Potential Management Options to Enhance Forest Resilience[1]

Second Approximation - May 2012

The table below outlines a suite of potential management options that can be considered when planning and undertaking forest management activities. They are designed to foster resilient forests, and are not intended to be prescriptive. Many factors in addition to climate change and variability come into play, and will need to be considered at appropriate scales.

#	Potential Management Option
	REFORESTATION
1	**Plant a broader range and new mixes of tree species over landscapes** –e.g. hardwood/conifer mix and seedlings from a range of seed sources, particularly from more southern or lower-elevation populations. Avoid practices that generate uniform post-disturbance stands that may be highly vulnerable to future disturbance (may be OK in a small percentage of stands but not across the landscape: There are trade-offs between yield and risk). Increase genetic variation at multiple scales (e.g. use a range of seed sources at the stand and landscape level) to reduce cumulative effects of over-planting a seedlot in an area.
2	**Assist migration** (potentially of seed, seedlings, pollen etc). Plant species mixes based on novel assemblages identified through scenario-based climate modeling. Plant and monitor species and provenance over a broader range of climatic and soil conditions to hedge against the risk of losing management investments.
3	**Emphasize species or populations that have the genetic ability to tolerate a wide range of environmental conditions** (wide climatic amplitude).
4	**Prompt reforestation** of all harvested and disturbed forests with a suitable variety of species and provenances adapted to both today's and predicted future climates (e.g. assisted migration); in some areas this could include planting species that have historically occurred south of the BC border. (A time frame of 30 years out may be as far as we can reliably forecast for climate based seed deployment).
5	**Plant resistant genotypes**—use resistant (and/or pest and disease tolerant) planting stock. Plant drought-resistant species in areas that are prone to increased drought; consider companion planting and species management (certain species grow well together); re-direct pests/pathogens to other hosts/understory shrub and vegetative community.
6	Develop seed strategies to assess what seed sources may be newly or no longer appropriate for BC, now or within several decades; **manage seed inventory** accordingly.
7	**Bank surplus seed** – broader use of non-local seed sources may require the procurement and banking of many different seedlots.
8	**Establish genetic outposts** (small plantations of seed or pollen sources that are adapted to projected future climates in remote locations) to hasten the adaptation of forests in unmanaged areas.

	FOREST HEALTH
1	Implement measures to **reduce hazard and/or risk o**f loss to forest health agents.
2	Use prescribed burning to **reduce fire risks** and forest vulnerability to insect outbreaks. Introduce fire into ecosystems where historical fire cycles have been disrupted by past fire exclusion.
3	**Prevent the introduction or spread of invasive species**, and remove or control undesirable invasive species.
4	**Control root disease** by removing infected stumps where feasible.

[1] Adapted from *Vulnerability of Canada's Tree Species to Climate Change and Management Options for Adaptation* by Mark Johnston et al. CCFM 2010

	PLANNING
1	**Measure and plan for variability and diversity at the forest scale**: Accept considerable variability at lower scales that result in diversity and complexity at the forest scale.
2	Plan for and manage within the context of an uncertain future: **include experimentation**, learning and adapting to deal with uncertain ecological and management interactions, shifts in disturbance regimes, and ecological community reorganization.
3	Develop landscape patterns that **enable species and genotype flow northward and upslope**.
4	Develop conservation strategies (including but not limited to natural reserves) to **maintain biological legacies** for future climate.
5	Retain or restore areas that can likely tolerate anticipated climate change to **retain plants and animals that could provide seed, pollen**, and genetic material for future generations.

	HARVESTING
1	**Manage age classes** to reduce risk, not just for the first 20 years, but all the way through the rotation. Cut the forest profile. Address forest health issues, and enable continual recruitment of biological legacies.
2	**Harvest vulnerable and poorly adapted stands first**, including species most susceptible to pests.
3	Develop forest harvest patterns and regeneration regimes that **generate a diversity of stand ages and compositions over landscapes.** Vary the size and shape of clearcuts, and leave patches or stream buffers.
4	Use silvicultural systems that **maintain or enhance genetic diversity**. Broadly implement alternative partial harvest systems and various silviculture techniques to generate micro-environments suitable for survival of migrated species.
5	Use **harvesting as a forest health tool** for stand replacement. Replace with better-adapted species/genotypes Strategically determine where harvesting occurs. Undertake sanitation cutting in stands already infected.
6	Manage species for **shorter rotations** to minimize losses to the current inventory from disturbance. Where economic conditions allow, use intensively managed plantations dedicated to wood supply to focus efforts on a smaller more productive forest estate which could be managed to reduce the impacts of climate change. Aim for carbon conservation benefits on other areas.
7	**Focus** management on currently **productive sites** and those likely to remain more productive under future climates. Limit efforts on poor sites.
8	**Account for changes in future site conditions** in management decisions (e.g., anticipate where moisture may become limiting).

	STAND TENDING
1	Modify management of the current generation of trees to **take the risks of mal-adaptation into account**.
2	**Fertilize high value at-risk stands to bring them to rotation** before climate change-induced mortality.
3	**Thin stands on drought-prone sites** to reduce water use where it will not increase susceptibility to wind throw or disease.