EXECUTIVE SUMMARY

A New Climate for Conservation

Nature, Carbon and Climate Change in British Columbia

Dr. Jim Pojar

ACKNOWLEDGEMENTS

Commissioned by the Working Group on Biodiversity, Forests and Climate, an alliance of ENGOs, including:

BC Spaces for Nature
Canadian Parks and Wilderness Society
David Suzuki Foundation
ForestEthics
The Land Trust Alliance of BC
West Coast Environmental Law
Yellowstone to Yukon Conservation Initiative

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FOREWORD

This is a summary of a technical report commissioned by the Working Group on Biodiversity, Forests and Climate, an alliance of environmental non-governmental organizations (ENGOs) including: B.C. Spaces for Nature, Canadian Parks and Wilderness Society, David Suzuki Foundation, ForestEthics, Land Trust Alliance of B.C., West Coast Environmental Law, and Yellowstone to Yukon Conservation Initiative. The full 99 page technical report is available at http://wcel.org/resources/publication/new-climate-conservation. This summary is written using terminology intended for a broad audience. A glossary is provided at the end of the document.

Dr. Jim Pojar, forest ecologist, who prepared the report, has extensive professional experience in applied conservation biology, forest ecology, sustainable forest management, ecological land classification, and conservation, with a wealth of field experience throughout British Columbia.

For the complete listing of people who contributed to the report, please see Acknowledgements in the opening pages of the full report.

The hope is that this synthesis of scientific information (on primarily terrestrial ecosystems) will be an important contribution to the current rethinking of nature conservation and climate action planning in British Columbia. The author and reviewers acknowledge several areas that were not within the scope of this project but would augment our current knowledge. For example, our comprehension of impacts to biodiversity would be greatly enhanced by a deeper understanding and application of Indigenous Ecological Knowledge in B.C. in collaboration with First Nations peoples. Other topics that were outside the scope of the report, but that would be important parts of a comprehensive analysis, include:

- a socio-economic analysis of the implications of a carbon economy and forest carbon initiatives;
- a greater understanding of market leakage from conserving forests and reducing harvest levels;
- implications of genetically modified organisms; and
- the role of B.C.'s ecosystems, including oceans, in the larger global climate scenarios.

Introduction

Photo Aaron Ward

This Executive Summary is based on the 99-page technical report, *A New Climate for Conservation: Nature, Carbon and Climate Change in British Columbia*. The report explores the strategic role of nature conservation in a climate action strategy for ecological adaptation (Part 1) and ecological mitigation (Part 2), with the key recommendation to develop a comprehensive and integrated Nature Conservation and Climate Action Strategy for the Province of British Columbia (Part 3):

Part 1 presents available science on current climate-change projections, and present and future impacts of climate change to ecosystems, species, genotypes, and the processes linking them. The review focuses primarily on forested systems, and also addresses non-forest and aquatic systems. Ecosystem *resilience* and *adaptation* options, in relation to climate change, are outlined. Current thinking in conservation science is then summarised in light of external pressures. B.C.'s existing conservation planning and forestry management are reviewed in terms of their ability to respond to the challenges of climate change.

Part 2 summarises literature on natural capital, ecosystem services and the role of ecosystems in climate-change *mitigation*. Variations in *carbon sequestration and storage* in different ecosystems are discussed and research gaps in forest carbon dynamics are identified. Current opportunities for an offset market through carbon activities such as avoided *(forest) degradation, ecological restoration* and *improved forest management* are also explored, in light of recent pilot projects in B.C.

Part 3 integrates the findings from Part 1 and Part 2 in a central recommendation—to develop a comprehensive and integrated provincial Nature Conservation and Climate Action Strategy. To be efficient this strategy must combine nature conservation and carbon/climate management planning. To be effective, it must embrace the fundamental role of conserving natural ecosystems for adaptation and mitigation of climate change, and for nature's many other ecosystem services, which underpin sustainable options for current and future generations.

the key recommendation: develop a comprehensive and integrated Nature Conservation and Climate Action Strategy

The following summary addresses each of the three parts of the report.

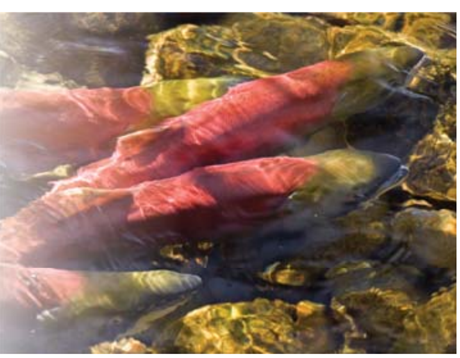
Part 1:
Climate Change, Biodiversity and Adaptation

Photo Kurt Hahn

Importance of British Columbia's Biodiversity

British Columbia's dazzling array of climates, landforms and ecosystems represents a natural heritage that is globally significant. From steppe to alpine, tundra to rainforest and mountain wilderness to rich coastal estuaries, these ecosystems provide habitat for assemblages of plant and animal species that are unusually rich for a northern temperate region. British Columbia is home to three-quarters of Canada's mammal and bird species, 70 percent of its freshwater fish, 60 percent of its evergreen trees, and thousands of other animals and plants.

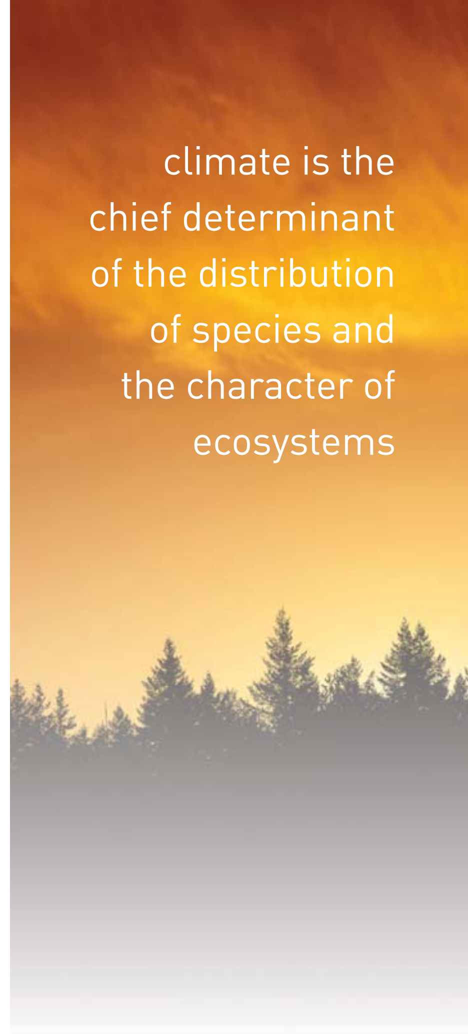
Some of these species, such as the Vancouver Island marmot, exist nowhere else on earth. Some, such as mountain goat and mountain caribou, live mostly in this province. For many others, such as grizzly bears and salmon, British Columbia has become a globally important refuge as populations have declined precipitously or been eliminated elsewhere across their historical range. British Columbia also has a global stewardship responsibility for a large proportion of the world's remaining ancient temperate rainforests, wild rivers and rich marine ecosystems.



Salmon are sensitive to temperature change throughout their life cycle. *Photo Robert Koopmans*

Climate Change is Underway

Global climate change is underway. Significant warming has already occurred on land and in water and the continuing changes are expected to happen faster and be more pronounced in British Columbia than the global average. British Columbia's climate over the next 100 years will become even warmer, with mean annual temperatures warming by 3 to 5˚C if current trends continue unabated. There will be more extreme weather events with increasing intensity of storms, floods, wildfires and drought. As this century progresses, B.C. can probably continue to expect warmer and wetter winters especially in the north, progressively warmer and drier summers in the southern half of the province, and wetter, initially cooler, but ultimately warmer summers in much of the northern half of the province.



Impacts of Climate Change on B.C.'s Biodiversity

Climate change is already significantly impacting healthy ecosystems in British Columbia, and will likely cause more dire consequences for fragmented or degraded ecosystems. Changes in species range and abundance, life cycle and behaviour, survival rates and genotypes, have all been detected and have reverberating effects on ecosystem structure and functions. Impacts have occurred on all scales, from the dramatic impacts of mountain pine beetle populations on vast areas of forests, to dieback of single species like the western redcedar. Other types of change, such as the arrival/departure dates of migrating birds, and impacts on insects and the food webs they support, are all being witnessed.

Projected Impacts of Climate Change on B.C.'s Biodiversity

Climate is the chief determinant of the distribution of species and the nature and character of ecosystems, and thus is a key driver of biodiversity. Over the past 4,000 to 4,500 years, British Columbia has had a relatively stable climate, leading to the current pattern of ecosystems. The anticipated impacts of climate instability and change on B.C.'s biodiversity are diverse, complex and not well understood. Biodiversity will be affected at ecosystem, species, and genetic levels. These impacts are all interrelated.

Future Ecosystem Responses

The predicted changes in climate in this century are expected to result in significant ecological change, in addition to what has been witnessed to date. Although uncertainties abound, two principles guide the interpretation of these changes. First, ecosystems do not migrate—species do. Second, most species cannot disperse (move) quickly enough to keep pace with the projected changes. These two factors together will affect how future ecosystems take shape as plant and animal species shift their ranges largely independently and at different rates.

While some species, such as mule deer, can disperse and move long distances quickly, many species will not be able to relocate so readily as ecosystems change. *Photo Tom Tietz*

The glaciers of Glacier National Park have retreated significantly in recent decades.
Photo Amar Veluri

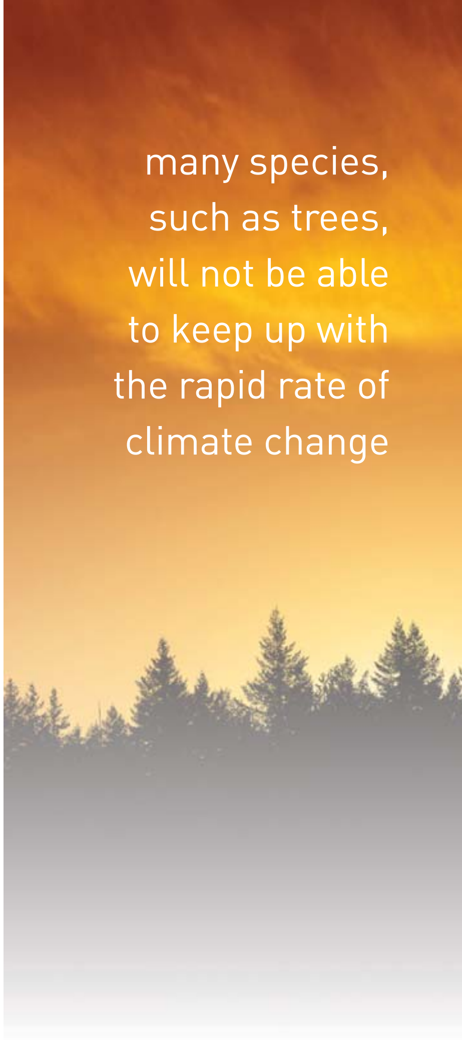
Over time, projected changes will result, at least in southern B.C., in trends such as increases in weedy, drought-tolerant, and alkali-tolerant species, and decreases in moisture-loving and acid-tolerant species. Elements of southern forests and grasslands will expand northward but these grasslands will probably be 'mongrel' ecosystems with high proportions of invasive species. Forests will move upslope into alpine habitats. Decreasing snowpacks, shrinking glaciers, melting permafrost, warming streams and oceans, increasing frequency and intensity of disturbances—including pest outbreaks, wildfires, storms, floods, drought and erosion—will negatively affect the structure and function of all present-day ecosystems. In other words, they will undergo ecological upheaval and some will unravel.

Mountain goats will increasingly encounter species of lower elevations moving into traditional alpine habitats. *Photo Jason Puddifoot*

As agents of change, shifting disturbance regimes and patterns could become as important as increasing temperatures and changing levels of precipitation. The increasingly acute threat to nature as we know it is not climate change acting in isolation, but rather the combination of climate change and intensifying changes made to natural landscapes and systems by humans. Responses of B.C. ecosystems to these changes will be complex and are difficult to predict because they reflect the combined and synergistic effects of changing climate, natural disturbances, land and resource uses, and the spread of invasive species.

Some of these changes may have short-term benefits for people, for example, a longer growing season, but most will adversely affect the province's natural capital and the goods and services that British Columbians derive from nature. Climate-related impacts are already changing the way ecosystems work for us. The ability of ecosystems to produce oxygen, purify water, make soil or adjust to disturbances will be challenged in new and unpredictable ways. As well as natural disturbances, increased human disturbances, diseases, and invasive species will exacerbate the effects of climate change.

What we do on land matters for the oceans as well. Oceans are a large sink for CO_2, but as emissions of CO_2 go up, oceans are absorbing more CO_2 and acidifying at an escalating rate. Thus as calcium carbonate becomes less available, the oceans are becoming less hospitable for many organisms—including shellfish—that store carbon in their bodies, shells, and skeletons, and on which we directly and indirectly depend for food and our economy.



Future Species Responses

Species confronting rapid environmental change will either go extinct or survive in one of three ways: by acclimatizing, evolving, or migrating to suitable habitats elsewhere. Those that adapt in their original location will have additional competition from other species or *genotypes* better suited to the new local environment. Many species will not be able to keep up with the rapid pace of climate change, especially if habitats have already been degraded by various land uses. Both species richness and the numbers of species at risk are highest in low elevation areas of southern B.C., where the current conservation crisis will only get worse as land and water degradation exacerbates climate change impacts.

Species adapted to specialised habitats are more likely to persist as long as their special habitats continue to exist. Impacts from climate change to *keystone species*, which exert a disproportionately large influence on ecosystems, will have huge cascading consequences for other species and for ecosystems. Indeed, the overall effect on biodiversity and ecosystem services will be much greater than *extirpation* of some threatened and endangered species.

While climate change will force widespread species migrations poleward, to higher elevations, or to cooler (for example, north-facing) aspects, many species, like trees, cannot migrate quickly enough. Tree species, which dominate the province's forests, can be considered *foundation species* of paramount importance to B.C.'s biodiversity. Some, like whitebark pine, are already of conservation concern, and others deserve close attention. In addition, historic patterns of dispersal of these species are being disrupted by habitat loss and fragmentation, so there is uncertainty about how such populations will migrate and disperse in response to rapid climate change.

The ocean is a crucial carbon sink that is now becoming increasingly acidified as it absorbs more and more CO_2 This reduces the availability of calcium, which shellfish such as this dungeness crab need for shell-making.

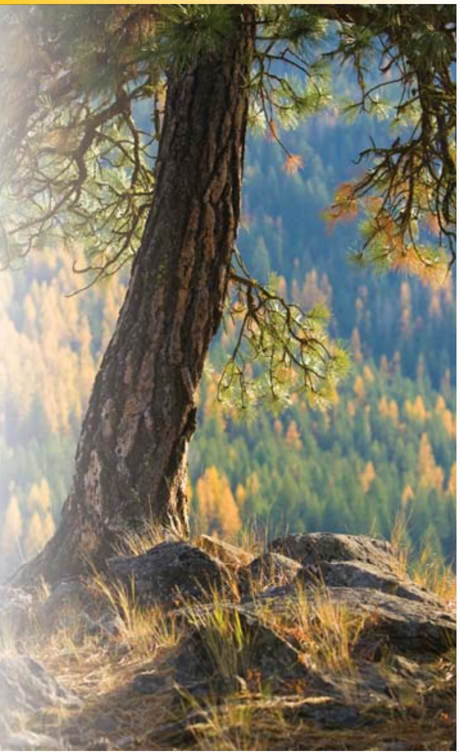
Photo (left)Jeffrey Waibel, (above) Hanson Quan

Future Genetic Responses

The ability of species to respond genetically to environmental change is difficult to predict. It depends on their population genetics and life history traits. However, except for a handful of commercially important species, such as the conifers, we know very little about the genetic architecture of B.C.'s native species.

Ultimately, the factors of rapid climate change and increased disturbances will lead to genetic erosion (reduced genetic diversity) and declining productivity of populations. This decline will be greatest for genetically specialized species, e.g., Douglas-fir and ponderosa pine. During this period, opportunistic pioneer species that can adjust *phenotypically* (by altering their *morphology*, physiology, or development) to different environments (thereby exhibiting 'plasticity') will have the best chance of migrating and adapting. Migrations will have variable consequences for different species.

There are likely to be different patterns of genetic variation among the major groups of plant species. In contrast to trees, some shorter-lived herbaceous species might be able to evolve on a time scale comparable to change in climate, that is, within decades. Invasive short-lived herbs with long-distance seed dispersal, e.g., knapweed, will probably be most successful at migrating in a changing climate, but B.C.'s specialized native species could have the best genetic potential to adapt over time.



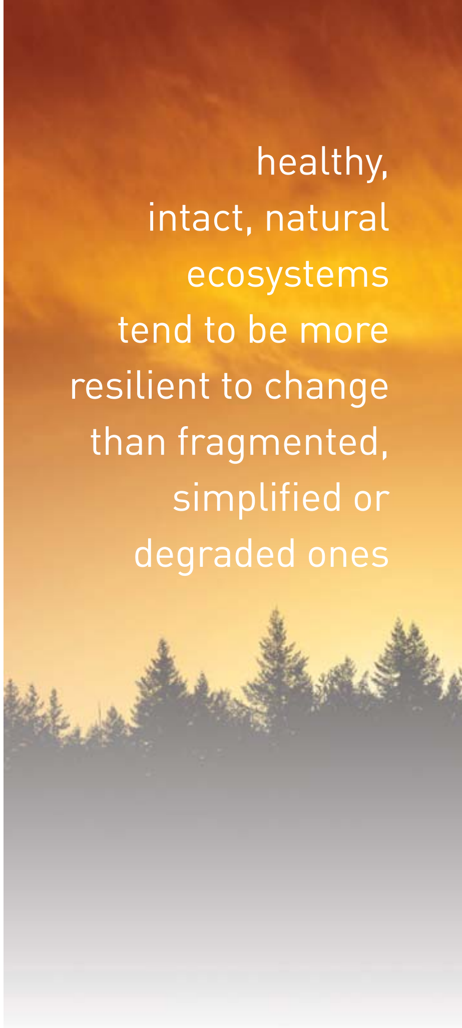
Ponderosa pine, a genetically specialized species that could be extremely vulnerable to rapid climate change. *Photo Geoffrey Holman*

The burrowing owl is already under stress in B.C. along the northern periphery of its traditional range. *Photo Frank Leung*

Some species have evolved rich genetic resources to deal with considerable environmental variability. For example, sockeye salmon have developed much local, stock-level genetic variation in response to different (heterogeneous) spawning and rearing habitats. This genetic diversity has enabled sockeye to adapt locally and quickly, and to sustain productivity despite past fluctuations in climate. This should help them respond—within limits—to future climate change.

British Columbia species that live at the edge of their range as *peripheral populations*, e.g., burrowing owl, and species that harbour genetically distinct and reproductively isolated populations as *cryptic species,* e.g., seaside juniper, will be important genetic resources in the future. Peripheral populations can possess valuable adaptations to local marginal environments that could become more widespread. They also can have the genetic raw material for evolution in changing or new environments; populations close to northern and southern range boundaries are likely to be better adapted to some environmental changes than the modal (most frequent) genotype. But even if a species' potential range expands, much of its newly available habitat may have already been converted or degraded and will most likely be increasingly vulnerable to invasive species.

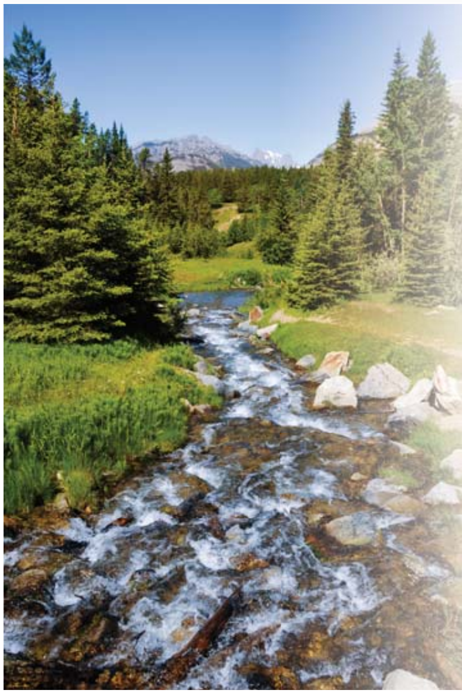
Hybridisation, a common process in many species and in B.C., will probably increase as species and populations migrate and mix with differing genetic consequences. Alien species—perhaps including genetically modified organisms—could genetically swamp related native species.



Resilience and Ecological Adaptation

Intact, functional, natural ecosystems could be more resilient to climate change than are ecosystems that are fragmented, simplified or degraded by human activities. Resilient ecosystems can regenerate after disturbances, resist and recover from pests and diseases, and adapt to changes in temperature and water availability—including those resulting from climate change. More diverse, complex systems tend to be more resilient; fragmented or degraded systems tend to be less resilient; and even resilient systems will radically shift if the environment changes sufficiently.

Intact systems tend to be more resilient than degraded systems for several reasons. At the local site level, natural ecosystems create their own sheltering and buffering microclimates, which slow the rate of change and give resident species more time to migrate or adapt. Natural forests in particular play a major role in protecting the quality and quantity of water by buffering the impacts of storms, floods, erosion, drought and rising temperatures. At the broader level, landscapes that are more intact (not fragmented by roads or shifted from natural patterns of habitat by industrial use) may enable populations to adjust to climate shifts by providing safer, less stressful, more functional enclaves for persistence, and linkages for migration.



Natural forests buffer the environment from extreme weather events such as storms, floods, erosion and droughts. *Photo Yanik Chauvin*

Natural ecosystems can soften the impact of migration lags—slowing the rate of landscape change, moderating microclimates, and providing alternative habitats. For species occupying discrete forest stands or habitat patches, successful migration may require maintenance of within-species gene flow among the stands or patches of ecosystem types. Intact landscapes can facilitate this flow, while fragmented landscapes can impede it.

Conservation of biodiversity is everyone's responsibility. *Photo Ken Canning*

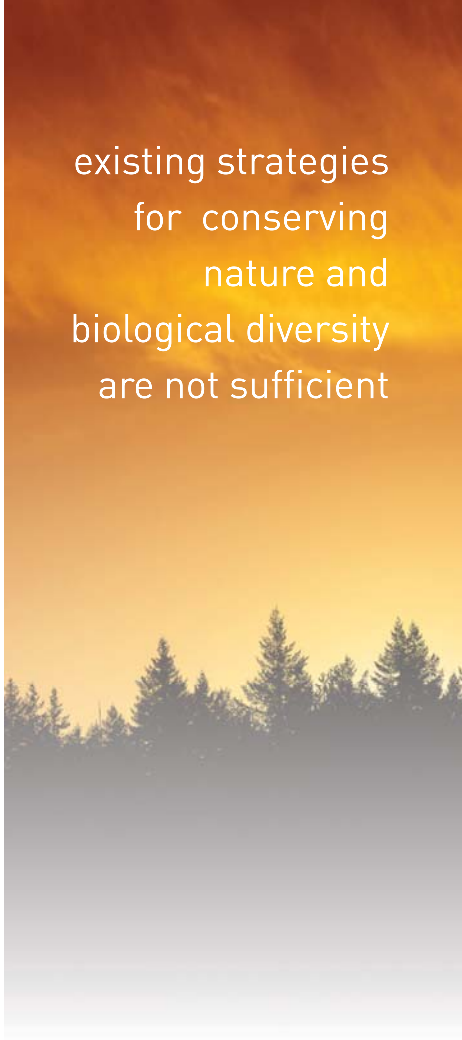
Existing parks on their own cannot safeguard biodiversity. Additional buffer areas, such as the Taku valley where these mountain goats live, are needed.

Photo (right) Johnny Mikes, (below) Timothy Epp

Planning for Ecological Adaptation

Projected climate changes are of a magnitude and character to have huge ramifications for genomes, populations, species, communities, ecosystems, and landscapes. On top of this, the uncertainty about the rate, dimensions, and projected impacts of climate change makes managing for the future even more difficult. Existing strategies for conserving nature and biological diversity are not sufficient. Some existing management tools remain effective, some need major modification, and new approaches must be developed so as to enhance ecosystem resilience.

While existing parks continue to be pillars of a nature conservation strategy and act as 'arks' and ecological benchmarks, most are not big enough to sustain biodiversity on their own. The reserve system needs to be enhanced substantially and integrated with more effective off-reserve conservation. The question of 'how much is enough' land base protection to support biodiversity has become more complex because of inadequate understanding of the shifting scenarios of climate change and the extent to which landscapes are already degraded. Maintaining the integrity and connectivity of entire landscapes is now more important than ever.



Beyond Preservation: Managing the Matrix

Conservation biology research has long pointed out that a constellation of protected areas is insufficient to maintain biodiversity values, that it is also necessary to ensure that the lands in between—the *matrix*—are not hostile to species on the move. Climate change underlines the necessity of a nurturing matrix. Enabling species movements through the broader landscape will be key to maintaining as many species as possible. Conservation of biodiversity must take place at multiple scales in all jurisdictions and be the responsibility of everyone.

Managing the Forest Matrix

Key recommendations for managing the forest matrix include protecting primary forest, providing buffers to protected area boundaries, reducing conversion of old growth (or primary) forests to *industrially managed forests* or natural forests to *plantations*, and providing *connectivity*. Contemporary management must shift to *improved forest management practices* that strive to maintain forest biodiversity and ecological functions by:

- maintaining and restoring fully diverse forests, with structure and complexity at all scales, from the stand to the landscape level,
- embracing environmental variability and uncertainty,
- decreasing landscape fragmentation,
- extending rotation lengths to restore diversity and add structure in landscapes where it has been lost,
- addressing as wide a variety of ecosystem components (not just trees and vertebrates) and functions as possible, and
- reducing pressures on keystone and foundation species.

In the past, management approaches incorporating principles of conservation biology have been suggested or implemented to limited degrees in some areas of British Columbia's forested land base. The predicted consequences of climate change now bring an additional and urgent impetus for their application. Planning for landscape resilience in the face of climate change is novel—and will require significant shifts in approach. It is time for British Columbia to embrace these concepts and become a global leader in modern forest management.

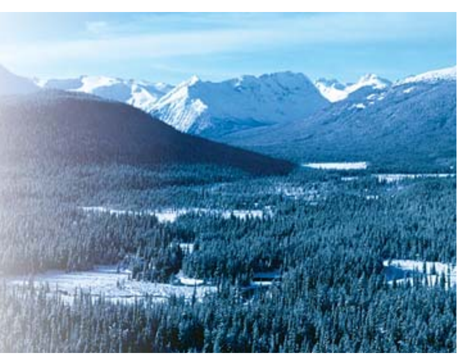
Connectivity among protected areas is essential to provide space for nature to self-adapt, to adjust to the new conditions brought on by climate change. *Photo (left) Wayne Sawchuk, (above) Laure Neish*

Part 2: Biodiversity, Climate Change and Mitigation

Photo iStock

As outlined in Part 1, the conservation and restoration of B.C.'s natural ecosystems and biodiversity is the best risk-management approach for adaptation to climate change and, as such, can stand alone as a key climate action strategy. The conservation argument becomes even more compelling when combined with the benefits of a conservation strategy for climate mitigation through:
1) protection of the *carbon sink* and *sequestration* functions of ecosystems;
2) immediate avoidance of emissions caused by *deforestation* and/or *degradation* of forest carbon stocks; and 3) expansion of sinks through ecological restoration, to enhance carbon sequestration and storage in the long term.

Given the internationally identified need to immediately reduce *greenhouse gas* (GHG) emissions, any potentially effective strategies must be seriously considered. Both technological mitigation and ecological mitigation will be required. Technological mitigation aims to reduce emissions of carbon through alternative technologies, such as carbon capture systems and alternative energies. Ecological mitigation aims to reduce emissions through avoided degradation and deforestation, and to increase the size of the carbon sink and annual sequestration through restoration.



B.C.'s forests constitute a massive carbon recycling system, avoiding its depletion will assist our efforts to manage CO_2 levels.

Photo Jim Pojar

Natural Capital and Ecosystem Services

B.C.'s forests and grasslands, lakes and rivers are capital assets that provide vital goods, life-support services and life-enriching benefits. A preliminary accounting of B.C.'s ecosystem services, including adaptation and mitigation services (that is, carbon storage and sequestration), suggests the huge importance of our natural legacy.

Role of Ecosystems and Biodiversity in Climate Change Mitigation

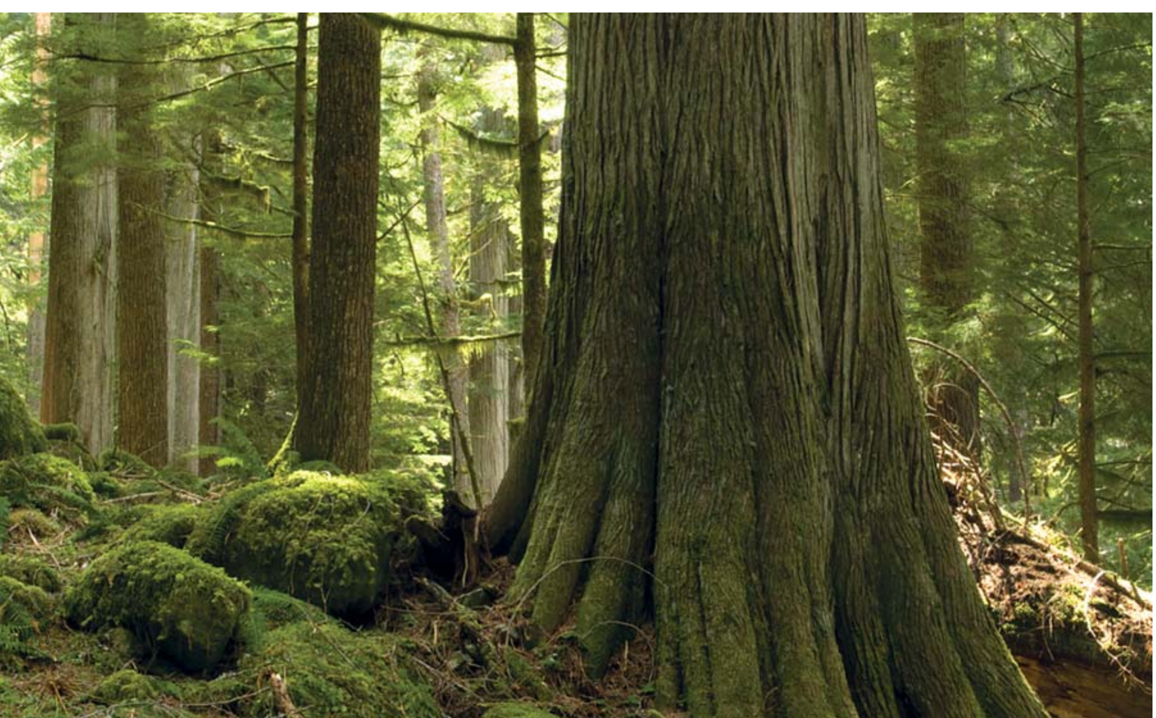
Ecosystems naturally affect the amount of CO_2 in the atmosphere by playing a central role in the carbon cycle. Plants capture CO_2 from the atmosphere and store it as wood or other plant matter. Decomposition results in additional storage in soils and in release of some CO_2 back to the atmosphere. Because ecosystems both absorb and release CO_2, the relative balance between the two processes determines whether a particular ecosystem is a net *carbon source* or a sink. Depending on how they naturally function, and how they are managed, ecosystems can therefore either contribute to or reduce greenhouse gas emissions and climate change.

Ecosystems—especially forests and peatlands—play a dominant role in the carbon cycle of British Columbia. Grasslands and alplands also have significant roles. Well over half of B.C. is forested. The carbon stored in the trees, roots and soils of these forests averages 311 tonnes per hectare. Old-growth forests steadily accumulate carbon for centuries and store vast quantities of it, up to 1100 tonnes per hectare in B.C. temperate rainforests—some of the highest storage capacities in the world. B.C.'s forest ecosystems are estimated to store 18 billion tonnes of carbon. Large pulses of CO_2 are released when forests are cleared or disturbed by logging, wildfire, or outbreaks of insects and diseases.

There is a strong link between ecosystem conservation and carbon stewardship. Almost one-fifth of the world's carbon emissions come from deforestation and land degradation. Closer to home, B.C.'s Greenhouse Gas Inventory Report indicates that logging was responsible for 72.7 MtCO2e (megatonnes of CO_2 equivalent) emissions in 2007 alone. While BC does not include these emissions in official provincial GHG emission totals in accordance with Canada's decision under the Kyoto Protocol, this makes logging the single largest source of GHG emissions in BC, followed by the energy sector at 54.1 MtCO2e. Even heavily discounting the logging emissions to account for carbon stored in long-lived wood products after harvesting, this is still a massive contribution to our GHG emissions that will not be compensated for by newly replanted forests for decades—if ever.

Factoring the enormous though variably secure carbon storage in B.C. ecosystems into management planning will be a key strategy. Conserving nature, as part of a comprehensive Climate Action Plan, is already recognized by the international scientific community through commitments to protecting carbon sinks and encouraging mitigation through avoiding deforestation and degradation as well as ecological restoration.

old-growth forests steadily accumulate carbon, and can store up to 1100 tonnes per hectare



Forests, wetlands and grasslands play significant roles in the carbon cycle. *Photo (above) Geoffrey Holman, (left) Timothy Epp*

Changing Policy on Forest/Carbon Mitigation in B.C.

Carbon stewardship policies and practices in B.C. have been slow in coming for historical, institutional, and philosophical reasons. Traditionally, B.C.'s forests have been managed for wood production, and the economic arguments for forest carbon and ecosystem services are relatively new in Canada.

Policy discourse has been stalled over research gaps in carbon/forest dynamics, gaps that prevent a full understanding of what form of forest management provides the best atmospheric benefit. Questions have focused on isolated elements of the carbon life cycle. Do young replacement forests absorb carbon more rapidly than old forests? What are the immediate carbon impacts of converting primary forests to plantations? Are trees put to better use in wood products and in bioenergy, as a substitute for higher carbon-intensive building materials and fuels, or left growing to absorb and store carbon? Are forests net sinks or sources of carbon? Is carbon storage in forests a permanent solution? These questions have been difficult to answer in the absence of a full life-cycle analysis of carbon under different scenarios, but consensus is emerging on many points, as noted in the next section.

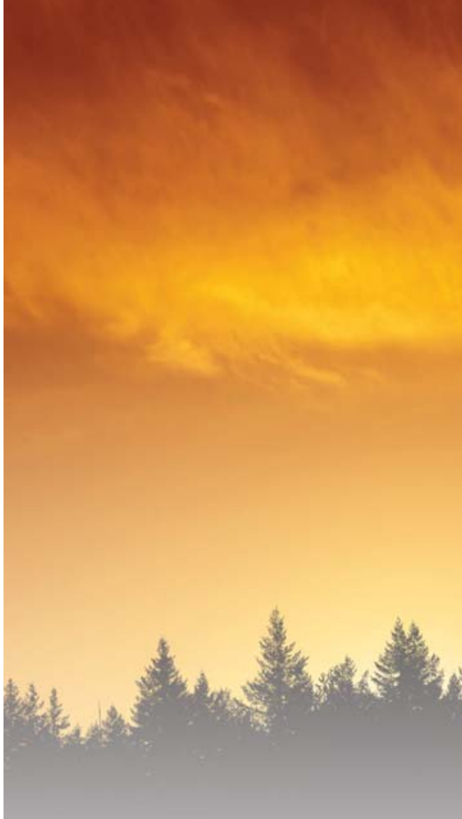
Newly planted trees cannot quickly recoup the stock of carbon lost due to logging, recovery takes a long time and may never attain original levels of carbon storage. *Photo George Clerk*

Emerging Research into Forest/Carbon Dynamics

Natural ecosystems play a key role in mitigating climate change. In B.C., forests and their soils are the chief reservoir of living and dead carbon, and thus are a linchpin of carbon dynamics. In summary:

- Protecting forests provides immediate net carbon benefits. Currently stored carbon has much greater value to the atmosphere than future anticipated carbon some decades hence. Given that the conservative Intergovernmental Panel on Climate Change target is to reduce carbon emissions 80 percent to 95 percent below 1990 levels by 2050, the imperative is to avoid needless release of any additional carbon currently stored in trees or soils.
- When old forests are logged and their soils disturbed, they release carbon to the atmosphere immediately, and continue to do so for decades and sometimes for over a century.
- Logging results not only in losses to above- and below-ground carbon stocks, but also in lower rates of sequestration for three to four decades, until rates of net carbon uptake in the secondary forest return to pre-harvest rates.

Logging releases lots of carbon to the atmosphere while temporarily removing one of the major natural engines of carbon uptake and storage. *Photo iStock*



Natural ecosystems play a key role in mitigating climate change. Not only as a reservoir for carbon but also as a source of biodiversity. *Photo Robert Blanchard*

- Industrially managed forests store less carbon than natural forests. Carbon stock recovery takes decades and even centuries, and managed forests may never attain original carbon storage levels if they continue to be logged and replanted on short commercial rotations.
- Regardless of whether some types of B.C. forests are a net source or a sink at any given moment, they continue to store tonnes of carbon as long as the trees remain, even if they are dead.
- Intact peatlands, northern permafrost ecosystems, grasslands and alplands in the terrestrial realm, and oceans, all have roles to play in carbon sequestration and storage and should be part of a climate change mitigation strategy.

industrial forestry releases large amounts of carbon to the atmosphere, losses which usually are not fully recoverable

The consensus of scientific opinion appears to be that clearcut logging old-growth forests for wood products and converting the primary forests into industrially-managed forests, especially plantations, releases large and not fully recoverable amounts of carbon to the atmosphere. This release over time is most significant for ecosystems where large natural disturbances are relatively rare—including coastal and interior temperate rainforests, wet montane and subalpine forests, plus smaller scale areas within drier landscapes where disturbances are naturally rare.

Ecosystems with higher disturbance frequencies will also continue to store tonnes of carbon, and their stored carbon has much greater value for mitigating emissions now than does anticipated post-reforestation storage decades from now. Certain scenarios, using bioenergy and wood products as secondary by-products, might offer a net carbon gain through the substitution for fossil fuels, but near-term carbon storage in standing forests (even with canopy dieoff) is invaluable.

Infrequently disturbed landscapes dominated by mature and older forests and their soils can store several times as much carbon as intensively managed, industrial forest landscapes. In terms of carbon stewardship, moving further towards an agro-industrial approach to forest management is a losing proposition.

Increased conservation of forests makes economic sense. *Photo Linda Mirro*

From a global perspective, the use of wood products can have lower GHG implications than the use of many other products, for example, steel or concrete. However, in the present policy and regulatory environment, there are insufficient guarantees that substitution of wood for more manufactured materials will occur. Rather than increasing the volume of low-quality products, a focus on higher quality, more expensive, and therefore less expendable wood products will provide greater benefits for long-term carbon storage. Overall, the benefits of carbon storage by intact natural forests are immediate and greater than anticipated storage (or more accurately, avoided emissions) in wood products in the future.

Forest/Carbon Mitigation Pilots

The ecological services of B.C.'s forests, by way of soil and water conservation, flood control, biological legacies, biodiversity niches and buffer forests provide compelling arguments for their conservation. Modeling of different scenarios examining future values for timber, recreational use of forests, non-timber forest products, and carbon storage indicates that increased conservation of forests also makes better economic sense than business-as-usual management approaches.

Some of the first pilot forest projects in B.C. providing real data on carbon values are underway. The first sales of forest *carbon credits* for avoided degradation and improved forest management have occurred in California. The California forest protocols provide a model for B.C. to follow and to improve on, with regard to avoided deforestation and degradation. International standards, protocols and markets are beginning to coalesce around forest carbon projects.

A climate change mitigation strategy can help sustain the web of life, our natural capital and ecosystem services, and ecological connectivity.

Photo iStock

Scientific knowledge of carbon dynamics and methods for quantifying complex fluctuations are expanding rapidly. It is now possible to assess carbon pools in different forested ecosystems with trajectories over the next 100 years, taking into account succession and disturbances. As the science emerges, the policy is also catching up to account for *additionality, permanence* and *leakage*.

To be serious about climate change mitigation, British Columbia must adopt a climate change mitigation strategy that:

- Maximizes the amount of carbon retained in the forest ecosystem—in biomass, forest litter, and in the soil;
- Prioritizes conservation of productive and long-lived coastal, interior wetbelt, montane, and subalpine forests;
- Restores forests that have been logged or that have experienced stand-replacing natural disturbances to regrow and realize their carbon sink and storage potential;
- Sustains the web of life/biodiversity, conserves natural capital, and maintains ecosystem services and connectivity;
- Develops forest/carbon offset protocols that simultaneously address biodiversity goals and objectives of reducing carbon emissions from harvesting; and
- Takes advantage of the economic opportunities provided by carbon offset activities.

B.C. must adopt a multidimensional strategy for climate change mitigation.

Photo Henry Feather

Part 3:
Priority Recommendations

Photo Jason Verschoor

1. Integrate Nature Conservation Strategies with Climate Action Strategies

The conservation of natural ecosystems has clear and immediate benefits for adapting to and mitigating climate change, benefits that should be accorded full value and understood as dual components of a comprehensive climate action strategy. The obvious overlaps, methodologically (and perhaps spatially), between conserving carbon and conserving biodiversity lead inevitably to the conclusion of integrating biodiversity conservation with carbon mitigation and adaptation strategies.

A pika in the Rockies. Pikas are particularly sensitive to the high elevation impacts of climate change. *Photo CPAWS*

The two strands of this report converge in its central recommendation: **to develop a comprehensive provincial Nature Conservation and Climate Action Strategy that a) combines goals of biodiversity conservation and climate change action, and b) recognizes the fundamental role of ecosystem conservation in both ecological adaptation and mitigation.**

To strengthen the rigour, credibility and efficacy of such a strategy, discussions concerning policy initiatives must involve a variety of stakeholders and policy makers and be informed by a combined scientific and socio-economic analysis. A well-developed B.C. strategy could be a model for other jurisdictions that recognize the importance of including nature conservation as part of a comprehensive climate solution.

An obvious first question relevant to implementing a climate action strategy that focuses on biodiversity and ecosystem services (primarily carbon sequestration and storage), hinges on a rigorous evaluation of the degree of spatial overlap, in terms of priority areas, between the two goals. Geographic areas that are priorities for both the biodiversity survival strategy and the carbon mitigation strategy must be identified immediately before opportunities are further foreclosed. Undertaking this technical analysis will require new mapping decision-tools, including enduring features analysis, and a new mindset in terms of evaluating ecosystem services.

We must act immediately, to both reduce emissions and slow the rate of ecosystem degradation. The following key priority actions could immediately set in motion a comprehensive nature conservation and climate action strategy.

2. Broaden Core Protected Areas into a Climate Conservation Network

Fourteen protected area complexes in B.C. already each cover more than 250,000 ha and these should form the basis of an expanded conservation network, which should aim for the scientifically credible maximum. Minimum targets should be at least an additional 35 percent of the land base managed for biodiversity and carbon, complementing our existing parks and protected areas that cover almost 15 percent of B.C.—raising the total area of an interconnected climate conservation network to 50 percent or beyond. With mapping decision-tools that identify overlapping priority areas for conserving biodiversity and persistent carbon storage and sequestration, core conservation areas should be expanded and connected to maximize biodiversity and carbon opportunities.

New land designations and/or tenures will likely be required to guide management of the expanded conservation network that falls outside of existing protected areas. The new conservation areas should be designated primarily for biodiversity and ecosystem services, particularly that of carbon storage and sequestration. Industrial activities that would reduce the resilience or carbon stocks of these areas should not be permitted. However, a variety of activities might continue within these areas, as long as they are compatible with the long-term objectives of biodiversity conservation and adaptation, and with maximizing carbon uptake and storage.

Connectivity across the province's borders will also be key. Transboundary connectivity and corridors for migration and ecological transport should address:

- latitudinal movements – north from the U.S. (Washington, Oregon, Idaho and Montana) to B.C., and from B.C. to Yukon, Northwest Territories, and Alaska;
- longitudinal movements – east from Southeast Alaska to B.C., and from B.C. to Alberta and the northern Great Plains;
- transboundary rivers such as the Stikine, Taku, Alsek-Tatshenshini, Yukon, Liard, Peace, Columbia, Flathead, Okanagan; and
- broadly linear physiographic features or between-mountain corridors such as the Rocky-Columbia-Mackenzie Mountains, Cascade-Coast Mountains, Rocky Mountain-Tintina Trenches, Pacific Coastal Trough (Puget Sound-Georgia Basin-Hecate Depression-Alexander Depression).

Altitudinal movements upslope within mountain ranges should also be considered.

B.C. needs an additional 35% of the land base to be managed primarily for biodiversity and carbon

Connectivity between political regions and ecosystems will aid species in broad landscape movements—longitudinal, latitudinal and altitudinal. *Photo (above) Johnny Mikes, (left) David Lewis*

Work underway by organizations such as the Yellowstone to Yukon Conservation Initiative seeks to link a network of protected areas embedded in a matrix of compatible land uses. Existing large protected area complexes include:

1. Tatshenshini-Alsek
2. Atlin-Taku (in process)
3. Stikine
4. Muskwa-Kechika
5. Haida Gwaii
6. Great Bear Rainforest
7. Strathcona-Clayoquot
8. Chilcotin Ark
9. Garibaldi-Stein
10. Cascades/Okanagan
11. Wells Gray-Cariboo Mountains
12. Central Rockies
13. Purcell-Selkirk
14. Crown of the Continent.

Bighorn sheep in the Chilcotin Ark.

Photo Paul Tessier

3. Introduce New Tools, Legislation and Incentives

There are strategies already in place, initiated by various sectors, including *ecosystem-based management* (EBM), voluntary stewardship and 'best practices' for industrial activities (for example, Forest Stewardship Council certification of logging tenures) that could address both biodiversity and carbon benefits. These initiatives should be supported and strengthened.

However, law reform is required to give ecosystems, species, and ultimately ourselves the best chances of survival across the landscape. The integration of 'nature and climate' strategies requires a new way of structuring our laws and land tenure system. A full review, to determine how laws and policies need to evolve to meet this challenge, should be a top priority.

Clayoquot Sound. *Photo David Elfstrom*

In the interim, these priorities are recommended:

1. Enable new and existing mechanisms for land use decision-making to identify and establish areas for climate change purposes—that is, creating interconnected core conservation networks.
2. Create new land designations and/or tenures that recognize areas conserved for carbon stewardship, and clarify rights and responsibilities associated with these areas, particularly the rights of First Nations.
3. Fast-track amendments to draft protocols and standards to enable forest conservation and ecological restoration initiatives/projects under B.C.'s Emission Offsets Regulation, accompanied by financial incentives to ease the transition.
4. Enact legislation to protect ecosystems and species at risk.
5. Create incentives for protecting key habitat via private land stewardship, including support for conservation offsets.
6. Require consideration of climate change in environmental assessment laws, including impacts on resilience, biodiversity and ecosystem services.
7. Reform laws and policies to remove barriers to biodiversity conservation and enable ecosystem-based management.

These reforms should be accompanied by sharing of information with communities about climate change, biodiversity, and human well-being as well as strategies for management, ecosystem valuation and new business opportunities in ecological restoration and carbon stewardship. Engaging communities that are currently stressed not only by economic downturns in the resource industries, but also by some of the impacts (such as wildfire and flooding) of climate change itself, with a different vision of the landscape, might be key to economic revitalization and community restoration.

4. Provide Incentives for Stewardship in Every Sector

A conservation network needs to be complemented by supportive, nurturing matrix lands (that is, lands outside of protected areas, buffers and connecting corridors), in which human uses are sustainable, and carbon storage/sequestration and biodiversity conservation are maximised. Legal and financial incentives and tools to steward carbon and nature should be expanded to enable sustainable livelihoods across all levels of communities, including First Nations, rural regions, community forest groups, landowners, land trusts, tenure holders and local governments, and must be respectful of First Nations land rights. People should be supported in initiatives for improved carbon/biodiversity management practices in all areas—forestry, agriculture, energy, recreation, and private land stewardship or conservation.

a conservation network needs to be complemented by supportive, nurturing matrix lands

5. Take the Lead on Carbon/Biodiversity Valuation

British Columbia is well-positioned at the institutional, legal, social, ecological and economic levels to take advantage of the emerging economy of natural carbon sequestration. B.C. has become a leader in Canada with the creation of a Climate Action Plan that establishes a regulatory framework for offsets, in conjunction with the Western Climate Initiative states and provinces. The business of carbon and ecosystem services is expanding over the full spectrum of carbon activities from *reforestation* and *ecological restoration* to avoided *degradation/deforestation*. Other forest carbon activities like *Improved Forest Management* could provide other ways to manage existing industrial forests for carbon, biodiversity and wood products. Opportunities are arising regionally and internationally through the California Climate Action Reserve and potentially the Pacific Carbon Trust.

Subalpine forest in the Rockies. *Photo Cory Johnson*

The mechanism for developing carbon stewardship projects is in its infancy in British Columbia (although B.C. companies have been doing it overseas for years) and offers a huge opportunity. The protocols and standards we create must take advantage of our homegrown expertise and our world class legacy of ecological resources. Industry, land managers, First Nations, ENGOs (environmental non-governmental organisations) and government need to align behind a common broad global vision, as it is only within the global context that B.C./regional forest carbon offset initiatives/projects will trade to their highest value. In terms of reduced emissions, protection of biodiversity, and generation of income, B.C. should be aiming at the highest standards both in legal reform and the international market for carbon/conservation credits. We have the opportunity and expertise to develop forest projects that command the highest prices and ensure best management practices for biodiversity conservation and adaptation. With high values, there are more opportunities for funding mechanisms. This could help alleviate the transition from a resource economy, based on exporting carbon to global markets in the form of wood, to a more diversified economy, based on absorbing and storing atmospheric carbon from the global commons.

6. Establish the Principle that Humans are Part of Nature and our Survival is Intertwined with Nature's Survival.

Confronted with the extreme threat of climate change, society must recognize that our survival is dependent on the survival of nature and that we who are pre-eminently part of nature will determine its fate. The Secretariat of the Convention on Biological Diversity (CBD) has concluded that the capacity of forests to resist change, or recover following disturbance, is dependent on biodiversity at all scales. The findings demand global implementation of strategies that integrate carbon and nature, because the resilience and stability of natural ecosystems are linked to the permanence of carbon stocks. British Columbia and its globally significant ecosystems should be leading the way.

Humans are part of nature, our survival is dependent on a healthy, functioning planet. *Photo Jim Pojar*

Conclusion

The need to act now in response to rapid global climatic change is escalating. There is already ample evidence that the climate is warming, that the impacts in British Columbia will continue to be significant, and that the province's web of life is threatened. While policy debates to date have concentrated on the enormous task of reducing greenhouse gases from energy sources, we must now expand the focus to include the role of nature and its ability both to enable adaptive responses and to mitigate greenhouse gas emissions. This report reviews the relevant science and offers clear recommendations for bold action by the B.C. government—to develop and implement a science-based nature conservation and climate action strategy.

Glossary

Note that the following definitions refer to the meaning of these terms within the context of this report and its focus on forest ecosystems. In other contexts, these words may have additional or different meanings.

Adaptation – In the context of ecology, adaptation means adjustment to environmental conditions and includes the many means by which an organism becomes better able to survive and reproduce in its habitat. In the context of humanity's response to climate change, adaptation means the actions, behaviours, initiatives and measures to reduce the vulnerability of natural and human systems to actual or expected climate change effects. Various types of adaptation exist from technological projects, like the raising of dikes to protect cities from rising waters, to biodiversity conservation efforts, like the protection of critical habitats, corridors and buffers to reduce the vulnerability of migrating wildlife.

Additionality – Reduction in greenhouse gas (GHG) emissions at sources or enhancement of removals by sinks that is additional to any that would occur in the absence of the project or activity.

Biodiversity – The full variety of life, including genes, species, ecosystems, and the interactions among them.

Carbon credit –Tradable evidence of avoided greenhouse gas emissions. To generate a carbon credit, an action is taken that helps to reduce the release of $C0_2$ into the atmosphere, for example, greenhouse gas pollution prevention upgrades to a production facility. The credit may be traded or sold to a facility that has been unable to reduce its emissions to allowable levels. A carbon credit is usually equivalent to one tonne of carbon dioxide equivalent.

Carbon offset – The act of reducing greenhouse gas emissions in one location to compensate for gases emitted in another, for example, by supporting a renewable energy project to offset emissions due to personal air travel. Carbon offsets tend to be voluntary actions.

Carbon sequestration/storage – The removal and storage of carbon from the atmosphere in carbon sinks (such as oceans, forests or soils) through physical or biological processes, such as photosynthesis. Although sequestration refers to both removal and storage, the active 'removal' part of the process is associated more with sequestration and, for the purposes of this report, carbon storage is used to highlight that process.

Carbon sink – An area, such as a forest, that, over a long period of time, absorbs more $C0_2$ than it emits.

Carbon source – An area that, over a long period of time, emits more $C0_2$ than it absorbs.

Connectivity – The degree to which a landscape facilitates or impedes the movement of organisms and processes. Connectivity includes ecological connections among habitats, species, communities, and processes. Connectivity enables the flow or movement of energy, nutrients, water, disturbances, organisms and their genes over both time and distance.

Conservation biology – The scientific study of life on Earth for the purpose of its conservation.

Cryptic species – A group of species that satisfies the biological definition of species; that is, they are unable to reproduce with each other, but their appearance is very similar (in some cases virtually identical).

Deforestation – The permanent conversion of forested land to another land use or the long-term reduction of tree canopy cover in a defined area to less than 10 percent. (This definition excludes forestry activities unless they result in the permanent loss of forest cover.)

Ecological restoration – Deliberate activities aimed at returning the original structure, composition, function and species of a degraded forest. Examples of restoration activities include planting native tree species and removing forestry access roads.

Ecosystem based management – Attempts to base management decisions on consideration of whole ecosystems, including social and economic dimensions, rather than individual species or resources.

Extirpation – The loss of a species from a specific area, rather than from its whole range (which is extinction).

Forest degradation – According to the Intergovernmental Panel on Climate Change (IPCC), forest degradation occurs when canopy cover and/or stocking of the forest are reduced through logging, fire, wind or other disturbances, provided that the canopy cover remains above 10% (cf. definition of deforestation). However, in a more general sense, forest degradation is the long-term reduction of the overall capacity of the forest to supply benefits, including wood, biodiversity, habitat and any other product or ecosystem service. (See text B2 box on Forest Definitions, in the full report).

Foundation species – Species that play a large role in the dynamics of an ecosystem as a result of their widespread distribution and abundance; for example, primary tree species or deer species that are the base of a complex predator-prey system.

Genotype – The genetic makeup of an organism, being the sum total of all the genetic information in the organism.

Greenhouse gases (GHG) – Gases in the Earth's atmosphere that absorb or emit heat. This process is the fundamental cause of the greenhouse effect. An excess of greenhouse gases leads to global warming. The main greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

Hybridisation – Cross-breeding; combining genes from different species to create a hybrid individual.

Industrially managed forest – A forest that is managed primarily to maximize timber production.

Improved forest management – Management practices designed to increase carbon stocks or reduce greenhouse gas emissions from forestry activities, while improving forest health and protecting biodiversity. Examples include reduced impact logging, protecting forests that might otherwise have been logged, lengthening rotation periods, and improving the stocking of poorly stocked forests.

Keystone species – Species that have a disproportionately large influence on an ecosystem. Such species play a controlling role in ecosystem dynamics through their interactions with other species. Predators typically play a keystone role in ecosystems.

Leakage – An unanticipated decrease or increase in the greenhouse gas (GHG) benefits outside the accounting boundary of a carbon offset project.

Matrix lands – The lands that surround protected areas. The way in which the matrix is managed can help contribute to or detract from the ecological health of protected areas.

Mitigation – Practices that reduce emissions of greenhouse gases or help to remove them from the atmosphere.

Morphology – A species' outward appearance (as determined by its shape, structure and colour).

Natural forest – A forest composed of indigenous trees and not classified as a forest plantation.

Peripheral populations – Populations at the outer limits or periphery of the natural range for their species.

Permanence – The longevity of a carbon pool and the stability of its stocks within its management and disturbance environment.

Phenotype – The expression of a species' genes as mediated by the environment in which it lives, including its behaviour, appearance and other biological characteristics.

Plantation – Managed forest of introduced or native tree species, established through planting or seeding after harvesting, typically with only one or two tree species, all of the same age, with regular spacing between them. Such areas often lack many of the characteristics and elements of wild or natural forest ecosystems. (See industrially managed forest.)

Reforestation – The re-establishment of forest on temporarily unstocked lands.

Resilience – The capacity of an ecosystem to absorb disturbance, undergo change and still retain essentially the same function, structure, identity and feedbacks.

The Working Group on Biodiversity, Forests and Climate, is an alliance of ENGOs, including:

BC Spaces for Nature

Yellowstone to Yukon Conservation Initiative

David Suzuki Foundation — Solutions are in our nature

West Coast Environmental Law

CPAWS

ForestEthics

Land Trust Alliance British Columbia