield et al. 2007) assisted migration [17] (McLachlan et al. 2007; Hoegh-Guldberg et al. 2008), and most prominently, the expansion of linked networks of static protected areas (e.g. Hannah et al. 2002; Hannah 2008). At the same time, other studies have highlighted additional human dimensions

[15] A version of this chapter will be submitted for publication. Hagerman, S.M., Dowlatabadi, H., Satterfield T., and T. McDaniels. Expert views on biodiversity conservation in an era of change.
[16] Areas whose locations and levels of protection change through time and space
[17] The deliberate introduction of species into areas where they have not existed in recent history. Also referred to as "assisted colonization" and most recently, "managed relocation".

such as livelihoods, property rights and governance that have not yet been integrated with current proposals (e.g. Hagerman and Chan 2009; Heller and Zavaleta 2009). Additionally, recent work based on a synthesis of existing data and observations at professional meetings suggests the presence of additional problem dimensions that have not been publicly expressed or systematically examined (Hagerman and Dowlatabadi 2006). Examples of these under-examined dimensions include the role of disturbance in mediating species transitions, and consideration of revised conservation objectives. These apparent discrepancies suggest that the challenge of adapting conservation policy is more multi-dimensional than has been articulated thus far.

The purpose of this paper is to better understand the multi-dimensional challenge of adapting conservation policy to the impacts of climate change by systematically examining the views of experts on the impacts of climate change for biodiversity and implications for conservation policy. In doing so, this paper aims to: a) provide in-depth understanding of the diversity of expert views that currently exists on this topic (with a focus on conservation objectives and means), b) highlight some potential implementation challenges, and c) identify key unresolved topics for future research. This paper proceeds from here in four parts. First we outline a set of key concepts in policy change and adaptation in linked social-ecological systems (SES), this is followed by a description of the methods, then we report on the views of experts, and lastly, we discuss the implications of our findings for understanding the challenge of conservation adaptation specifically, and how this relates to theories of policy change more broadly.

5.2. CONCEPTS IN POLICY CHANGE IN LINKED HUMAN-ECOLOGICAL SYSTEMS

We begin with the premise that social-ecological systems (Berkes and Folke 1998) are linked, co-produced systems that display multi-scalar, historically contingent, non-linear change dynamics (Crumley 1994; Gunderson and Holling 2002; Walker 2004; Reynolds et al. 2007). By SES, we mean complex systems of coupled social and ecological dimensions that interact across scales. This view derives jointly from Holling's seminal work on multiple stable states and non-equilibrium behavior of ecological systems (Holling 1973), and related insights on non-linearity, path dependence in other fields (e.g. Pierson 2004), and multiple potential outcomes in complex adaptive systems (CAS) (e.g. Levin 1998). More specifically, this work is situated and interpreted in the context of theories of policy change, including *integrated* theories of change

such as developed by resilience scholars (e.g. Gunderson and Holling 2002). We discuss these below.

5.2.1. Policy change and adaptation - patterns of change

Policy in any sector is made and re-made over time in response to interacting human and ecological drivers, and this is similarly true for conservation (Wynn 2004; Loo 2006). From research in the policy sciences, some scholars have argued that policy change consistently proceeds "incrementally" (Lindblom 1959). And that incremental change occurs for intrinsic (that is the way the world works), and strategic reasons (cf Kingdon 1995). Or with more nuance, that incrementalism applies to some aspects of policy change, such as the generation of new alternatives, but not to the larger process of agenda setting (Kingdon 1995). Other scholars, some adopting Stephen Gould's punctuated equilibrium metaphor from evolutionary biology, have argued that patterns of change are more accurately described as occurring in punctuated spurts of more substantive and infrequent change that follow prolonged periods of relative constancy and stasis (e.g. Baumgartner and Jones 1991; Kingdon 1995; Howlett and Ramesh 2003; Repetto 2006).

Similarly, resilience scholars who focus on integrated social-ecological systems also invoke a punctuated equilibrium understanding of policy change as part of the predicted dynamics of the adaptive cycle (Gunderson and Holling 2002; Walker et. al. 2004). For example, Gunderson and Holling (2002) describe the dynamics of the adaptive cycle as: "cycles of slow accumulation of natural and cultural capital – in an ecosystem, an institution, or a society –interspersed with rapid phases of reorganization where, for transient moments, novelty can emerge to become subsequently entrained."

5.2.2. Policy change and adaptation - contributing triggers of change

Among other fields, scholars working from policy sciences and resilience theory have sought to identify the underlying mechanisms and determinants of non-equilibrium dynamics either for specific policies, or SES more broadly. In the policy sciences, the social variables commonly identified as contributing triggers towards change include various combinations of the role and

history of ideas, beliefs, technology, the interests of key actors, institutions, market forces, learning, and scientific information (e.g. Sabatier and Jenkins-Smith 1993; Hajer 1995; Kingdon 1995; Howlett 2001; Sabatier 2007). For resilience scholars, non-equilibrium dynamics of change are understood as driven by slow (e.g. soil development; cultural change) and fast variables (e.g. forest fires; market collapse), from *both* biophysical and social domains that interact across scales (Gunderson and Holling 2002; Walker 2006).

Drawing on the above insights, and because the purpose of this paper is to better understand the challenge of adaptation and change in the domain of conservation policy (in this case to the impacts of climate change), we pay particular attention to the interacting roles of 1) the history of debate about new policy proposals, 2) the state of the science including uncertainty 3) the role of values and beliefs and 4) policy windows. Below, we describe in more detail why these particular variables matter in this particular problem context and with respect to our stated objective. [18]

History of debate of new proposals: Kingdon (1995) has shown that while new policy ideas may appear to emerge suddenly, they often have a lengthy history of debate. Further a "gestation period" of "floating up" (and, commonly previous, rejection), is often required for ultimate acceptance: "…without the preliminary work, a proposal sprung even at a propitious time is likely to fall on deaf ears" (Kingdon 1995: 128). This observation matters in the context of understanding policy change in the domain of conservation because previously rejected ideas may eventually be seen as acceptable, or even required, given biophysical and other forces of change (discussed below).

*The role of scienc*e: In some cases new scientific information can be an important contributing factor towards policy change (Ingram and Fraser 2006). In other cases, new scientific information may be a necessary, but insufficient ingredient for policy change. Moreover, while scientific uncertainty is sometimes cited as a barrier to adaptation (e.g. we don't have enough information and knowledge to act), or mobilized by special interests to delay the development of

[18] Adaptive policy change results from a tangle of additional factors interacting across scales and domains and beyond that which we examine here. At the same time, research from both the policy sciences and resilience theory has converged on the observation that a small set of key variables tend to govern the dynamics of change in a given system.

new policies, there is little evidence from historical case studies to suggest that the presence of uncertainty in-and-of itself is a barrier when empowered actors are motivated to change (Oreskes 2004). Lastly non-equilibrium dynamics create irreducible system uncertainties in SES, which implies that decision-making can only proceed in the face of uncertainty in any case. By irreducible uncertainties we mean uncertainties that are perpetuated by the properties and dynamics of linked social-ecological systems.

The role of values and beliefs: The acceptance of new policy proposals tends to occur when they reinforce pre-existing perceptions and values (Kingdon 1995; Sabatier 2007). As Kingdon argues: "proposals that survive…are compatible with the values of the specialists" (Kindgon 1995: 132). By values we mean held beliefs and preferences about what is desirable and important at a given point in time. Similarly, risk and decision scientists use the term "mental models" to describe collections of assumptions, evidence, experience, morality and cultural norms that form conceptions of how the world works, or ought to work (e.g. Morgan et al. 2002). All make the point that in combination with other social and ecological factors, values have material policy consequences in that they can prevent or catalyze change, and contribute to shaping the nature of change when it occurs. Thus new proposals that challenge held values (that are not yet ready to yield to change) are unlikely to gain support (at least temporarily). On this last point, we know, from environmental historians (e.g. Cronon 1996), and economists (Buchanan 1987), that values, and their expression in policy objectives that were suitable for the social, ecological and technological context of one time period, may be either ill-suited, not desired or untenable in a different time period and context. In other words, values can be labile in the longer term. Buchanan invokes the concept of "relatively absolute absolutes" to describe the observation that the values that represent a given "constitution" of alternatives at a given time are stable in the short term, but prone to change in the long term (Buchanan 1987).

The role of policy windows: Lastly, when new policy ideas do emerge, research has shown that it is often the result of the confluence of previous conditions (e.g. the passage of time and labile values) facilitated by an (punctuated and temporary) opportunity, or "policy window" (cf Kingdon 1995). A policy window may be predictable (e.g. scheduled policy review) or unpredictable (an extreme event, a real or perceived crisis). Importantly, policy windows can close with the *perception* that the challenge has been addressed, even if it hasn't (Kingdon 1995).

In the domain of biodiversity conservation, some view climate change as "crisis that would be a terrible thing to waste" (Valli Moosa, IUCN outgoing president at the opening of the World Conservation Congress, 2008, referencing economist Paul Romer). The implication being that we can use the climate crisis as an opportunity to facilitate change.

5.3. METHODS

Modified expert elicitation

This paper is based on a modified expert elicitation with 21 biodiversity and climate adaptation scientists. Expert elicitation uses structured interviews (or questionnaires) to assess the subjective judgments of experts on technical topics at a given point in time (Morgan and Henrion 1990). The method can yield quantitative or qualitative results and is particularly suited to topics where scientific uncertainty is high, and unlikely to be reduced on a time scale relevant for decision-making (e.g. Morgan et al. 2006; Kandlikar et al. 2007). A key strength of expert elicitation with respect to aiding decision-making and identifying future research needs is that it does not seek to identify consensus within a group. Rather, it highlights the current diversity (and locus) of agreement *and disagreement* within an expert community that may not be voiced in more public fora (Morgan and Keith 1995).

These features implicated an expert elicitation as an appropriate methodology for our study precisely because we were interested in the views of experts, (defined here as individuals with specialized knowledge, in this case on topics relating to the impacts of climate change on biodiversity pattern and process, with demonstrated experience and involvement in climate-change related projects and/or publications), on technical topics (e.g. the potential impacts of climate change on patterns and processes of biodiversity), under conditions of irreducible uncertainty. At the same time, given that biodiversity conservation is seen as "a mission oriented discipline" (Meine et al. 2006) we simultaneously sought to leave open the possibility to examine potential interactions between technical judgment and values in shaping expressed preferences. [19] As a result, our methodology consisted of semi-structured (not structured)

[19] In recognition of the difficulty of separating values from scientific judgments, the first elicitation of experts designed by Morgan and Keith only explored climate change dynamics. As they grew more confident in the

interviews with attention to technical concepts as well as expressed value positions, where they were offered. Thus our approach departs from conventional expert elicitations where considerable effort is made to reduce the influence of values, "motivational bias" and other heuristics (Appendix B).

Participant selection

We purposively sought individuals from academic, non-governmental organizations (NGO) and government perspectives. Criteria for inclusion were both substantive and practical. Substantive criteria included demonstrated expertise and involvement in climate change and biodiversity research (e.g. academic publications, involvement in global or regional scale climate change and/or conservation policy development, inclusion of climate change as agency mandate). Individuals were identified through a review of the literature on climate change adaptation, involvement of the authors in biodiversity management initiatives, and through agency directories. Because the majority of interviews were conducted in person, practical criteria for inclusion included resources for travel, which ultimately involved attendance at three major biodiversity meetings (two in North America and one in the United Kingdom) as well as numerous regional (British Columbia) workshops and planning meetings. [20]

Thirty-six individuals were invited to participate in this study. Of these, 33 agreed and 3 did not respond; however the total number of interviews ultimately completed was 21.[21] Interviews were conducted between December 2007 and December 2008 and lasted from 45-120 minutes. Participants and their affiliations are listed in Table 5.1. Although the core of this paper is based on the formal interviews, this data is supplemented by dozens of informal discussions (interview encounters) and extensive observations at biodiversity meetings and workshops between 2005-2008.

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potential for this method, they attempted an elicitation of ecological impacts of climate change. The responses from that study highlighted the challenges in intertwined values and interpretation of evidence.

[20] In a few cases where last minute scheduling changes did not allow for in-person interviews, interviews were conducted over the phone.

[21] Unfortunately, we were only able to schedule interviews with 2/3 of the pool of experts due to time and resource constraints.

Interview protocol and analysis

The interview design, developed over a period of two years, was rigorously reviewed by domain experts to reflect the current thinking in ecology, conservation and climate change adaptation, and pilot-tested with 3 ecologists. The first author conducted all interviews. Following some general questions about an interviewee's expertise in the context of conservation, the interview schedule addressed topics including: 1) drivers of ecosystem change, 2) conservation objectives, 3) conservation means including interventions, 4) uncertainties and decision-making, 5) implementation and governance, 6) and criteria for success (sample interview questions are contained in Appendix C; consent form contained in Appendix D). Due to each individual's particular expertise and variable time constraints, the degree to which specific topics were discussed varied across participants.

Interviews were recorded, transcribed verbatim, and systematically coded using qualitative data analysis software (HyperRESEARCH 2.8, 2007). Saturation of concepts indicated that our sample size was a sufficient representation of current perspectives among the domains of academic, NGO and agency scientists (Figure 5.1). Due to the purposive selection of participants this sample is not representative of all individuals with relevant expertise, but conceptual saturation does suggest we were able to bring to light the diversity of views that currently exists on this topic amongst this group of individuals. While our small sample necessarily limits quantified frequencies of agreement or disagreement, we do nonetheless indicate a coarse measure of commonality for some key topics by indicating how many experts expressed a given view (Table 5.2). [22] Expert views are reported anonymously, but numbers in parentheses at the beginning of excerpted interview quotes indicate the response of a specific interviewee.

5.4. FINDINGS: EXPERT VIEWS

In this section we report on the views of experts. Our findings are organized by perspectives on: 1) policy frameworks (including means and objectives); 2) perceived relationship between

[22] Noting both that the absence of expression does not indicate disagreement, and that commonality of a view may not necessarily equate with technical accuracy.

uncertainty and decision-making; and 3) governance and implementation. Practical and theoretical implications of these findings are discussed in Section 5 that follows.

5.4.1. Potential elements of a new framework for conservation policy

All interviewees expressed the view that a paradigm shift in conservation practice was required to adapt to the impacts of climate change.

> (11) We talk about paradigm shift all the time but this actually is. What should our position be on threatened species and translocation? What are we trying to conserve, or preserve, or is that even the right word? Yes, we are doing climate change impact assessments, but what does this really mean?
>
> (18) Nothing is as simple as space anymore. It never was as simple as space – but now we are not going to get away with it.
>
> (4) There are clearly some rules that we thought were hard and fast, that won't be anymore. Definitions of native species are not going to work anymore because species may undergo complete natural range migrations and show up in places that they have never been in human history. [And] parks that have couched their reason for existence…their entire management goal…to protect a certain species or vegetation type that may no longer be there in the future. It doesn't mean that we don't need that protected area, we have too few protected areas, it means it's going to have to completely rethink its raison d'être.

Conservation means (management strategies)

Expert opinion varied with regard to the specific attributes (here distinguished as means and objectives) that a climate change–motivated paradigm shift or a new conservation framework would entail. When asked about potential adaptive conservation means (management strategies), most experts echoed the suite of strategies commonly proposed in the literature (referenced in the Introduction): such as expanding protected areas, migration corridors, and making the matrix areas more hospitable to change.

> (4) We are going to be losing representation of species. Some species are going to be moving out of protected areas, and that means we need to add more protected areas to compensate.
>
> (8) One of the best things we can do is to protect big landscapes - keeping in mind movement corridors.

> (16) It would be more sensible to have a sequence of land acquisitions along a corridor where things are likely to move - and selecting these based on areas that are still good for their present as much as their potential future value.
>
> (13) One of the major challenges is to make the intervening landscape less inhospitable to species so that they can actually track the climate change through the landscapes.

Similarly, one participant attending a regional climate change-planning meeting summarized the primary means to respond to climate change as to: "save more [area] and save aggressively".

Other views were less commonly volunteered or widespread. One expert identified the need to integrate the role of disturbance processes in facilitating the species/population transitions that the above-mentioned strategies are designed to accommodate.

> (15) What [conservation organizations] want to think about, is how do [species] get from here to there? If you force the [bioclimate envelope] models with the same climate forcing, they will all produce similar endpoints. But it is the transition that you are going to have to manage through. The species or assemblage replacements scenarios imply some kind of big disturbance or series of disturbances - something that makes the space. From a manager's perspective, thinking about what you need to do to manage your way through the transition, is at least as important, maybe more directly important, as thinking about the endpoints from the models.

The importance of available niche space for migrating species was echoed more obliquely by another expert.

> (17) [discussing the utility of corridors to enable range shifts]….which I have trouble with because you know, are there really empty niches?

While only two experts highlighted the role of disturbance and the availability of niche space in facilitating/enabling range shifts it may be that this is a critical dimension for designing effective conservation adaptation strategies. Moreover, the role of disturbance underpinned more commonly discussed topics on intervention and active management in conservation adaptation more broadly. On this, some experts expressed a preference for minimum intervention in conservation areas.

> (16) It is best to let things work its natural way....we tend not to do a particularly good job when we intervene.

> (21) We should be helping species adapt and…not interfering – letting them stay, natural. And letting the processes go as they will.
>
> (19) Nature can handle things better than we can. We just don't know enough.

At the same time, most respondents (including those with an initial "no intervention" preference) (Table 5.2), agreed that interventions were already central to conservation, but that in many cases it would come to be more systematically realized and increasingly necessary to achieving conservation goals given climate change and other interacting drivers such as land use.

> (9) We've been messing with nature for a long time - now we have to do it in a more formalized way. The first time I learned that that wasn't going work [lack of human intervention in conservation] was when the nature Conservancy purchased Kipahulu Valley in Hawaii. The first thing that they did was to close it to the pig hunters [thinking] that would benefit everything. Well, it benefited the pigs and they started thriving…Pigs fed on guava…moved uphill, took the guava seed and pooped, and the guava spread throughout much of the valley. So rather than benefiting it by locking it up, it was a negative.

> (6) I remember one story about a nature reserve that was established in India because it was the breeding or overwintering site of some swan. And the international NGOs, got together…to buy this area and the first thing they did was to kick people off, whom had been farming the area. Well, in doing that the habitat changed, and it no longer became an overwintering area.

Considering interventions in light of climate change some experts expressed the following:

> (13) It [lack of intervention] wouldn't work. It wouldn't work in fragmented landscapes.
>
> (21) I have seen the devastation of…invasive species [that] come in and destroy everything else. So…if invasive alien acacia comes in and wipes out the Fynbos - I still don't think that's okay just because they are the winners.
>
> (2) Subtle or creative intervention - in other words the forces of nature will allow things to adapt. But because of the rate of change, we can help accelerate the effectiveness of some of those natural forces. [But] I am not sure how effective major interventions are going to be. Like translocating all the world amphibians... we've got to learn how to do this, there is a learning by doing element.
>
> (15) If there are assemblages [conservation organizations] particularly care about, then I think you're going to have to advise some active management strategy to keep them. I just don't see any other way realistically that that is going to happen.

Many argued with distinction that intervention was inevitably necessary, but necessarily site specific.

> (19) If it is a large contiguous or relatively representative system of conservation areas then I think you tend to let nature take care of itself. If it is small and isolated and you have relatively little in the matrix…then I think you have to have more intervention.
>
> (6) It is site-specific. There are areas where people have been so involved in altering and changing systems for years that there has to be a lot of active management.

The depth of discussion on intervention and active management for *in situ* adaptive conservation with this group of experts is partially at odds with the degree of consideration in the literature (Figure 5.2). Assisted migration, the deliberate translocation of an imperiled species from one location to another where it has not existed in recent history, is the notable relative exception (e.g. McLachlan et al. 2007). On this emerging topic, many experts in our study viewed the prospect of assisted migration proposals with reluctance and skepticism.

> (11) Our [conservation NGO] general view on it is that it's too risky at this point.
>
> (4) I'm not a big fan of that. People have a great nurturing tendency…[but] we really need to keep [these efforts] in perspective and not have people's desire to help out, get us into a situation where we are intervening, without any guidelines or principles, in a system that we don't understand very well.
>
> (19) My opinion is – wow - ain't that [assisted migration] tragic. Isn't that the canary in the coal mine that should be getting all of us to take notice and ask whether we want to be in that situation - because that is incredibly expensive…you would rather be doing preventative medicine…than paying for it afterwards.
>
> (18) [assisted migration-like interventions] are…I don't want to say doomed to failure, but they are doomed to failure! Conservation doesn't get much money and it isn't about to get a lot of money. Those types of things are very expensive. Additionally, they select for species that we think are important. And moving those species to new locations will further challenge the species that are being challenged in those systems that may have some important function. You will select for the charismatic, we may not select for the functionally important. And if you look at our past history in biological manipulation, it doesn't ever go well.

At the same time, many experts (some who previously voiced resistance to assisted migration) acknowledged that it would be necessary in some cases.

> (18) I certainly think there is a place for moving some things. I think that moving some coastal plant species farther north isn't a bad idea - or south depending on the hemisphere. But moving species without a bigger functional plan, and having thought out what the unintended consequences might be, makes me nervous. It also seems like a tremendous use of resources.
>
> (16) For some species it is going to work tremendously well - the reason we have such trouble with invasive plant and animal species is that some species are easy to move around and then take off. But I think we need to use as large a diversity of management tools as we have available.

As with consideration of interventions more broadly, some experts similarly recalled the history of deliberate species translocations.

> (9) We've already done it! We are there. We just haven't had the ethical conversation about what this really means when you do it on a large scale. Doing it for a handful of species is one thing doing it for several hundred or thousand species is another.
>
> (1) We are going to end up moving species around intentionally to save them - obviously we already do that. Climate change is going to force our hand and we are going to end up moving species that can't get around urban and agricultural barriers - to get them to places where they are going to be more likely to persist.

Indeed conservation organizations are currently engaged in translocations albeit in response to other drivers (e.g. habitat loss).

> (8) We are….moving [plant communities]…farther north…but that is not really - its not really climate change. It is more, this piece is being destroyed and houses are being put up and we are going to save what we can of the native vegetation and move it somewhere else.

Conservation objectives and success

The findings above describe a range of potential pathways (means) to achieve a specific end or objective. For conservation biologists, the fundamental objective can be summarized "the protection and perpetuation of the Earth's biological diversity" (Meine et al. 2006). As noted in the introduction, the primary means to achieve this end over the past 3-4 decades has been the establishment of protected areas that seek to separate valued ecosystem attributes from proximate anthropogenic stressors. The management (or means) objectives that currently guide these efforts

are the representation and persistence of *a priori* identified species biodiversity targets (Margules and Pressey 2000). Thus standards of conservation success are currently measured in terms of hectares protected from proximate stressors; representation of ecosystems (or ecosections) within larger regions; and the persistence of viable populations of specific species in specific places.

Some respondents argued that conservation success in an era of climate change could be evaluated using this same general approach (focus on biodiversity patterns), recognizing that patterns would inevitably be changing through time.

> (5) Right now, our success is judged by our ability to maintain the species and ecosystems that we have...right now. Under a new climate we would have new ecosystems and new species lists. The way of evaluating success would be the same but the list would be different. We are going to see whole new assemblages of plants and animals that we have never seen before. We are going to lose some species and ecosystem-types…just because of climate change. And we have to realize that there is not a darn thing we can do about that. You would just have to accept that that was the case…we are just going to have to adapt to a new reality. It means that our entire ecosystem classification that we have been working on for thirty years will be useless…well, it will be of historical interest, it won't be useless pardon me (laughing).
>
> (12) The target is allowing evolution to happen. We will have completely reorganized ecosystems at all levels - we have to allow species to move…to evolve. And if they can't…then they are going to go extinct. That is the way the cookie crumbles.

In contrast, others argued that conservation success as measured and guided by system function is the only realistic pathway because we "can't control species composition" (18).

> (15) What it might mean is to change the goal a little bit. People have said we want…the actual assemblage of what we have now [to persist]. Maybe what you want to have to persist are the natural processes, recognizing that this will [result in] different assemblages. [Standards of success] might need to evolve.
>
> (6) [The goal] is trying to conserve the capacity of the system to adapt and develop. So it is not a static view of structures, but much more subtle, and more about latent properties of resilience, adaptive capacity and evolutionary potential.
>
> (18) Leave [behind] the spatial model of conservation and start thinking more about large scale conservation that is not based on creating protected barriers. So you no longer have as your conservation goal a protected area or a sustained species. Rather your goal is how do you sustain a functional landscape…or a functional resource. Function is what it gets down to…that is a great metric. It's asking what are the functions you want to preserve,

> rather than what is the place or…species you want to preserve – and how do we get to that? For some places it may be how do you maintain water, the most robust run-off and flow given snow is changing to rain and disappearing…as opposed to saying this is a great river because it has salmon in it! So we are no longer doing conservation for conservation sake - with the awareness that we do not have a static status quo.

> (6) I prefer very broad [objectives] like functioning landscapes, not specific kinds of age structure, or compositional features. Those are way too detailed targets. It's one of those things that can easily get over-defined.

Some interviewees expressed complex views on changing objectives and expectations that reflect the tension between technical understanding of ecosystem dynamics and personal value preferences. One adaptation scientist who specializes in ecosystem dynamics and managing ecological change said:

> (11) I still think that I am stuck on some sort of preservation paradigm Although regions should be sustainably managing change, I don't want to see some of those things change! Because if you give up on [specific species and ecosystems] - it's hard if you give up on that. Then what are you trying to achieve? So it's full of sort of contradictory stuff.

This was echoed by another conservation scientist.

> (12) We are going to go through a period of intense discomfort as species go extinct and as we don't recognize the ecosystems that are being reassembled.

Similarly, a prominent IPCC author and conservation scientist commented on tensions between conservation goals and the protection of vulnerable populations in a question and answer session at the World Conservation Congress. Responding to a statement from the audience that there will be conservation winners and losers and some species will stay in the "game of life" and some won't, s/he noted that: "We have to be very careful about being sanguine - developing parts of the world are going to suffer…we like the world as it is."

Others underscored the social context and potential implications of adapting conservation policy objectives.

> (15) It is a very dangerous thing for the conservation community to think about changing its goals in this way – but it may be something that some of them are going to have to have the courage to think about. It is dangerous in a number ways. One is that it could be perceived as a slippery slope. That, oh well, we're not going to succeed so we are going to change the rules. Secondly is that it will endanger their support: if you give up on

> sphagnum bogs in North Carolina, and someone really cares about sphagnum bogs, they might say I will give my money to someone who is going to do the job if you're not going to do it. And thirdly, the conservation movement for the last hundred years has been predicated on preserving places. And we can argue about whether that was realistic or not, or whether their notion of pristine was correct, but it has a lot of appeal to it for people who care about the outdoors. The notion that you are going to preserve processes, that then shape places can be appealing to a bunch of academics who understand that things weren't an equilibrium anyways, but is that going to have the same degree of popular appeal? It's not clear - how you tell people that?

Indeed, when asked how conservation NGO's respond in practice to suggestions to manage for functioning landscapes rather than specific biodiversity targets, one expert responded:

> (18) Well people don't respond terribly well to it because it means changing their business model and the way they do business. The conservation paradigm is very entrenched….this spatial idea is at the base of what conservation has been and it is hard to get people to think beyond that. It makes people feel uncomfortable to think beyond [the spatial] because protected areas or species numbers are very definable metrics. You can say we have protected x-number of hectares, or we have protected 500 Ibis's. People can count it, and they feel like they can say they've succeeded. The conservation community has gotten very locked into this idea of being able to say that they have succeeded. As opposed to realizing that they are in a longer-term engagement.

Conservation triage

Discussions about standards of success and revising conservation objectives in an era of climate change were also closely aligned with the concept of conservation triage, which can be defined as the deliberate and explicit decision not to invest resources into conserving a given population, species or ecosystem in favour of diverting resources towards other conservation target (s) with the knowledge that doing so will likely result in the demise of the former target.

> (13) Inevitably one has to make some harsh decisions such as what you give up on. And no doubt there will be species that we give up on. If you have a species with weak populations that has no hope in hell of surviving....we would say [to policymakers], unless there is available climate space and suitable habitat…one would have to question the value of investing large sums of limited resource in protecting that species. When that resource could go into protecting other species that would benefit.

> (8) I'm all for it [triage]. It's a reality…you know the project that we are working on now…one of the sort of decisions that can be made is that that [species] is not able to be saved and just let it go - I'm not against those kinds of decisions.

A similar view was voiced during a panel session on climate change and biological adaptation at a major conference in 2007. In this instance, the moderator responded to a question from the audience about "abandoning place-based conservation" and asked the panel: "are we thinking about triage?" A panelist and IPCC lead author then responded: "we are going to have to make hard ethical choices for species and habitats that have so little hope that they are not worth trying to save. I hate to say this, but this is the reality of the situation. The flip side of this is that it frees up more money to buy up more reserve land."

As with discussions on interventions and assisted migration, some experts noted that we already engage in a form of implicit triage in considering the various priority-setting schemes that guide decision-making of conservation NGOs (e.g. Conservation International and prioritization based on biodiversity "hotspots").

> (9) I think we have to start talking about triage. I don't see how you can walk away from it - we do it now. We [have] just elected not to have the conversation.

> (2) Focusing on a certain set of issues inevitably excludes another set. Which is the bang for buck story... you know, what can you do to get the maximum benefit? They [existing prioritization schemes] are all guides - they are all a desperate attempts to make trade-offs palatable.

Nevertheless, echoing the history of discussion on conservation triage as "ethically pernicious and politically defeatist when applied to biological conservation" (Noss 1996), some considered the following:

> (1) I can imagine that there are people out there that are not willing to give up on any species and they would think that conservation triage is offensive but they might think that conservation prioritization is reasonable.

Irrespective of the similarities or differences of triage as current and future practice, the challenge of designing the basis and criteria for explicit (and active) triage assessment in conservation as a response to climate change and other interacting stressors emerged as a key (if uncomfortable) challenge.

> (17) We used this concept of triage…and I was really uncomfortable with it. But… since it is very likely that species and ecosystems are going to unravel, it is really important that we as a conservation community, and including other stakeholders too, have a

> conversation about what the criteria should be for making decisions about what ecosystems we save. If we don't talk about the criteria…it is just going to be ad hoc. Which could be even worse. There is just too much to do, and so priority setting has to happen.
>
> (2) It is assessing where we can afford to let go…de facto species will go. We don't have the framework for tolerating loss. We have to figure out, for critical ecosystems to start with, what are the minimum sets of species within functional groups that are essential for [ecosystem] function? And then build up from there to not tolerate the loss of the raw scaffolding.
>
> (9) It is a tough conversation, and one that I think we need to have openly. But I think you'd want to try to ensure that at least one member of every genus survived - to try to maintain evolutionary options. And absent that, at least one species from every family … but that is arbitrary and capricious, and you could come up with another strategy.

Echoing this last respondent, another expert noted:

> (6) [triage] opens up a whole other set of issues and problems. How do you define who is worse off? By whose metrics? What sort of indicators do you use?

Similarly, a government conservation scientist asked at a conservation and climate change - planning meeting: "What if these species don't have a hope in hell?" [referring to the results of a vulnerability assessment], "How do we handle this?" This sparked a lively discussion of whether managers should think more about vulnerable species or less. Some argued the latter - that the most vulnerable species should be taken out of the assessment. Others felt that extra measures and resources should be put towards keeping them in the assessment precisely because of their vulnerability. In the end, the tension was displaced with the comment that "the trouble with these conversations is the data gaps that exist".

Still another expert in the elicitation questioned the transferability of triage to the realm of conservation – both in terms of species-level dynamics and resource availability and allocation.

> (1) I don't see any problem with it [triage]. The trouble is that is the units we are trying to save aren't usually individuals - there is a point of no return with individuals. I am not as convinced that there is a point of return with species. So it seems reasonable to do conservation triage on the one hand, on the other hand given how little money is invested in conservation, I am not convinced that that is necessarily the best way to go about things. So the California Condor, we have spent tons of money trying to save the species and the question is if we went from a purely triage point of view we would have let it go

> extinct and spent our money on other species. But it is not clear to me that we would have had the money to spend on other species. People rally around the California Condor and attract money for it - so then the question is, if you are attracting money for it, is it taking away from money that could be attracted for other conservation programs?

A similar concern was expressed during a panel session on climate change and species extinctions at the World Conservation Congress. There, a panelist stated: "I am really concerned that policy makers are going to start asking questions about why we are investing money on wimpy species and huge dollars fighting species that are doing very well, [this represents] an awful nexus of problems."

At least part of the resistance to the concept of triage (where expressed), centered on the social context of conservation decision-making. Some experts voiced concern that explicit triage in objective setting would problematically alter the focus away from increasing resources, and set in motion a dangerous precedent and slippery slope on the path to "letting go".

> (21) It [triage] just makes it so easy - and the same with commoditization - being able to pay offsets - I mean it is a completely slippery slope.
>
> (4) I think that there is little question that we will have to be doing triage. The reality of life is that if you devote yourself entirely to triage and none too increasing the amount of resources available to deal with a problem - well then you'll wind up doing lots of triage. Whereas if you put a lot of effort into increasing the amount of resources that you have to deal with the problem, that minimizes the amount of triage that you have to do. Sure you have to worry about triage a little bit but, that is not where we want to put our main focus. You don't want to give people the impression that triage is the solution to the problem.

When asked if the conservation community needed nonetheless to start thinking about what a triage decision process would look like the same expert as above replied:

> (4) Yes, I think that is quite reasonable. But, there is a social context to this and you need to make sure that you're not giving people the idea that you are just going to do triage. You need to emphasize that hopefully we will get funding in place to deal with this in a much broader way. We may have to do a little triage on species, but I think the message would be, "we don't want to be in a position of doing a lot of triage". … At the same time in the long term you want to have intelligent triage, so that you are a maximizing the positive impact of what resources you do have.

Playing God, nature designers and ecosystem engineers

Combined, discussions on conservation means (namely active interventions), and changing conservation objectives including triage often raised the concept (with both reluctance and matter-of-factness) of humans as playing God, nature designers, or ecosystem engineers.

> (9) Assisted migration raises some huge ethical issues….basically you are...in charge of nature at that point. We are nature designers.
>
> (17) I'm not a great fan of this [assisted migration]. Maybe for species of a particular concern or that has some special value from a cultural standpoint. But…I don't want to play God. If species are going to blink out, we have to accept that. I hate to accept that, I don't want to lose any species.
>
> (2) What it means [conservation in an era of climate change], is an ecosystem engineering approach. We need more ecosystem engineers.
>
> (13) Some conservationists seem to be locked into a mindset that doesn't respect the dynamics of nature. It is easy for [me] to say that - less easy for a deep conservationists who has for all of his or her life worked on one set of reserves - to be told by someone like me you are going to have to give up on some of these things - they would say, I've spent 50 years of my life doing this - how can you tell me that? [But] the reality is, you will have to give up on some of those things because you won't be able - unless you create artificial conditions, and people do that sort of stuff. It is moving away from nature conservation…to wildlife gardening.

5.4.2. Basis for informing means: science, uncertainty and decision-making

In considering the criteria and basis for implementing new means such as assisted migration or new objectives including triage, some experts highlighted the lack of knowledge that they felt would be required to inform such activities.

> (21) I don't think that we can justify major [triage-type] choices. We don't know the role of species in ecosystems. There was a conference this year [2008], where they discussed these things. The conclusion was that we just don't know enough to tell you that we don't need that species. We can't tell you that – we don't know…we can't make those decisions.

Again invoking history, others highlighted that conservation decisions are currently, and have historically been based on uncertain and partial information (and that many of the uncertainties

are irreducible in any case), which implicates learning by doing and adaptive management as the path forward.

> (15) I think there is a mismatch - if you ask [conservation and resource managers] what they need, you get back a bunch of specifics. If you look at what they do today, they don't use any of those specifics anyways! I don't believe they actually need them to think about the future. They're not using them now, I don't understand why they think they need them to think about the future. If I thought it was true that you need 10 km scale climate predictions that were 90% accurate for the next 40 years I would be really depressed, because we're not going to get that in the next 10 years… If we really needed that, we might as well just start flipping coins. I don't think we need that to make urgent decisions.

> (17) [I disagree with those] who say we shouldn't go forward with adaptation because there is still too much uncertainty. We need to start testing ideas and do it in a way that has flexibility for us to change course if it's obvious that we've made mistakes. But to be willing to make mistakes - because if we are so overly cautious, we are going to be waiting and waiting until we have perfect data, and then it will be too late.

> (6) I am a firm proponent of the latter argument [decision-making under uncertainty]. If you wait until you know enough to act with certainty it's going to be too late. The other side of it is that I believe really strongly, that what ever we do, whether we are transplanting species across ranges…or trying to change drivers, we are going to make a hell of a lot of mistakes. It is a question how we deal with those mistakes.

5.4.3. Implementation and governance

Experts who held the view that new interventionist management strategies would be required in the face of uncertainty commonly led to a discussion of the barriers to implementing adaptive management and learning by doing.

Institutional barriers

> (15) We need the capacity to recognize that some of those early decisions won't work out. Adaptive management sounds great in theory, but in practice you don't want to be the guy that is wrong first, because you don't get a chance to be wrong twice. In an adaptive management context, which is clearly the philosophy that you need for these conservation decisions, there has to be a way for the ones that don't work out not to end people's careers.

> (6) It is a very conservative system [and] that is a huge challenge. There are lots of disincentives for [innovation] at the research level, at the applied level, the management level - there are lots and lots of disincentives for doing things differently - it is not encouraged.
>
> (4) There are laws and regulations that codify this stuff [invasive species] and that means that they have a pretty long regulatory process to go through to get it fixed. So while I don't think there are any huge intellectual barriers, it may well take years to change it.

Others highlighted that it takes time for a change in thinking to set in and not to incite resistance.

> (19) It takes a while for a paradigm shift…to walk in. And I have started noticing in the last year or so that people are saying things that they certainly weren't saying five years ago. So there is a timeframe that it takes for people to shift thinking.

Similarly, an adaptation conservation expert noted that:

> (18) I don't like to believe that people won't come around. Since I started doing this…there has been a lot more openness. Granted a lot of it is window dressing - a lot of it is people changing what they do so it feels adaptive. But I don't fault the conservation biologists - they are the product of the educational system, and the model that they came out of – and there is comfort in that. So while I want to shake people and say it's not working…the work that they are doing is important. Protected areas are a key part of adaptation. But they need to be done within a broader context.
>
> (6) The thing that is conserved is the capacity for change. The capacity to change our functional or utilitarian view of what biodiversity does for humans, but also a capacity for people to change that perspective over time, because they have, and they will. So it is a dynamic set of expectations, and values and goals that people express. And how you set up the institutions and systems that allow those objectives and approaches to evolve over time is as much a part of it as trying to keep certain species in certain places.

Livelihoods

Topics relating to livelihoods in the context of adaptive conservation were mentioned in only two cases but reported here because despite minimal attention in the climate change literature, the intersection between livelihoods, rights and conservation has been a central concern of those addressing the social dimensions of conservation (e.g. Wilshusen et al. 2003; Brockington 2006; West 2006) and will likely continue to be so as proposals for conservation adaptation become the basis for management and policy.

When asked if livelihoods were considered alongside species projections in conservation adaptation projects a climate adaptation specialist responded:

> (10) These conversations [livelihoods and conservation adaptation] aren't meeting. But there needs to be more bringing together…otherwise we run into a situation down the line, where it is much worse. And we've seen how community and conservation needs have clashed in the past. This is an opportunity…to bring the people who think dominantly about conservation and the people who think dominantly about livelihoods, and the scientists who are thinking about these climate scenarios to start working together because we are going to have to respond to this in a more connected fashion, to meet the scale of this challenge.

When asked what was required the same expert responded:

> (10) For people who are looking at these [bioclimate envelope] maps and scenarios I'd say…we need to be developing a way of feeding into the scenario planning, the information that is coming from the ground. From both conservation practitioners, and communities. Feeding the on-the-ground reality into what is being projected. [This would] make the recommendations that experts make on these projections more realistic in terms of what can be achieved…otherwise people are going to say: "what the hell are you suggesting?"

A concrete example of this is found in the conservation implementation negotiations for the central and north coast of British Columbia where the stressors facing First Nations are outside the traditional realm of "conservation".

> (19) First Nation's primary focus is on communities that have 95% unemployment, huge suicide rates, substance abuse, alcohol etc. etc. our primary priority has got to be to get these people jobs and get back their sense of pride and their well-being. Then, we will have the luxury of focusing on things like protecting ecosystems - but until then, yeah that's just a luxury.

Jurisdictions

Others underscored the need for organizations and agencies to work across jurisdictional divides in a cross-sectoral and multi-stakeholder context in order to integrate conservation efforts within the broader landscape context.

> (4) There is a great need to work across jurisdictions…land management units are like little fiefdoms. People sometimes work across them, but people don't really collaborate across long distances. Unless we think about how we are managing change across much larger areas, across jurisdictions, and across management unit lines, then we could be

> working in opposition. If one protected area is managing to promote change of a particular species and another is promoting retention where it is, you will wind up with management efforts that are working against each other.
>
> (13) There is a need for cross-sector engagement. So if one is desiring to build an ecological network within a fragmented landscape…[you need] partnerships between conservation organizations and…government agencies, those involved in water resource management for flood protection, river management, agricultural policy, farmers, foresters, landowners, land managers. It requires a huge stakeholder engagement to effectively implement a landscape scale program.

At the same time, others highlighted the complexity of multi-stakeholder processes even working within a relatively static model of ecosystem change – let alone incorporating the dynamics of climate change. As one senior negotiator involved in ecosystem-based management process for the central and north coast planning process commented during an informal conversation about academic proposals for conservation adaptation and incorporating climate change into management frameworks: "these folks are just trying to get a handle on adaptive management in a static context – asking them to consider climate change will blow their minds. They can't agree on a static model". S/he went on to note that in this case where the negotiations have had a lengthy (decade long) history of personal effort for many of the individuals involved that: "the heads of the people involved recognize this [impacts of climate change] but their bodies won't let them – there is a visceral resistance to change" given all that has occurred and given all the effort that has already gone into the plan as it currently exists.

One expert similarly noted on consensus processes for adaptive management in another region:

> (6) This is one of the reasons why the [regional planning process] is stuck…and not going anywhere - because of the complexities of the social interactions. Folks can't come to consensus...they can't even get "maybe" in terms of…the vision of the immediate future. Everyone is saying...this is mine and this is mine...there is no institution that allows for those sorts of discussions to occur - to get through those things...so what happens are ephemeral, emergent, planning processes that the Nature Conservancy, or some NGO, or some government puts together, but then disappears...It is a missing institution problem so that you can collaborate enough so that some actions can be taken.

5.5. IMPLICATIONS FOR UNDERSTANDING ADAPTATION IN CONSERVATION POLICY

Overall, these results point to the emergence of a set of key policy ideas amongst climate change and conservation experts, and underscore an important set of future research needs and questions.

5.5.1. Interviews reveal active consideration of topics not widely represented in the literature

The experts in this study raised a number of outlier topics that are not currently represented in the conservation adaptation literature. These include the need to consider disturbance regimes in understanding and ultimately enabling species and population transitions; the need to systematically integrate property rights, livelihoods, and governance with proposed adaptation options such as new protected areas; and the need to discuss decision-making/prioritization criteria including explicit conservation triage. In some cases the greater, extra-literature, set of views detected here may simply represent the evolution and front of knowledge as it develops in this relatively new field. This is arguably the case for the first two examples (disturbance regimes and human concerns), where expertise from different fields is only just being integrated for the purpose of better understanding the specific challenge of conservation adaptation. For example, the integration of vegetation dynamics and global land use change insights with bioclimate envelope outputs, and the budding awareness of insights from research of livelihoods and rights in a conservation context with consideration of what that might mean for conservation adaptation proposals such as the expansion of new protected areas in the context of climate change.

In the case of conservation triage, we were somewhat surprised by the extensive discussion and complexities of views on the topic given the relatively little attention this concept has received in the literature (Figure 5.2) [23] except as being "morally corrosive" (e.g. Noss 1996). This finding may be indicative of still nascent ideas, and yet they have potentially important implications for understanding conservation adaptation more broadly. Some interviewees volunteered the discussion of triage as being necessary to adapting conservation policy to the impacts of climate

[23] Since this study (and literature search) was completed, a recent paper by Bottrill et al. 2009 has addressed the concept of triage in the context of conservation prioritization. Further, the concept of triage is referenced in the following agency reports (Dunlop and Brown 2008; Baron et al. 2008) and in Daedalus (Parmesan 2008).

change. For others, when asked, it led to extensive and often impassioned discussion. Some rejected the concept of triage outright, but most agreed that while undesirable and problematic, some form of triage would occur and so they regarded open transparent discussion of the concept as important, especially as it might come to be applied in practice. These findings suggest that moving beyond outright rejections of triage-like proposals and to instead explicitly discuss its development (or not) is paramount. Recalling Kingdon (1995) these nascent discussions of interventions, revised objectives and triage can be seen as going through a gestation period. With time, they may become "suddenly" acceptable through a policy window.

There are a number of possible reasons why conservation triage has not been systematically examined in the context of climate change and conservation policy.[24] Some experts may be reluctant to examine the potential scientific basis of a triage framework as part of their career foci given that other prominent conservationists have spoken disparagingly of the concept (e.g. Noss 1996; Pimm 2000), or they may be tacitly recognizing the fact that explicit triage-thinking falls outside current conservation norms, which are designed to maintain - not let go of extant species or systems. [25] Going against this norm to take on triage in one's academic career would arguably come with substantial professional risk – especially for young scholars. Additionally, many conservation scientists engage in the work that they do precisely because they care deeply about the processes and patterns of life on Earth. In many cases, they have dedicated a lifetime of work to raising awareness and advancing research with the goal of maintaining biodiversity across scales. Adopting a triage type framework of explicit loss and active intervention may be seen to challenge the core of this effort. Thus the cost of adopting a triage framework for many conservationists may be seen as prohibitive. We will come back to this point below.

One last potential explanation for the louder conversations on triage detected here relative to the literature relates to precautionary concern and ambivalence towards more interventionist alternatives and the "messaging" that results in social settings: here defined as the deliberate

[24] Note here early efforts to do so in a non-climate change /landscape scale / no human dimensions /restoration context (Hobbs and Kristjanson 2003).

[25] Conservation in practice is based on various prioritization schemes (e.g. hotspots). The conservation triage concept discussed by experts here is meant expresses an explicit and active form of decision making in which decisions would take the impact of climate change into account. Despite the core similarity of existing prioritization and so-called triage in a climate change context (both at ecosystem and species scale), the fact remains that the term "triage" (e.g. acknowledging letting go, or giving up on species), and active triage (managing transitions and incurring knock on losses for example) remains contentious.

decision not to discuss triage in public. A number of experts acknowledged the technical necessity for triage ("we need to figure out the criteria") yet stated that they were not discussing it publicly in order to maintain a focus on other preferred alternatives (such as increasing resources for conservation and new protected areas). Such topical avoidance reflects understandable precautionary behavior in defense of 'slippery slope' fears that examining or discussing interventions, ecosystem engineering and triage might bring their possibility more fully into being – a self-fulfilling prophecy of sorts. Together, the detection of extensive consideration of triage in our interviews combined with ambivalence towards the concept indicates the complex relationship between individually held knowledge and the mobilization (or not) of that knowledge in more public spheres of the scientific literature.

5.5.2. New policy alternatives may be more strongly shaped by the values of specialists than the state of the science

As indicated above, publicly accepting the implications of climate change including the possibility of increased interventions and triage arguably incurs substantial social costs - both personally and for the current objectives of conservation (e.g. maintain *a priori* species and ecosystem in place). The result is that technical understandings of biodiversity change dynamics are placed in tension with value-based commitments of experts to prevailing ideas of conservation as wild spaces and dedication to protected areas. This may partially explain why some of the proposed conservation adaptation alternatives have been described as "window dressing" (alternatives that contain modifications that look adaptive but that do not pose a substantive challenge to conventional means, objectives and expectations).

From the perspective of psychologists, this observation can be understood as a problem of "protected values", where people strongly prefer not to trade one value or objective of importance for another equally important value because doing so would challenge held beliefs, values or norms (Baron and Spranca 1997). Combined, these observations indicate the blurred boundary between objective science and advocacy in the stated "science-based" approaches of many regional, national and international conservation organizations (The Nature Conservancy as one example). Although this study was not designed to examine the relationship between conservation advocacy and science, the topic was volunteered on a number of occasions.

> (2) I hate to see myself as an advocate…but almost unavoidably I am. I work with [large conservation organization], I've come from that background. I can't split myself in half. It is very tricky. But I've got to maintain credibility, and it is very difficult if you are seen as a big greeny.
>
> (17) I have to be very careful. But people like E.O. Wilson, or Tom Lovejoy, who have plenty of respectability, can be strong advocates at this point [in their careers], so I don't know where the breaking point is....

More broadly, the above observations lend support to the proposition by Kingdon (1995) described in the introduction that new proposals are unlikely to gain support if they are in contrast with the held values of existing specialists. At the same time, we know that values are labile over time, which leaves open the possibility for future more substantive change.

5.5.3. The presence of uncertainties does not hinder development of new alternatives

Related to the acceptance of new policy alternatives is the relationship between scientific uncertainty and decision-making. In our study, many experts argued that uncertainties relating to climate change and conservation are irreducible and therefore that experimentation and decision-making must proceed in a learning-by-doing approach. For the majority in this pool of experts, the presence of uncertainty in and of itself is not regarded as barrier to change. Rather, the most formidable barriers to change in conservation policy and practice as indicated by our results, are not uncertainty or lack of knowledge, but can be found in a precautionary ambivalence to interventions, durable values and a resistance to anticipated difficult trade-offs, and institutional barriers.

Finally, while climate change is seen by some as a potential policy window for change, the evidence above indicates that the factors just listed currently constrain substantive policy change. In fact, it is possible that the challenge of adapting conservation is considered sufficiently addressed by proposals to expand protected areas and implement migration corridors. The broad problem context of "climate change" as a potential policy window may actually now be closed as attention is tuned to implementing new protected areas as a key response. One can cautiously speculate that a future expression of crisis, failure of the current response, or scheduled review may once again open up the discussion for more transformative dialogue on adaptation.

Additionally, a new policy window may require the turnover, or critical mass of a new generation of conservation scholars trained less in preservationists ideals and perhaps more so in interventions and managing ecological processes. With time, it is possible that debates previously rejected, but now with a history of debate, and as values (potentially) change that more substantive change will come under consideration.

5.6. CONCLUDING REMARKS

The results of this study underscore the complexity of adapting conservation policy to suit an era of climate change. The results specifically highlight the need to build on the important initial efforts and existing scholarship in conservation adaptation to further engage with additional problem dimensions that include the role of disturbance and intervention in species transitions, revised objectives, conservation triage, and human dimensions including livelihoods, property rights and governance. It also demonstrates that policy adaptation as it unfolds in science-based conservation will do so influenced by a tangle of science, values, experience and motivation.

No one set of conservation means and objectives will best protect biodiversity in the face of climate change and other interacting drivers in the long term: there is no panacea (Ostrom 2007). The intent of this paper is not to advocate one conservation framework as a complete successor to another. Rather it is to highlight the ecological and social complexities of adapting conservation policy to the impacts of climate change. Conservation policy has changed in the past and it will continue to evolve. We hope that this study has highlighted some potential pathways for further examination and discussion.

Table 5.1. Experts whose views are reported on in this Chapter.

NAME	AFFILIATION	ROLE
	NGO	
Geoffrey Blate	WWF-World Wide Fund for Nature	Climate Change Coordinator
Michael Case	WWF-International	Climate Change Research Scientist
Cassandra Brooke	WWF – Australia	Manager, Climate Change Adaptation Science
Rhadika Dave	Conservation International	Climate Change Adaptation Manager
Lee Hannah	Conservation International, Center for Applied Biodiversity Science, Arlington, Virginia, USA	Research Fellow Climate Change Biology and Bdy. Corridor Design
Lara Hansen	EcoAdapt	Chief Scientist and Executive Director
Michael Harley	AEA group	
Jody Holmes	Rainforest Solutions Project	Conservation Scientist
Pierre Iachetti	Nature Conservancy of Canada	Director of Conservation Science and Planning
Tony Janetos	Joint Global Change Research Institute, College Park, MD, USA	Director
Wendy Foden	International Union for Conservation of Nature	Programme Officer Climate Change - Species Programme
	Academic	
Andrew Dobson	Princeton University, Department of Ecology and Evolutionary Biology	Professor
Lance Gunderson	Emory University, Department of Environmental Studies	Associate Professor
Paul Ehrlich	Stanford University, Centre for Conservation Biology	Professor
Jennifer Martiny	University of California Irvine, Department of Ecology & Evolutionary Biology	Associate Professor
Guy Midgley	South African National Biodiversity	Chief Specialist Scientist – Global Change Research Group
Dov Sax	Brown University, Ecology and Evolutionary Biology	Assistant Professor
J. Michael Scott	University of Idaho, Department of Fish and Wildlife Resources	Professor
	Government	
Andy MacKinnon	British Columbia Ministry of Forests and Range	Research Ecologist
Del Meidinger	British Columbia Ministry of Forests and Range	Research Scientist, Forest Ecology
Dave Spittlehouse	British Columbia Ministry of Forests and Range	Research Climatologist
Tory Stevens	British Columbia Ministry of the Environment	Protected Areas Ecologist
N = 21		

Table 5.2. Summary of views on recurrent topics across total expert sample: (√) indicates that this view was stated during the elicitation, (-) indicates that this topic was not discussed (e.g. because it was outside the realm of a respondent's expertise, ( ) boxes without any marker indicate the absence of expressed view for the theme in that column. It does not mean that the general topic was not discussed, just that the themes listed here were not expressed. For example, Expert 2 shows three empty boxes under Success and Objectives. In this case, this individual discussed other (procedural) metrics of success (e.g. monitoring programs), but not the three themes listed here.

	Means	**Interventions**		**Triage and Prioritization**			**Success and Objectives**			**Uncertainties and Decision-making**		**Implementation**	
Expert No.	*New Pas and Migration Corridors*	*Opposed*	*Necessary*	*Implicit already*	*Undesirable but necessary*	*Opposed -slippery slope*	*Revise objectives*	*Focus on Process and Function not pattern*	*Gradients*	*No experimenting without prior evidence*	*Action/Experiment in the face of uncertainty*	*Jurisdictional and livelihoods*	*Institutional barriers*
1	√		√	√	√		√	√	√		√	-	-
2	√		√	√	√						√	-	-
3	√		√	-	-	-	√				√	√	
4	√	√	√		√	√	√			√	√	√	√
5	-		√		√		√				√		√
6	-		√	-	-	-	√				√	√	√
7	√		√	-	-	-	√				√	-	-
8	√		√	√	√			√	√		√	√	
9	√		√	√					√	-	-	√	-
10	√		√	-	-	-				-	-	√	√
11	-	√				√	√	√			√	√	√
12	√	√	√	√	√		√	√	√	-	-	√	
13	√		√		√		-	-	-	-	-	√	
14	-		√	-	-	-	√				√	√	√
15	-		√	-	-	-	√	√			√	√	√
16	√	√	√	-	-	-	-	-	-		√	√	
17	√	√	√		√		-	-	-		√	√	
18	√	√	√		√		√	√			√		√
19	√	√	√	√					√			√	√
20	-		√		√		√	√			√	√	√
21	√	√	√	√		√	√		√		√	-	-

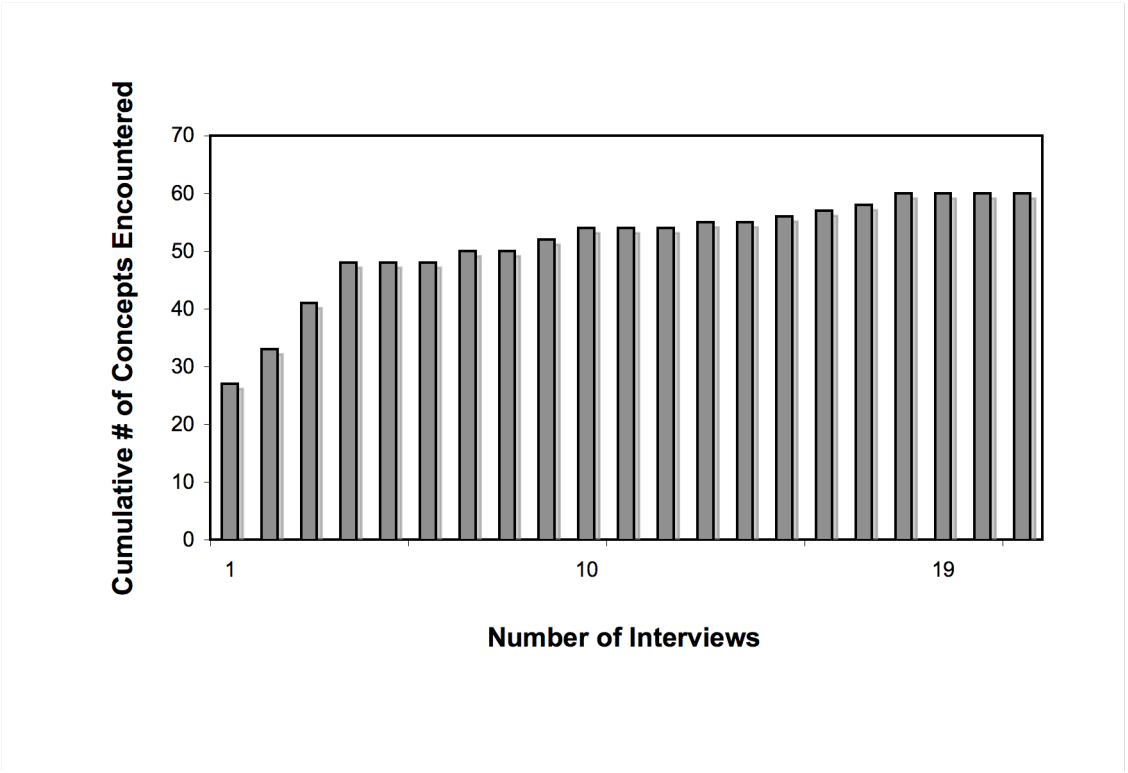

Figure 5.1. Cumulative number of concepts encountered with increasing interviews (total formal interview n = 21)

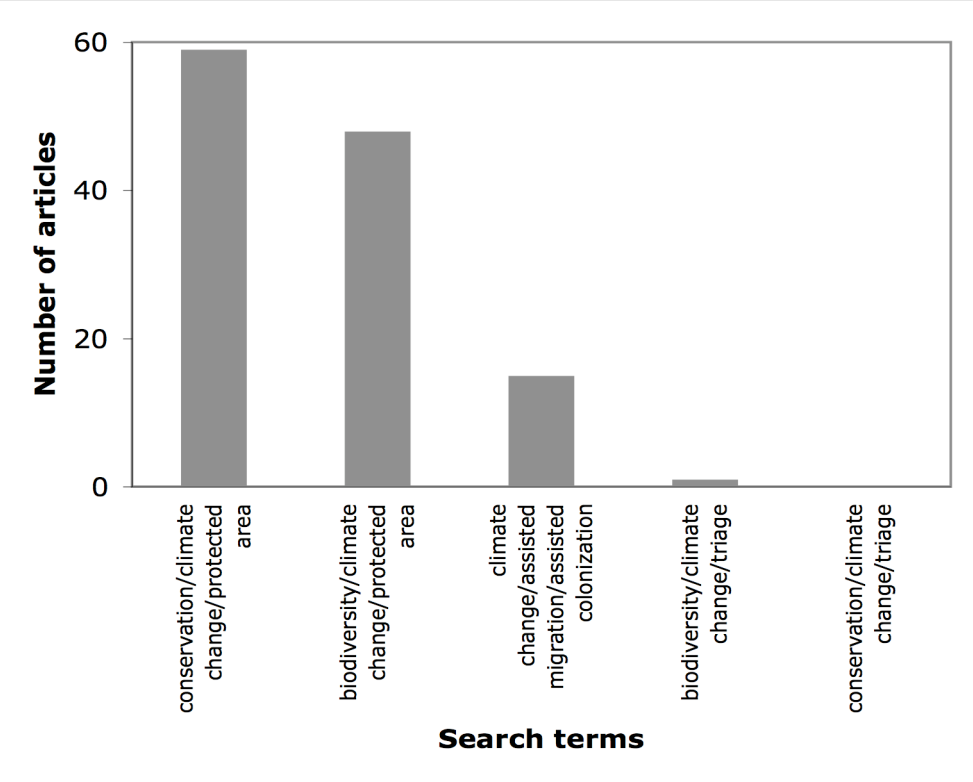

Figure 5.2. Number of papers published on a range of strategies for adapting conservation policy to the impacts of climate change. Web of Science search Dec. 17.08 (1965-2008).

5.7. REFERENCES

Baron, J., Spranca, J., 1997. Protected Values. Organizational Behavior and Human Decision Processes 70, 1-16.

Baumgartner, F.R. and Jones, B.D., 1991. Agenda dynamics and policy subsystems. Journal of Politics 53, 1044-1074.

Bengtsson, J., Angelstam, P., Elmqvist, T., Emanuelsson, U., Folke, C., Ihse, M., Moberg, F., Nystrom, M., 2003. Reserves, resilience and dynamic landscapes. Ambio 32, 389-396.

Brockington, D., Igoe, J. and K. Schmidt-soltau, 2006. Conservation, human rights, and poverty reduction. Conservation biology 20, 250.

Dunlop, M. and Brown, P.R., 2008. Implications of climate change for Australia's National Reserve System: A preliminary assessment. Report to the Department of Climate Change,

Gunderson, L.H., Holling, C.S., 2002. Panarchy: understanding transformations in human and natural systems.

Hagerman, S. and Dowlatabadi, H., 2006. What - biodiversity set-asides may not protect against climate change? Climate Decision Making Center – Seminar.

Hannah, L., 2008. Protected Areas and Climate Change. Annals of the New York Academy of Sciences 1134, 202-212.

Hannah, L., Midgley, G.F., Lovejoy, T., Bond, W.J., Bush, M., Lovett, J.C.,Scott, D. and F.I. Woodward, 2002. Conservation of biodiversity in a changing climate. Conservation Biology 16, 264-268.

Heller, N. and E. Zavaleta, 2009. Biodiversity management in the face of climate change: A review of 22 years of recommendations. Biological Conservation 142, 14-32.

Hobbs, R.J., and L.J. Kristjanson, 2003. Triage: How do we prioritize health care for landscapes? Ecological Management and Restoration 4, Suppl., February.

Hoberg, G., 1996. Putting ideas in their place: A response to "learning and change in the British Columbia forest policy sector". Canadian Journal of Political Science 29, 135.

Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P.,Thomas, C.D., 2008. Assisted Colonization and Rapid Climate Change. Science 321, 345-346.

Howlett, M., 2001. Canadian Forest Policy. 446.

Howlett, M. & M. Ramesh, 2003. Studying Public Policy: Policy Cycles and Policy Subsystems. Oxford University Press, Toronto.

Ingram, H. and Fraser, L., 2006. Path dependency and adroit innovation: the case of California water. In: Robert Repetto. (Ed.), Punctuated equilibrium and the dynamics of US environmental policy. Yale University Press, New Haven, pp. 78-109.

IPCC, 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 104.

Kandlikar, M., Ramachandran, G., Maynard, A.,Murdock, B. and W. Toscano, 2007. Health risk assessment for nanoparticles: A case for using expert judgment. Journal of Nanoparticle Research 9, 137-157.

Kingdon, J., 1995. Agendas, Alternatives and Public Policies. Harper Collins College Publishers, New York, NY.

Lenoir, J., Gegout, J.C., Marquet, P.A., de Ruffray, P.,Brisse, H., 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320, 1771.

Loo, T., 2006. States of Nature: Conserving Canada's wildlife in the twentieth century. UBC Press, Vancouver.

Margules, C.R. and Pressey, R.L., 2000. Systematic conservation planning. Nature 405, 243-253.

McLachlan, J.S., Hellmann, J.J.,Schwartz, M.W., 2007. A framework for debate of assisted migration in an era of climate change. Conservation Biology 21, 297-302.

Morgan, G. and D. Keith, 1995. Subjective judgments by climate experts. Environmental Science and Technology 29, 468A-476A.

Morgan, G., Adams, P. and D. Keith, 2006. Elicitation of expert judgments of aerosol forcing. Climatic Change 75, 195-214.

Morgan, M.G. and M. Henrion, 1990. Uncertainty: A guide to dealing with uncertainty in quantitative risk and policy analysis. Cambridge University Press, Cambridge.

Noss, R., 1996. Conservation or Convenience? Conservation Biology 10, 921-922.

Oreskes, N., 2004. Science and public policy: What's proof got to do with it? Environmental Science and Policy 7, 369-383.

Ostrom, E., Janseen, M.A.,Anderies, J.M., 2007. Going beyond panaceas. Proceedings of the National Academy of Sciences 104, 15176-15178.

Parmesan, C., 2008. Where the wild things were. Daedalus Spring, 31-38.

Parmesan, C., 2006. Observed Ecological and Evolutionary Impacts of Contemporary Climate Change. Annual Reviews of Ecology and Systematics 37, 637-669.

Parmesan, C., Yohe, G., 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421, 37-42.

Pimm, S.L., 2000. Against triage. Science 289, 2289.

Rayfield, B., James, P.M.A., Fall, A.,Fortin, M., 2008. Comparing static versus dynamic protected areas in the Quebec boreal forest. Biological Conservation 141, 438-449.

Repetto, R., 2006. Punctuated Equilibrium and the Dynamics of U.S. Environmental Policy. 292.

Rinnan, R.A., Michelsen, A.,Baath, E. and Jonasson, S., 2007. Fifteen years of climate change manipulations alter soil microbial communities in a subarctic heath ecosystem. Global Change Biology 13, 28-39.

Sabatier, Paul and Jenkins-Smith, H.C., 1993. Policy change and learning: an advocacy coalition approach.

Suttle, K.B., Thomsen, M.A. and Power, M.E., 2007. Species interactions reverse grassland response to changing climate. Science 315, 640-642.

Thomas, C., D., Cameron, A., Green, R., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siqueira, M.F., Grainger, A., et al, 2004. Extinction risk from climate change. Nature 427, 145-148.

Walker, B., Gunderson, L., Kinzig, A., Folke, C.,Carpenter, S. and Schultz, L., 2006. A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-Ecological Systems. Ecology and Society 11,

Walker, B., Holling, C.S., Carpenter, S.R.,Kinzig, A., 2004. Resilience, adaptability and transformability in social-ecological systems. Ecology and Society 9, June 12, 2005.

West, P., Igoe, J.,Brockington, D., 2006. Parks and peoples: the social impact of protected areas. Annual Review of Anthropology 35, 251-277.

Wilshusen, P.R., Brechin, S.R., Fortwangler, C.,West, P.C., 2003. Contested Nature: Conservation and development at the turn of the twenty-first century. In: Steven R. Brechin. (Ed.), Contested Natures: promoting international biodiversity conservation with social justice in the twenty-first century. State University of New York Press, Albany, pp. 1-22.

Wynn, G., 2004. "Shall we linger along ambitionless?": Environmental perspectives on British Columbia. BC Studies 142/143, 5-67.

6. ADAPTING CONSERVATION POLICY TO THE IMPACTS OF CLIMATE CHANGE: PROMOTION, AMBIVALENCE AND RESISTANCE AT THE WCC [26]

6.1. INTRODUCTION

The impacts of climate change pose a fundamental challenge to existing conservation frameworks. Evidence continues to accumulate that changing precipitation and temperature regimes will interact with other stressors (e.g. land use change) to initiate a cascade of impacts on biological processes and distributions (Thomas et al. 2004; Parmesan 2006; Suttle et al. 2007; Rinnan et al. 2007; Lenoir et al. 2008). These system dynamics are at odds with the prevailing conservation approaches, which are commonly predicated on assumptions of stable biodiversity targets and that seek to protect these targets within static protected areas. The recognized challenge is that some conservation targets (e.g. species or ecosystems) will no longer be viable in reserve areas created or maintained for their protection. As a consequence, "the entire rationale behind parks and other protected areas is going to need to be rethought for a warming world" (Kunzig 2008).

Addressing the challenge of how to adapt conservation policy to the impacts of climate change was a central focus of the recent World Conservation Congress (hereafter referred to as the WCC). The "New Climate for Change" was one of three central foci that included over 60 sessions on various aspects of climate change mitigation and adaptation. A subset of these sessions specifically addressed the implications of climate change for *adaptive* conservation efforts. These sessions included: "What Will it Cost to Make the World Protected Areas Network Resilient to Climate Change?"; "Climate Change and Species Extinctions: New Approaches to Support Decision Makers and Planners"; and "Climate-Proofing Biodiversity Inside and Outside Protected Areas Through Connectivity Conservation Initiatives". In these sessions, the key question was: in what ways does conservation practice need to change in response to climate change? Further portending a sense of change in conservation policy and practice, IUCN Chief Scientist Jeff McNeely stated prior to the WCC that there is a growing sense "that climate change is poised to trump everything" (pers. comm., September 2008).

[26] A version of this chapter has been submitted for publication. Hagerman, S., Satterfield, T. and H. Dowlatabadi. Adapting conservation policy to the impacts of climate change: promotion, ambivalence and resistance at the WCC.

Understanding the challenges associated with changing beliefs that define objectives in specific decision contexts and how people promote, resist, modify and navigate these changes and decisions is discussed and understood in different ways in different fields. Decision analysis scholars recognize a hierarchy of trade-offs and an overarching framework within which trade-offs are exercised. Frameworks (termed *constitutions* by economists) prevail for lengthy periods of time and reflect values, knowledge and expectations of control and outcomes at the time of their design. Within these frameworks trade-off decisions (further defined below) are made that reflect the divergent interests and values of the actors involved. Over time, changing forces from different domains (e.g. technological, biophysical, social) can trigger a new decision framework (with new means, objectives, expectations and norms) (Buchanan 1987). With this change comes a new set of rules for trade-offs in the option (or trade-off) space where previously unacceptable values, stakeholders, strategies or alternatives become newly acceptable. The challenge of adapting conservation decision-making frameworks to the impacts of climate and other forces of global change is an example of a new set of forces testing the overarching framework of the last four decades of biodiversity conservation.

In other fields, scholars focused on the politics of knowledge highlight the influence that particular problem framings have on rendering some options and alternatives more visible/acceptable than others (Brosius 1999). Using social theories of *discourse,* and their often-unrecognized powers of persuasion*,* these scholars understand that particular problem framings (or constitutions), implicate some alternatives "logical" or indicative of the "natural order of things". For these scholars, knowledge can be actively portrayed to highlight specific problem dimensions in order to support specific problem framings (e.g. Geiryn 1995) and the option space that results. These framings are further seen to demarcate some fields of expertise as legitimate stewards of a constitution (existing or new), including determination of the scale at which decisions should be made. As with the above, these scholars highlight that overarching problem framings are durable but also prone to change through time (Brosius 1999).

Embedded within a given decision framework or constitution, is the option space that is acceptable/made visible at a given point in time. At this level, some conservation scholars see the challenge in terms of "navigating trade-offs" (Garnett et al. 2007). Trade-offs are decisions about what to do (manage the resource for biodiversity or resource extraction?); by what means?

(protected area or active restoration?) where (over what spatial area?); and when (prioritizing actions over time) (Gregory 2002). They are considered trade-off decisions because achieving one objective comes at the cost of something else of value (typically a different type of value – area protected and area available for resource use). These decisions arise from constraints on resources including space, and cost, interacting with the different beliefs and objectives that support and are reinforced by the existing, overarching framework of valued objectives and indicators within which trade-offs are exercised. Conservationists working from this perspective have synthesized prescriptive lessons in effort to improve "the ability of key actors to identify, analyze and negotiate conservation and development trade-offs" (e.g. Advancing Conservation in a Social Context: Conceptual Framework): they ask that: 1) trade-offs be recognized/identified, 2) trade-offs be explicit, and that 3) there is a transparent deliberative process for decision-making that attends to key dimensions of representation, fairness and transparency (Advancing Conservation in a Social Context: Conceptual Framework; Garnett et al. 2007).

Further to these efforts, scholars working from the perspective of decision sciences and behavioral decision-making, have shown that limits to knowledge, and cognition can hamper efforts to achieve the first criteria (e.g. trade-off recognition), and that resistance on moral grounds and trade-off avoidance can derail hopes that contentious trade-offs be made explicit (e.g. Satterfield and Levin 2007; Gregory 2002). From the perspective of psychologists working in this field the problem of trade-off avoidance can be understood as one of "protected values", where people strongly prefer not to trade one value or objective of importance for another equally important value because doing so would challenge held beliefs, values or norms (Baron and Spranca 1997). Others describe these difficult and perceived illegitimate comparisons as "taboo tradeoffs" (Tetlock et al. 2000).

All of the above disciplinary perspectives describe various pieces of either an overarching decision constitution (and how this resists and changes through time) or the social dynamics of trade-off negotiation and or avoidance that occurs within that space. The challenge we focus on here is that adapting conservation policy to the impacts of climate change will simultaneously require revision to values, objectives and the alternatives that these support. And further than we need to scrutinize the implications of these decisions for those whom they will most affect.

The aim of this paper is to document and examine aspects of promotion, ambivalence and resistance to debates on the potential for a new decision constitution for conservation as they occurred at the World Conservation Congress. We asked: 1) what were the key debates and areas of tension related to proposals for adapting conservation policy to the impacts of climate change 2) how did these tensions play out in different settings of the Congress and 3) to what extent did Congress outcomes diverge from existing conservation policy frameworks? To varying extents we draw on the insights of the perspectives outlined above to help us understand observed patterns of durability and (less so) change in ongoing efforts to adapt conservation policy.

Our central argument is that the process of developing and adopting an adaptive conservation decision constitution is currently stalled in policy spheres as a consequence of the recognized, anticipated and currently undesirable *within* conservation trade-offs (e.g. species x species or ecosystem x ecosystem) that would result with a new option space. In other words, trade-off avoidance derived from commitments to conventional preservationist principles of conservation at least partially explains why the existing decision constitution has remained intact, despite increasing recognition of its untenable foundations given forces of global change.

This paper proceeds from here in three parts: following a section on methods, we report and interpret our empirical evidence; lastly we conclude with reflections on the extent to which climate change may have "trumped everything" at the WCC, and implications for understanding policy adaptation in this context.

6.2. METHODOLOGY

6.2.1. The site

This research was conducted at the WCC hosted by the International Union for the Conservation of Nature (IUCN), held in Barcelona Spain, October 5-14, 2008.[27] The IUCN is the world's "largest global environmental network" whose stated mission is to "influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to

[27] This research is part of a larger collaborative "Event Ethnography" project. In this collaboration, I participated as one of over 20 researchers conducting ethnographic research across a range of conservation issues that included among others, indigenous rights; biofuels; marine issues and payments for ecosystem services. The collaboration began prior to the Congress and is ongoing through bi-weekly teleseminars.

ensure that any use of natural resources is equitable and ecologically sustainable". Organized as a "democratic membership union", the IUCN consists of over 1,000 members (200 government and 800 NGO) across 140 countries and 11,000 scientists who volunteer in 6 commissions.

The WCC is held every four years and heralded as "the world's largest and most diverse conservation event" whose aim is "to improve how we manage our natural environment for human, social and economic development" (IUCN). Over 7800 representatives from non-governmental organizations (NGOs), governments, indigenous groups, academe and business attended the event. Considering the above and its official observer status at the UN General Assembly, the activities of the IUCN including the WCC represent a key site of conservation agenda setting and opportunity to examine the formulation, promotion and debate of policy alternative as they unfold in real time.

6.2.2. The approach

This study is part of a larger collaborative ethnographic project examining the social context of conservation trade-offs across various topical domains (e.g. biofuels; indigenous rights; marine issues) at the WCC (Brosius, in preparation). It is collaborative in the sense that co-researchers share data and insights for the purpose of gaining a fuller understanding of trade-offs at the WCC than could be achieve by a sole researcher (Figure 6.1). [28] The data presented here are also part of a longer four-year trajectory of research that has aimed to better understand the linked ecological and social challenges of adapting conservation policy to the impacts of climate change. Thus this work can be read both as an element within the broader topical and ethnographic investigation of trade-offs at the WCC, and an element along the temporal trajectory of research into the evolving dialogue on conservation adaptation in particular (Figure 6.2).

In this study we used ethnographic methods to document the content and social context within which key conservation adaptation topics were identified, framed, promoted and contested at the WCC. This event ethnography (Brosius, in preparation) approach can be considered a

[28] Insights are shared by weekly tele-seminars prior to the Congress, daily meetings held during the Congress (photo), and ongoing teleseminars, collaborative writing and data sharing (post-Congress). However this paper reflects my data and observations.

combination of rapid or time-constrained ethnographic assessment (cf Low et al. 2005) and institutional ethnography (e.g. Gusterson 1992; King 2008), whose purpose is to capture engagements between scientific experts, decision makers and NGO actors in the context of a time-condensed policy-setting meeting. By documenting and analyzing the social interactions and production of knowledge that emerges at these events, this paper follows in the methodological tradition of "studying up" (Nader 1972; Gusterson 1997), and is in keeping with calls for anthropology to overcome the "continued aversion to studying power brokers such as scientists, government decision makers, industry leaders…" and *in addition to the local,* focus analyses on "institutions and populations of power and provide rich accounts of how knowledge and policies are produced…." (Lahsen 2008).

Specifically, the analysis presented here is based on: 1) detailed participant observation at more than 13 workshops, knowledge café's and Pavilion events during the Forum portion of the Congress, 2) observations conducted during Contact Groups and Plenary sessions of the Members Assembly and 3) 8 semi-structured interviews (between 45 minutes to 90 minutes) with leading biodiversity-climate change experts from domains including academe, NGOs and from the IUCN secretariat. Combined, these research activities amount to over 50 hours of observational data on the content and nature of debates around the implications of climate change for biodiversity conservation.[29] The strength of this approach as applied in this policy-making setting and in relation to our questions is to reveal nuance between the perspectives of individuals voiced in private, and how and why these perspectives are mobilized (or not) in social contexts where specific objectives are sought.

6.2.3. The WCC

The ten-day meeting is organized into two distinct parts: the Forum (days 1-5) and the Members Assembly (Days 6-10). The Forum is a "grand public bazaar...bringing together people from all over the world to discuss, share and learn" (IUCN – World Conservation Learning Network). "Bazaar" is an accurate descriptor in that the Forum activities are indeed part spectacle, festival,

[29] The focus of my work at the Congress was specifically related to conversations relating to the implications of climate change for adaptation of biodiversity conservation as seen by experts in these debates. There are numerous other directly related issues that I do not cover. Including, for example, conversations around Reducing Emissions from Deforestation and Degradation (REDD) and Climate Change and Indigenous Rights. As part of the Collaborative Event Ethnography, future work will seek to integrate the results of these related issues.

and marketplace. The opening ceremonies for example included Cirque du Soleil acrobats, a live orchestra, slide show and the Prince of Asturius. The Forum consisted of 4 fast-paced days of over 800 concurrent workshops, roundtables, world premiers, book and journal launches, dance parties, art and film, receptions that begin and end in the early hours of the day.

The frenetic pace of the Forum is followed by five measured days of the Members Assembly. A fraction of the participants are in attendance for this latter portion of the Congress and the locus of activity shifts from everywhere and all at once to the central location of the main plenary hall (Figure 6.3). The Members Assembly consists of parliamentary-like proceedings where IUCN members "debate and establish environmental policy" (IUCN). Specifically, members debate and vote on over100 resolutions; approve the inter-sessional programme that will guide the work and policies of the IUCN for the next four years; and elect a new President and Council. The Members assembly also consists of "Contact Group" debates. Contact Groups are scheduled for motions that "address substantial policy issues, or [if] members would benefit from greater clarification of the issues…" (IUCN, WCC Motions Manual). Their purpose is to "provide members the opportunity to prepare consensus text and/or harmonize text to avoid contradictions in adopted resolutions or recommendations" before going to plenary.

6.3. CONSERVATION ADAPTATION AT THE WCC: PROMOTION, AMBIVALENCE AND RESISTANCE

Our combined participant observation / interview methods revealed three central observations related to efforts to adapt conservation policy to the impacts of climate change at the WCC: 1) many acknowledge in interview settings that the impacts of climate change necessities consideration of a revised decision constitution including new interventionists alternatives and revised objectives and expectations 2) however we observe active avoidance of these concerns in public spheres of the WCC, and the resultant persistence and promotion of the means and objectives that uphold current frameworks. We suggest that this observation can at least partly be explained by the *anticipated* (and resisted) *within* conservation trade-offs (species for species) implicated by a more transformative framework, and that this resistance is linked to the currently held beliefs and values of many of the key actors. We describe these empirical observations and this interpretation below.

6.3.1. *Climate change and the expressed need for a new decision constitution*

At the WCC, the impacts of climate change were widely seen to necessitate a "paradigm shift" in conservation policy. In workshops, panelists spoke of the need to "adopt a business unusual approach - business as usual is no longer an option." Others asserted that: "[we need to] to move beyond a static approach" to conservation. Still others argued that we need a: "paradigm shift - we talk about paradigm shifts all the time but this actually is." Considering over two decades of discussion on the challenges that climate change poses to biodiversity conservation as currently practiced (e.g. Halpin 1997; Peters and Darling1985; Hannah et al. 2002), and the stated intention of the meetings agenda on this topic, the above expressions for change are well expected.

In public spheres of the WCC, the suggested attributes for conservation adaptation largely reflect established proposals. The most common of these proposals being the expansion of protected areas and increasing connectivity (Noss 2001; Hannah et al. 2002; 2008) (Figure 6.4). Advocates of this approach argue that: "climate change is…going to eliminate habitat within protected areas and make it necessary to identify new areas for protection in order to conserve species and ecosystem services…" (panelist of session titled: "What will it take to make protected areas resilient to climate change). Or as expressed in this same session by another prominent conservation scientist: "the key conservation response to climate change is the expansion of [the] protected area network to allow dispersal of climate change impacted species". And further: "…we are going to be losing representation of species. Some species are going to be moving out of protected areas, and that means we need to add more protected areas to compensate" (conservation biologist panelist).

Further indication of the prevalence and relatively high profile (relative to other potential strategies) of this strategy was found in the workshop on "Climate Proofing Biodiversity Inside and Outside of Protected Areas Through Connectivity Corridors". In this session, the panelists promoted the virtues of connectivity corridors in New South Wales (and other regions including the Yellowstone to Yukon initiative) with a "world premier" video projected onto two massive movie screens within the largest Congress ballroom. The message conveyed on the screen is that nature and the "evolutionary cradle" face "impending crisis and evolutionary turmoil". Without

landscape connectivity, it is argued, "species may find themselves staring down the barrel of extinction…we need to act fast - it is critical that this grand vision is achieved".

6.3.2. Friction in pubic and private spheres: grappling with an "awful nexus of problems"

While the central problem framing for adaptive conservation focused on the need to implement new protected areas and connectivity corridors, workshop participants were pressing for details. In doing so, a number of nascent aspects of conservation adaptation were voiced. Two topics were particularly contentious: 1) management of invasive and "non-native" species, and interventions in an era of climate change and shifting species ranges and 2) objectives, expectations and within conservation trade-offs (species for species as expressed in the concept of triage – described below).

Interventions

On the challenge of invasive species in the context of climate change, one participant noted in a workshop setting that: "sometimes changes are indicators of adaptation and not necessarily a threat." This was followed by the comment that climate change would "benefit some species". A tense exchange between the audience and panelists followed. One panelist replied: "I am going to put my…negotiators hat on and try to be as diplomatic as possible [long pause] that is a real Northern and European perspective. Developing parts of the world are going to suffer. I don't know if I am overreacting, but we have to be very careful about being sanguine…we like the world as it is." At the same time, this panelist highlighted that interactions between climate change and invasive species represent a "huge underappreciated issue" and further that: "I am really concerned that policy makers are going to start asking questions about why we are investing money on wimpy species and huge money in fighting species that are doing very well… [this represents] an awful nexus of problems."

The challenge of invasive species in the context of climate change extended beyond debates over whether or not to accept/reject the arrival of non-native species in a given conservation area. It further included discussion of interventionist proposals for assisted migration. Assisted migration (the deliberate relocation of an imperiled species from its historical range to new locations not

inhabited in the recent history) has been topical in the conservation literature for the past two years (McLachlan et al. 2007; Hoegh-Guldberg et a. 2008). Reflective of these within academy proposals, a participant from Parks Canada asked the panel on "Climate Change and Species Extinctions: New Approaches to Support Decision Makers": "Species translocations set us up for dreadful choices related to what to move where – are you headed this way?" The immediate response was that:

> Species translocations are expensive and we are not ready - policy-wise. Even if we had a species translocation solution, I don't think it will be allowed (pause) we have got to get policy-makers to think about this – we need to start experimenting (pause) - [we have to be careful of] letting the genie out of the box – invasive species wise.

Another panelist immediately isolated and underscored the precautionary portion of the previous experiment/caution-blended comment saying: "we need to be very careful" that we don't cause "massive and irreversible changes".

This exchange flowed directly into a question posed by a self-identified conservationist who asked if the future of conservation given climate change would be to let nature unfold as it will, and specifically: "Do we have to save every species?" Oddly, in this case the moderator did not direct the question to the panelists, but rather moved directly to the next questioner. However, the next questioner noted that the species that benefit from corridors might be invasives and thus expressed a similar theme to that which was bypassed. One panelist replied with a measure of exasperation and sarcasm saying: "I am delighted that the audience is setting the bar so low – arrest or adapt? We have got to do both!" The response is delivered in reply to the worn debate of mitigation vs. adaptation. While society must do both, the heart of the question was not to ask either or, but rather to get at the thorny issue of limits to adaptation and the possible need to more fundamentally revise objectives. Picking up more directly on the questioners meaning, another panelist noted that despite the difficulty with these questions: "it forces us to examine what is it that we are trying to achieve? Is it species, ecosystem services, evolutionary processes?"

At this point, the medium sized conference room of 120 seats is now filled to capacity. The audience, some sitting cross-legged on the floor and others behind them standing three deep to the back door fall quiet, looking around to each other and to the panelists with blend of bewildered and deflated expressions. At last the moderator exclaims: "we have had a very static

approach in the past – the climate change agenda changes all that. Issues of how to deal with this turn out to be very challenging."

Interviews allowed for greater examination of topics relating to interventions such as assisted migration and the observed views were similarly complex. Some argued that despite uncertainties that "we need to start experimenting" and that it is time to "get our hands dirty," and become "ecosystem engineers." Others expressed a reluctance towards conservation interventions and "playing God" with statements from an NGO scientist that assisted migration is "too risky at this point," and "doomed to failure".

Expectations

A second nascent topic that emerged in response to discussions on conservation adaptation included conservation expectations in an era of climate change. Similar to the audience member who pressed panelists on the ability/feasibility of conservation to "save all species", a participant in another session challenged panelists advocating proposals to "Climate Proof Biodiversity" through the implementation of conservation corridors. The participant questioned the message being sent to policymakers that if we act now (with new protected areas) we "can fix this," arguing that such statements and proposals "could imply that we can fix it when we know full well we can't."

With the exception of the above examples, conversations relating to expectations were not readily visible in the public spheres of the Congress. The uncomfortable recognition that conservation triage will happen *de facto* (species will go extinct) and that a transformative framework that would include more explicit and active conservation prioritization, trade-offs or triage may be implicated, was however a key topic in interviews. One respondent replied to an inquiry of the need for conservation trade-offs and triage by stating: "that isn't a trade-off that is reality," and further that:

> Inevitably - one has to make some harsh decisions…And no doubt there will be species that we give up on - inevitably. If you have a species with weak populations that has no hope in hell of surviving…we would say [to policymakers] - unless there is available climate space and suitable habitat for a species one would have to question the value of

> investing large sums of limited resource in protecting that species. When that resource could go into protecting other species that would benefit.

Others were less blunt, more conflicted, but pragmatic nonetheless on the topic of conservation trade-offs as expressed using the concept of triage. Here a conservation biologists and adaptation specialist states:

> We used this concept of triage... and I was really uncomfortable with it. But what I think is important is that since... species, and ecosystems are going to unravel, it is really important that we as a conservation community…have a conversation about what should the criteria be for making decisions about what ecosystems we save... if we don't talk about the criteria, and have a process for establishing that….it is just going to be ad hoc. Which could be even worse.

In this case the researcher is referring to criteria for identifying which species and ecosystems to "save" and which to "let go" – essentially directing conservation resources elsewhere knowing that doing so may well leave the forgone target vulnerable to range contraction or extinction. The task of conceptualizing the criteria for triage was further highlighted by another scientist who noted the daunting myriad interacting biotic uncertainties at play.

> (heavy sigh)… I don't think that we can…justify major choices…we just don't know [the role of species in ecosystems]. There was a conference held this year [2008] where they discussed many of these things - and the conclusion was that we actually just don't know enough to tell you that we don't need that species. We can't tell you that - we don't know …we can't make those decisions.

To some extent, further science may aid in identifying trade-offs in this context – however, recognition of the dynamics of linked social-ecological systems and irreducible uncertainties is in contrast to this scientist's assertion that because of uncertainty "we can't make those decisions". Others picked up further on the issue of criteria for triage and "tolerating loss":

> One of the strategies is tolerating loss [somber tone]. It is assessing where we can afford to let go…I don't think we have the framework for tolerating loss…Essentially what's got to happen is that we have to figure out, for critical ecosystems to start with, what are the minimum…set of species within functional groups that are essential for this thing to function? And not tolerate the loss of any of those things.

In other words, conservation trade-offs (here conceptualized by interviewees as *within*-conservation, species for species trade-offs expressed in the concept of conservation triage) are a pressing possibility that the existing decision-making framework is ill-suited to accommodate.

6.3.3. Avoidance in public spheres

Despite interview-based acknowledgments of the need for interventions such as an "ecosystem engineering" approach, "harsh decisions", "frameworks for loss" and "triage", discussion of these thorny topics was diluted in the more public venues of the Forum and Members Assembly. Across 13 panels dedicated to (or with a central focus on) climate change adaptation and biodiversity conservation, these thorny possibilities were mentioned only in passing (in the question and answer period) on the two occasions as indicated above.

Instead, the more public, and palatable (to some) discussions of connectivity and new protected areas dominated the delivered discussions. Moreover, not only were topics on interventions and expectations largely absent in the delivered public proposals, they were actively guarded against in some settings. Two examples illustrate how anticipation of within species trade-offs resulting from a potentially new decision constitution with new means and objectives (e.g. interventions and expectations) were actively avoided in the policy setting spheres of the WCC, and in science communication more generally - in spite of their recognition in private settings.

The first example comes from events during the Contact Group for the major climate change, biodiversity, and adaptation resolution (Motion 99). As 10-15 people settled in to a small meeting room after a full day of programme hearings in the plenary, the sponsors of the motion turn to each other to ask "who called for this?" The Convention for Biodiversity representative for the World Wildlife Fund International was ready with the addition of new language as s/he read a pre-prepared proposed change into the microphone. With unanimous support, the resolution would come to read (addition in italics): "The World Conservation Congress at its 4th Session in Barcelona Spain, 5-14 October 2008:

> 2. CALLS on the Parties to the CBD to develop specific strategies to be incorporated into their national biodiversity strategies that will:
>
> b) ensure that the loss of native biodiversity is not increased by measures to combat *and adapt to* climate change."

Two days later the resolution passed in the Members Assembly with 100% of government and 99.3% NGO approval. The addition of the words "and adapt to" can be read as an example of avoidance to interventions and anticipated losses of native species.

In a second example drawn from an interview with a prominent conservation adaptation scientist, we see how discussion of new and contentious trade-offs (here as a result of triage) is actively avoided in public spheres. Here the scientist is speaking about triage decision frameworks.

> There is little question that we will have to be doing triage. The reality…is that if you devote yourself entirely to triage and none to increasing the amount of resources available to deal with a problem - well then you'll wind up doing lots of triage…you have to worry about triage a little bit but, that is not where we want to put our main focus. You don't want to give people the impression that triage is the solution to the problem.

And further:

> Triage isn't the answer to doing the least bad job… there is a social context to this and you need to make sure that you're not giving people the idea that you are just going to do triage…in the interim we may have to do a little triage on species. But the message would be: we don't want to be in a position of doing a lot of triage"… at the same time in the long term you want to have intelligent triage, so that you are a maximizing the positive impact of what resources you do have.

6.3.4. Understanding avoidance: resistance to forgo held values and revise objectives

The above observations demonstrate the difficulties with which a new decision constitution and its new trade-off space may be adopted. Avoidance or resistance behavior of the sort just described can at least partially be understood along two lines: precautionary ambivalence and the problem of protected values. Firstly, the reluctance of experts to discuss engineering approaches and revised objectives in public spheres of the WCC (and beyond) may stem from reasonable concern over unleashing new alternatives under the pressure of "urgency" that could lead to undesirable outcomes. This can be understood as a healthy precautionary attitude to guard against emergency measures enacted or imposed in the name of urgency without careful, systematic deliberation. Indeed, there was a flavour of urgency in many sessions (recall the assertion in film that "species may find themselves staring down the barrel of extinction…we need to act fast - it is critical that this grand vision is achieved"). And yet large-scale species die

offs, or loss of significant land base for human populations due to rising sea levels does call for intentional changes to conventional practice.

Secondly, the protected values problem arises when individuals resist evaluating one category of value against another (e.g. ecosystem health and cost) (Gregory 2002; Satterfield and Levin 2007) because it poses a fundamental challenge to deeply held positions including ethical ones – and so these become "protected" and thus often nonnegotiable (Satterfield and Levin 2007). Here experts privately (and to a limited extent publicly) acknowledge that a new decision constitution will necessarily include increased interventions and adjustments to objectives including frameworks for loss and triage where species x species trade-offs will be the result (an example of protected values of a *within-class* (or category) type). However, this rational understanding of change clashes with held values that are not compatible with this new constitution - and so avoidance of public airing of these topics results.

In their examination of a deliberative process concerning the remediation and cleanup of a nuclear production facility, Satterfield and Levin synthesize from Baron and Spranca (1997) and Fiske and Tetlock (1997) a set of "hallmarks" of protected values, which we similarly find evidence for in our observations at the WCC. They include: a) ***Denial and suspension of unpalatable alternatives:*** here observed as public resistance to interventions and triage and continued promotion of the protected areas/connectivity proposal and b) ***Slippery slope arguments*** - the concern that accepting a contentious alternative will set a dangerous precedent for future management, here observed as concerns that discussion of species x species trade-offs and triage will send a dangerous public "message".

The following exchange with a conservation adaptation scientist working with a major NGO demonstrates this clash of rational understanding of biophysical change dynamics in opposition to held (preservationist) values and linked ideals about nature.

> I still think that… I am stuck on some sort of preservation paradigm (laughing). Although regions should be sustainably managing change, I don't want to see some of those things change!... Because if you give up on - it's just hard if you give up on that. Well then - what are you trying to achieve? So it's full of sort of contradictory stuff, all of this, and you just have to deal with it.

These observations underscore the social processes that moderate efforts to achieve normative criteria for dealing with trade-offs within any decision constitution, and for evaluating the need to change overarching decisions constitutions.

6.3.5. Trade-off invisibility and the organization of the WCC

In the above we have shown how conservation trade-offs for conservation scientists in this problem domain are primarily conceptualized in terms of *within* conservation trade-offs. But so-called "conservation and development" trade-offs are also important because whatever conservation strategies are implemented, they need to be considered in the context of those whom the strategies will most impact. The structural organization of the WCC agenda by topically focused "streams" meant that sessions addressing adaptation strategies for protected areas and biodiversity conservation were largely considered in isolation from other topics discussed at the meeting – topics such as human rights and livelihoods. So while conservation scientists deliberated the financial costs of implementing new protected areas, down the hall indigenous groups and other actors were voicing their concerns with conservation more broadly within the "Rights and Conservation Journey". [30] In the latter case, topics of concern include those common to the literature on social impacts of protected areas that has shown that protected areas can incur a range of impacts on social practices including the alteration of livelihoods, changes in resource access, the exacerbation of prior conflicts, or increasing the vulnerability of particular populations (Harper 2002; Wilshusen et al. 2003; Neumann 2004; West et al. 2006; Brockington et al. 2006)

One outcome of the isolation between discussions about adapting conservation policy in the context of achieving biodiversity objectives, and discussions of social dimensions of conservation more broadly, was that livelihood, rights and governance dimensions of the former were mentioned only sporadically. Examples where these topics were mentioned include the statement by a Conservation International scientist who noted in a workshop setting that in seeking to enhance connectivity in response to climate change that "non-protected areas are very important [for biological adaptation] and also very important for people". He further asserted that

[30] In sessions that included: Recognizing and supporting indigenous community conserved areas"; Conservation and justice: a rights based approach; Land tenure, resource rights and conservation: collaborative experience and lessons for future practice; New developments in assessing the social impacts of protected areas and operationalising the "do no harm" principle.

adaptive strategies "need to be especially careful to consider the needs of people". In a second instance, a panelist from Costa Rica speaking in the session on Climate Proofing by Biodiversity Corridors, noted that "local communities have to be part of the decision-making" and further that participation at "fancy meetings like this in Barcelona are a hell of an expense [that] Latin American people can't access." From the audience, a participant from The Nature Conservancy commented that: "we have heard…big ideas without local implementation." This question wasn't immediately addressed, but later in the session in response to the virtues of the Y2Y corridor as extolled by their strategic advisor, ("Big fat wilderness, we've still got lots of it…there is full local support [of a Nahanni protected area initiative]…it is a wonderful thing"), the panelist from Costa Rica underscored: "a word of caution in using the same approach everywhere - people don't depend on land for food up north."

Overall, this structural separation resulted in a critical missed opportunity to increase understanding of the potential conservation and development trade-offs and implementation challenges involved in adaptive conservation proposals that often include expanding protected areas. It further perpetuated an implementation blindness of sorts that is sometimes present in the conservation adaptation literature as expressed in the statement that we need to "expand protected areas regardless of political boundaries" (Li et al. 2006). This view critically fails to consider the potential impacts of conservation activities on livelihoods and rights (Chan and Satterfield 2008). The importance of linking regional scale proposals with local realities was however discussed in an interview with an adaptation specialists working with a major NGO in the south:

> These conversations [livelihoods and proposals for adaptive conservation] aren't meeting...there needs to be more…bringing together of these scenarios for both community and conservation. Otherwise we run into a situation…where it is much worse…we've seen how community needs and conservation needs have clashed in the past.

When asked what was required the same expert responded:

> For people who are looking at these [bioclimate envelope] maps and scenarios…I'd say …we need to also be developing a way of feeding into the scenario planning, the information that is coming from the ground…and make the recommendations that experts make on these projections more realistic in terms of what can be achieved. I think they need to be able to relate it to the on-the-ground situation. Otherwise people are just going to look at them and say, like what the hell - what are you suggesting?

6.3.6. Trade-offs and participation: an instructive moment

In a related conversation on participation in adaptation initiatives, a different scientist with a major NGO spoke as few others did about participatory process and proposals for conservation adaptation. Their view underscores the challenge of achieving fair, equal and transparent deliberation in conservation.

> The reason that we want to run this…assessment as a consultative process is that we want government buy-in. We want governments to be committed to implement the adaptation strategies that come out of it. And there needs to be some trickery involved here because - well not trickery, but there needs to be a process where the government or scientists or policymakers or decision-makers or whoever are the ones who come up with the adaptation options. Because if not, it's going to be [us] persuading them that those options are really good. And so, a whole lot of options are probably going to be discussed and brainstormed. You know the pros and cons of each will be elaborated. But we hope that they will decide that the ones that are good for nature are going to be the ones that are adopted and implemented. So that's going to be the trick of the whole thing in that whole process. It's not necessarily to promote what we want to do, or have them do, but have them, kind of, be partners in that.

This single perspective reinforces the concerns of scholars who have sought to bring "critical reflection on the upsurge of participatory rhetoric in local governance" (Bickerstaff and Walker 2005; also Santos and Chess 2003; Kasperson 2006). For these scholars and others "broadening of involvement in local decision-making" is seen as a "good thing" in effort to integrate multiple perspectives into decision-making, but one that involves analyzing and grappling with the full range of challenges involved in doing so (Bickerstaff and Walker 2005). Chief among these challenges are assumptions and prescriptions for equal empowerment that embed some prescriptive checklists for "competence and fairness" in participation (cf Habermas in Webler 2001). As Bickerstaff and Walker (2005) demonstrate using empirical data from two citizen planning processes, all forms of participation are shaped by specific power relations that tend to reinforce unequal power relations.

Kasperson (2006) similarly argues that in this "heyday of the stakeholder express"… "much of what now passes under the rubric of stakeholder involvement has more to do with assuring and legitimating the goals of sponsoring managers than introducing new perspectives and knowledge or empowering those who occupy the spectator mainstream or live on the margins of community and society". All this to say that we should be attentive in advocating and interpreting the

outcomes of fair and transparent participatory decision-making as a common (and important) criteria for navigating trade-offs as outlined in the introduction.

6.4. CONCLUDING REMARKS: DID CLIMATE CHANGE "TRUMP EVERYTHING" or HAS CONVENTIONAL THINKING PERSISTED?

The intent of this research was to bring to light key technical discussions on adaptive conservation at the WCC and further to examine the social processes of promotion, ambivalence and resistance to these discussions as they occurred at the WCC. On the specific topic of climate change adaptation and biodiversity conservation, our observations suggest that despite proclamations that climate change will "trump everything" – many of the key actors involved – IPCC authors; IUCN secretariat; conservation NGOs are still working within and actively reinforcing the means, objectives and expectations of the decision constitution of the past four decades. As measured by the outcomes of public workshops, panel presentations and Contact Group activities of the WCC, the delivered proposals and policy resolutions were continuous with respect to long-standing conservation objectives (e.g. identify and protect vulnerable species and ecosystems) and means (e.g. by way of protected areas, connectivity corridors) and expectations (resistance to alternatives that would incur within conservation trade-offs). Thus fundamental changes in the established conservation constitution (conservation objectives, means expectations) appear for now, to be elusive. We have argued that this observation is at least in part a consequence of a precautionary ambivalence, as well as value-based commitments to the existing constitution. We offer some final reflections on these observations below.

Despite the now strong evidence and consensus that climate change poses a fundamental challenge to conventional assumptions of conservation (e.g. Parmesan 2006; Hannah 2008), the ensuing debate on how to adapt to this challenge continues to be shaped by the trade-off space of the existing (recognized untenable) conservation framework. Clearly, some possible implications of a new constitution for conservation involve potentially contentious changes including new means and objectives (e.g. increased interventions and species x species trade-offs). Resistance to these changes is arguably linked with fears about forgoing long held values including the sense that protected areas are few enough as is and the defense of them that results. The result is

that systematic, transparent discussion about changing policy needs has remained somewhat constrained in public spheres.

And so despite the empirical evidence, technical understanding of biophysical change dynamics, and ambivalent or blatant expressions for means and objectives that would comprise a new decision constitution in interview settings, the evidence presented in this paper demonstrates that prevailing value commitments to the current conservation paradigm are durable nonetheless in the face of this change. At this point in time, there is little evidence that they will easily recalibrate to a new decision constitution, however strongly implicated. At the same time, our interview-based evidence clearly illustrates that perspectives are in flux. Further, the history of conservation and conceptions of wilderness more broadly, demonstrate that values and objectives do change over time (Cronon 1996). Combined, it is reasonable to suggest a measure of caution in developing propositions towards more substantively adaptive conservation regimes, while at the same time encouraging consideration and open discussion of the necessary suspension of conventional conservation assumptions and the strong value positions on which they rest.

We conclude with one final comment on the role of the WCC itself. The WCC is promoted as a forum for learning and information exchange between actors from political and scientific worlds. Despite its potential for exchange and learning, our findings in this context suggest a reinforcement of conventional thinking, at least as delivered in public spheres and measured by Congress outputs. In the words of one of our interviewees, the WCC is seen (in positive terms) as an instrument of "norming".

> The gathering of the clan is always an important thing. It's for reinvigoration…for norming. To...compare results and norming the messages so that we're not saying very different things.

Indeed, despite emergent and tense discussions resting right at the conversation surface, the existing decision constitution has been "normed" and reinforced. While substantive/measurable change on this topic failed to materialize at this Congress, the outcomes of the 2012 (or even interim) meetings may be quite different.

Figure 6.1. Event ethnography group at a daily meeting at the WCC.

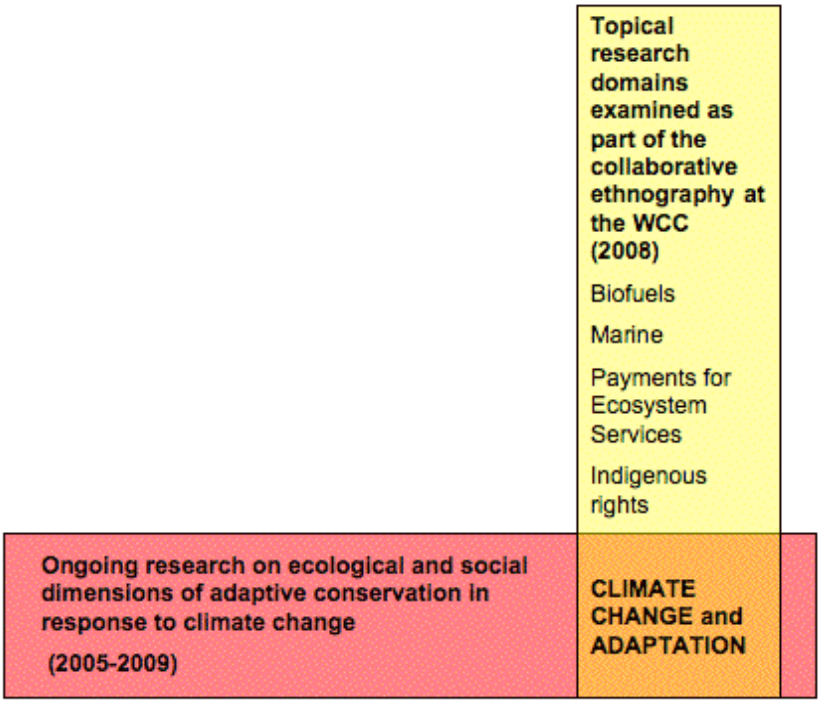

Figure 6.2. Situating the research in this paper. This research occupies the overlapping area (indicated in orange) both as part of the event ethnography research project (2008), and a longer four-year research trajectory examining the linked ecological and social challenges of adaptive conservation.

Figure 6.3. IUCN – WCC Members Assembly - Ken MacDonald Photo

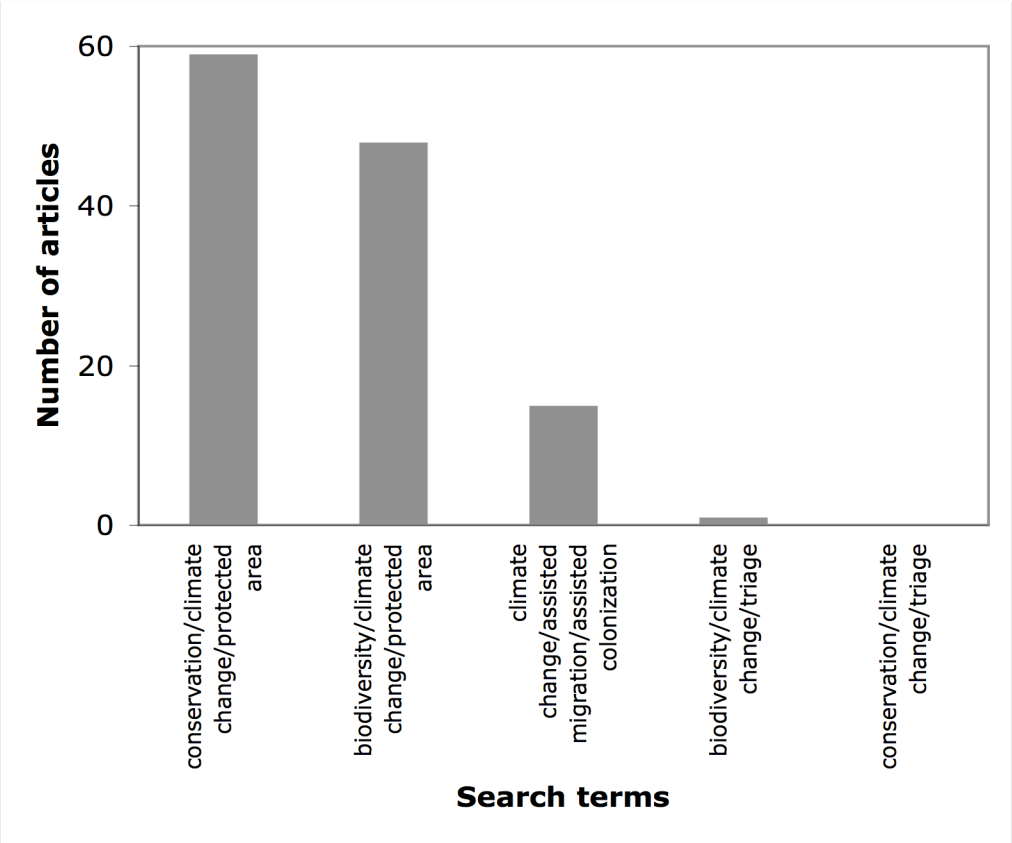

Figure 6.4. Number of papers published on a range of strategies for adapting conservation policy to the impacts of climate change. Web of Science Search Dec. 17.08 (1965-2008).

6.5. REFERENCES

Advancing Conservation in a Social Context: Working in a World of Trade-offs. http://www.tradeoffs.org/static/ConceptualFramework.pdf

Baron, J., Spranca, J., 1997. Protected Values. Organizational Behavior and Human Decision Processes 70, 1-16.

Bickerstaff, K., Walker, G., 2005. Shared visions, unholy alliances: power, governance and deliberative processes in local transport planning. Urban Studies 42, 2123-2144.

Brechin, S.R., Wilshusen, P.R.,Fortwangler, C.I. and P.C. West, 2003. Contested nature: Promoting international biodiversity with social justice in the twenty-first century.

Brockington, D., Igoe, J. and K. Schmidt-soltau, 2006. Conservation, human rights, and poverty reduction. Conservation biology 20, 250.

Brosius, J.P., 1999. Anthropological engagements with environmentalism. Current Anthropology 40, 277-288.

Buchanan, J.M., 1987. The relatively absolute absolutes. Draft paper prepared for presentation at SEA meeting

Chan, K.M.A. and T. Satterfield, 2008. Justice, equity and biodiversity. In: S. Levin and Daily, G.C. and Colwell, R.K. (Ed.), The Encyclopedia of Biodiversity. Oxford, Elsevier Ltd.,

Cronon, W., 1996. Uncommon Ground: Rethinking the human place in nature. 561.

Garnett, S., Sayer, J. and J. du Toit, 2007. Improving the effectiveness of interventions to balance conservation and development: a conceptual framework. Ecology and Society 12,

Gieryn, T., F., 1995. Boundaries of Science. 393-443.

Fiske, A.P. and Tetlock, P. 1997.Taboo trade-offs: reactions to transactions that transgress spheres of justice. Political Psychology 18, 255-97.

Gregory, R., 2002. Incorporating value trade-offs into community-based environmental risk decisions. Environmental Values 11, 461-488.

Gusterson, H., 1997. Studying up revisited. Political and Legal Anthropology Review 20, 114-119.

Gusterson, H., 1992. Coming of age in a weapons lab: culture, tradition and change in the house of the bomb. The Sciences 32, 16-23.

Guston, D., 1999. Stabilizing the boundary between US politics and science: the role of the office of technology transfer as boundary organization. Social Studies of Science 29, 87-111.

Halpin, P., 1997. Global climate change and natural-area protection: Management responses and research directions. Ecological applications 7, 828.

Hannah, L., 2008. Protected Areas and Climate Change. Annals of the New York Academy of Sciences 1134, 202-212.

Hannah, L., Midgley, G.F.,Millar, D., 2002. Climate change-integrated conservation strategies. Global Ecology and Biogeography 11, 485-495.

Harper, J., 2002. Endangered species: Health, Illness and Death Among Madagascar's People of The Forest. Carolina Academic Press, Durham, North Carolina.

Hoegh-Guldberg, O., Hughes, L., McIntyre, S., Lindenmayer, D.B., Parmesan, C., Possingham, H.P.,Thomas, C.D., 2008. Assisted Colonization and Rapid Climate Change. Science 321, 345-346.

IPCC, 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 104.

Kasperson, R., 2006. Rerouting the stakeholder express. Global Environmental Change 16, 320-322.

King, B., 2008. Commercializing conservation in South Africa. Environment and Planning A Advance online publication,

Kunzig, R. 2008. Is focusing on “hot spots” the key to preserving biodiversity? Scientific American Earth 3.0. October.

Lahsen, M., 2008. Comment on Susan A. Crate's "Gone the bull of winter? Grappling with the cultural implications of an anthropology's role(s) in global climate change. Current Anthropology 49, 587-588.

Lenoir, J., Gegout, J.C., Marquet, P.A., de Ruffray, P.,Brisse, H., 2008. A significant upward shift in plant species optimum elevation during the 20th century. Science 320, 1771.

Low, S.M., Taplin, D.H. and M. Lamb, 2005. Battery Park City: An ethnographic field study of the community impact of 9/11. Urban Affairs Review 40, 655-682.

Malcolm, J.R., Liu, C., Neilson, R.P., Hansen, L.,Hannah, L., 2006. Global warming and extinctions of endemic species from biodiversity hotspots. Conservation Biology 20, 538-548.

McLachlan, J.S., Hellmann, J.J.,Schwartz, M.W., 2007. A framework for debate of assisted migration in an era of climate change. Conservation Biology 21, 297-302.

Nader, L., 1972. Up the Anthropologist: Perspectives gained from studying up. In: D. Hymes. (Ed.), Reinventing Anthropology. Pantheon Press, New York, pp. 285-311.

Neumann, R.P., 2004. Moral and discursive geographies in the war for biodiversity in Africa. Political Geography 23, 813-837.

Noss, R.F., 2001. Beyond Kyoto: Forest management in a time of rapid climate change. Conservation biology 15, 578-590.

Parmesan, C., 2006. Observed Ecological and Evolutionary Impacts of Contemporary Climate Change. Annual Reviews of Ecology and Systematics 37, 637-669.

Peters, R.L., Darling, J.D.S., 1985. The greenhouse effect and nature reserves: Global warming would diminish biological diversity by causing extinctions among reserve species. BioScience 35, 707-717.

Rinnan, R.A., Michelsen, A.,Baath, E. and Jonasson, S., 2007. Fifteen years of climate change manipulations alter soil microbial communities in a subarctic heath ecosystem. Global Change Biology 13, 28-39.

Santos, S., Chess, C., 2003. Evaluating citizen advisory boards: The importance of theory and participant-based criteria and practical implications. Risk analysis 23, 269.

Satterfield, T. and J.Levin, 2007. Risk communication, fugitive values, and the problem of trade-offs: diagnosing the breakdown of deliberative processes. In: B. Johnston. (Ed.), Half-lives and half-truths: confronting the radioactive legacy of the Cold War. SAR Press, Santa Fe, New Mexico, pp. 165-191.

Suttle, K.B., Thomsen, M.A. and Power, M.E., 2007. Species interactions reverse grassland response to changing climate. Science 315, 640-642.

Tetlock, P., Kristel, O.,Elson, B. and J. Lerner, 2000. The Psychology of the unthinkable: taboo tradeoffs, forbidden base rates, and heretical counterfactuals. Journal of Personality and Social Psychology 78, 853-870.

Thomas, C., D., Cameron, A., Green, R., Bakkenes, M., Beaumont, L.J., Collingham, Y.C., Erasmus, B.F.N., de Siqueira, M.F., Grainger, A., et al, 2004. Extinction risk from climate change. Nature 427, 145-148.

Webler, T., Tuler, S.,Krueger, R., 2001. What is a good public participation process? Five perspectives from the public. Environmental management 27, 435.

West, P., Igoe, J.,Brockington, D., 2006. Parks and peoples: the social impact of protected areas. Annual Review of Anthropology 35, 251-277.

Wilshusen, P.R., Brechin, S.R., Fortwangler, C.,West, P.C., 2003. Contested Nature: Conservation and development at the turn of the twenty-first century. In: Steven R. Brechin. (Ed.), Contested Natures: promoting international biodiversity conservation with social justice in the twenty-first century. State University of New York Press, Albany, pp. 1-22.

7. CONCLUSIONS AND SIGNIFICANCE OF RESULTS

7.1. SUMMARY OF THESIS OBJECTIVES

The purpose of this research was to integrate across a set of ecological *and* social insights to develop a more holistic understanding of the challenge of adapting conservation policy to the impacts of climate change. Two overarching questions guided this research: 1) do the impacts of climate change necessitate a different set of means, objectives and expectations than indicated by current conservation adaptation proposals designed to respond to the impacts of climate change (i.e. proposals that include new protected areas and migration corridors as the primary adaptive strategy); and 2) if there is evidence that this is so, what are the barriers to implementing a conservation policy framework with new means, objectives, expectations and norms?

In Chapter 2, the impacts of climate change for biodiversity processes and patterns were reviewed, along with the implications of these impacts for conservation policy. In Chapter 3, key concepts from three fields were synthesized to generate an integrated set of propositions for addressing the challenge of adapting conservation policy to the impacts of climate change. These propositions suggested the need to consider new (more interventionist) means, recalibrated objectives (tailored to limited predictive capacities), and consideration of conservation triage in decision-making. In Chapter 4, the history of conservation policy adaptation in a specific case (British Columbia) was examined to gain insight into potential future dynamics of policy change under uncertainty. In Chapter 5, the views of experts were elicited in relation to the propositions derived in Chapter 3. This effort revealed active engagement and consideration of a new set of means and objectives. In Chapter 6, aspects of promotion, ambivalence and resistance to different proposals for conservation adaptation were examined as they unfolded in a key conservation policy-setting context.

7.2. KEY INSIGHTS AND FINDINGS

Each individual research chapter contributes to a specific piece of insight into the broad challenge outlined above, and the two questions more specifically. Collectively, the papers in this dissertation underscore that the impacts of climate change do implicate the need for consideration of paradigmatic or "constitutional" change in conservation policy (new means,

objectives, expectations and norms) beyond that which has already been proposed by established conservation adaptation proposals (e.g. expanding protected areas, implementing migration corridors and managing matrix areas) (Noss 2001; Hannah et al. 2002; Williams et al. 2005; 2008). Further, this research underscores the complex interplay between science, uncertainty and the held values of experts that has so far tended to reinforce the existing decision constitution and temper the degree of policy change (Chapter 6).

Four synthetic points are emphasized in this brief concluding synthesis: 1) the feedback loop that would inform and allow for change and policy adaptation is mediated by social dimensions, 2) this has led to policies that are adaptive in name, but not substantively different from the means and objectives associated with the conservation framework of the past four decades (i.e. maintaining *a priori* identified species and ecosystems by means of protected areas with minimum preferred intervention), 3) the features of an alternative set of means and objectives exist in expert conversation, but these have not yet found traction in either scientific or policy realms, and 4) innovation and change when it occurs will likely come from outside the current actors.

For the most part, the experts whose views are reported in this thesis recognize the potentially transformative impacts of climate change for conservation means, objectives and expectations of success. There was for instance, active engagement with topics including the need to more fully consider active interventions such as disturbance in managing species range transitions; assisted migration; revised objectives; and conservation triage (Chapter 3 and 5). Respondents in this study spoke of the need for a "paradigm change", that "it is time to start talking about triage", and that we "need ecosystem engineers". And yet, after decades of discussion in expert spheres (Peters and Darling 1985), the most commonly advocated proposals are largely consistent with the means (protected areas with minimum intervention) and objectives (*a priori* identified species and ecosystems) of the past four decades of conservation policy (Figure 6.4) (Chapter 6).

The result is that the feedback loop that would theoretically prompt policy adaptation in response to the impacts of climate change has not been completed. Why? As shown in Chapter 4, uncertainty has not, in and of itself, been a barrier to conservation policy change in the past, and most experts agree that it need not be a barrier to experimenting with new conservation means

including interventions such as assisted migration (Chapter 5). Yet, as shown in Chapters 5 and 6, the values and objectives of key actors, conservation NGOs and in some cases scientists themselves, have mediated the degree of change that has occurred. The results are "adaptive" conservation proposals that employ the same sets of means in the hope of achieving the same objectives as past efforts, and thus are adaptive in name only. Combined, these results highlight that policy adaptation within "science-based" conservation, as it is often referred to, is a tangle of social dynamics, including value-based commitments to conventional preservationist ideals of static, pristine nature. This has in part, resulted in resistance to consideration of new means, objectives and expectations, given the anticipated difficult trade-offs that they would impose.

7.3. CONTRIBUTION

Collectively, the chapters constitute a contribution to the emerging field of conservation adaptation, and to the literature on change in linked human-ecological systems more broadly. They do so by: summarizing the impacts and implications of climate change for conservation policy (Chapter 2); bringing together previously disparate literatures and applying them to the challenge of adapting conservation policy (Chapter 3); identifying triggers and dynamics of conservation policy change in a specific human-ecological system so as to better understand the relationship between uncertainty and policy change, and changing conservation ideas over time (Chapter 4); providing new empirical evidence of active consideration of conservation adaptation views not previously reported or underreported in the literature (Chapter 5); and lastly by providing empirical evidence and new insights into how durable commitments to preservationist–type values currently shape and constrain efforts to adapt conservation policy to the impacts of climate (Chapter 6). Preservationist-type values are described in the sense of a preference for existing elements of non-human nature as expressed by an adaptation scientist in Chapter 5:

> (11) I still think that I am stuck on some sort of preservation paradigm Although regions should be sustainably managing change, I don't want to see some of those things change! Because if you give up on [specific species and ecosystems] - it's hard if you give up on that. Then what are you trying to achieve?

7.4. ANTICIPATED AND ACTUAL OUTCOMES

Conducting this research was an adaptive process in and of itself. Initially (and with a measure of naiveté), I considered the process of contributing to understanding the challenge of conservation adaptation to be one of a) reviewing the impacts of climate change interacting with other drivers on processes and patterns of biodiversity (Chapter 2) b) deriving an integrative set of propositions from the literature on linked human-ecological systems, decision-making under uncertainty, and the human dimensions of conservation (Chapter 3), and c) testing these propositions, which included consideration of new (more interventionist) means, recalibrated objectives (tailored to limited predictive capacities), and consideration of triage in decision-making, in a case comparison study.

My initial idea was to compare responses to the propositions for adaptive means and objectives (Chapter 3) across key actors (government, First Nations, conservation NGO's, industry) in two regions of British Columbia. The regions under consideration were 1) the North Coast Forest District, site of the ongoing implementation negotiations for Ecosystem Based Management and 2) the Rocky Mountain Forest District, in the eastern interior of the province. These two regions were chosen for both their similarities (relatively high biodiversity profile and forestry prominent economies) and differences (exposure and local experience with a large-scale ecological disturbance in the form of the Mountain Pine Beetle, in the Rocky Mountain District). The rationale for considering a case comparison study was that this would aid in refining the propositions and identify the unique and shared implementation challenges and opportunities in two specific decision contexts.

However, the case comparison was not attempted. The reason for this is that early on in this research I observed substantive resistance in expert spheres (i.e. review process) to the propositions derived in Chapter 3. Resistance was specific to topics including disturbance and species transitions, and the potential need to recalibrate objectives and consider explicit frameworks for species loss (i.e. conservation triage). This observation led me to reconsider the focus and approach to this research, even though I had anecdotal evidence that these topics were of increased interest to some (e.g. conversations at conferences and workshops). In response, I backed up at least one step from a study of implementation in specific cases to instead elicit the views of a broader expert sample on *their* views on topics identified in Chapter 3. The rationale

for an expert study was that *if* experts identified increased active interventions, revised objectives and conservation triage as key dimensions of adapting conservation policy to the impacts of climate change, then it would be the result of systematically collected empirical data from a pool of established experts, and not merely qualitatively derived propositions (Chapter 3).

The expert study once completed, did in fact, reveal active engagement of experts with topics including interventions, expectations and triage (Chapter 5). And so I became interested in why, despite the presence of these views and consideration of new means and revised objectives, did existing proposals for conservation adaptation seem nonetheless to mostly reinforce the current means and objectives (maintain *a priori* conservation targets by means of strategically located protected areas). Attending the World Conservation Congress gave me a fantastic opportunity to examine aspects of why this is so (Chapter 6).

More specific to the individual chapter outcomes, I initially expected that the presence of uncertainties in and of themselves, would act as an influential barrier to designing and implementing an adaptive policy response. However, as shown in Chapter 4, decision-relevant uncertainties prevailed as a constant backdrop during all phases of change in the system. In contrast, evidence indicates that the objectives and values of key actors (in this case the forest industry and the Province) were influential in triggering change in the face of substantive uncertainties (e.g. implementing sustained yield in the face of scarce inventory data), and impeding change in the face of substantive evidence (e.g. delayed artificial regeneration despite a half century of evidence indicating failed natural regeneration).

Both aspects of this pattern were observed in the views of experts on adapting conservation policy. While some experts argued that we must have certainty before implementing more interventionist alternatives, many more experts acknowledged that we must adopt a learning-by-doing approach in the face of irreducible uncertainty. This latter position represents the view that uncertainty need not be seen as a barrier to change. At the same time, prevailing resistance to interventionist alternatives and revised objectives was observed in policy spheres. It has been argued here that this is at least in part explained by the durable value commitments of key actors and resistance to anticipated difficult trade-offs; and not necessarily because of the presence of uncertainties (of which there are many). As noted in the paragraph above, the observations from

the expert elicitation similarly indicate that the objectives and values of key actors are at least as influential in determining the dynamics and details of policy change as are the presence of uncertainties.

Finally, I anticipated that views expressed by experts in interview-based settings might flow relatively unimpeded into public policy spheres. By this I don't mean that I assumed that new ideas about conservation would be met without resistance in public spheres. However, I did think that views articulated in interviews would at least occupy some comparable portion of the public agenda for discussion by these same individuals. This was not the case. There was a noticeable difference between interview-based and public conversations beyond that which might be explained by institutional barriers, or a lack of mechanisms for knowledge transfer, or even the developing front of knowledge (and so time lags therein). Rather, as argued in Chapter 6, anticipated trade-offs implied by a paradigmatic, different decision constitution are in some cases, actively resisted by key actors. This resistance has at least in some part shaped the movement of knowledge from expert to policy spheres, and thus the adaptive response so far.

7.5. STRENGTHS AND LIMITATIONS OF THIS RESEARCH

Interdisciplinary research of this kind, and for the purposes of a dissertation, requires a large measure of humility. The possible strengths in some areas of this work simultaneously come with limitations in other areas – trade-offs if, you will. Readers trained in specific disciplinary domains may well be wanting deeper engagement within the various fields of policy analysis, ecology, politics of knowledge, or environmental values. Readers may also wish to see the application of specific theoretical lenses to this work. These readers will be disappointed. However, readers interested in understanding the *linked* ecological and social dimensions of adapting conservation policy to the impacts of climate change may be more satisfied with this effort. It is my contention that there is benefit (if not with academic risk) in simultaneously examining the impacts of climate change on patterns and processes of biodiversity, the history and human dimensions of protected areas, and how the values of experts shape adaptive responses in the social context of decision-making in practice.

Specific limitations of this work within its context as an interdisciplinary project are discussed below, chapter-by-chapter. Some of the limits/weaknesses can be taken as learning experiences from which I will do things differently in the future, others aspects are simply limits to a chosen research strategy that need to be acknowledged but that can't necessarily be overcome.

As indicated above, the propositions in Chapter 3 including new (more interventionist) means, recalibrated objectives (tailored to limited predictive capacities), and consideration of triage in decision-making, were met with resistance (in the review process) in some (disciplinary) corners of the expert community. This prompted *extensive* contemplation, multiple revisions and re-structuring of the argument in Chapter 3 that occurred over an almost two-year period. In hindsight, if I encounter this type of response in the future, I will pause to gather at least some small pilot test of empirical data – even for a conceptual/propositional piece - which is all that Chapter 3 was ever intended to be. Given my position as a (new) researcher working outside of the disciplinary boundaries of conservation biology, combined with the controversial content, I suspect that some measure of empiricism would have helped immensely – both in the writing process with my co-authors and in the broader review process.

In the end, the empirical results presented in Chapter 5 did reveal active engagement on topics including disturbance and species transitions, and the potential need to recalibrate objectives and consider explicit frameworks for species loss (i.e. conservation triage). Nevertheless, I consider Chapter 3, perhaps more than any of the others, as one written at a particular point in time – in this case, early on in conceptual development of this thesis. While it was necessary and useful to delineate a conceptual framework for the empirical work that followed, in my view, Chapters 4, 5 and 6 are stronger as I subsequently found my footing in interdisciplinary research.

The limits to the historical profile in Chapter 4 relate primarily to data sources, chosen variables and the scale of the analysis. Firstly, on data sources, the use of Annual Reports from the Ministry of Forests and Ministry of Environment as key sources limits the extent to which more detailed and diverse perspectives were revealed in this paper. I did not examine the archives to obtain field notes from survey foresters, or to uncover correspondence between key political actors. That level and richness of detail would have been fascinating, but appropriate to a more disciplinary (historical) study. The purpose of Chapter 4 was rather to provide a historical *profile*

in the context of work on complex adapting systems for the purpose of providing insight into triggers and dynamics of policy change. The extent of empirical evidence that is presented is arguably robust in comparison with similar efforts in the field of linked social-ecological systems. Secondly on alternative variables and scale, the selection of the specific variables examined in this paper measured at the regional scale reveals specific patterns that may not have been revealed by analysis guided by a different set of variables, or even the same variables but at a smaller scale. For example, a focus on change dynamics in coastal versus interior regions would likely have revealed patterns not detected by this broader scale framing.

For the expert interviews, there are numerous layers of research judgments that precede the data (here quotes) that are presented and interpreted in these two final research papers. Research decisions made from the stage of interview design (what questions to ask?), expert selection (who to invite?), how to conduct the elicitation itself (stick rigidly by the schedule, or follow key opportunities to examine specific topics even at expense of not getting through the whole schedule?), coding (which themes are the most important?), quote selection (which quotes best articulate a given theme?), all combine to successively reduce and highlight a specific subset of the empirical data "captured" at a given period of time. The combined result of the above is a particular interpretation of the challenge of adapting conservation policy to the impacts of climate change at a particular point in time by a specific set of methods and research decisions, which I have tried to clearly articulate in the individual chapters. While alternative quantitative approaches (e.g. survey methods) may have been used as an alternative research strategy, I consider the insights revealed, and richness of voice that came from the qualitative interviews to outweigh the potential generalizations that might have been made from a quantitative study.

Another concern is the potential risk of inaccurately interpreting the technical responses provided by ecological experts. However, with seven years training as an ecologist and seven more years working as "Registered Professional Biologist" in the field of ecology I consider myself fairly well-calibrated to the disciplinary language and key concepts used by the ecologists and biologists whom I interviewed. More concretely, I always asked for clarification during an interview when a response was vague, and efforts toward triangulation were made to corroborate findings by comparing data from multiple sources (e.g. participant observation; documents; interviews).

Access was another dimension that shaped the content of the data presented in this thesis. In some cases, lack of access occurred when I was unable to schedule an interview with an expert (even after their acceptance, and my persistence over time). Scheduling interviews was a constant challenge. I had hoped to interview more individuals, and as indicated in Chapter 5, it seemed that I would be able to (owing to numerous more acceptances than completed interviews). However, after more than a year's effort in scheduling and congenial emails back and forth in some cases, eventually, I had to be satisfied with my relatively small sample size and the data that I did have for the purpose of this thesis. While it is absolutely the case that I planned to have a larger number of interviewees within this thesis effort, I am confident that the key concepts currently under consideration in this field have been represented. As shown in (Figure 5.1) saturation of concepts was reached at the 18th interview.

I was recently assured (beyond Figure 5.1. and 4 1/2 years knowledge in and of the field) that saturation of concepts was reached when I presented a talk outlining the concepts raised in expert interviews at the University of Washington (February 2009). There, an audience member, and National Parks scientist approached me afterwards to recount how s/he had spent countless hours debating with colleagues this exact collection of topics (triage, interventions, revised objectives) within their own planning meetings. But nevertheless, continued practice as oriented to conventional conservation means (protected areas) and objectives (*a priori* species and ecosystem objectives). This individual's interpretation of why these topics and the change in practice that would accompany them had not gained any purchase in policy spheres was, in their words, "passion", and commitment to preservationist ideals.

In other cases, lack of access occurred when I was unable to attend meetings, which were closely guarded by key actors (even despite pre-arrangements). This happened in the context of the Adaptive Management sub-group for the Ecosystem Based Management Working Group. In other cases I had much fuller access, as was the case with the Nature Conservancy Climate Change Planning Process. In the latter stages of this research, affiliation with the MacArthur Foundation (partial funders of my involvement in the WCC project), undoubtedly opened doors for me to access the experts attending the WCC. In fact, many of the experts were themselves funded by "MacArthur" and so some common ground and likely perceived initial vetting of my

credentials were already established. With only one exception (who did not reply), everyone I invited to an interview at the WCC agreed and completed an interview.

7.6. POTENTIAL AVENUES FOR FURTHER RESEARCH

Because of the way that this thesis developed (section 7.3), topics relating to implementation challenges of potentially new means and objectives (as described above) were only addressed in passing. This leaves open the opportunity to test propositions relating to new (more interventionist) means, recalibrated objectives (tailored to limited predictive capacities, and consideration of triage in decision-making), in case studies involving specific planning processes. Further, as indicated by this thesis, evidence of changing perspectives exists at the surface, even though these perspectives have not resulted in a changed decision constitution of the sort that would include the means and objectives just described. I look forward to examining the ways in which these perspectives change and/or further resist change over time, in response to interacting forces of global change, and evidence of success or failure of the current approach. My hope is that rapport established with this particular expert sample will enable subsequent interviews with some of the same individuals (as well as an expanded pool of both experts and other key actors) in different settings and over time.

7.7. FINAL SUMMARY AND IMPLICATIONS FOR POLICY

The objectives of conservation and ideas about nature have changed over time from iconic wilderness spaces (Cronon 1996), to efforts of the past four decades to maintain and protect biodiversity patterns and processes primarily by protected areas. The impacts of climate change pose the latest potential trigger towards reconsidering another iteration of conservation. Yet even in the face of mounting empirical evidence of the impacts of climate change on biodiversity (e.g. Parmesan 2006), and technical understanding of the biophysical change dynamics and their implications for potentially new (more interventionist) means, and revised objectives (Chapter 5), a publicly precautionary ambivalence towards a new decision constitution combined with durable value commitments to preservationist ideals has shaped the adaptive response so far.

At this point in time, there is little evidence that these positions will easily recalibrate to a new decision constitution however strongly implicated. At the same time, the interview-based evidence clearly illustrates that perspectives are in flux. Further, the history of conservation and conceptions of wilderness more broadly demonstrate that values and objectives about "nature" can and do change over time (Cronon 1996). Combined, it is reasonable to suggest a measure of caution in developing propositions towards a more paradigmatic framework for conservation policy while at the same time strongly encouraging open discussion (not necessarily adoption, but *discussion*) of potentially new means and revised objectives including many of the contentious topics addressed in this thesis.

It has just been stated that there is little evidence to suggest that preservationist-type value positions where they are held, will yield easily. It is perhaps more likely that just as change was triggered from the outside of the system boundaries in the context of BC conservation policy (Chapter 4), that this will similarly be the case in adapting conservation to the impacts of climate change. There may in fact be little incentive for the traditional conservation actors, including the big conservation NGOs to revise their stated objectives. As noted by one of the interviewees in Chapter 5, if one NGO isn't going to save sphagnum bogs, people will give their money to someone who will (at least try). Indeed, there is evidence of more substantive change or discussion of potential change, emerging in the grey literature including government reports and assessments (Baron et al. 2008; Dunlop and Brown 2008). Within expert spheres however, it may take the next generation of conservation scholars to engage more actively with new concepts including substantive change in means, objectives and expectations.

For those who are willing and interested, the research gaps identified in the expert elicitation (including the role of disturbance in species range shifts, and linking conservation proposals with livelihoods), will make a useful contribution to the design of future conservation adaptation strategies. In other cases, actors will likely continue in their efforts to maintain current means and objectives within adaptive-looking proposals that do not pose a challenge to the current decision constitution. While at the same time, others may begin the process of constructing a new framework. Thus a whole-scale substitution of one decision constitution for another is not expected (or necessarily advocated). But rather the slow erosion of the existing one (erosion that may occur with evidence of its failure), and the simultaneous construction of a new constitution

complete with a new option space for newly accepted strategies, objectives, values and expectations. How exactly this will unfold, remains to be seen.

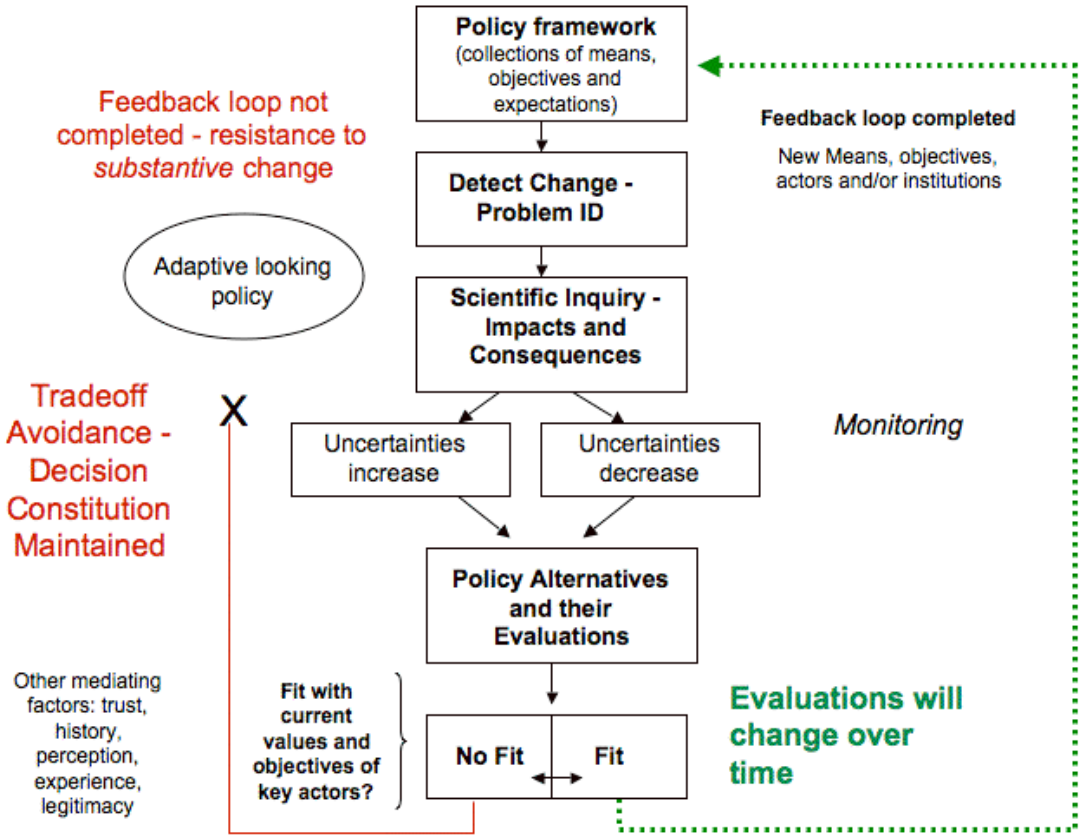

Figure 7.1. Understanding current efforts to adapt conservation policy to the impacts of climate change.

7.8. REFERENCES

Baron, J.L., Joyce, L.A., Kareiva, P., Keller, B.D., Palmer, M.A.,Peterson, C.H. and Scott, J.M., 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources. A report by the US Climate Change Science Program and the Subcommittee on Global Change Research. 873.

Cronon, W., 1996. Uncommon Ground: Rethinking the human place in nature. 561.

Dunlop, M. and Brown, P.R., 2008. Implications of climate change for Australia's National Reserve System: A preliminary assessment. Report to the Department of Climate Change,

Hannah, L., 2008. Protected Areas and Climate Change. Annals of the New York Academy of Sciences 1134, 202-212.

Hannah, L., Midgley, G.F.,Millar, D., 2002. Climate change-integrated conservation strategies. Global Ecology and Biogeography 11, 485-495.

Noss, R.F., 2001. Beyond Kyoto: Forest management in a time of rapid climate change. Conservation biology 15, 578-590.

Parmesan, C., 2006. Observed Ecological and Evolutionary Impacts of Contemporary Climate Change. Annual Reviews of Ecology and Systematics 37, 637-669.

Peters, R.L., Darling, J.D.S., 1985. The greenhouse effect and nature reserves: Global warming would diminish biological diversity by causing extinctions among reserve species. BioScience 35, 707-717.

Williams, P., Hannah, L., Andelman, S., Midgley, G.F., Araujo, M.B., Hughes, G., Manne, L., Martinez-Meyer, E.,Pearson, R., 2005. Planning for Climate Change: Identifying Minimum-Dispersal Corridors for the Cape Proteaceae. Conservation Biology 19, 1063-1074.

Appendix A: BEHAVIOURAL RESEARCH ETHICS BOARD CERTIFICATE OF APPROVAL

The University of British Columbia
Office of Research Services
Behavioural Research Ethics Board
Suite 102, 6190 Agronomy Road, Vancouver, B.C. V6T 1Z3

CERTIFICATE OF APPROVAL - MINIMAL RISK

PRINCIPAL INVESTIGATOR:	INSTITUTION / DEPARTMENT:	UBC BREB NUMBER:
Hadi Dowlatabadi	UBC/College for Interdisciplinary Studies/Resources, Environment & Sustainability	H07-02589

INSTITUTION(S) WHERE RESEARCH WILL BE CARRIED OUT:

Institution	Site
N/A	N/A

Other locations where the research will be conducted:
This research will be conducted at scientific conferences, workshop meetings; and participants place of work.

CO-INVESTIGATOR(S):
Timothy L. McDaniels
Shannon Hagerman
Theresa Satterfield

SPONSORING AGENCIES:
National Science Foundation (US) - "B05-0516: Decision Aiding in Pacific Northwest Resource Management Given Irreducible Uncertainties"
Various Sources

PROJECT TITLE:
Threats to biodiversity and options for management given climate change

CERTIFICATE EXPIRY DATE: December 17, 2008

DOCUMENTS INCLUDED IN THIS APPROVAL: **DATE APPROVED: December 17, 2007**

Document Name	Version	Date
Protocol:		
Research Proposal	N/A	October 26, 2007
Consent Forms:		
Consent Form	2	December 10, 2007
Questionnaire, Questionnaire Cover Letter, Tests:		
Interview Schedule	N/A	November 15, 2007
Letter of Initial Contact:		
Interview Request Letter	N/A	November 15, 2007

The application for ethical review and the document(s) listed above have been reviewed and the procedures were found to be acceptable on ethical grounds for research involving human subjects.

Approval is issued on behalf of the Behavioural Research Ethics Board and signed electronically by one of the following:

Dr. M. Judith Lynam, Chair
Dr. Jim Rupert, Associate Chair
Dr. Laurie Ford, Associate Chair

Appendix B: ELICITING THE VIEWS OF INDIVIDUALS INCLUDING EXPERTS

This paper is based on the views of (expert) individuals. Numerous approaches exist to elicit the views, judgments, perceptions and beliefs of individuals. These approaches span fields that include psychological research on decision-making, risk perception, cultural anthropology and political science. Specific approaches range from a) individual interview methods including mental models (Morgan et al. 2002), cultural models (Kempton et al. 1995), expert elicitation (Morgan et al. 2001; Morgan et al. 2006), ethnographic interviews; constructed values (Gregory and Slovic 1997), and narrative valuation (Satterfield et al. 2000) b) individual questionnaire and survey methods including online deliberative polling (Fishkin 2006) and dynamic web-based approaches (Ahmad et al. 2006); and c) group-based methods such as focus groups, Delphi (Plummer and Armitage 2007) and structured decision-making (McDaniels and Gregory 2004).

Data validity and interpretation

Informing the practice and interpretation of both expert elicitation and ethnographic interviews is evidence from a range of disciplines that the judgments and beliefs of individuals are not fixed in time waiting to be "captured" by researchers. For instance, behavioral psychologists have demonstrated that both quantitative and qualitative based approaches to assess individual beliefs under uncertainty are subject to cognitive heuristics and biases that experts, employ in making subjective judgments (Tversky and Kahneman 1974; 1981).

Briefly these include the following:

- *Anchoring and adjustment* refers to the way in which people "anchor" at an initial point of reference for a given value and how this chosen point subsequently bounds the range of potential alternative values that might be considered based on subsequent information.
- *Availability* describes the tendency to evaluate the probability of an event occurring in the future by the frequency that an event has occurred in the (recent) past, or the "ease" with which an individual can imagine the event occurring. An important feature of this heuristic is that it is dependent on the nature of the event and whether or not it resonates emotionally with the individual.

- *Representativeness* refers both to the propensity to assume that patterns and situations known to occur at a large scale will also occur at smaller scales, and to the tendency to draw on pre-conceived broad notions of people/things/situations (that may contain no relevant information for a given judgment) to construct views.
- *Motivational bias* describes a range of professional, moral or strategic dimensions that may influence the judgments provided by experts.

This work has informed expert elicitation methodology and researchers using this method have developed strategies to reduce the impact of these influences. For instance by informing expert participants of what is known about human judgment and uncertainty prior to the elicitation so that they are made aware of the types of systematic biases at play. Or, more specifically, by asking experts to list the reasons for and against their response/judgment; to have experts to imagine scenarios which might yield values or answers outside of upper and lower bounds that they state initially; and to ensure (partial) anonymity in effort to reduce motivational bias.

More fundamental, are insights from perspectives in anthropology and sociology that have shown that any interview, whether it be an expert elicitation or an open-ended ethnographic interview, is a "meaning making" interaction (Holstein and Gubrium 1995; Cerwonka and Malkki 2007) that produces a particular representation or account of the views of an individual on a given topic at a given point in time and in a particular setting (Hammersley and Atkinson 1995). Regardless of techniques used to reduce bias, no interview, however well designed, lifts a veil to reveal a stable set of beliefs, knowledge or attitudes. So while considerable effort in this study was made to remove overt heuristics and biases (beginning for example with open ended questions followed by more specific probes, and asking for counterfactuals using the sensibilities of expert elicitation techniques), the position adopted in this paper is that the discussions that form the basis of these results are inevitably the product of beliefs, values, selective disclosure and social interactions at a given point in time. This does not negate their worth as a set of data – rather this is precisely the nature of the data that simultaneously produces a rich account of understanding at a given place and point in time.

REFERENCES

Ahmad, R., Bailey, J., Bornik, Z., Dowlatabadi, H., and Levy, E., 2006. A web-based instrument to model social norms: NERD design results. The Integrated Assessment Journal 6, 9-36.

Cerwonka, A. and L. Malkki, 2007. Improvising theory: process and temporality in ethnographic fieldwork. The University of Chicago Press, Chicago.

Fishkin, J.S., 2006. Strategies of Public Consultation. The Integrated Assessment Journal 6, 57-72.

Gregory, R., Slovic, P., 1997. A constructive approach to environmental valuation. Ecological Economics 21, 175-181.

Hammersley, M., and Atkinson, P., 1995. Ethnography: Principles in Practice. Routledge, New York, N.Y.

Holstein, J.A., and Gubrium, J.F., 1995. The Active Interview. Sage Publications Inc., Thousand Oaks, California.

Kempton, W., Boster, J. and J. Hartley. 1995. Environmental Values in American Culture. MIT Press, Cambridge Massachusetts.

McDaniels, T., Gregory, R., 2004. Learning as an objective within a structured risk management decision process. Environmental science technology 38, 1921-1926.

Morgan, G., Adams, P. and D. Keith, 2006. Elicitation of expert judgments of aerosol forcing. Climatic Change 75, 195-214.

Morgan, G., Fischoff, B.,Bostrom, A. and Atman, C., 2002. Risk Communication: A Mental Models Approach.

Morgan, G., Pitelka, L.F. and Shevliakova, 2001. Elicitation of expert judgments of climate change impacts on forest ecosystems. Climatic Change 49, 279-307.

Plummer, R. and Armitage, D.R., 2007. Charting the New Territory of Adaptive Co-management: A Delphi Study. Ecology and Society 12,

Satterfield, T., Slovic, P.,Gregory, R., 2000. Narrative valuation in a policy judgement context. Ecological Economics 34, 315-331.

Tversky, A. and Kahneman, D., 1981. The framing of decisions and the psychology of choice. Science 211, 453.

Tversky, A., Kahneman, D., 1974. Judgment under uncertainty: heuristics and biases. Science 185, 1124-1131.

Appendix C: SAMPLE INTERVIEW QUESTIONS

Introduction and background

- Can you tell me a about your work as it relates to climate change and conservation?
- How did you come to be involved in this work?
- What are your interests at this conference?

Means and objectives

- What adaptive strategies are required given climate change?
- What objectives would this achieve?
- What guidance would you give biodiversity managers as to what they should be trying to achieve?
- In the context of protected areas, how would you describe your views on acceptable levels of human activities?

    - Prescribed burn?
    - Eradication of invasives?
    - Disease control?
    - Translocation of species
    - Deliberate disturbance and removal of imperiled species to make room for new species?

- What are your views on interventionist proposals such as assisted migration?
- How should we think about invasive species in an era of dynamics species ranges?

Success

- In 50 years, if we have successfully responded to this challenge - what will we have achieved? What would success look like?
- In what ways do you think we may have to adjust our expectations of conservation initiatives?
- How (or have) your views on conservation adaptation changed over time?

Uncertainties and decision-making

- What are your thoughts on the relationship between uncertainties in outcomes of new strategies and the possibility of trying them nonetheless?

- A topic that is coming up in relation to conservation and climate change is the concept of **"conservation triage".** Have you heard this? What does it mean to you? What do you think about it?

Implementation and governance

- What do you foresee in the way of social challenges where implementation of adaptive strategies are concerned?

- What do you see as the barriers to trying new things and becoming "ecosystem engineers"?

Other

- What do you see as the key unresolved issues for conservation adaptation
- Is there anything else that you would like to add/discuss?
- Is there anyone else who we should speak with?

Appendix D: CONSENT FORM

Principal Investigators:

Dr. Hadi Dowlatabadi, Ph: 604.822.0008, Email: hadi.d@ubc.ca
Dr. Terre Satterfield, Ph: 604.822.2333, Email: satterfd@interchange.ubc.ca.

Co-Investigator: *Shannon Hagerman* (PhD Candidate), Ph: 604.715.3444, Email: hshannon@interchange.ubc.ca

This study is being conducted as part of the co-investigator's doctoral degree and its findings will form part of the thesis. The results of this study will be published in a peer-reviewed journal.

Sponsor: This research is funded by a University Graduate Fellowship (UGF) grant from the University of British Columbia, and a grant from the US National Science Foundation.

Purpose: The aim of this study is to understand the views of experts on conservation, drivers of change and options for management in an era of global change.

Study Procedures: You are being invited to take part in this research because we understand that you are knowledgeable about issues relating to biodiversity and conservation (theory, practice or both). This study involves an interview that will take approximately 1 hour of your time. The interview will be audio-recorded.

Benefits: We will be pleased to send you a copy of the final report.

Confidentiality: Your identity will be kept strictly confidential. Documents and audio files of the interviews will be stored in a secure location, and only accessed by the listed investigators. The interviewees will be identified by code number only, with the correspondence table only known to the investigators. When we publish our findings, we have the option of offering you *Full confidentiality* – meaning that your name will not be identified in any way in the research report, or *Partial confidentially* – meaning that your name will be listed as a participating expert. **At no time will we link your name to specific responses.** Please note that your anonymous responses may be able to be identified if a reader is able to link them to your public record of published work. Please indicate your desired level of confidentiality by **circling the desired choice**:

Full confidentiality (no mention of your name) / Partial confidentiality (your name listed as one of experts interviewed)

Contact for Information about the study: Please do not hesitate to contact the Principal or Co-Investigators (see phone numbers and email addresses above) if you have questions about this study.

Contact for concern about the rights of research subjects: The Behavioural Research Ethics Board at the University of British Columbia has approved this research. 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 or if long distance e-mail to RSIL@ors.ubc.ca.

Consent: Your participation in this study is entirely voluntary and you may refuse to participate or withdraw from the study at any time. Your signature below indicates that you have received a copy of this consent form for your own records, and that you consent to participate in this study.

Respondent's Signature…….. Date ……