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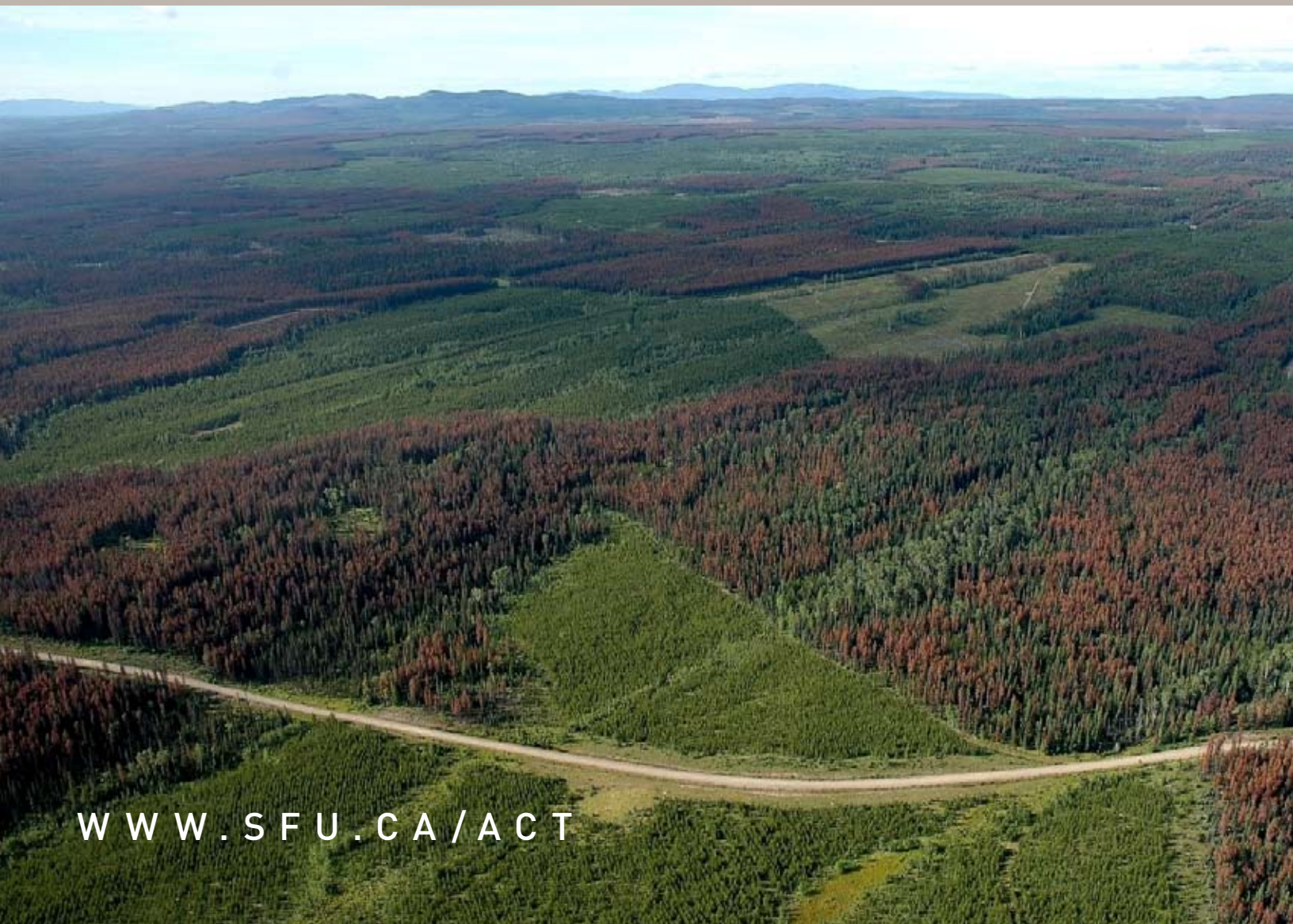
ADAPTATION TO
CLIMATE CHANGE TEAM

SUMMARY RECOMMENDATIONS

# CLIMATE CHANGE ADAPTATION AND BIODIVERSITY



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SUMMARY REPORT

# CLIMATE CHANGE ADAPTATION AND BIODIVERSITY

## TRANSITIONING TO AN ECOSYSTEM-BASED ECONOMY IN BRITISH COLUMBIA

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# ACKNOWLEDGEMENTS

**Jon O'Riordan**, lead policy author for ACT's first set of findings, is a former Deputy Minister of the Ministry of Sustainable Resource Management in the British Columbia provincial government. Jon has completed 35 years in the public service, mostly with the provincial government in environmental management and land and resource planning. In his most recent position in Sustainable Resource Management, he was responsible for completing six regional land and resource management plans. Jon also led the development of Land Information BC, where all the provincial data and information about legal title and resource values on Crown and private lands are stored.

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ACT would like to thank **BC Ministry of Environment** experts Donna Caddie, Project Manager, Living Water Smart, and Tory Stevens, Terrestrial Ecologist, Natural, Recreation and Cultural Heritage Branch, Parks and Protected Areas Division, for kindly providing a technical review of this document.

**ACT** (the Adaptation to Climate Change Team) is a five-year series of six-month sessions that brings leading experts together with decision-makers and experts from industry, community, academia, and government, to explore the risks posed by climate change and generate policy recommendations for sustainable adaptation. This first set of findings is partly based on information gathered during ACT's first conference, *Communities in Jeopardy: Plant, Animal and Human*, held March 31-April 1, 2008 as part of the six-month session on biodiversity and adaptation to climate change.

The **Wilburforce Foundation** was the key sponsor for this six-month research session and policy recommendations report.

The **Bullitt Foundation** was the key sponsor for the Communities in Jeopardy: Plant, Animal and Human conference.

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# INTRODUCTION

*"In a healthy society, economy always follows ecology, and education precedes them both"*
Ken Carey, *Starseed, The Third Millennium: Living in the Posthistoric World*

British Columbia is one of the most biologically diverse places on earth, a veritable "biodiversity ark" – a refuge for thousands of species, from Canada's largest population of large carnivores to the denizens of some of the last old-growth forests on the continent. Those species, threatened by the spread of human activity, now face an additional serious challenge posed by the impacts of climate change.

This report lays out key aspects of this compounding challenge to BC's biodiversity, and recommends ways to adapt by making the transition to an ecosystem-based economy that will include the full value of the province's ecosystems in resource decision-making. This transition will necessitate a paradigm shift from the sectoral, agency-specific approach to one that considers ecosystems as whole systems that are governed, ideally, by a single agency. This shift will allow British Columbia to address the impacts of climate change while sustaining the province's economy.

The report provides a suggested timeframe for implementation. In light of the unprecedented economic situation facing the government over the next few years, it is expected that there will have to be flexibility in the nature and timing of implementing the recommendations.

Biodiversity denotes "the wealth and variety of all living things," and is defined as "the interactions across the total variety of life." It is typically considered at three levels: species diversity, genetic diversity, and ecosystem diversity.[1] The biodiversity of BC's natural ecosystems contributes to much more than the traditional, resource-based economy of the province and its resource-dependent communities—timber, food, water, fish etc. Our ecosystems provide a rich array of services such as: controlling flooding, helping to clean drinking water sources, storing carbon, and moderating air and water temperatures.

Climate impacts will have such profound effects on these values that a significant adjustment in governance of these resources is required over the coming years to ensure successful adaptation to these changes. Otherwise, the combination of habitat fragmentation by uncoordinated human activities, together with unprecedented changes in temperature and precipitation, will impact the province's economic health and impair the environment's ability to function. These are all profound threats to BC's unique "biodiversity ark".

The following recommendations on biodiversity and provincial adaptation policies make up the first of a series of policy briefs produced by Simon Fraser University's Adaptation to Climate Change Team (ACT). ACT recognizes the importance of the mitigation efforts being spearheaded by the BC government to reduce greenhouse gas emissions, and focuses on ways to incorporate the partner priority of adaptation to climate change impacts. This summary draws on more detailed information contained in a companion report entitled *Climate Adaptation and Biodiversity: Background Report*, and Annex A to this document, "Economic Value of BC's Natural Capital", which outlines an approach for valuing ecological goods and services designed to support and maintain resilient resource-based communities.

## BIODIVERSITY IN BC

In 2008, a number of eminent scientists released an important, comprehensive assessment of the current status of biodiversity in BC, entitled "Taking Nature's Pulse – The Status of Biodiversity in British Columbia – 2008".[2] This report notes that biodiversity is essential for the sustainability of ecosystems. These systems lose their natural resilience to change when they become simplified due to losses in their component parts caused by human disturbance and natural processes, including climate change. Changes in ecosystems in turn result in a reduction in the goods and services that they provide, producing significant economic, environmental, and social consequences that often require government action to protect the public interest. A potent current example is the massive pine beetle infestation in the BC interior

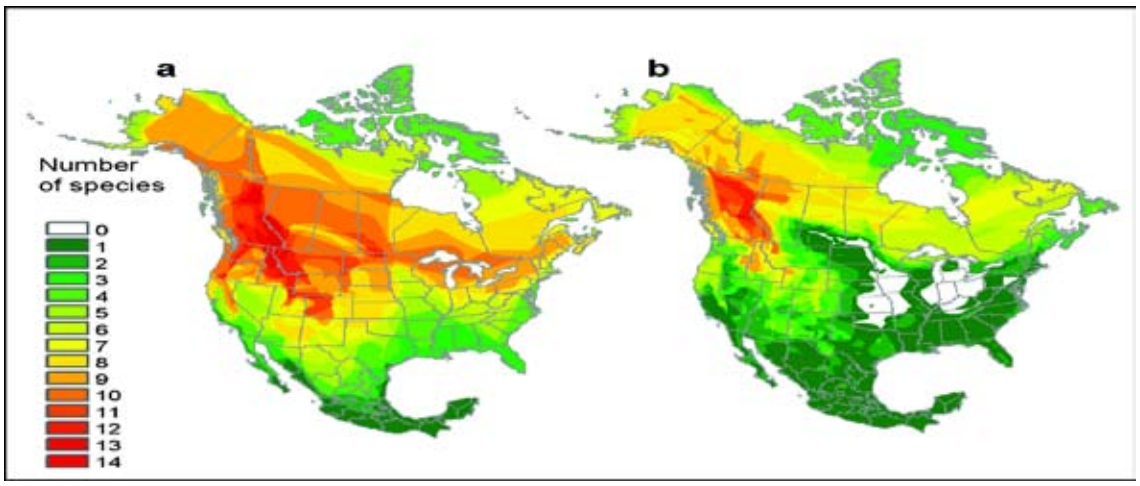
1 Resources magazine, Spring 2008
2 Austin, M.A. et al. 2008

region, resulting from a combination of warmer winters and a less resilient forest ecosystem caused by silviculture practices, including fire suppression, that reduced natural buffers to the spread of infestation.

## THE STATUS OF BIODIVERSITY IN BC

BC is home to some of the richest and most diverse ecosystems in Canada. As a result of intense human activity affecting major ecosystems elsewhere in North America, BC and Alaska have become refugia for 17 significant species of carnivores such as grizzly bear, and of ungulates such as mountain caribou and mountain sheep, as illustrated in Figure 1. As this diagram shows, the species diversity of North America has dropped drastically, with BC remaining as one of the last truly diverse biological regions in Canada. Ecosystems have been classified into 16 zones known as Biogeoclimatic Ecosystem Classification Zones (BECs), illustrated in Figure 1 of the accompanying Background Report. BC provides the majority of the remaining global range for 99 species and for six of the 16 BEC zones that occur in the province (coastal Douglas fir, interior cedar-hemlock, montane spruce, mountain hemlock, sub-boreal pine-spruce, and sub-boreal spruce).

**Figure 1: Biodiversity refugia (17 species) ("a" refers to historical conditions, "b" to the present)**




*Source: Laliberte, A. & Ripple, W. (2004)*

Over the past century, habitat fragmentation due to human activity on the land and water base in BC has simplified a number of critical ecosystems to the point that they are considered of conservation concern in the Biodiversity BC report. In particular, they are losing their natural resiliency to adapt to external pressures, and as a result becoming increasingly vulnerable to climate change.

Key conclusions of the Biodiversity BC document[3] include:

- Four of the BEC zones are of provincial conservation concern (coastal Douglas-fir, interior Douglas-fir, ponderosa pine, and bunchgrass).
- 43% of species assessed to date (1,400+) and more than half of the ecological communities (300+) are of provincial conservation concern.
- Significant areas of wetlands have been converted or degraded.
- Fresh water flows in lakes, rivers, wetlands, and groundwater systems are being harshly impacted by human activities.

3 Austin, M.A. et al. (2008)

- Seasonal concentrations of species, such as migrating birds and spawning salmon, are particularly vulnerable to human impacts.

In addition, the Ministry of Environment has stated that 168 Species at Risk Act (SARA)-listed species occur in BC and are expected to increase by 10–15 species annually – e.g. Vancouver Island marmot, Cassin's auklet, bull trout.[4]

> *"British Columbia's biodiversity is globally significant because of its variety and integrity, but without immediate action, it is vulnerable to rapid deterioration, especially in light of climate change."*[5]

## CLIMATE CHANGE PROJECTIONS FOR BC

At the ACT workshop on climate change, biodiversity, and resource-based communities held in Spring 2008 to support development of this policy document, a number of scientists outlined projections for changes in BC's temperature and precipitation (provided in Table 1), as set out in the Background Report. As the level of $CO_2$ in the atmosphere will heavily influence actual changes, the table below projects temperature and precipitation increases for two emissions scenarios. Generally, temperatures are expected to rise 2–7°C over the next 70 years, while precipitation is predicted to decrease by up to 50% in the summer and increase up to 25% in the winter in southern BC. In north central BC, temperature increases will be similar, but precipitation will likely increase in both winter and summer.

**Table 1: Projected changes in temperature and precipitation for southern, northern, and central BC regions for the years 2020, 2050, and 2080**

| | 2020 | | 2050 | | 2080 | |
|---|---|---|---|---|---|---|
| | Temperature (°C) | Precipitation % Change | Temperature (°C) | Precipitation % Change | Temperature (°C) | Precipitation % change |
| Southern BC | | | | | | |
| Winter | 0 to 2 | -5 to +15 | 1.5 to 3.5 | 0 to +20 | 2 to 7 | 0 to +25 |
| Summer | 0.5 to 2 | -30 to +5 | 1.5 to 4 | -35 to 0 | 2.5 to 7.5 | -50 to 0 |
| Central BC | | | | | | |
| Winter | 0 to 2 | -5 to +15 | 1.5 to 4 | 0 to + 30 | 2.5 to 6 | +5 to +40 |
| Summer | 0.5 to 1.5 | -10 to +5 | 1.5 to 4 | 0 to +30 | 2.5 to 6 | +5 to +40 |
| Northern BC | | | | | | |
| Winter | 0 to 2.5 | 0 to 20 | 1.5 to 5.5 | 0 to +25 | 2.5 to 9 | 0 to +45 |
| Summer | 0.5 to 1.5 | -10 to +10 | 1.5 to 3.5 | -10 to +15 | 2 to 6 | -15 to +25 |

*Source: Spittlehouse, D.L. (2008)*

Regional and temporal variations will amplify these changes in average seasonal temperatures and precipitation. For example, mean annual temperatures in the Cariboo-Chilcotin have increased between 3 and 4°C over the past 50 years;[6] according to PCIC's Regional Analysis Tool, January minimum temperatures are projected to increase by as much as

4 Ministry of the Environment (2008)
5 Austin, M.A. et al. (2008)
6 Dawson, R.J. et al. (2008)

4°C by the 2080s. Overall, these changes will have profound impacts on the structure of forests, hydrology, and pest infestation, and the frequency and severity of wildfires. These problems, together with reduced salmon populations and increasing floods and droughts, will deeply compromise community economic viability. Current government policies are ill-equipped to handle this double threat to human and ecosystem well-being.

For the first time in recorded history the natural range of variation, representing the normal range of temperatures and precipitation for ecosystems over the past 100 years, will shift due to climate change, with profound implications for ecosystem stability.

All public policies on maintaining biodiversity in BC, as set out in a number of provincial statutes and regulations, are based on the continuation of the historical natural range of variation. We urgently need new policies that incorporate the magnitude and impacts of these predicted changes.

**Some climate-related predictions for BC's forests:**

- An increase of 1°C will shift ecosystem zones 300m in elevation upwards and 150km northwards; a 2–5°C increase translates to a 600–1500m rise in elevation and a shift 300–750km northwards.
- This shift is estimated to occur at a rate of 40km per decade, while some components of ecosystems are capable of shifting only six km per decade.
- Forested ecosystems will change significantly in BC towards drier forest types in the south and warmer, moister forest types in the north.
- These changes may result in increased disease outbreaks, wild fires, drought stress, and loss of ecological function.[7]
- Such climate changes will result in regional shifts of vegetation types across the landscape.
- The largest impacts will be in forested ecosystems.
- The Ministry of Forest and Range estimates that the total forested land base in BC is approximately 60 million hectares, of which 35 million are in areas that are either protected or not operationally available for harvesting.
- The timber harvesting land base is therefore about 25 million hectares, of which only 0.2 million are actually harvested each year.
- Accordingly, most of the trees now standing will endure the changes in climate predicted for the next 70 years, and even changing the species planted following harvest will have a very limited effect on adapting forests to climate change.

## ADAPTATION STRATEGIES

Three broad strategies are available for adapting to potential climate change through management of terrestrial and aquatic ecosystems:

- Managing the working land base outside protected areas;
- Protecting ecosystems in legally established protected areas;
- Re-connecting the landscape across protected areas to support enduring features;
- Restoring degraded ecosystems to become more resilient.

7 Canadian Parks and Wilderness Society (2007)

# ADAPTATION POLICIES FOR MANAGING BC'S LAND AND WATER RESOURCES

As over 86% of BC's land base is not formally protected by legislation, the primary focus for our new policy agenda should be on the working land base, which is subject to varying degrees of human intervention. The new focus of policies should be to maintain ecosystem resiliency and connectivity, as functioning ecosystems will be better able to survive the changes in environmental conditions forecast over the next 70 years.

## FOREST AND RANGE PRACTICES LEGISLATION

Forest and range legislation provides for some protection of conservation areas under old-growth management areas and identified wildlife strategies. However, these areas are protected only under the Forest and Range Practices Act. They are not protected under other legislation such as the Land Act, which enables development of Crown lands; oil and gas legislation; or the Water Act, which in part regulates run-of-river power projects. Consequently, the ecological integrity of units initially protected by decisions under forest and range legislation can be jeopardized by decisions made by other statutory decision makers on the same land base. In a climate-challenged world, it is imperative that consistent ecosystem-based principles be applied to all decisions in terrestrial and watershed ecosystems. There is provision under Sections 93.1–93.3 of the Land Act for the government to ensure that landscape objectives established under forest and range legislation can be applied to all other provincial enactments. However, these sections of the Land Act have not yet been proclaimed.

Existing legislation provides for maintenance of ecosystems on the working land base under several policies, most of which neither cover the whole landscape nor treat ecosystems holistically:

- Management of old-growth forests occurs in Old Growth Management Areas (OGMAs). Only about 30% of the OGMAs are legally established to date; the balance are either identified but not legally established, or have yet to be analyzed. In the latter cases, forest stewardship plans can default to applying basic regulated values for protecting biodiversity that may not support ecosystem resiliency.
- The Ministry of Environment has powers to establish wildlife habitat areas and ungulate winter ranges that protect habitats for important species. However, the level of protection for wildlife habitat areas is capped at one percent of the Annual Allowable Cut on the Timber Harvesting Land Base. The balance of these designations has to be found on the non-contributing land base, that is, areas not currently economical to harvest.
- The division between the two designations is an economic one not based on ecological principles.
- In the Central and North Coast Land and Resource Management Plans, the government has established ecosystem-based objectives for forest management. These objectives differ substantially from the legislative provisions in the Forest and Range Practices Act. In the Plans, the level of forest harvest is an output based on maintaining of ecosystem function, whereas under the Act, forest harvesting levels are established as inputs or constraints on the level of biodiversity management. In the Plans, large riparian reserves from logging ensure properly functioning fish-bearing streams, and the ecological structure of the forests is maintained to improve resiliency. This is the largest area in BC in which resources are legally managed on an ecosystem basis. These landscape objectives are under review by the provincial and First Nations governments, and scheduled to be completed by March 2009.
- Lack of coordination in the development of resource roads is another important challenge to maintaining ecosystem resilience. Road access has significant impacts on biodiversity – the physical structure of roads impacts ecosystems, and public access disturbs migration patterns and fragments habitat. However, road development is currently carried out by separate provincial agencies in silos that support forestry, oil and gas, tourism, and

mining activities. Attempts to coordinate access to Crown lands have so far failed, but must be reinforced to assist adaptation to climate change.

- Riparian areas adjacent to streams contain the most diverse and valuable ecosystems in watersheds. Properly functioning, they protect against flooding, store water for use later in the summer, and filter clean water for drinking water purposes. Climate change scenarios all point to increasing flood risk, summer droughts, and erosion of watercourses, affecting water quality; therefore, maintaining healthy riparian areas will become even more important in the future. Although the provincial government has policies under the Water Act and the Forest and Range Practices Act to protect these ecosystems, decisions about riparian areas are also made by several separate agencies, including local governments, with the result that they are not managed as whole ecosystems and their integrity is being downgraded. This could have serious consequences for salmon and other fish populations – changes in temperature and hydrology will have profound impacts on less resilient aquatic ecosystems.

To sum up, there is no ability under provincial legislation to assess the cumulative effects of multiple decisions on the land base and watersheds. As a result, biodiversity is threatened and natural capital is being drawn down. This loss of biodiversity will have other significant economic impacts on communities, such as increased risk of flooding as wetlands are impacted, extended droughts in summer as the natural water storage capacity of ecosystems is reduced, and increased sedimentation of drinking water supplies, requiring either boil water advisories or additional, expensive water filtration and treatment.

## CURRENT GOVERNMENT INITIATIVES

The government recognizes the need to strengthen current policies for managing lands and water to adapt to future changes in climate. Although a number of initiatives in government are beginning to shift towards an ecosystem-based approach to resource management, they do not yet appear to form a coherent policy for integrating the economic opportunities associated with ecosystem-based management and addressing the urgent need to meet the scope of change being postulated. Initiatives that are working toward an ecosystem approach are described below.

### 1. CONSERVATION FRAMEWORK

The Conservation Framework under development by the Ministry of Environment (MoE) represents a shift in policy to a proactive, ecosystem-based approach from a reactive, species-by-species approach for managing species at risk. The province has predicted that the current number of 168 *listed* species at risk will increase by at least 10–15 a year due to both habitat fragmentation and the increasing effects of climate change. It has also become clear that the province has insufficient capacity to react to these species at risk on a case-by-case basis and to fashion the individual management plans required under federal legislation.

> The shift envisioned in the Conservation Framework is designed to prevent species from being threatened, by acting *before* species are listed as at risk, improving the science of prediction, and setting priorities for management.

MoE also wants to act in a collaborative manner with other partners for more efficient and effective use of limited resources, and to invest more wisely by applying risk analyses.

The Framework has three goals:

- Contribute to global efforts for species and ecosystem conservation;
- Prevent species and ecosystems from becoming at risk;
- Maintain natural diversity of species and ecosystems.

The risk analysis approach for species and ecological communities is based on the following four steps:

- Determine priorities for ecosystem action based on each of the three goals;
- Assign species management primarily to one of the goals;
- Determine management activities;
- Align resources and activities to implement management activities.

A landscape level of analysis that will address connectivity is under discussion. MoE is leading this initiative in collaboration with other provincial agencies, notably the Integrated Land Management Bureau, Forests and Range, Energy and Mines, and Aboriginal Affairs and Reconciliation. These five ministries now form an Integrated Land Management Board that advises the Premier's Office on all land and resource policy and is in the process of integrating their respective business plans.

The Conservation Framework has the potential to act as a key strategy to support increasing ecosystem resiliency, though it needs to be broadened to address larger issues than species at risk – namely, the ecosystems that are already of "conservation concern" and the increasing effects of climate change on these ecosystems and others that have yet to be impacted.

### 2. LIVING WATER SMART

Living Water Smart, released in June 2008 by the province, also proposes a shift to an ecosystem-based approach to water and watershed management, with an emphasis on maintaining or restoring healthy watersheds.[8] The plan contains a large number of actions, most of which have to be undertaken by 2012, so it is in the formative phase of development. The key policies relevant to biodiversity are as follows:

- All land and water managers will protect stream health and consider the full range of stream benefits when making decisions on watersheds.
- Water legislation will recognize flow requirements for ecosystems and species.
- New approaches to water management will address the implications of a changing water cycle, increased flood risk, and other impacts on water caused by climate change.
- Community development strategies will be created to recognize the importance of riparian zones in adapting to climate change.
- Wetland and waterway function will be protected and rehabilitated.

### 3. FUTURE FOREST ECOSYSTEM INITIATIVE

This initiative is being led by the Ministry of Forests and Range and was instigated by the Chief Forester after the pine beetle attack in BC's central interior. It has a number of components:

- Ecosystem-based forestry in the Central and North Coast Land Resource Management Plans (LRMPs);
- Bio-energy strategy to increase the use of wood-based bio fuels;
- Shift of old-growth to second-growth forest harvesting and processing;
- Effects of climate change on forest condition;
- Mountain pine beetle strategy;
- Improved science in genetics and silviculture;
- Assessment of carbon balance in forested ecosystems.

8 Living Water Smart (2008)

One of the more innovative components of the strategy in terms of ecosystem management is the potential for storing carbon in forested ecosystems. The government has established the Pacific Carbon Trust, which receives funds from public sector organizations, that is part of the government's goal to become carbon neutral by 2010; the current charge for emissions is $25 per tonne of carbon equivalent. It is anticipated that over 900,000 tonnes of carbon will be charged to the Fund by 2010, making for an initial fund of approximately $25 million. The government is also currently drafting a carbon offset regulation, which will set the rules for applying resources in the Fund to new ways of reducing carbon emissions over and above requirements set out in current legislation and policy. Policies associated with potential offset sources will have to meet international criteria, including independent analysis of the incremental change in carbon balance. From a biodiversity viewpoint, forest management is not officially included in the national inventory for carbon emissions. However, the forest sector is undertaking analyses to determine under what circumstances forested ecosystems might sequester carbon that would be incremental to those amounts stored as a result of existing government policies, and therefore be considered carbon projects under the emerging regulation.

There is a possibility that carbon management may align with policies to increase ecosystem resiliency. If some landscapes that would have been subject to logging or other resource developments are specifically set aside as natural areas, they might qualify for carbon offsets and at the same time maintain ecosystem resiliency. It will be important that all provincial regulatory agencies are aligned in identifying and managing these areas on a consistent basis, which as noted above is not the case at present, so that their ecological integrity is maintained on the landscape. As is the case with the other initiative listed above, this component of the future forest initiative is still in its formative stages.

There are also positive economic impacts associated with an ecosystem approach to climate change. Through life-cycle analysis, the BC Forest Climate Change Working Group has identified the potential benefits of using wood to replace steel and concrete in construction in order to reduce global carbon emissions. In addition, climate change may increase forest and agricultural productivity in some regions of the province.

The BC forest sector has established the BC Forest Climate Change Working Group, consisting of representatives from six forest organizations, with the goal of making the forest sector carbon-neutral by 2015. Its policies cover both mitigation, i.e. reduction in carbon emissions, and adaptation – the main focus of this report. This working group should consider aligning its resources with those of government to help implement the main recommendations of this report as they apply to the forest resources.

## 4. ADAPTATION POLICIES FOR PROTECTED AREAS

Approximately 14% of BC (14 million hectares) is protected under federal, provincial, or local government authorities. These areas were partly set aside to represent the range of ecosystem zones in the province at the time they were established. As we have outlined above, the representation of these zones will shift significantly by the end of the century due to climate change. Because protected areas enjoy limited human disturbance, they provide ideal landscapes in which to monitor ecosystem changes resulting from climate change, enabling a long-term monitoring program that could be used to assess the representation of protected ecosystems as they change over time. The current boundaries of these areas should be maintained until the effects of shifts in species and ecosystems due to climate change are better understood.

## 5. RE-CONNECTING THE LANDSCAPE ACROSS PROTECTED AREAS

With the shifts in ecosystems anticipated over the coming years, it will be important to identify landscapes with enduring features that are better able to adapt to change. Part of the adaptation strategy for protecting biodiversity should therefore focus on connecting these areas and sustaining their integrity through appropriate land use policies controlled under a single decision maker. The Ministry of Environment has recently recommended the need to "create and maintain landscape and watershed connectivity to enable dispersal of species".[9]

9 Ministry of Environment (2008)

### 6. PROTECTION OF PRIVATE LANDS

A number of conservation agencies have been established in BC with mandates to purchase and manage private lands for conservation. In 2004, the government established the Public Land Trust with a one-time grant of $8 million to encourage the various conservation agencies to work together and set targets for purchasing lands with conservation value; over the years these conservation agencies have acquired significant parcels of land. The next phase of developing a biodiversity strategy for the Public Land Trust should include the implications of climate change; for instance, there is a need to identify key migration corridors on both Crown and private lands where species shifts need to be supported rather than blocked as in the current system of fragmented habitat management conducted by a range of public and non-profit agencies. Some of these critical migration corridors might be candidates for funding as carbon offsets under the Pacific Carbon Trust. This approach to protecting species and ecosystems at the landscape level is still under development in the Conservation Framework.

### 7. ADAPTATION POLICIES FOR RESTORING DEGRADED ECOSYSTEMS

Government programs designed to restore ecosystems that have been degraded due to poor resource development practices include: the Forest Investment Account – a successor to the Forest Renewal Program set up in the 1990s; the Forest Investment Initiative; and the Forest Science Board. In addition, the province established the Living Rivers Trust Fund to invest in the restoration of salmon habitat. However, overall current funding for restoration programs is too limited to address the predicted changes to ecosystems. These programs therefore need to be targeted to address specific ecosystems that are currently at risk, but which could be improved to provide a full range of ecological goods and services. Attention should be given to determining areas that could qualify for funding under the proposed carbon offset projects regulation.

## THE CASE FOR AN ECOSYSTEM-BASED ECONOMY

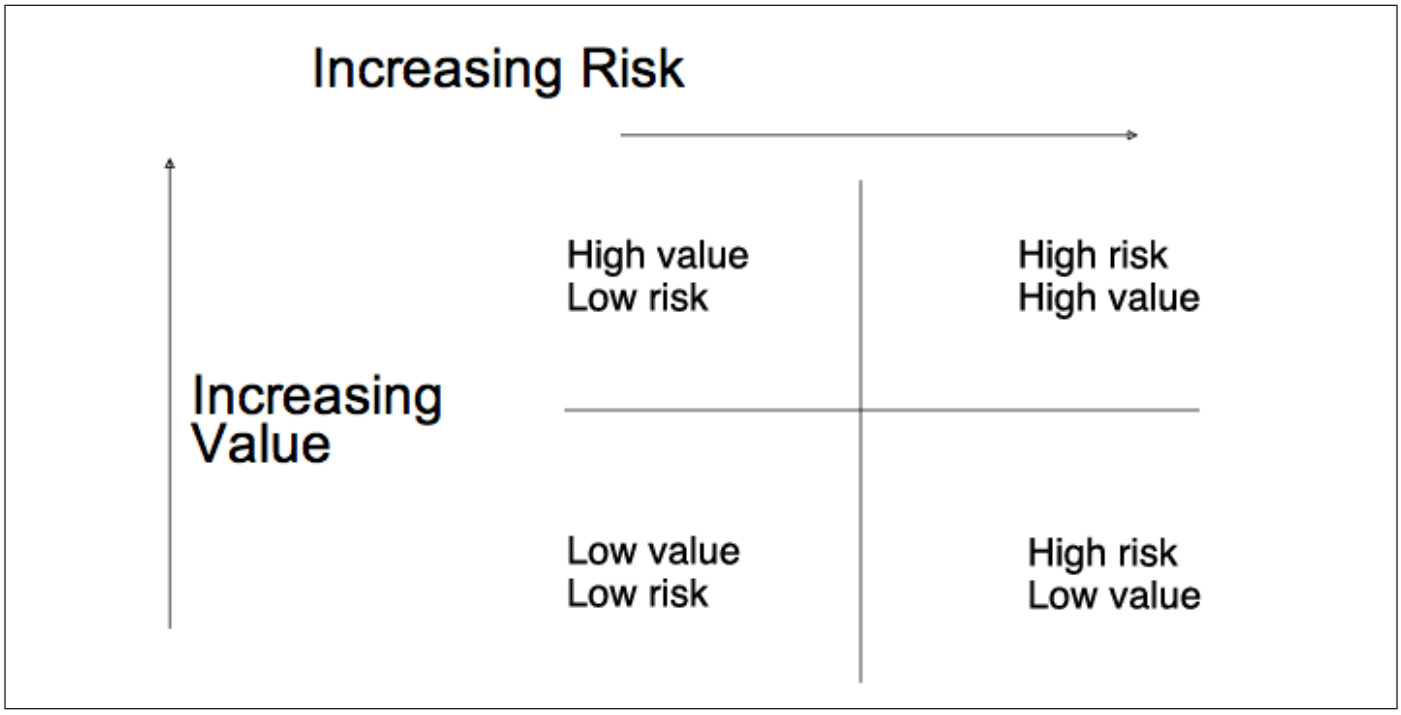
The challenge of adapting to climate change requires a new economic model that integrates ecosystem management with the resource-based economy. This new business case is based on sustaining market resource values in timber, water, food, etc., supplemented by a carbon budget as is emerging under the Pacific Carbon Trust and potentially the Western Climate Initiative, together with avoiding expenditures associated with losing ecological function. This model critically hinges on maintaining ecosystem health, which requires a new approach to decision making.

At present, water and land decisions are made on a demand-driven basis by a number of individual provincial agencies in accordance with statutory authorities but with little or no coordination. No single agency is responsible for either assessing the cumulative impacts of these separate decisions or determining if they exceed the carrying capacity of the ecosystem. As a result, the resilience of ecosystems declines.

If the government acts now to address this lack of coordination by extending the innovations that it is currently considering, it can accelerate its transition to an ecosystem-based approach to resource management. A single decision-making authority for land and water decisions would help optimize efficient use of government resources and potentially expedite decision making on a consistent basis that integrates economic and ecological criteria. Precedents for such a structure exist – for example, the Climate Action Secretariat.

If a single decision-making model is to be applied for all land and water decisions, it would best be based on a risk assessment model as outlined in Figure 2. Most attention would be given to decisions in areas with high economic values and high environmental values, such as oil and gas areas with high ecological values; densely populated watersheds such as in the Okanagan, where water is becoming a limitation to economic growth; and in watersheds with high timber values. In areas of low ecological value or where cumulative demands are not an issue, decisions could be based on routine results based regulations.

**Figure 2: Risk matrix**




*Source: O'Riordan, J. (2008)*

The shift to an ecosystem-based decision-making approach can be made in stages over a number of years.

## 8. PROFESSIONAL RESPONSIBILITY

Over the past few years there has been a significant shift from command and control regulations to professional responsibility where qualified professionals provide advice to corporate decision makers. Recently the Association of Professional Biologists has issued an Advisory Practices Bulletin, which indicates that professional biologists provide advice on an ecosystem management basis. Its three key principles of stewardship are as follows:

- Ecosystems should be maintained or restored in a healthy resilient condition.
- Human activities are viewed as part of, not separate from, ecological systems.
- The use or alteration of ecosystem components will be undertaken in a manner that sustains the ecological processes of which they are part.

Stewardship is defined as "the care and management of ecosystems to ensure a continued flow of ecological goods and services to nature and humans".

The convergence of these principles together with the policy recommendations outlined below must become the framework for managing biodiversity through climate adaptation.

## RECOMMENDATION 1:

That the shift to an ecosystem approach be undertaken prudently by the provincial government and be based on the following steps:

- Within two to five years, all resource decisions by all provincial agencies should be made according to consistent ecosystem-based principles. For example, biodiversity conservation areas identified under Forest and Range Practices legislation should also be protected in other provincial regulations and enactments.

- Proclaim Sections 93.1–93.3 of the Land Act to enable this policy to be implemented.
- Reinstate landscape-level planning based on enduring units and establish ecosystem health indicators that will guide decisions in the future.
- Resource road decisions should be coordinated across agencies to maximize joint use of roads and minimize development of new roads.
- The Integrated Land Management Board should formally adopt a policy for managing cumulative impacts on the Crown land base and watersheds.

### RECOMMENDATION 2:

That following completion of the steps in Recommendation 1, the government transition to a governance structure in which all land- and water-based decisions are either made by a single agency, or coordinated across several agencies through the oversight of a single agency, to ensure consistency in maintaining ecosystem functionality.

### RECOMMENDATION 3:

That government review the current caps on biodiversity under the Forest and Range Practices legislation and regulations to base them on ecological principles and ensure that they support ecosystem resiliency in a changing climate by 2010.

### RECOMMENDATION 4:

That by 2010, government undertake a formal risk assessment model for resource decision making, in which most attention is given to decisions that involve high ecosystem values and high resource values, and more routine decisions are applied to areas with low ecosystem values and resource values.

### RECOMMENDATION 5:

That by 2012, government consider how to include the conservation of biodiversity and connectivity as an offset in the draft carbon budget regulation. Both government and business sectors operating on the land base should identify areas for conservation, over and above those required under legislation, as business cases for funding under the Pacific Carbon Trust.

### RECOMMENDATION 6:

That by 2010, MoE and Parks Canada establish a long-term monitoring program of representative ecosystems in protected areas to assess climate change induced ecosystem change in undisturbed environments.

### RECOMMENDATION 7:

That by 2012, the province establish a matrix of enduring features on the landscape that will be more resilient to climate change and then maintain connectivity of these areas, ensuring that they are protected in land and water decisions.

### RECOMMENDATION 8:

That the Public Land Trust, working with government agencies, acquire and manage key areas suitable for connectivity as part of a climate change adaptation strategy.

# VALUING ECOSYSTEM GOODS AND SERVICES

> *"The World Business Council on Sustainable Development has defined the most crucial question of the 21st Century as – how do we value natural capital (ecosystem services) in a free market economy?"*
> Bruce Sampson, former VP Sustainability, BC Hydro

This report argues that the current system of biodiversity-related governance in BC needs to change in order to address the magnitude of predicted climate change impacts on a range of essential ecosystem goods and services, which fall into three categories:

- *Economic goods* such as food, fibre, water, air, etc., generally valued in accordance with market principles. The impact of mountain pine beetle is a stark example of the economic consequences of climate change on a simplified ecosystem – i.e. pine forests whose age structure has been modified by forest harvesting. The resulting reduction of timber harvest will have major economic consequences for resource-based communities in the Interior.
- *Ecological services* such as carbon storage, temperature moderation, water and air quality, flood reduction, and water conservation are generally not valued by markets, but can be valued in terms of cost avoidance or replacement costs of equivalent services. Recent flooding in North Vancouver causing damage to homes is an example where modification to riparian vegetation on mountain streams has reduced their ability to absorb high rainfall events.
- *Cultural and aesthetic services* such as recreation, aesthetic values, cultural and spiritual values. Again, markets do not value these services, though First Nation values are incorporated in consultation and accommodation negotiations over resource uses. One example is changes in fish populations that have reduced grizzly bear populations, and subsequently impacted tourism values.

The magnitude of the costs incurred with the loss of ecosystem goods and services will mount over time in face of climate change, so the earlier that government shifts to an ecosystem based approach to resource management, the sooner it will begin to reverse these trends and build the new economy. Accordingly, we would like to make the following recommendations:

### RECOMMENDATION 9:

Government in conjunction with the Pacific Institute for Climate Solutions (PICS) employ methods of valuating ecosystem goods and services to explicitly include assessment of carbon offsets for maintaining functioning ecosystems.

### RECOMMENDATION 10:

Government to undertake an economic assessment of the impacts climate change may bring to resource-based communities using information gained from valuing ecosystem goods and services. The model now being led by the Ministry of Community Development for managing the long-term effects of mountain pine beetle infestation on resource communities should be adapted to apply more broadly across the province.

### RECOMMENDATION 11:

Ecosystems cross jurisdictional boundaries. Accordingly, to maintain ecosystem resiliency across the province, all levels of government need to make the transition to an ecosystem-based approach to resource management on a terrestrial and watershed basis. By 2010, the province should lead a collaborative approach to ecosystem based management with federal, local and First Nation levels of governance

**RECOMMENDATION 12:**
Government seek funding partners across all levels of government, the private and the non profits sectors to align funding to apply this new esosystem based economic approach across the province

# RESEARCH AND MONITORING

The science of climate change is not perfect. Information on the health of a representative range of ecosystems is limited and likely inadequate in light of changes yet to occur. Plans should therefore be made to build a science base of data and information to improve predictions of climate change and add them as a layer in the integrated data systems such as Hectares BC that being developed by the province. An existing PCIC example of regional climate change modeling on resource development in the Cariboo-Chilcotin region provides a prototype for this initiative.

Public understanding and support for the shifts in governance recommended in this report will be enhanced by better education about the effects of climate change on ecosystem services. Many citizens are removed from interactions with the natural environment and need to re-connect through education, both at the school and post-secondary levels of education.

**RECOMMENDATION 12:**
Collaborate with BC universities to provide a detailed assessment of climate change projections at the sub-regional scale to provide a common base for analyzing climate adaptation strategies for a range of policy areas including biodiversity.

**RECOMMENDATION 13:**
BC's education system at both the secondary and post-secondary levels include a course available to all students on biodiversity and the value of ecological goods and services, so that they develop awareness of the importance of maintaining ecosystem integrity in a changing climate.

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SUMMARY REPORT

# CLIMATE CHANGE ADAPTATION AND BIODIVERSITY

## Annex A

## ECONOMIC VALUE OF BC'S NATURAL CAPITAL: AN ECONOMIC ARGUMENT FOR THE TRANSITION TO AN ECOSYSTEM MANAGEMENT APPROACH

Prepared by: Eric Kimmel

Originally Released: December 3, 2008
Updated: January 27, 2009

### RENEWED ECONOMIC DEVELOPMENT

British Columbians have an extraordinarily deep-seated connection to their natural environment. For generations, BC's natural capital assets have provided families with lucrative resource-based employment opportunities, established vibrant rural communities, funded provincial healthcare and public schools, provided sources of clean water and renewable energy, and offered a legacy of natural and recreational amenities that inspire the world. First Nations peoples used and occupied BC's vast stock of lands and resources to form and organize their communities, and practice their customs and traditions.

Natural capital is the stock of BC's natural resources that yields ecosystem goods and services over time, supports all human, plant, and animal life, and forms the economic foundation that sustains all human life. Governments, businesses, and the public are becoming increasingly aware that economic prosperity and community resiliency are closely associated with biological diversity and healthy, functioning ecosystems. The severity of climate change, biodiversity loss, and the degradation of ecosystems will likely impose societal and economic costs that will have a discernible impact on the quality of life for many rural and urban communities across the province.

These challenges have instilled a renewed sense of urgency to develop a governance framework that establishes a new relationship between human populations and our natural environment, and in which decision makers consider the full economic value of ecological goods and services produced by our natural capital. We propose that the provincial government transition the management of BC's natural capital from a conventional, top-down, extractive resource-based economy, with little or no emphasis on the value of non-marketable ecosystem services, to a restorative, bottom-up, ecosystem-based economy that considers the full value of all ecosystem goods and services. A made-in-BC ecosystem management approach should include the following strategies:

1. Incorporate the economic value of the full range of ecosystem services into the decision-making process when considering proposed land and resource development projects;
2. Ensure that the preservation and restoration of high-value species, habitats, and well-functioning ecosystems guide commercial interests outside legally protected areas;
3. Expand existing and develop new formal market systems that allow payment for and trading of ecosystem services, such as carbon offsets;
4. Pursue renewed economic development opportunities that promote non-timber forest products and restore the competitiveness of the timber forest industry by focusing on niche, high value-added products compatible with projected climate change-induced impacts;
5. Expand existing transition programs that provide financial support for forest sector workers adversely affected by pine beetle infestation and structural and cyclical changes.

We believe BC's recent climate change initiatives, and the prevailing cyclical and structural changes to the forestry sector, strategically position the government for advancing an ecosystem management approach to govern the province's rich store of natural capital assets.[10]

### BC'S NATURAL CAPITAL AND ECOSYSTEM GOODS AND SERVICES

Natural capital comes in the form of marketable products that directly provide economic benefits to communities, such as timber, food, and minerals, usually accounted for in the province's gross domestic product (GDP). Additionally, natural capital provides a flow of indirect ecosystem services that create economic benefits whose values are not easily recognized or captured. These services are non-marketable because buyers and sellers do not trade their services in formal market structures. Indirect ecosystem services include nutrient recycling, climate regulation, water purification, recreation, and tourism.

10 We use the forest industry as an example because of both its prominence in the BC economy and the current, significant biophysical impact on BC's forests and range (i.e. pine beetle infestation).

**Table 1: Classification of ecosystem goods & services provided by BC's forests, wetlands, grasslands, and alpine regions**

| INDIRECT SERVICES (NON-MARKET BENEFITS NOT ACCOUNTED FOR IN GDP) | | | DIRECT GOODS (MARKETABLE BENEFITS ACCOUNTED FOR IN GDP) |
|---|---|---|---|
| **Support services** Services that are necessary for the support of all other ecosystem services | **Regulating services** Benefits obtained from regulation of ecosystem processes | **Cultural services** Non-material benefits obtained from ecosystems | **Provisioning services** Products obtained from ecosystems |
| • Nutrient cycling<br>• Soil formation<br>• Primary production | • Climate regulation<br>• Air quality regulation<br>• Disease regulation<br>• Storm and flood protection<br>• Water purification<br>• Erosion control<br>• Pollination<br>• Sediment retention | • Spiritual<br>• Recreation and tourism<br>• Aesthetic<br>• Inspirational<br>• Educational<br>• Sense of place<br>• Cultural heritage | • Food<br>• Fresh water<br>• Timber<br>• Fuel wood<br>• Fiber<br>• Bio-chemicals<br>• Genetic resources<br>• Medicines |

*Source: Voora, A.A. & Venema, H.D. (2008)*

## THE IMPORTANCE OF BIODIVERSITY AND ECOSYSTEM FUNCTIONS TO BC'S ECONOMY

In recent years, awareness has grown that biological diversity is critical to maintain the stability of ecosystem functions. However, our prevailing patterns of production and consumption are leading to the conversion of our grasslands, wetlands, and forests, adversely affecting the province's biological diversity (see Table 2). The provision of ecosystem goods and services derived from our stock of natural capital is inextricably linked to the diversity of our biological resources – the glue that holds everything together. The loss of biodiversity and the ensuing effects on ecosystem functions occurs at three different levels:[11]

1. Altered biodiversity may change the productivity of ecosystems, disrupting the flow of valuable environmental goods and services such as timber supply, soil fertility, climate regulation, carbon sequestration, and water purification.
2. Changes to biodiversity may reduce the resiliency of ecosystems to withstand the introduction of invasive species, increasing the frequency and magnitude of disturbances such as wildfires and pest outbreaks.
3. Very importantly, biological diversity enhances ecosystem resiliency, which enables ecosystems to adapt to shifting environmental conditions such as climate change.

**Table 2: Snapshot of the state of biodiversity in BC**

| |
|---|
| Approximately 3,600 species and subspecies have been recorded in BC. At least 1,348 or 1/3 of all species and subspecies in BC are currently at risk, and 87% of them are not legally protected.* |
| Habitat destruction, fragmentation, degradation, and pollution, as well as invasive species and overexploitation are the major causes of biodiversity loss and stresses on ecosystem functions. |
| More than half of the ecological communities in British Columbia are of provincial conservation concern. |

*Source: Austin, M.A. et al. (2008); *David Suzuki Foundation and Sierra Legal (2007)*

11 Vold, T. & Buffett, D.A. (2008)

Ecosystem productivity, resiliency, and adaptability permit the sustainable provision of ecosystem goods and services to BC communities. Choosing resource use options that reduce or alter biodiversity may adversely affect ecosystem functions and diminish the economic value of the services they provide. This scenario is already unfolding, resulting in adverse effects on the quality of life for many communities. Governments will be compelled to expend substantial public funds to replace the degraded services – a course of action that may turn out to be more expensive than avoiding the damage in the first place. For that reason, the conservation and restoration of biodiversity, within the context of achieving other essential provincial objectives, is crucial to maintaining and enhancing a range of economic benefits for BC communities.

Policy attention recently given to conserving and restoring natural capital assets goes beyond satisfying environmental, aesthetic, or moral aspirations. It is also about the economy, jobs, material well-being of our families, and developing and sustaining healthy, wealthy, and resilient communities. There are profound economic implications to preserving, restoring, and renewing BC's natural capital assets. A resilient stock of natural capital creates resilient communities by enhancing the diversity of marketable products and ecosystem services, creating a source of stable and diversified local employment opportunities, and providing a heritage of natural amenities for recreational and cultural uses.

British Columbia is now at a pivotal time. Our changing climate is one of the most challenging environmental and economic issues of the century. Climate change will fundamentally change the way we work, live, and play, and in particular, it will profoundly change the approach we use to manage the vast stock of valuable natural capital that has helped to mold British Columbia's history, identity, progress, and economic prosperity. The advent of changing climatic conditions is expected to exacerbate existing stressors, exerting pressure on the health and resiliency of our natural capital.[12] BC therefore faces the challenge of managing its natural capital in an era of climate change, economic uncertainty, and structural and cyclical challenges facing resource-based communities.

Ecosystem goods and services produced by our stock of natural capital have significant economic values, yet they are often given too little weight in policy decisions because their economic values are not fully quantified and expressed in real-dollar terms. The costs of environmental damage, the depletion of natural capital, and the full value of indirect ecosystem services do not show up on accounting balance sheets and cash flow assessments like other commercial services and manufactured goods produced in the broader economy. As a result, natural capital is often undervalued and not accounted for in the decision-making process. For this reason, many land and natural resources are not used in ways that support the best economic interest of BC communities.[13] One way to overcome this obstacle is to assign monetary values to ecosystem services. The Boreal Ecosystem Wealth Accounting System is an evaluation framework designed to measure and report the physical conditions and the full economic value of Canada's boreal region's natural capital and ecosystem functions.[14] The purpose of this framework is to offer decision makers a natural capital balance sheet that can be used to assess the economic impacts associated with pursuing a broad range of land and resource use options. For example, provincial regulators may use the estimated economic values as a baseline to compare a variety of resource-use options for a particular region. Provincial decision makers may access the data as a way to rationalize choices to harvest timber, conserve habitat for vulnerable species and carbon offsets, or extract non-timber forest products using an economic measure.

12 Refer to supplementary Background Report for an exhaustive review.
13 Costanza, R. & Folke, C. (1997)
14 Anielski, M. & Wilson, S. (2006)

**Table 3: Boreal ecosystem wealth accounting system**

| NATURAL CAPITAL | ECONOMIC VALUES |
|---|---|
| Forests | Market values:<br>• $14.9 billion in market value-related GDP<br>Costs:<br>• $150 million in estimated cost of carbon emissions from forest industry activity<br>Non-market values:<br>• $5.4 billion for pest control services<br>• $4.5 billion for nature-related activities<br>• $1.85 billion for annual net carbon sequestration<br>• $5.75 million in subsistence value for Aboriginal peoples<br>• $79 million in non-timber forest products<br>• $18 million for watershed services<br>• $12 million for passive conservation value |
| Wetlands and peatlands | Non-market values:<br>• $77 billion for flood control and water filtering by peatlands<br>• $3.4 billion for flood control, water filtering, and biodiversity value by non-peatlands<br>• $383 million for estimated annual replacement cost value of peatlands sequestering carbon |
| Minerals and subsoil assets | Market values:<br>• $14.5 billion in GDP from mining and oil & gas related activities<br>Costs:<br>• $541 million in federal government expenditures in subsidies to oil and gas sector<br>• $474 million in government expenditures in subsidies to mining sector |
| Water resources | Market values:<br>• 19.5 billion in hydroelectric generation |
| $37.8 billion (Market value) + $93.2 billion (Non-market value) = $131 billion (Total economic value) | |

*Source: Anielski, M. & Wilson, S. (2006)*

These estimates suggest that the economic value of ecosystem services generates more economic benefits than traditional resource extraction of natural capital by a factor of 2.5. These estimated values do not imply that we should do away with mineral extraction and timber harvests; they do, however, highlight the economic significance that non-marketable ecosystem services provide to the well-being of communities above and beyond traditional resource-based commercial activities. For example, the market value of forest sector-related activities accounts for 11% of the total economic value produced by Canadian boreal forests, compared to 10% for non-market forest ecosystem services, suggesting that ecosystem services such as pest management generate as much economic value as marketable forest products such as pulp. Another way to think about the value of the ecosystem services is that, if they were destroyed, we would need to find substitutes for functions such as pest management, flood control, and water purification that might cost much more to produce and operate than those that nature already provides. This indicates a basis upon which decision makers can evaluate the economic impacts associated with pursuing different resource use options. For example, the conservation of natural habitat to accommodate carbon sequestration, recreational activities, and non-timber forest products may prove a better option based on the economic values for a particular region than using the land to harvest timber. Alternatively, laying out economic values for a suite of resource-use options may find that an optimal mix of timber harvest, non-timber forest products, recreational activities, and habitat conservation yields better use of that land than resorting to a single purpose. If we are resolute in using economic values as a measure of well-being and progress, then we should at least incorporate the value of non-market ecosystem services within our decision-making framework. Failing to do so will always favor land and resource uses that erode natural capital, with little regard to pursuing alternative options.

## METHODS FOR VALUING ECOSYSTEM SERVICES

Determining the monetary value of goods and services traded in formal market structures is a relatively simple task. Prices for marketable ecosystem goods, such as timber products, are available on formal exchanges. In the absence of formal market structures, we resort to valuing ecosystem services using indirect estimation methods. Economists use a variety of techniques to elicit the economic value of non-marketable ecosystem services (see Table 4); non-market valuation techniques can be used as part of a broader economic impact assessment used to estimate the benefits and costs associated with alternative resource use options. All of these techniques have their strengths and weaknesses. It is important to point out that applying them requires disentangling and quantifying the impacts between climatic, biological, and ecosystem functions, then transforming those results into monetary value – a time-consuming and technically challenging endeavour.[15] One major issue, as yet unresolved, is how to use non-market value estimates to make decisions or choices about managing natural capital. Society will not always base its decisions exclusively on economic values. Economic value is one factor that guides and informs policy development; decision makers must also consider other issues such as distributional impacts and budgetary constraints.

**Table 4: Non-market valuation techniques**

| NON-MARKET VALUATION TECHNIQUES | DESCRIPTION | APPLICATION |
|---|---|---|
| Averting expenditures | Ecosystem services provided to communities avoid expenditures that would occur in the absence of those services | Wetlands provide flood control, which avoids property damage |
| Replacement cost | The costs associated with replacing ecosystem services using human built systems | Wetlands treat natural waste, which could be replaced with costly artificial treatment systems |
| Factor income | The enhancement of incomes associated with a particular ecosystem good and service | A productive supply of timber enhances the income of forestry-related workers and communities |
| Travel cost | The demand for recreational amenities requires travel, which implies that the cost of travel is a reflection of the value of that amenity | The value a family places on visiting a provincial park must be at least the cost they incurred to travel to the site |
| Hedonic pricing | The value of ecosystem services is reflected in property values | The price of a house located on a beach exceeds the price of an identical house in the interior with less attractive scenery |
| Contingent valuation | The value of an ecosystem service is derived from posing hypothetical scenarios that depict changes in the condition and/or provision of ecosystem services | The value of a species is reflected in people's willingness to pay to conserve critical habitat |

*Source: Groot, R.S. et al. (2002)*

## PAYMENT FOR ECOSYSTEM SERVICES

The basic principle behind paying to maintain or restore ecosystem services is that conserving land that could otherwise be used to generate economic activity reduces the production of marketable products such as timber, grazing, or agriculture. The conservation of land and resources maintains the provision and benefits of ecosystem services, but it does so at a cost, including foregone benefits of income, jobs, and tax revenue associated with removing productive land and resources from the marketplace. The net benefits of conserving or restoring ecosystem services may outweigh the net benefits of developing marketable resources; nevertheless, the fact remains that selling extractable resources infuses real cash into the pockets of business, families, and government coffers. No matter how intuitively appealing it is to

15 Nunes, P. & Van den Bergh, J. (2001)

ascribe economic values to ecosystem services, we must decide how to pay for them in a way that replenishes the actual real dollar cash flow taken out of the system as a result of reducing the sale of marketable products such as timber. One approach that merits further consideration is to apply market principles to rectify the cash flow imbalance. Individuals and public or private entities that benefit from the provision of ecosystem services should pay for the full value of these services; individuals and public or private entities who incur the costs of providing ecosystem services should also receive fair compensation. For example, retaining a specified number of tree species in a particular area stores and sequesters carbon along with providing habitat for wildlife and recreation, and purifies water for communities located downstream. However, the land base under consideration is tenured to a private entity required to harvest a specified volume of timber, ensuring steady revenue flows to the government's general revenue fund. The conservation of land and resources implies a reduction of the volume of timber harvested, incurring a cost to industry and government through reduced cash flows. However, if a market existed in which the ones who benefit pay for the continued provision of ecosystem services to the ones who incur the costs, it would be possible to replace the cash flow taken out of the system.

## BC'S FOREST SECTOR PROFILE

British Columbia contains approximately 60 million hectares of forest and ranges that provide a suite of resources for human and natural uses.[16] The forest industry harvests approximately 0.3% of BC forests annually, generating over $18 billion in annual sales revenues, which constitute 13% of BC's GDP and 43% of BC's total manufacturing shipments.[17] Industry operations provide over $3.7 billion in total payments to governments and employ over 234,000 workers.[18] BC's forest industry is at the epicentre of the provincial economy. Disruptions in the industry will almost certainly have adverse economic implications felt on a province-wide scale, especially in rural communities, where the bulk of the industry operates. For this reason, any suggestion to reduce harvestable timber supplies in an effort to increase ecosystem resiliency and diversify forest-based economies faces considerable resistance from communities, industry, and governments. However, the push for economic renewal in the forest industry and resource-dependent communities could not come at a better time; the industry faces remarkable challenges, which also provide opportunities to revitalize a strained sector (see Table 5).

16 Council of Forest Industries (2007), estimates for 2004
17 Council of Forest Industries (2007), estimates for 2004
18 Council of Forest Industries (2007), estimates for 2004

**Table 5: Forestry sector challenges**

| ANTICIPATED CLIMATE CHANGE-RELATED IMPACTS[a] |
|---|
| • Losses in productivity are expected to occur in warmer and drier regions of the south, while modest gains are expected in the north<br>• Climate change will likely alter optimal growth conditions for tree species and local populations<br>• Changes will likely alter rotation age, wood quality, wood volume, and size of logs |
| • Wildfires and pest outbreaks will likely impact BC forests to a greater extent than the effects of changes in tree species and productivity |
| • Age distribution of BC forests is skewed towards older trees, making them more susceptible to pest and fire disturbances |
| • Increase in disturbance in younger forests will affect forest growth, species composition, and wildlife habitat<br>• Changes in fire regimes will likely affect the safety of people and property |
| **BIOPHYSICAL IMPACTS OF PINE BEETLE INFESTATION[b]** |
| • The current beetle epidemic has now killed over 400 million cubic meters of marketable timber<br>• Over half of the marketable pine in BC's central and southern interior is already dead, and this is projected to increase to 80% by 2013. About 25-30% of the volume on the province's timber harvesting land base is pine. In a large portion of BC's interior, pine makes up over 50% of the harvestable timber.<br>• The infestation is now affecting over 8 million hectares of forest in the central and southern interior of British Columbia<br>• The cumulative area of BC affected (red-attack and grey-attack) is estimated at 13.5 million hectares |
| **ECONOMIC IMPACTS OF PINE BEETLE INFESTATION (PROJECTION DERIVED FROM PRINCE GEORGE TIMBER SUPPLY AREA ASSESSMENT )[c]** |
| • Revenue drop of $587.2 million (5.5%)<br>• Net regional product reduction of $271.7 million (8.6%)<br>• Reduction of royalties and indirect taxes paid, $84.7 million (11.5%)<br>• Decrease of $98.8 million in total labour income (6.2%)<br>• Loss of 2,660 employment positions (4.8%) |
| **INDUSTRY STRUCTURAL AND CYCLICAL CHANGES[d]** |
| • Appreciation of the Canadian dollar costs BC's forestry industry $130 million per year<br>• Slumping US housing market as a result of the sub-prime mortgage crisis and lowest lumber prices since 1991<br>• 15% export tax required by the Softwood Lumber Agreement between Canada and the United States (the US represents 87% of the market for BC lumber)<br>• Forestry exports in 2007 were at a 10-year low<br>• Technological changes and changing consumer preferences will alter productivity, alongside climate change stressors[e]<br>• BC's international competitors, such as the South American and Oceanian forest industries, will likely experience production benefits as a result of climate change, further stressing BC's forest sector[f] |

Footnotes specific to Table 5:

a Spittlehouse, D.L. (2008)

b Ministry of Forests and Range. Mountain Pine Beetle Action Plan 2006-2011.

c Patriquin, M., Heckbert, S., Nickerson, C., Spence, M. & White, B. (2005). The baseline AAC level in the TSA used for this analysis is 9,360,000m3. This level was set in 1996, and was maintained until 2002. In response to the mountain pine beetle infestation, the AAC was raised to 12,244,000m3 in June 2002 and further increased to 14,944,000m3 in October 2004. A recent BC Ministry of Forests timber supply review included a longer-term assessment of the future AAC level in light of the mountain pine beetle impact on the forest. The current projection of the sustainable AAC level in the TSA is anticipated to be 7,880,000m3. The reduction in the level of AAC is expected in approximately 15 years.

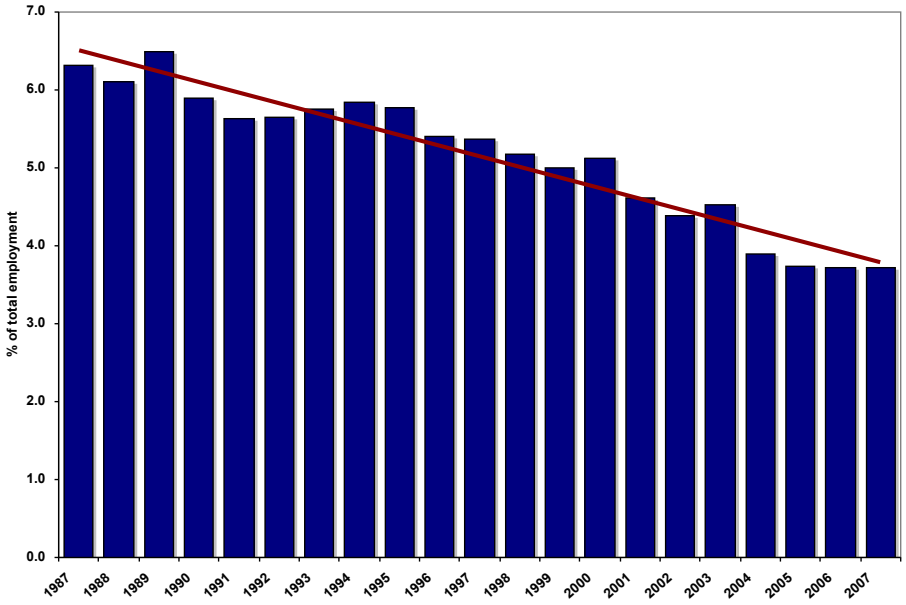
d Ministry of Forestry and Range and Ministry Responsible for Housing. (2008),

e Spittlehouse, D.L. (2008)

f Spittlehouse, D.L. (2008)

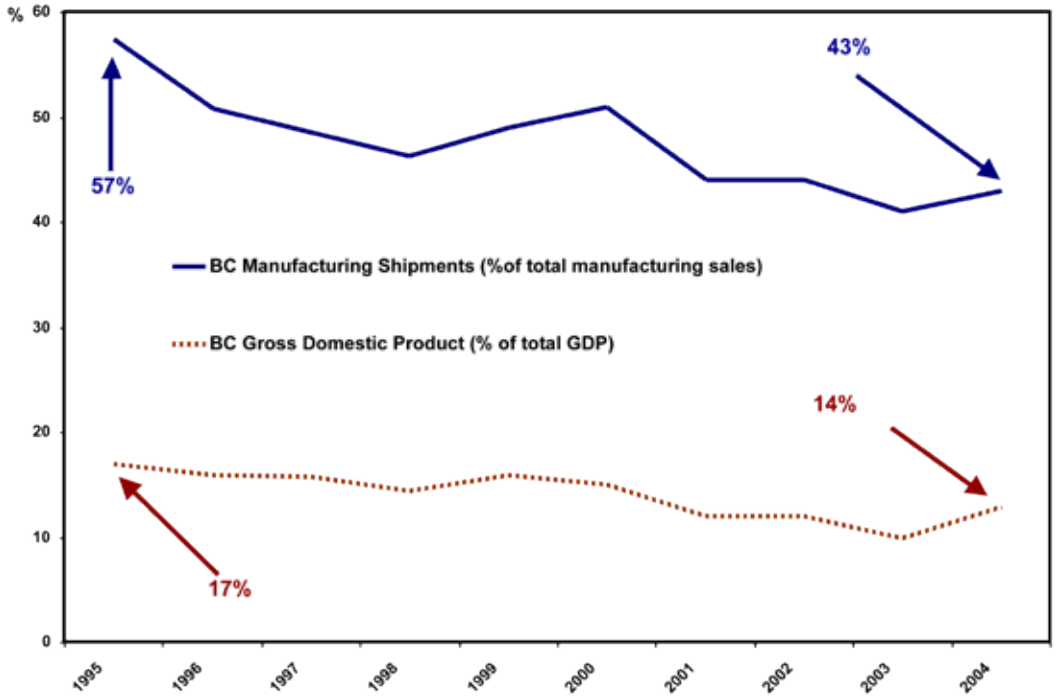
Despite the current cyclical challenges facing the industry, the forest sector remains the dominant economic driver in BC. However, changes in the prevailing economic indicators suggest a downward trend relative to other sectors of the economy. Figures 1-3 show the relative changes in employment, manufacturing, and exports.

**Figure 1: Total forest sector employment as a percentage of total employment in BC**



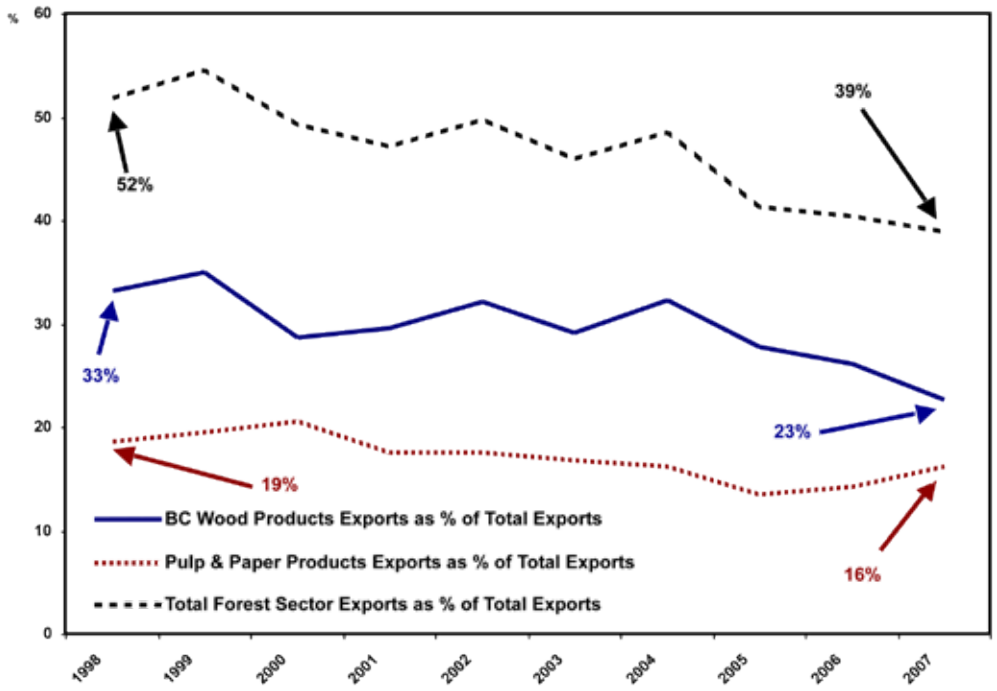

*Source: British Columbia Statistics (2008b)*

**Figure 2: Share of forest sector manufacturing shipments (% of total sales) and GDP (% of GDP)**




*Source: Data for graph retrieved from Council of Forest Industries (2008)*

**Figure 3: Share of Forest Sector Exports (% of total exports)**




*Source: British Columbia Statistics (2008a)*

## AN ECOSYSTEM MANAGEMENT APPROACH TO GOVERNING BC'S NATURAL CAPITAL

We believe government should examine the application of an ecosystem management approach to govern our natural capital. This would consist of "managing areas at various scales in such a way that ecological services and biological resources are conserved while appropriate human uses are sustained…. It focuses on ecological systems as a whole rather than on just some of their parts, includes public involvement in the goal-setting process, [and] integrates conservation into economic activity".[19] The ecosystem management approach is a paradigm shift from a conventional, top-down, command and control, linear management approach to a nonlinear, adaptive management, bottom-up approach that fosters collaborative decision making and planning. The ecosystem management approach has recently re-emerged as a viable policy and planning tool that is aptly suited to address climate change mitigation and adaptation, and community economic development initiatives that align with current government policy within the context of prevailing market conditions.[20] It may also offer opportunities to pay for the preservation of valuable ecosystem services. For example, managing forests for carbon storage and capture may replenish forest sector and government revenues by: selling carbon offsets; putting aside critical habitat to facilitate species and ecosystem adaptation to changing climate conditions; and creating business opportunities for non-timber forest products.

## LINKAGES WITH THE BC CLIMATE ACTION PLAN'S MITIGATION MEASURES

Maintaining intact ecosystems and/or restoring degraded ecosystems prevents the release of carbon into the atmosphere. Government agencies and industrial emitters eligible to purchase carbon offsets as part of a greater cap and trade system will have the opportunity to pay for the conservation or restoration of ecosystems that contain large carbon storage pools or effectively sequester carbon. BC's forests store an average of 311 tonnes of carbon per hectare of land, or an estimated total of 18 billion tonnes of carbon.[21] The total economic value of the carbon stored in BC's forests is therefore estimated

19 Brussard, P.F., Reed, J.M. & Tracy, C.R. (1998)
20 List retrieved from Voora, A.A. & Venema, H.D. (2008) with some derivations to highlight relevant points in BC
21 Wilson, S.J. & Hebda, R.H. (2008)

at $774 billion.[22] The return on a 20-year investment would amount to $1,072 per hectare/year, worth a total of $62 billion per year.[23] The use of the vast stock of carbon storage in BC's forests aligns with the BC Climate Action Plan, as it calls for a legally binding 33% reduction in greenhouse gas (GHG) emissions from 2007 levels by 2020.[24] The main components of the plan relevant to this discussion include a carbon offset program, integrated within a broader cap and trade system, including the government's commitment that all public agencies become carbon neutral by 2010.[25]

## LINKAGES WITH ADAPTATION RESPONSES AND BC'S CONSERVATION STRATEGIES

The primary objective of climate change adaptation within the context of biodiversity is to increase the resiliency of species and ecosystems in order to allow them to effectively respond and adapt to changing environmental conditions. This requires conserving critical habitat for vulnerable species, alleviating the effects of non-climatic stressors, and enhancing connectivity corridors to facilitate species migration. Purchasing carbon offsets allocates a portion of developable land and resources for carbon storage and capture; effective cross-ministerial coordination has the potential to use the same land and resources to conserve critical habitat for vulnerable species and/or establish connectivity corridors. In addition to payment of carbon and capture, conservation easements may also provide monetary compensation through tax credits or direct payments for preserving critical habitat. The province, in the newly released conservation framework, advances the policy of preserving critical habitat for vulnerable species; this policy is also entrenched in existing legislation (i.e. Forest and Range Practices Act, Wildlife Act) and advocated by many non-governmental, not-for-profit land conservation trusts.

## LINKAGES WITH BC'S RENEWED ECONOMIC DEVELOPMENT STRATEGIES

There is considerable interest in examining and developing policies to renew the forest sector in an era of climate change, while revitalizing an industry that is facing severe cyclical and structural challenges. The Future Forests Ecosystem Initiatives (FFEI), Forests for Tomorrow, the Pine Beetle Action Plan, the Bio-Energy Plan, and the Community Development Trust are initiatives launched by the BC government in response to current and anticipated climate change impacts on BC's forest and range ecosystems, and the cyclical and structural challenges facing the forest industry and resource-dependent communities. These initiatives share some common themes:

1. Examine new approaches to forest and range management, and explore opportunities to maintain and enhance ecological resilience and ecosystem services under changing climate conditions.
2. Enhance short- and long-term economic sustainability for communities.
3. Conserve long-term forest values that include the value of ecosystem services.
4. Address the current impacts associated with the pine beetle infestation and the cyclical and structural changes to the forest sector.

The prevailing business activities in the forest sector largely consist of timber harvesting and the manufacturing of wood and pulp and paper products; the Ministry of Forests, the forest industry, and many resource-dependent communities maintain that these business activities will remain the dominant engine of the forestry sector. However, there is growing recognition of the need to diversify the industry's product base, provide short-term relief for communities affected by the pine beetle, reduce dependency on timber-based products for rural communities, and maintain and enhance ecosystem resiliency to better adapt to changing climate conditions. The aforementioned government initiatives advocate an increase in bio-energy production, non-timber forest products, and the development of niche timber products that produce added market value using less harvestable timber, as strategies to fill the void created by declining conventional forest sector activities.

22 Wilson, S.J. & Hebda, R.H. (2008)
23 Wilson, S.J. & Hebda, R.H. (2008)
24 British Columbia Climate Action Plan (2008)
25 British Columbia Climate Action Plan (2008)

## CONCLUDING REMARKS AND NEXT STEPS

In times of challenging economic conditions, fear and political rhetoric have a tendency to dominate and distort meaningful public debate about finding long-term and sustainable solutions to manage our natural capital. Media pundits and political opportunists are inclined to abandon pragmatic solutions based on economic fundamentals, in favour of short-term fixes. Concessions to resource industries that tend to accelerate the erosion of natural capital resonate, understandably, among resource-based BC communities facing financial adversity. It is true that communities confronted by perilous economic conditions demand and need immediate financial relief; nevertheless, diverse biological systems create resilient ecosystems, and resilient ecosystems yield sustainable flows of ecological goods and services that are the backbone of prosperous and vibrant economies over the long term, not just revenues today. Therefore, we must develop concrete solutions that help communities both now and in the future. Maintaining and restoring the resiliency of our ecosystems is an economic imperative, and requires pragmatic solutions geared to renewing economic development opportunities across BC.

We therefore propose that the BC government set the stage for the transition to an ecosystem-based economy by following these steps:

### 1. SHORT TO MEDIUM TERM (1-2 YEARS): ESTABLISH PROVINCIAL NATURAL CAPITAL AND ECOSYSTEM SERVICE ACCOUNT AND EXAMINE ECOSYSTEM PAYMENT MECHANISMS.

- Construct a natural capital account system that provides monetary values for BC's marketable and non-marketable ecosystem goods and services produced by the province's natural capital assets (i.e. forests, wetlands, grasslands, and alpine regions).
- Create a central agency that uses these estimates as a baseline to measure economic impacts associated with pursing resource use options, to inform the decision-making process.
- Estimate natural capital values at the watershed level, or using existing strategic planning boundaries.
- Build on the Climate Action Plan to examine the market value of selling carbon offsets as part of a broader national, continental, and international cap and trade system.
- Examine the viability of public agencies charging rent for the erosion of natural capital that generates valuable ecosystem services.
- Examine the viability of establishing a formal Ecosystem Service Exchange Market System to trade ecosystem services.

### 2. LONG TERM (3-5 YEARS): RE-EXAMINE STRATEGIC LAND AND RESOURCE PLANS TO INCORPORATE ECOSYSTEM MANAGEMENT APPROACHES COMPARABLE TO THE CENTRAL AND NORTH COAST PLANNING REGIMES.

- Update existing plans to consider changing climatic parameters and related impacts on the state of biodiversity and ecosystem functions.
- Maintain the ecological integrity of terrestrial, marine, and freshwater ecosystems when considering commercial activities on all Crown lands.

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