Checklist for adapting BC's landscapes to a changing environment

This checklist summarizes the key issues that need to be considered when climate proofing your landscape and your managed forests against the impact of climate change and is followed by more detailed opportunities on each aspect. It is important to note that managing in the face of uncertainty will require a portfolio of approaches, including short-term and long-term strategies and may vary based on spatial and temporal scales of decision-making. The goal of these strategies is to enhance ecosystem resistance and resilience as well as assist forested ecosystems to adapt to the inevitable changes as climate and environments continue to shift.

Planning

A. Structure

Ensured that the overall landscape has structures that can:

- buffer plants and animals against the expected change so that they can provide propagates ☐
- enable species and genotypes to flow northwards and up slopes ☐
- maintain biological legacies for future climate (may require the development of an In situ and ex situ conservation strategy) ☐

B. Species Diversity

Ensured that the overall landscape has a diversity of species by:

- establishing genetic outposts (small plantations of seed sources that are adapted to predicted future climates in remote locations) to hasten the adaption of forests in unmanaged areas ☐
- measure and plan for variability and diversity of species and densities at the ecosystem scale ☐
- accept considerable variability at lower scales to ensure diversity and complexity at the ecosystem scale (i.e., introducing species over a range of environments rather than within historic distribution, or projected future environments) ☐
- in areas of large disturbance that are outside its historical ranges of variation restore to current or expected future environments (novel species and density mixes to help adaptation) ☐
- manage to realistic outcome as well as conflicts and tradeoffs with other values ☐

C. Adaptive Capacity

Ensured that the risk and vulnerability of the landscape is reduced:

- take early defensive actions at key mitigation points to remove and block invasions of exotic species and undesirable resource conditions– this can be done through implementing detection/rapid response ☐
- anticipated forest mortality events and altered fire regimes ☐
- accommodated loss of species' populations on warm range margins ☐
- including experimentation that look at ecological and management interactions (e.g., learning sites) ☐
- monitoring shifts in natural disturbance regimes ☐
- monitoring ecological community reorganization ☐
- reexamining replicated forest plantation such as old genetic provenance or progeny tests as a means of gathering information about adaptation to recent and ongoing change ☐
- treat large scale disturbance as a management opportunity and integrate into planning ☐
- building mechanisms to anticipate surprises and threshold effects ☐

Harvesting

A. Landscape

Ensured that the overall landscape harvest planning has identified:

- age class distributions that will enable continual recruitment of biological legacies through out the rotation ☐
- productive sites and those likely to remain productive under future climate change so that management can focus on these areas in the long-term ☐
- vulnerable and poorly adapted stands and species that are most susceptible to pests as these sites may be a priority for harvesting first and to be replace with better adapted species/genotypes ☐
- areas where future site conditions may change (i.e., anticipate changes in soil moisture – either too little or too much) ☐

B. Silviculture Systems Implementation

Ensured that when the silvicultureal system is implemented:

- the system that you select will maintain or enhance genetic diversity ☐
- the systems (harvesting and follow up maintenance techniques) that you select will generate microenvironments suitable for survival of migrated species ☐
- a harvest pattern and regeneration regime was developed that generates a diversity of stand ages and compositions – including short rotation to minimize loss of current inventory from climate change induced disturbance ☐
- varied the size and shape of cuts (particularly clearcuts) and leave patches or stream buffers are used to create structural diversity ☐
- areas are identified where the economics will allow for intensively manage plantations dedicated to wood supply. This will focus efforts on a smaller more productive landbase and allow for carbon conservation benefits in other areas. ☐

Stand Tending Treatments

When considering stand treatment opportunities have you:

- identified areas for sanitation cutting in forest stands that are already infected with forest health issues ☐
- identified areas to remove root diseased infected stumps where feasible ☐
- identified areas where there is an increasing risk or hazard of forest health agents and need to take measures to reduce this risk. ☐
- identified areas where prescribed fire can be used to reduce fire risks and forest vulnerability to insect outbreaks and introduce where appropriate ☐
- located areas that need to be treated to prevent the introduction or spread of invasive species and remove or control undesirable invasive species that are currently present ☐
- identified areas that may be at risk of species mal-adaptation in the near term and require modified management practices. For example, fertilize high value stands to bring them to rotation before climate-induced mortality; thin stands on drought prone sites to reduce water use where it will not increase susceptibility to wind throw, diseases, or increase invasion by competing grasses ☐
- identified areas of landscape synchrony that require treatments to create diverse age classes, species mixes, within and across-landscape structural diversities and genetic diversities. ☐

Reforestation

(Note: plant establishment phases tend to be the most sensitive to climate-induced changes in site potential)

A. Tree Improvement and Assisted Migration Opportunities

When considering tree improvement or assisted migration options have you:

- planted resistant genotype stock that are pest and disease tolerant to forest health agents in your area ☐
- increased genetic variation at multiple scales (e.g., use a range of seed sources at the stand and landscape level) to reduce the cumulative effects from over planting the same source(s)/seedlot(s) in an area or management unit ☐
- emphasized species or populations that have the genetic ability to tolerate a wide range of environmental condition – this may mean looking for a range of seed sources particularly from more southern or lower-elevation populations ☐
- developed a genetic resource management/seed strategy to assess what seed sources may no longer be appropriate for BC, or will no longer be appropriate within several decades, and manage your seed inventory accordingly ☐
- planted and are monitoring species and provenances over a broader range of climatic and edaphic conditions to hedge against the risk of losing management investments ☐
- banked surplus seed – making broader use of non-local seed sources may require the procurement and banking of many different seedlots (note: a time frame of 30 years out maybe as far as we can forecast for climate based seed deployment). ☐
- identified where assisted migration of range (higher risk) or population (lower risk) expansion of specific species is an appropriate tool ☐

B. Increase species diversity at the stand level recognizing implications at the landscape level.

(Note: intensive management during revegetation through the early years of establishment may enable retention of desired species, even if the site is no longer optimal)

When developing your reforestation activities have you considered:

- prompted reforestation of all harvested and disturbed sites to ensure opportunities for the management of other values such as carbon. Beware of generating uniform post-disturbance stands that may be highly vulnerable to future disturbance (small percentage of stands (5%) may be fine, but not across the landscape). Note: tradeoffs may be required between yield and protection. ☐
- planting a broader range and new mixes of tree species over the landscape, e.g. broadleaf/conifer mixes (climate-based scenario modeling can support the development of potential species mixes) being conscious of projected changes in soil moisture regimes ☐
- planting drought-resistant species in areas that are prone to increased drought and frost resistant species in areas prone to increased frost. ☐
- identifying opportunities for companion planting/tree species management (certain species grow well together, spread/re-direct harmful pests/pathogens to other hosts/understory shrub and vegetation communities). ☐

Source: Ministry of Forests, Lands and Natural Resource Operations Forest and Range Practices Act (FRPA) Policy Assessment Workshop Adapting to Climate Change, Kamloops Session, June 2011.

Source: Mark Johnson 2009 - Vulnerability of Canada's Tree Species to Climate Change – and Management Options for Adaptation http://www.ccfm.org/english/coreproducts-cc.asp

Source: Millar, C.I., N.L. Stephenson and S.L., Stephens 2007. Climate change and forests of the future: managing in the face of uncertainty. Biological Applications 17(8): 2145-2151

Source: Littell, J.S, Peterson, D.L., Millar, C.I., & Kathy A. O'Halloran, K.A. (2012) U.S. National Forests adapt to climate change through Science–Management partnerships. *Climatic Change* 110:269–296. DOI 10.1007/s10584-011-0066-0