# Adapting Community Tree Management to Climate Change

April 2020

Columbia Basin Trust

# Tree Management in the Face of Climate Change

Climate change is expected to create new opportunities and challenges, and to exacerbate existing vulnerabilities in the Columbia Basin's (the Basin) trees and forests. Communities in the Basin require knowledge and tools to adapt the management of their trees and forests to climate change.

Community trees are those actively managed by communities, residents, businesses or other local organizations and include both the native and non-native trees planted as ornamentals, and trees growing naturally in forests within municipal boundaries and First Nations communities. Adapting community tree management to climate change involves increasing resilience to existing challenges, while also anticipating future conditions when making choices about community tree planting and management.

Changes in the Basin's climate have already been observed and are already causing stress to trees and forests in the Basin. The projected climate changes summarized in this report suggest community tree managers can expect significant transformations to the health and function of community trees during this century.

While climate is changing throughout the Basin, different communities are expected to follow unique adaptation pathways that suit their own local context.

**This report provides a broad overview of the natural forests and planted urban trees in and around communities in the Basin, describes the anticipated impacts from climate change, and includes a tool-kit with recommendations and best management practices to adapt community tree management to anticipated future climate conditions.**

**In text references are indicated by [square brackets] and each number corresponds to a downloadable reference list.**

This report was prepared for Columbia Basin Trust by Diamond Head Consulting

*Cover page: Revelstoke. Photo: Mariano Mantel*
*Below: Castlegar. Photo: Murray Foubister*

# Call for Action

## Climate Change in the Columbia Basin

The region is expected to become warmer and drier in summer, and warmer and wetter in all other seasons.

## Extreme Weather

More frequent and unseasonal extreme weather is expected, including drought, wildfire weather, storms, damaging frosts, and extremes of heat and cold.

## The Benefits of Community Trees

Trees and forests in communities provide shade, cooling, carbon sequestration, rainfall interception to prevent flooding, quality of life benefits and important habitat for a diversity of plants and animals.

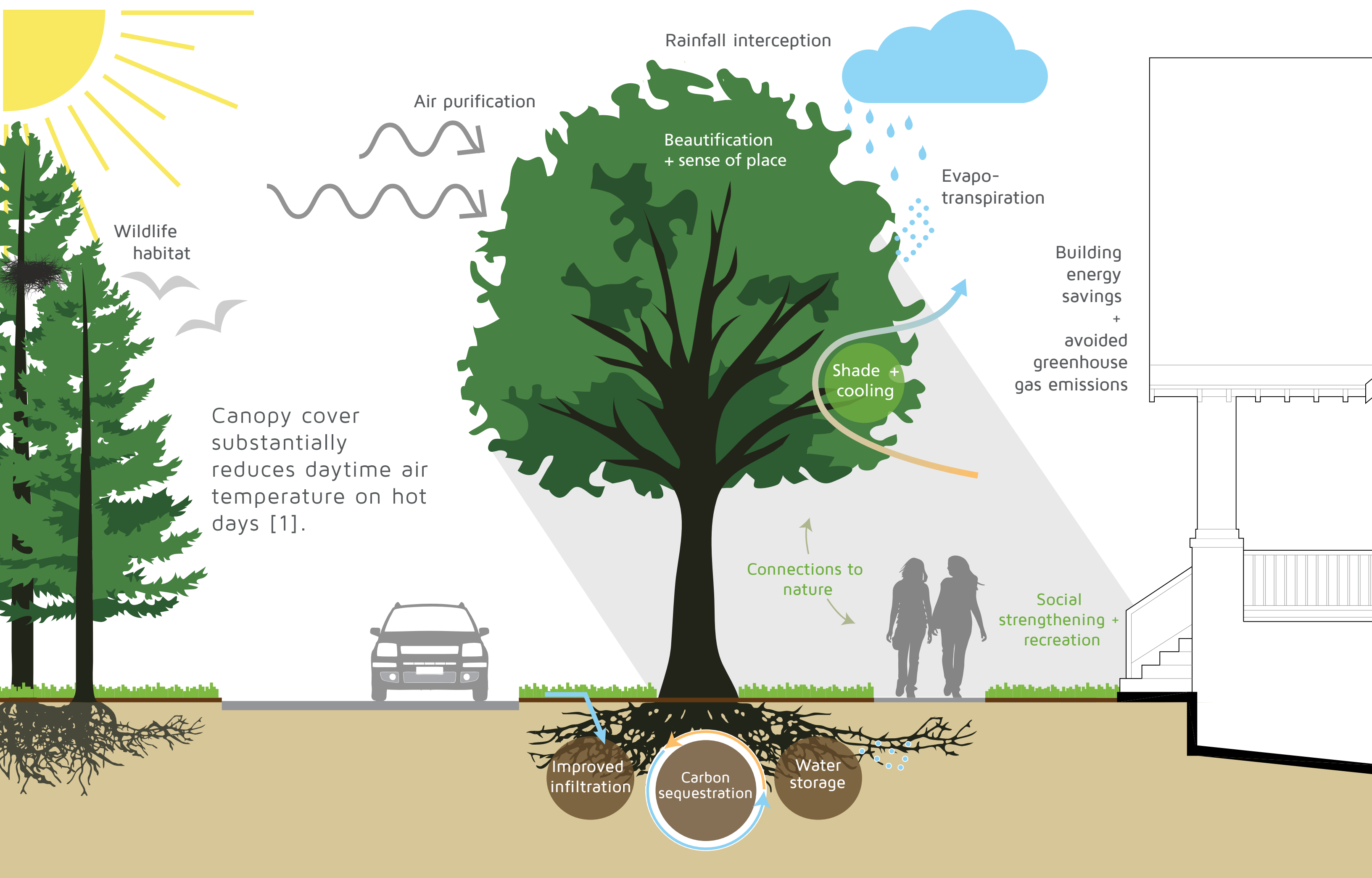
## The Vulnerability of Community Trees

Tree and forest health and distribution are already being impacted by a changing climate.

## Why Take Action?

Adapting community tree management to climate change now will increase the resilience of Basin communities and reduce the risks associated with declining tree and forest health.

### Benefits of Trees



# Forests in Columbia Basin Communities

Forests in the Basin communities are a mix of urban planted trees and natural forests distributed across streets, parks and private properties. Landowners, First Nations, the Province, local governments, institutions, and the forest industry all have a role to play in managing trees in and around communities.

## Natural Forests

The Biogeoclimatic Ecosystem Classification (BEC) system is used in British Columbia to classify and manage forest landscapes. Each BEC zone represents a landscape of typical climate and vegetation characteristics, modified by topography and soils, where distinct pathways of forest development are expected to occur [2,3]. The BEC system guides which species and, specifically which seed provenance, should be planted. Major communities within the Basin encompass one or more of four BEC zones:

Revelstoke

### Interior Cedar – Hemlock (ICH)

*Warm and moist forests with high species diversity at low to mid elevations throughout the Basin.*

*Native trees: Cedar, hemlock, Douglas-fir, western larch, western white pine, ponderosa pine, grand fir, birch, aspen, cottonwood*

*> For example, near Castlegar, Creston, Fernie, Nakusp, Revelstoke, Trail, and yaqan nuʔkiy (Lower Kootenay Band)*

Cranbrook. Photo:Federation of Canadian Municipalities

### Interior Douglas-fir (IDF)

*Warm, dry forests in the bottoms of major valleys in the central and southern parts of the Basin. Grasslands can occur on very dry sites and cleared range.*

*Native trees: Douglas-fir, lodgepole pine, western larch, ponderosa pine, aspen, cottonwood*

*> For example, near Cranbrook, Invermere, Radium, and ʔakink̓umǂasnuqǂiʔit (Tobacco Plains Indian Band)*

Golden. Photo: Maedi

### Montane Spruce (MS)

*Cool, dry forests at mid elevations in the eastern Basin. Precipitation mostly falls as snow.*

*Native trees: Lodgepole pine, Engelmann spruce, Douglas-fir, subalpine fir, western larch, aspen, cottonwood*

*> For example, near Elkford, Golden, Kimberley, and Sparwood*

South of Valemount. Photo: -JvL-

### Sub-Boreal Spruce (SBS)

*Cool, relatively moist forests at low elevations in the northernmost part of the Basin.*

*Native trees: Lodgepole pine, Douglas-fir, white spruce, subalpine fir, aspen, birch, cottonwood*

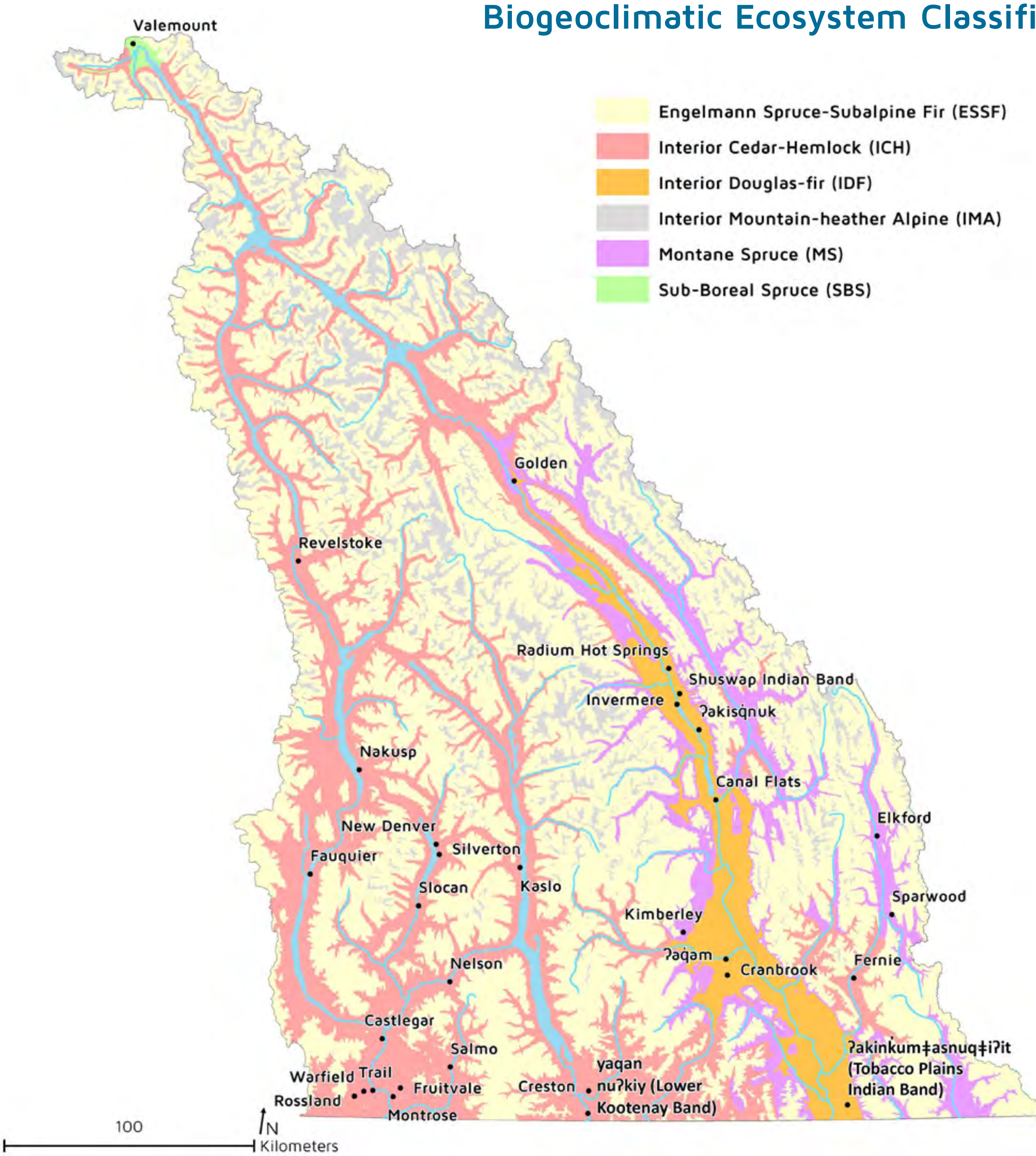
*> For example, near Valemount*

The Engelmann Spruce - Subalpine Fir (ESSF) and Interior Mountain-heather Alpine (IMA) also occur within the Basin but in high elevation areas.

# Columbia Basin Trust Region

## Biogeoclimatic Ecosystem Classification

[4]




## A Framework for Native Tree Selection: BEC and Climate Change

BEC zones are projected to change as our climate warms [5]. Native forests are typically planted with trees grown from seed that is genetically suitable for the climate and ecological conditions. Two approaches for selecting appropriate native species and seed are being developed by the BC government: 1) the Tree Species Selection Tool (TSST); and 2) Climate-based seed transfer (CBST) [6,7]. The TSST will be a source of best available scientific information for selecting native tree species given BEC, management objectives, ecological suitability and climate change adaptation. The CBST project will source seed from BEC units that are slightly warmer than the planting location BEC unit [7].

## Planted Urban Trees

At a regional scale, the suitability of species for urban planting in the Basin is controlled by the relative influence of Pacific maritime and continental climates, with the Purcell Mountains forming an important boundary.

East of the Purcell Mountains, communities such as Cranbrook, Golden, and Valemount experience more continental climates with larger differences between the coldest and warmest seasons and less precipitation. In these communities, commonly planted trees include maple, ash, elm, linden, cherry, crabapple, spruce, aspen, larch, mountain ash and pines [8].

West of the range, communities such as Creston, Nelson, Castlegar, and Revelstoke exhibit more maritime climate influences, with smaller seasonal differences in temperature and more annual precipitation. In these communities, commonly planted trees include all those above as well as honey locust, oak, western red cedar, horse chestnut and Douglas-fir [8]. A broader range of trees can be grown in these communities primarily because minimum temperatures and precipitation are less limiting.

## A Framework for Urban Tree Selection: Plant Hardiness

Because climate generally limits where certain species can grow, plant hardiness zones have long been used to select suitable urban trees and plants for particular areas.

Canada's Plant Hardiness Zone Index divides the country into zones using seven climate variables influential for plant growth and survival. In the Basin, hardiness zones range from Zone 3 to Zone 7, with lower numbers indicating areas of relative continentality (colder, drier) and higher numbers indicating areas of relative maritime influence (warmer and wetter). Plant hardiness zones have shifted since the system was first introduced, with most communities moving one zone number higher between 1930 and 2010 [9,10].

This report relies on Canada's Plant Hardiness Zone Index to group communities and assess urban tree suitability under current and anticipated future climate. Given that the climate has and is projected to continue to warm, it is assumed likely that communities will again move at least one zone number higher than their current hardiness zone by the end of the century.

Trees take decades to grow to maturity; a tree planted today should be suited to today's climate and the climate at the end of the century. Therefore, the urban tree selection approach will focus on selecting tree species that are hardy to the current zone, and trialling tree species hardy to one zone number higher.

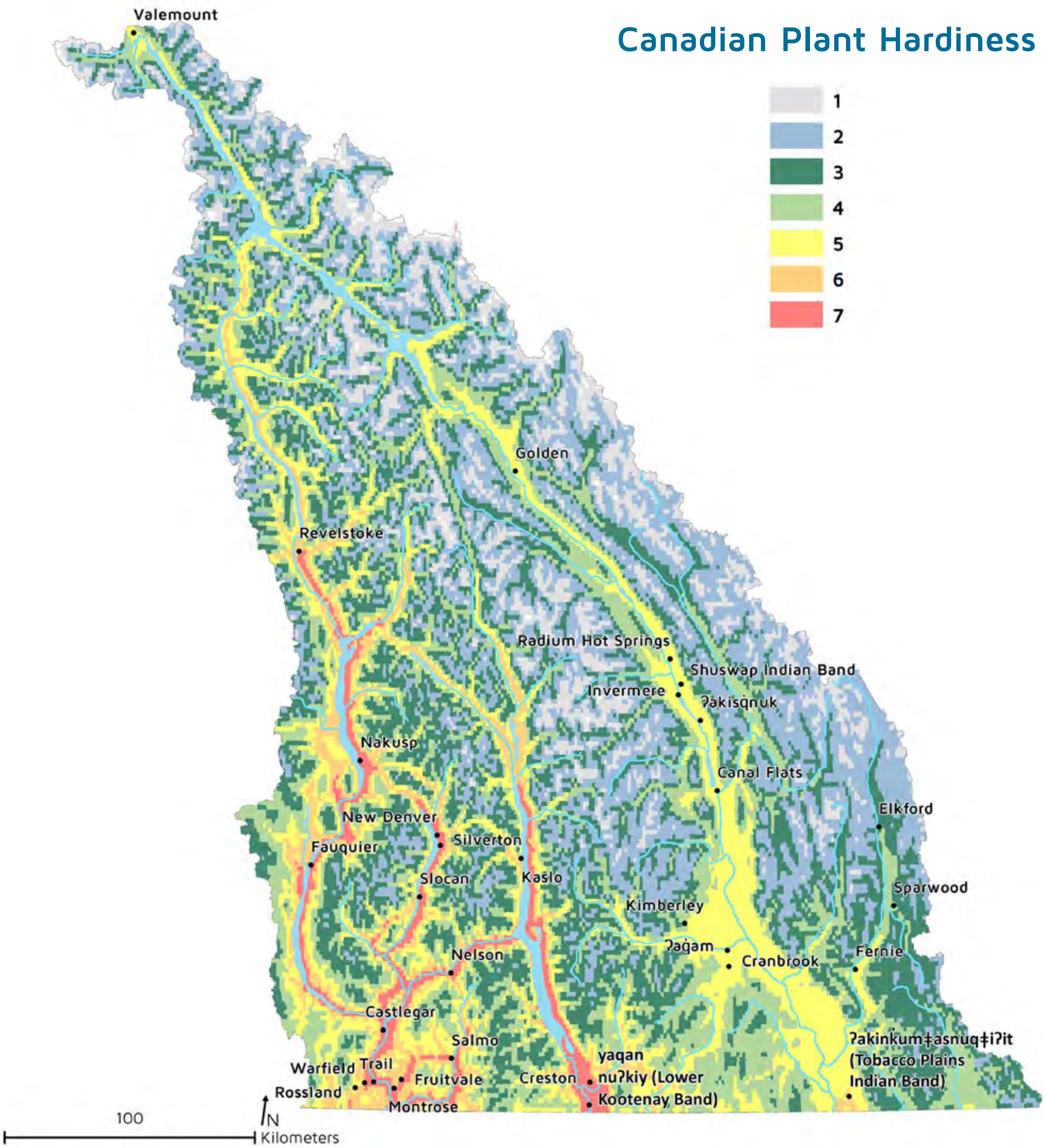
Under climate change whole communities are anticipated to experience longer periods of climatic moisture deficit, when plant demand for water exceeds moisture inputs from rainfall (see the next section). Trees and forests in communities with the highest climate moisture deficits are considered most vulnerable to seasonal drought. In addition to hardiness, urban tree selection in drought vulnerable communities should prioritize species that are drought tolerant.

**Communities in the Basin are listed below under their current (1981-2010) hardiness zone. The most drought vulnerable communities are marked with an asterisk (*).**

# Columbia Basin Trust Region

## Canadian Plant Hardiness Zones

[11]




*More Continental* ← → *More Maritime*

**Zones 3/4**

Elkford
Fernie
Sparwood

**Zone 5**

ʔaq̓am*
ʔakisq̓nuk*
Canal Flats*
Cranbrook*
Golden*
Invermere*
Kimberley
Radium Hot Springs*
Secwepemc (Shuswap Indian Band)*
Valemount

**Zone 6**

ʔakink̓umǂasnuqǂiʔit (Tobacco Plains Indian Band)*
Rossland
Revelstoke

**Zone 7**

yaqan nuʔkiy (Lower Kootenay Band)*
Castlegar*
Creston*
Fauquier*
Fruitvale*
Kaslo
Montrose*
Nakusp
Nelson*
New Denver
Salmo
Silverton
Slocan*
Trail*
Warfield*

*Trees and forests in asterisked communities are anticipated to be most vulnerable to drought due to climatic moisture deficits.

# Future Climate

The growth and distribution of trees and forests is broadly controlled by interactions between climate and the water and energy available for growth. At the local scale, soils, topography and other factors create microclimates that refine landscape patterns of tree growth and distribution.

In the past century, the Basin's mean annual temperature has warmed by 1.6°C [12,13]. Since the 1960s, glacial cover has declined by 15-23% [14]. Despite generally increasing annual precipitation, most communities are recording less summer rain and less winter precipitation falling as snow than they did prior to 1960 [12,13].

The impacts of climate change on trees are already being observed through longer fire seasons, acute droughts, pest outbreaks, unusual flooding, and planting failures [15,8]. Community tree managers in the Basin highlighted current challenges for managing trees including municipal watering and pruning capacity, drought stress, salt damage, animal browse, lack of appropriate tree planting spaces, forest pests and disease challenges, windstorm and wildfire hazard [8].

## Projected Future Climate

**The table on the following pages compares each community's climate normals over the 1961-1990 period to the projected climate for the 2080s** using an ensemble of climate models [16]. The emissions scenario used is the Representative Concentration Pathway[1] 8.5 [16].

Under an RCP 8.5 emissions scenario, communities are projected to experience the following by the 2080s [16]:

- An increase in average annual temperature of up to 6°C with warming in all seasons.
- More rain and less snow.
- Less summer rainfall.
- Growing seasons starting as early as March and ending as late as November.
- Milder winters and hotter summers.
- Extreme minimum temperatures may warm by as much as 10 to 12°C.

Communities are expected to receive more precipitations overall but seasonal variation is expected to mean precipitation increases in winter, spring, and fall but decreases in summer. Climatic moisture deficit (CMD) reflects the cumulative monthly moisture deficit from evapotranspiration exceeding precipitation, and is a useful indicator of drought or dryness. Projections for CMD show that, despite increasing annual precipitation, communities are likely to become drier due to warmer temperatures increasing evapotranspiration.

It is anticipated that climate change will result in shifting BEC zones and changing plant hardiness. The Province is working on modeling changes in BEC but results are not yet available. The Canadian Forest Service will also update hardiness zones based on new 30-year weather station data, however the timeframe for that update is unknown. There are no current plans to model hardiness zones based on projected climate data. Without model results from the relevant agencies, 2080s projections for BEC or hardiness zones cannot be reported with confidence. This is a knowledge gap that should be addressed to improve the precision of tree and forest climate adaptation options in the future.

Projected changes[2] in climate from the baseline period (1961-1990) to 2080s (RCP 8.5) for the major communities in the Basin are presented in the following table. Current BEC zones are reported but not projected to 2080s. Current hardiness zones are reported as the baseline and as one zone warmer (one number higher) in the 2080s column to guide species trials. In the absence of model data, this is a conservative guess of future change in hardiness zones.

1 RCP 8.5 is one of a suite of global greenhouse gas emission scenarios developed by the International Panel on Climate Change to project potential future climates. RCP 8.5 was selected as the basis for the 2080s climate projections in this report because it most closely resembles the current global pathway.

2 The climate variables shown, which are anticipated to be the most relevant for tree growth, have been generated using the ClimateBC application developed at the University of British Columbia; climate baselines have also been extracted from the same resource, which uses data collated by the Pacific Climate Impacts Consortium at the University of Victoria [16].

## Climate Normals and Projected Climate for Basin Communities

| Location | Period | Main BEC | Hard. Zone | Elev. (m) | MAT (°C) | MAP (mm) | MSP (mm) | GDD (5°C) | bFFP | eFFP | PAS (mm) | EMT | EXT | CMD (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ʔakisq̓nuk*** | Baseline | IDF | 5 | 861 | 4.9 | 414 | 170 | 1544 | 24-May | 10-Sep | 150 | -38.8 | 37.1 | 461 |
| | 2080s | | Trial 6 | | 10.5 | 450 | 161 | 2854 | 16-Apr | 12.-Oct | 75 | -28.6 | 44.2 | 607 |
| **ʔakink̓umǂasnuqǂiʔit (Tobacco Plains Band)** | Baseline | IDF | 6 | 833 | 6.2 | 475 | 201 | 1695 | 18-May | 15-Sep | 134 | -34.7 | 38.4 | 459 |
| | 2080s | | Trial 7 | | 11.8 | 503 | 185 | 3084 | 13-Apr | 20-Oct | 42 | -24.0 | 45.6 | 620 |
| **ʔaq̓am*** | Baseline | IDF | 5 | 815 | 5.7 | 414 | 184 | 1638 | 21-May | 13-Sep | 124 | -37.1 | 37.8 | 471 |
| | 2080s | | Trial 6 | | 11.3 | 441 | 171 | 2998 | 15-Apr | 15-Oct | 47 | -26.6 | 45.2 | 628 |
| **Canal Flats*** | Baseline | IDF | 5 | 814 | 5.5 | 380 | 167 | 1690 | 21-May | 13-Sep | 123 | -38.5 | 37.7 | 489 |
| | 2080s | | Trial 6 | | 11.1 | 407 | 155 | 2993 | 16-Apr | 13-Oct | 57 | -28.3 | 44.9 | 642 |
| **Castlegar*** | Baseline | ICH | 7 | 450 | 8.2 | 707 | 231 | 2099 | 30-Apr | 10-Oct | 134 | -27.3 | 38 | 377 |
| | 2080s | | Trial 8 | | 13.8 | 760 | 208 | 3567 | 10-Mar | 15-Nov | 25 | -14.8 | 44.7 | 526 |
| **Cranbrook*** | Baseline | IDF | 5 | 928 | 5.3 | 435 | 191 | 1583 | 23-May | 13-Sep | 140 | -37.4 | 37.2 | 434 |
| | 2080s | | Trial 6 | | 10.9 | 462 | 177 | 2879 | 16-Apr | 15-Oct | 56 | -26.9 | 44.5 | 590 |
| **Creston*** | Baseline | ICH | 7 | 597 | 7.3 | 624 | 215 | 1900 | 03-May | 30-Sep | 144 | -30.2 | 37.9 | 376 |
| | 2080s | | Trial 8 | | 12.9 | 667 | 198 | 3321 | 24-Mar | 04-Nov | 31 | -18.1 | 45.2 | 521 |
| **Elkford** | Baseline | MS | 3 | 1300 | 2.2 | 625 | 260 | 1010 | 09-Jun | 03-Sep | 294 | -40.7 | 32.8 | 214 |
| | 2080s | | Trial 4 | | 7.8 | 686 | 246 | 2129 | 29-Apr | 07-Oct | 164 | -30.6 | 40 | 341 |
| **Fauquier*** | Baseline | ICH | 7 | 480 | 7.4 | 651 | 249 | 1817 | 09-May | 30-Sep | 132 | -29.1 | 37.2 | 343 |
| | 2080s | | Trial 8 | | 12.9 | 695 | 225 | 3244 | 22-Mar | 07-Nov | 27 | -17.1 | 44.1 | 496 |
| **Fernie** | Baseline | ICH | 4 | 1010 | 4.7 | 866 | 330 | 1419 | 24-May | 11-Sep | 318 | -37.1 | 36 | 211 |
| | 2080s | | Trial 5 | | 10.3 | 939 | 308 | 2692 | 17-Apr | 15-Oct | 117 | -26.6 | 43.4 | 353 |
| **Fruitvale*** | Baseline | ICH | 7 | 618 | 8 | 699 | 238 | 2065 | 04-May | 06-Oct | 147 | -28.8 | 38.9 | 391 |
| | 2080s | | Trial 8 | | 13.5 | 748 | 215 | 3503 | 29-Mar | 10-Nov | 30 | -16.7 | 45.8 | 544 |
| **Golden*** | Baseline | IDF/MS | 5 | 789 | 4.3 | 550 | 180 | 1470 | 26-May | 16-Sep | 259 | -38.9 | 34.7 | 388 |
| | 2080s | | Trial 6 | | 9.9 | 612 | 171 | 2715 | 17-Apr | 15-Oct | 153 | -29 | 41.5 | 524 |
| **Invermere*** | Baseline | IDF | 5 | 833 | 5.1 | 395 | 164 | 1602 | 21-May | 14-Sep | 139 | -38.3 | 37.2 | 461 |
| | 2080s | | Trial 6 | | 10.7 | 430 | 155 | 2883 | 14-Apr | 15-Oct | 66 | -27.8 | 44.3 | 606 |
| **Kaslo** | Baseline | ICH | 7 | 578 | 7.5 | 813 | 235 | 1874 | 03-May | 06-Oct | 176 | -27.6 | 36.1 | 316 |
| | 2080s | | Trial 8 | | 13.1 | 888 | 215 | 3334 | 11-Mar | 14-Nov | 33 | -15.1 | 43 | 456 |
| **Kimberley** | Baseline | MS/IDF | 5 | 1120 | 4.5 | 586 | 222 | 1414 | 25-May | 15-Sep | 236 | -38.0 | 35.4 | 327 |
| | 2080s | | Trial 6 | | 10.1 | 632 | 208 | 2668 | 18-Apr | 16-Oct | 100 | -27.3 | 42.7 | 468 |
| **Montrose*** | Baseline | ICH | 7 | 591 | 8 | 686 | 237 | 2081 | 04-May | 06-Oct | 143 | -28.5 | 39 | 398 |
| | 2080s | | Trial 8 | | 13.5 | 733 | 213 | 3519 | 19-Mar | 10-Nov | 29 | -16.3 | 45.9 | 552 |
| **Nakusp** | Baseline | ICH | 7 | 466 | 7.5 | 772 | 265 | 1924 | 07-May | 03-Oct | 169 | -28.3 | 36.6 | 322 |
| | 2080s | | Trial 8 | | 13.1 | 837 | 243 | 3369 | 17-Mar | 11-Nov | 34 | -16 | 43.3 | 469 |
| **Nelson*** | Baseline | ICH | 7 | 535 | 7.8 | 707 | 229 | 1986 | 04-May | 08-Oct | 142 | -27.6 | 37.9 | 364 |
| | 2080s | | Trial 8 | | 13.4 | 762 | 208 | 3445 | 12-Mar | 14-Nov | 27 | -15 | 44.9 | 511 |
| **New Denver** | Baseline | ICH | 7 | 542 | 7.6 | 795 | 265 | 1922 | 05-May | 06-Oct | 166 | -27.9 | 36.7 | 304 |
| | 2080s | | Trial 8 | | 13.2 | 861 | 243 | 3378 | 13-Mar | 13-Nov | 32 | -15.7 | 43.6 | 449 |
| **Radium Hot Springs*** | Baseline | IDF | 5 | 838 | 5 | 399 | 174 | 1571 | 22-May | 15-Sep | 137 | -38.2 | 36.7 | 443 |
| | 2080s | | Trial 6 | | 10.5 | 435 | 167 | 2846 | 14-Apr | 16-Oct | 66 | -27.8 | 43.7 | 584 |

| Location | Period | Main BEC | Hard. Zone | Elev. (m) | MAT (°C) | MAP (mm) | MSP (mm) | GDD (5°C) | bFFP | eFFP | PAS (mm) | EMT | EXT | CMD (mm) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Revelstoke** | Baseline | ICH | 6 | 476 | 6.3 | 957 | 288 | 1736 | 08-May | 29-Sep | 328 | -31.9 | 35.6 | 267 |
| | 2080s | | Trial 7 | | 11.9 | 1063 | 268 | 3093 | 29-Mar | 03-Nov | 99 | -20.7 | 42.4 | 403 |
| **Rossland** | Baseline | ICH | 6 | 1023 | 3.7 | 935 | 287 | 1177 | 24-May | 28-Sep | 449 | -35.5 | 32.5 | 143 |
| | 2080s | | Trial 7 | | 9.2 | 1011 | 261 | 2354 | 17-Apr | 24-Oct | 163 | -24.3 | 39.5 | 270 |
| **Salmo** | Baseline | ICH | 7 | 666 | 7.4 | 757 | 271 | 1918 | 08-May | 02-Oct | 158 | -29.3 | 38.4 | 327 |
| | 2080s | | Trial 8 | | 13.0 | 808 | 247 | 3342 | 24-Mar | 07-Nov | 32 | -17.1 | 45.4 | 478 |
| **Shuswap Indian Band*** | Baseline | IDF | 5 | 866 | 4.9 | 400 | 168 | 1519 | 23-May | 13-Sep | 142 | -38.5 | 36.7 | 445 |
| | 2080s | | Trial 6 | | 10.5 | 437 | 159 | 2824 | 15-Apr | 14-Oct | 70 | -28.0 | 43.7 | 588 |
| **Silverton** | Baseline | ICH | 7 | 546 | 7.6 | 813 | 270 | 1860 | 04-May | 07-Oct | 168 | -27.8 | 36.8 | 300 |
| | 2080s | | Trial 8 | | 13.2 | 881 | 247 | 3386 | 13-Mar | 14-Nov | 32 | -15.4 | 43.8 | 446 |
| **Slocan*** | Baseline | ICH | 7 | 548 | 7.8 | 732 | 214 | 1990 | 04-May | 07-Oct | 157 | -27.9 | 37.9 | 377 |
| | 2080s | | Trial 8 | | 13.4 | 798 | 194 | 3449 | 14-Mar | 13-Nov | 30 | -15.4 | 44.8 | 522 |
| **Sparwood** | Baseline | MS | 4 | 1140 | 2.5 | 651 | 273 | 1041 | 05-Jun | 06-Sep | 295 | -39.6 | 33.1 | 198 |
| | 2080s | | Trial 5 | | 8.1 | 707 | 255 | 2183 | 25-Apr | 11-Oct | 151 | -29.3 | 40.3 | 329 |
| **Trail*** | Baseline | ICH | 7 | 440 | 7.9 | 705 | 231 | 2051 | 03-May | 07-Oct | 154 | -28.6 | 38.5 | 386 |
| | 2080s | | Trial 8 | | 13.4 | 757 | 208 | 3479 | 19-Mar | 11-Nov | 32 | -16.4 | 45.3 | 537 |
| **Valemount** | Baseline | SBS | 5 | 791 | 4.3 | 599 | 217 | 1395 | 27-May | 17-Sep | 243 | -37.8 | 34.5 | 310 |
| | 2080s | | Trial 6 | | 9.8 | 672 | 214 | 2620 | 16-Apr | 19-Oct | 111 | -27.4 | 41 | 426 |
| **Warfield*** | Baseline | ICH | 7 | 615 | 8.0 | 736 | 240 | 2018 | 02-May | 07-Oct | 155 | -28.5 | 38.6 | 380 |
| | 2080s | | Trial 8 | | 13.5 | 792 | 216 | 3518 | 18-Mar | 11-Nov | 31 | -16.4 | 45.4 | 532 |
| **yaqan nuʔkiy (Lower Kootenay Band*** | Baseline | ICH | 7 | 537 | 7.7 | 539 | 182 | 1935 | 01-May | 01-Oct | 117 | -29.6 | 38.4 | 434 |
| | 2080s | | Trial 8 | | 13.3 | 577 | 167 | 3434 | 22-Mar | 05-Nov | 24 | -17.5 | 45.6 | 585 |

Variables: **Hard. Zone** = Canadian Plant Hardiness Zone; **MAT** = Mean Annual Temperature (°C); **MAP** = Mean Annual Precipitation (mm); **MSP** = Mean Summer Precipitation (mm); **GDD** = degree-days above 5°C/growing degree-days; **bFFP** = beginning of frost free period; **eFFP** = end of frost free period; **PAS** = Precipitation as Snow (mm); **EMT** = Extreme Minimum Temperature (°C); **EXT** = Extreme Maximum Temperature (°C); **CMD** = mm of climatic moisture deficit based on the cumulative monthly average of months when evapotranspiration exceeds precipitation.

*These communities are anticipated to be most vulnerable to drought. Tree species with a high drought tolerance are anticipated to be a generally better suited to the future climate in these communities.

Note: Climate model limitations and uncertainties leave open the possibility that the region will experience conditions, such as extreme events and climate variations, different than those reported here [17].

# CLIMATE IMPACTS TO TREES AND FORESTS

## BY THE 2080s CHANGES SUCH AS...

### TEMPERATURES
Annual average up to 6°C warmer. Milder winters. Summer extremes above 40°C.

### PRECIPITATION
More rain except in summer. Less snow.

### MELTWATER
Faster snowmelt and glacial runoff. Earlier peak spring flows and lower late-summer flows.

### EVAPOTRANSPIRATION
Increased rates of evaporation and transpiration from waterbodies, soil and plants.

### GROWING SEASONS
Longer, warmer growing seasons.

### VARIABILITY
More frequent and unseasonal extreme weather is expected.

## WILL LIKELY CAUSE...

### SPECIES DISTRIBUTION SHIFTS
Forest species may shift northward and upslope. Some species in warmer and drier conditions will become maladapted to their current habitats. Subalpine species may experience migration failure and novel ecosystems may evolve.

### LESS MOISTURE AVAILABILITY
Valley bottoms may shift to grassland in the driest parts of the basin. Drought mortality and regeneration failure may increase and urban trees may need more water to establish. Changes may be rapid for forest species whose drought tolerance thresholds are exceeded.

### MORE EXTREME WEATHER
Extreme events may occur more often, leading to more tree damage. For example, extreme heat could cause premature defoliation in deciduous trees. Heavy wet snow or freezing rain could cause extensive tree damage.

### MORE PESTS AND INVASIVE SPECIES
Pests may reproduce more rapidly and more often. Climate stressed trees and forests may be more vulnerable to attack. Warming and disturbance could also open the door to new invasive species and habitats.

### LONGER, WARMER GROWING SEASONS
Longer growing seasons and milder winters may support species diversity and potentially more carbon sequestration. This effect is subject to many limitations due to the negative impacts of climate change on tree growth.

### LONGER FIRE SEASONS AND LARGER FIRES
Fires may burn larger areas. Fire risk is expected to increase everywhere and ecosystems not adapted to fire. In fire adapted ecosystems, overstocked stands could sustain significant tree mortality and soil damage from hot fires.

# Adaptation Toolkit

To adapt urban tree and forest management to climate change, communities in the Basin will need to address both existing vulnerabilities and the anticipated impacts from climate change. Reducing vulnerability now will advance climate adaptation by supporting healthy trees and forests that are more resilient to current and future stress. The tools and recommendations in this tool-kit address existing and future challenges to community trees, and target climate adaptation benefits where relevant. The tool-kit is separated into the following four themes:

1. Policy and Planning Tools;
2. Planting;
3. Management and plant health care; and,
4. Risk management.

Recommendations to adapt community tree management are made within each theme and relevant implementation tools are listed. These recommendations are primarily targeted to local governments who have the authority to implement policy tools that influence community tree management on public and private land. Links to best management practices resources as well as a Basin urban tree species list are also provided and these resources contain guidance relevant to everyone who manages trees.

*Radium. Photo: Province of British Columbia*

## Local Government Policy and Planning Tools

Local government policy can have a significant influence on the quantity, quality and composition of trees and forests, and on the powers a community has to adapt to climate change. This section introduces policy tools and frameworks, which are then referenced throughout the toolkit when they are relevant for the implementation of a recommendation.

### *Official Community Plan*

An official community plan (OCP) is a bylaw that municipalities and regional districts can use to define objectives and policies that guide decisions on planning and land use management. By making the objectives and policies regarding climate adaptation, planted trees and natural forests, all bylaws and projects undertaken must be consistent with the plan. Development permit area, described below, can also be designated in the OCP.

> **Climate Resilient OCPs**
>
> Columbia Basin Trust created a Resource Guide for communities in the Basin wishing to update their OCP.

### *Zoning and Land Use Bylaw*

Zoning and land use bylaws regulate building density, lot coverage, siting, set-backs and use of the land, among other things. Zoning is particularly influential over tree retention and replacement on private land as it regulates the maximum area that can be built on and therefore the proportion of land that is potentially left for trees and forests. Zoning can also be used to provide the guidelines for Development Permit Areas.

### *Development Permit Areas*

Development Permit Areas (DPAs) can be created to protect development from hazards, such as wildfire, as well as to protect the natural environment or to achieve climate action goals for energy and water conservation and the reduction of greenhouse gas emissions. Within a DPA, unless a development permit is obtained, development is restricted. Using DPAs together with the zoning or land use bylaw can be a powerful tool to control development outcomes such as the creation of FireSmart structures and landscaping, and water and energy efficient building and landscapes to meet the OCP climate adaptation objectives.

### *Development Cost Charges*

Development Cost Charges (DCCs), as established by bylaw, require new developments to pay for the provision of new or expanded infrastructure such as sewers, water, drainage, streets and parks required to service new developments. DCCs can be used either to fund capital costs or to incentivize developments by reducing DCCs for projects that demonstrate low environmental impacts according to defined criteria (e.g. tree planting to reduce energy consumption, stormwater interception, etc.).

### *Runoff Control Bylaw*

Runoff control bylaws regulate rainwater runoff from developments. This bylaw can be used to establish a maximum impermeable surface percentage, which influences how much permeable surface the site must have, and therefore how much space is available to support trees and other vegetation that supports rainwater infiltration into the soil water reservoir.

### *Floodplain Regulation*

Local governments can designate floodplains and specify appropriate development setbacks within those areas. Protecting floodplains is likely to protect more riparian forests and moist sites.

### *Screening and Landscaping Bylaw*

Local governments can require screening or landscaping to buffer land uses, preserve, protect, restore and enhance the natural environment or prevent hazardous conditions. The requirements in the bylaw can be used to require, for example, landscaping that is appropriate in a sensitive ecosystem, xeriscaping or FireSmart landscaping, or the selection of tree species suitable for future climate.

### *Subdivision and Development Servicing Bylaw*

Subdivision and development servicing (SDS) bylaws are used to regulate the provision of works and services required to subdivide land. They regulate street, sidewalk, boulevards, street lighting, underground wiring, the location and construction of water and sewer lines and drainage on a subdivision. This bylaw can be used to require, for example, street trees and minimum soil volumes, access roads or trails to create fire breaks around subdivisions, and green infrastructure such as bioswales for drainage and infiltration.

**Climate Resilience and SDS Bylaws**

Columbia Basin Trust created an SDS Guidance Document for communities in the Basin.

### *Tree Bylaw*

Municipalities can regulate tree protection and require replacement trees on public and private land. Tree Bylaws typically protect trees above a certain size, specific tree species, significant trees (e.g. designated as heritage), trees in specific areas (e.g. steep slopes, riparian areas or environmentally sensitive areas) and/or public trees. Tree bylaws can be used, for example, to protect specific species of importance to the community, require better adapted species to be planted, or require a minimum number of trees be retained or planted with development.

### *Soil Removal and Deposit Bylaw*

Soil removal and deposit bylaws regulate the movement of soil with the province's approval. This bylaw can be used to avoid negative impacts from soil storage on environmentally sensitive areas and can help prevent the spread of invasive species by regulating movement of soil.

### *Noxious or Destructive Insect and Pest Bylaw*

Local governments can require people to prevent or clear their properties of noxious weeds and insects.

### *Urban Forest Strategies*

Urban forest strategies define the urban forest values being managed in a community and establish a shared vision for the future. Strategy development typically involves the inventory and assessment of the urban forest resource, stakeholder engagement to define the issues and opportunities for management and the establishment of a vision, and an implementation framework. Implementation is typically achieved through bylaws and urban forest management programs with technical details contained in a sub-set of documents such as:

- An urban forest operations manual, which contains specific, technical guidance such as planting, maintenance, risk management and extreme weather response.
- City tree policy, which typically defines the level of service for public trees and outlines the retention and removal of public trees.
- Neighbourhood planting plans to guide where and what will be planted.

### *Biodiversity Strategies*

Biodiversity strategies define the biodiversity values being managed in a community and establish a vision for the future. While there is overlap with an urban forest strategy, a biodiversity strategy tends to focus on the identification of biodiversity hubs and corridors to be protected or restored. The implementation of a biodiversity strategy is typically achieved through natural areas management programs, parkland acquisition, and through environmental DPAs or bylaws.

### *Community Wildfire Protection Plans*

Community Wildfire Protection Plans identify wildfire risk in and around a community and make recommendations to create more FireSmart communities, such as recommending low flammability tree species, spacing or pruning. These plans typically provide recommendations to improve the effectiveness of wildfire response, to treat hazardous fuels on crown and municipal lands, and to develop more FireSmart communities. Implementation is typically achieved through a fuel management program, post-fire restoration planning, FireSmart education, wildfire DPAs or bylaws. Funding for FireSmart planning may be available through the Union of BC Municipalities and First Nations' Emergency Services Society of BC.

### *Integrated Stormwater Management Plans*

Integrated stormwater management planning is a comprehensive approach to rainwater management that considers land use planning, stormwater engineering, flood and erosion protection and environmental protection. These plans can help guide how development is managed to preserve or enhance the health of aquatic and riparian ecosystems, and increase water harvesting and infiltration to support healthy trees and forests. Documents that support implementation include drainage plans and reports that detail drainage resources and storm servicing requirements. Implementation is typically achieved through bylaws.

## Urban Tree Species List

An urban tree species list has been drafted to support this tool-kit and is available for download. This list is a resource to help Basin tree managers select climate and site suitable trees. The recommendations provided in the following sections sometimes refer to specific attributes, each of which is included in the species list. Species can be sorted by attributes including hardiness zone, drought tolerance, tree size, suitability as a street tree, shade, waterlogging tolerance, wind breakage, bear attractant and invasive potential. The list is a draft developed from literature and online sources and should be improved over time to incorporate community tree managers' local experience with urban tree species performance. For native forest species selection and planting, refer to the Province's Tree Species Selection Tool.

*Sparwood. Photo: District of Sparwood*

## Planting Recommendations

This theme provides recommendations to adapt tree planting to climate change in order to sustain and grow planted and natural forests within Basin communities.

### Planted Trees

**1 Prioritize tree planting in locations where it will most benefit community climate adaptation:**

- Establish tree planting programs and set targets for canopy cover or tree density to drive tree planting rates on public and private land in the community.
- Develop neighbourhood planting plans to achieve specific benefits, such as shading and cooling pedestrians and buildings, intercepting stormwater over paved areas and/or sequestering carbon.

**TOOLS:** OCP and local area plans | Urban forest strategy | Biodiversity strategy | Tree bylaw | Screening and landscaping bylaw| Metro Vancouver Design Guidebook: Maximizing Climate Adaptation Benefits with Trees | The Sustainable Urban Forest Guide | International Society of Arboriculture (ISA) brochures

**2 Create planting sites with soil and water infrastructure that will support healthy trees from establishment to maturity:**

- Require adequate soil volumes in streets to support large canopy trees wherever possible (see recommendation below).
- Encourage or require surface permeability and stormwater infiltration (see options below).
- Encourage or require non-potable water harvesting options for storing water to irrigate trees and landscapes.
- Where soils are compacted and degraded, rebuild soil profiles.
- Where de-icing salt is used and road speed is greater than 60 kph, set planting sites well back from the road edge, raise planting sites and/or wash planting sites down with freshwater in the spring.

**TOOLS:** OCP | Subdivision and servicing bylaw | Runoff control bylaw | Zoning bylaw | Urban forest strategy | Integrated stormwater management plan | Development cost charges | Species list | Metro Vancouver Design Guidebook: Maximizing Climate Adaptation Benefits with Trees | Soil profile rebuilding

#### RECOMMENDED SOIL VOLUME AND SPACING FOR URBAN PLANTING SITES

| Tree size | **Large** (> 15 m tall, 10-20 m spread) | **Medium** (10-15 m tall, 7 – 12 m spread) | **Small** (< 10 m tall, < 8 m spread) |
|---|---|---|---|
| **Min soil volume*** | 20 – 150 $m^3$ per tree | 10 – 70 $m^3$ per tree | 5 – 35 $m^3$ per tree |
| **Tree spacing** | 12-15 m | 10-14 m | 3-9 m |

*Target at least 0.3$m^3$ (prefer 0.6$m^3$) of soil for every 1 $m^2$ of crown projection (~1 m depth). Connect soil volume between trees to reduce the soil volume target by up to 50%. NOTE: smaller volumes can be provided but will reduce the ultimate size of the tree and increase root damage potential. Structural soils or modular soil cell systems can provide soil volume under hardscape, or connect adjacent soil areas.

#### STORMWATER INFILTRATION OPTIONS TO SUPPORT TREE HEALTH

Distribute and store runoff to allow it to infiltrate into the soil where it can be accessed by tree roots. Examples include bioswales, berms, raingardens, French drains, bioretention tree pits, permeable surfaces, and infiltration trenches in street designs to help redirect stormwater runoff into planted boulevards.

**3** **Select tree species that are likely to be well suited to both the current and future climate and site conditions, and to maximize ecosystem services and minimize risk:**

- Select species that are tolerant at the present hardiness zone or to any lower zone number (colder zones).
- Select the largest canopy species suitable for the soil volume and above ground growing space to maximize the ecosystem services produced.
- Select species with moderate to high shade density in leaf except where views or solar access are required.
- Avoid species with high branch breakage potential, high flammability (evergreen conifers), invasive potential or that attract wildlife that may pose a threat to humans.
- In drought vulnerable communities, plant trees with moderate to high drought tolerance and encourage xeriscaping.

**TOOLS:** Urban forest strategy | Community wildfire protection plan | Biodiversity strategy | DPAs | Screening and landscaping Bylaw | Species list

**4** **Increase the diversity of urban species and genetic stock to reduce risk exposure from losses due to pests or diseases:**

- Establish targets that drive urban species diversity. For example, limit planted populations to <5% of any species and <10% of any genus.
- Work together with local nurseries to procure a diversity of species grown from seed as well as clonal propagation.
- Trial non-invasive urban tree species tolerant to as much as one hardiness zone number higher (warmer zone) than your present zone to test new species.

**TOOLS:** Urban forest strategy | The Sustainable Urban Forest Guide

## Natural Forests

**5** **Increase species, genetic and structural diversity within forest stands and re-align species composition to meet expected future conditions:**

- At the stand level, plant a diversity of native species that are suited to the site ecosystem and future climate, and encourage or require the same on private land.
- Where appropriate use deciduous species and/or consider maintaining low tree densities with traditional food plant species in the understory to reduce wildfire hazard.
- Work together with local nurseries to grow native species and genotypes tolerant of warmer, drier conditions as guided by the Province's Climate-Based Seed Transfer project for different BEC units.
- Where native species are failing to thrive, trial novel assemblages of native and nearby native species where appropriate.
- Develop species composition plans that will sustain cultural values.

**TOOLS:** Climate-based seed transfer | Tree Species Selection Tool | Urban forest strategy | Community wildfire protection plan | Biodiversity strategy | DPAs | Screening and landscaping Bylaw

**6** **Restore soil and hydrology to support healthy forest stands from establishment to maturity:**

- Encourage or require the use of naturalized drainage features such as wetlands, and stream daylighting.
- Encourage preservation of native soils in-situ.
- On drought prone sites, and only in locations that are safe to flood, slow the flow of surface water across the landscape (e.g., mimic beaver dams or create ditches and mounds).

**TOOLS:** OCP | Subdivision and servicing bylaw | Soil removal and deposit bylaw | Runoff control bylaw | Integrated stormwater management plan | Development cost charges

## Management and Plant Health Care Recommendations

This theme makes recommendations to adapt management activities for maintaining healthy trees and forests from establishment to maturity.

### Planted Trees

**7** **Implement best practice standards for tree planting to prevent young tree failures:**

- Require that new trees meet Canadian Nursery Stock Standards.
- Require that tree planting meet the Best Management Practices for tree planting as defined by the International Society of Arboriculture (ISA).
- Fence new trees where deer browse is an issue.
- Educate residents on how to properly plant and care for young trees.

**TOOLS:** Urban forest strategy | Subdivision and servicing bylaw| Canadian Nursery Stock Standards | ISA BMPs Tree Planting | treesaregood.org | ISA brochures

**8** **Implement best practices for whole of life-cycle tree care to maximize tree health and life expectancy:**

- Watering: young trees should be watered in the summer for at least 3 years after planting and up to 5 years in drought vulnerable communities.
- Mulching: Apply organic mulch to the root zone of trees to reduce water loss in the soil through evaporation.
- Young tree pruning: Prune young trees on a 3 year cycle for the first 15 years of life.
- Cyclical pruning: Prune trees older than 15 years on a 5 year cycle.
- Integrated pest management: Develop plans to manage pest species of concern and provide training for identification and treatment.
- Wood utilization: Explore options for using the biomass generated from thinning for forest health, such as for wood chips for mulching, composting and/or cogeneration.
- Tree protection: Implement tree protection standards for construction around trees.
- Stewardship engagement:
    - Educate residents on proper tree maintenance and to avoid transporting firewood where there is a risk of spreading invasive insect pests such as gypsy moth.
    - Develop an adopt-a-tree program to encourage residents to water newly planted street trees.

**TOOLS:** Urban forest strategy | Tree bylaw | Subdivision and servicing bylaw| Screening and landscaping bylaw| ISA BMPs Tree Pruning | ISA BMPs IPM | treesaregood.org | ISA brochures | Invasive Species Council buy it where you burn it

**9 Inventory and monitor planted trees to enable adaptive management:**

- Inventory planted trees and update inventory with the pruning cycle.
- Integrate a GIS tree inventory with a municipal work order and asset management system to inform budgeting for tree planting and maintenance.
- Use inventory data to identify patterns of site or species performance issues and to monitor urban forest targets.
- Create a regional network of community tree managers to share data on key forest metrics such as tree mortality, species performance, tree and forest health.
- Subscribe to the Canadian Food Inspection Agency (CFIA) plant pest surveillance notifications and provide training to identify urban tree pests threats.

**TOOLS:** Urban forest strategy | ISA BMPs Tree Inventories | CFIA plant pest surveillance

## Natural Forests

**10 Protect and enhance forest ecosystems to maximize forest health:**

- Thin or use prescribed burning to reduce competition and water demand where forest stands are stressed and in decline.
- Clean up fresh woody debris that could provide habitat for bark beetles (e.g., large diameter Douglas-fir).
- Inventory and protect watersheds, springs, riparian and wetland ecosystems and any other naturally moist or cool sites that are likely to be buffered from climatic moisture deficit.
- Encourage or require the removal of noxious weeds and infestations of destructive insects.

**TOOLS:** OCP | Zoning and land use bylaw | DPAs | Urban forest strategy | Biodiversity strategy | Development cost charges | Flood plain regulation bylaw | Screening and landscaping bylaw | Noxious or destructive pest bylaw | List of regulated invasive plants in BC

**11 Inventory and monitor forest ecosystems to enable adaptive management:**

- Periodically inventory natural forests and sensitive ecosystems and shifts in wildfire hazard within municipal boundaries to detect change over time.
- Provide training to identify natural forest damage agents.
- Review Provincial aerial overview summary reports annually to monitor changes in forest health.

**TOOLS:** Biodiversity Strategy | Standards for mapping ecosystems at risk in BC | Field guide to forest damage in BC | Aerial overview summary reports

*Fernie.*

## Risk Management Recommendations

This theme makes recommendations to adapt management of both the risks to trees from climate hazards as well as the risk from trees to people and property.

### Planted Trees

**12 Develop risk inspection and mitigation standards for community trees in the vicinity of people, buildings and infrastructure:**

- Ensure that inspection and risk mitigation standards and actions are implemented operationally and documented.
- When surplus to community needs, close and rehabilitate roads and trails to minimize ongoing maintenance and risk management workloads.

**TOOLS:** Urban forest strategy | ISA BMPs Tree Risk Assessment | ISA brochures

**13 Develop an extreme weather response plan for community tree management:**

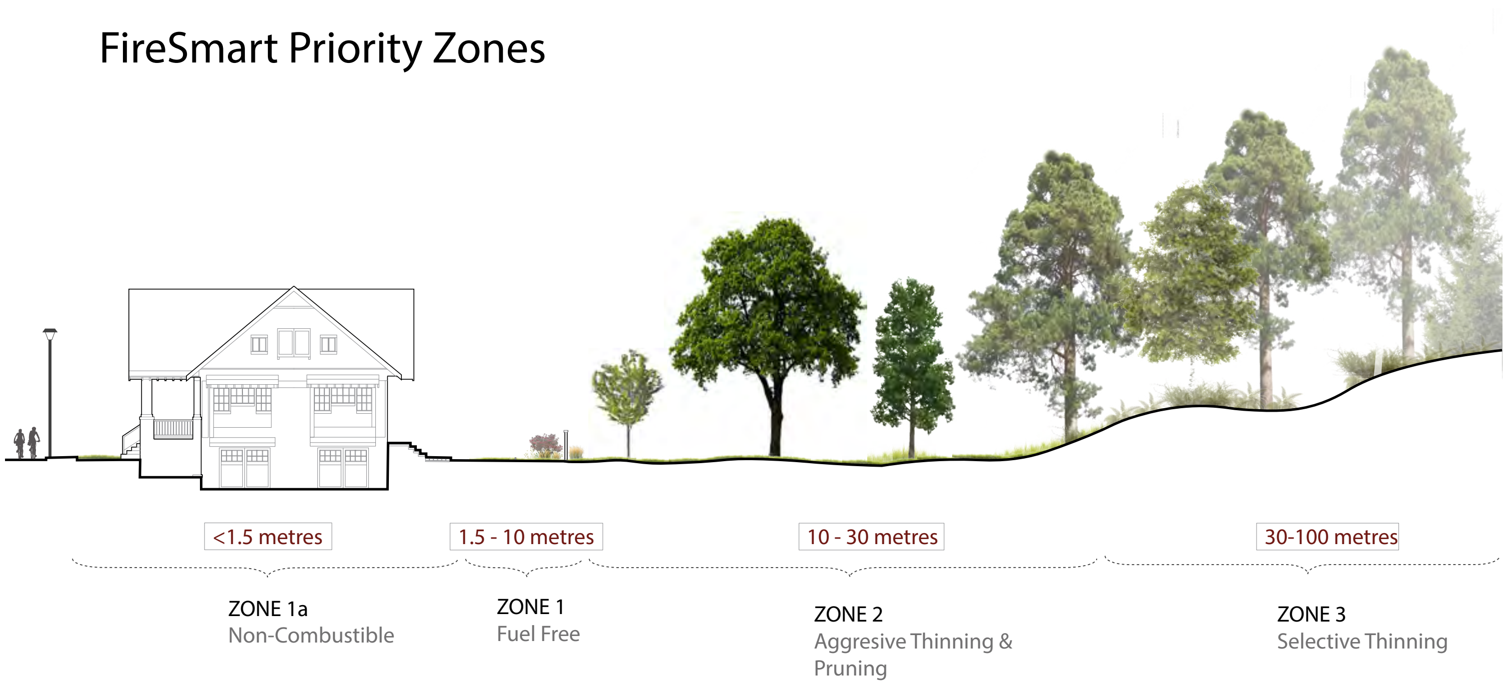
- Document call-out procedures and key contacts.
- Enable rapid and coordinated responses to immediate hazards with equipment, crews and/or contractors specified.
- Outline the post-event clean-up and restoration processes and debrief for learning.

**TOOLS:** Urban forest strategy | Tree Canada Emergency Preparedness

**14 Encourage or require FireSmart standards on public and private land:**

- Require FireSmart landscaping in new developments per the FireSmart Priority Zones.
- Plant deciduous trees in wildfire interface parks and public lands.
- Educate residents to plant and maintain FireSmart landscaping.

**TOOLS:** OCP | DPAs | Screening and landscaping bylaw | Community wildfire protection plan | Species list | FireSmartCanada.ca | Union of BC Municipalities | First Nations' Emergency Services Society



## Natural Forest

**15 Encourage or require risk management of forest stands adjacent to the urban interface or valued targets such as people, buildings and infrastructure:**

- With development, require a Registered Professional Forester to assess windfirmness of new stand edges and wildfire hazards in retained stands or buffer strips, and develop risk mitigation recommendations or prescriptions to inform conditions of the development.
- With development, require trails or access roads around new housing lots to create wildfire fuel breaks.
- Develop and implement fuel treatment prescriptions for high risk stands to reduce fuel hazards and create fuel breaks.
- In the event of widespread tree mortality, for example due to forest pest outbreak or drought, rapidly develop prescriptions to mitigate risk and restore forests.

**TOOLS:** Community wildfire protection plan | DPAs | Tree bylaw | CFIA plant pest surveillance | Union of BC Municipalities | First Nations' Emergency Services Society

**16 Develop a wildfire restoration plan for community forest stands to prevent impacts to slope stability, recreation, ecosystem and water quality:**

- Plans generally address erosion control, access rehabilitation, hazardous tree removals.
- Revegetate sites rapidly following disturbance with a diversity of native species that are suited to the site ecosystem and future climate. Where appropriate use deciduous species to lower forest fuel hazards.

**TOOLS:** Community wildfire protection plan | Tree Species Selection Tool | Climate-based seed transfer | Biodiversity strategy | Urban forest strategy | Union of BC Municipalities | First Nations' Emergency Services Society

# Adaptive Planning

Community tree management will need to adapt to climate change in order to maintain healthy and resilient Columbia Basin trees and forests. Trees and forest ecosystems deserve broad integration and consideration as essential infrastructure in Basin communities because they can support both climate mitigation and adaptation.

This tool-kit provides a range of recommendations and tools to manage urban planted trees and natural forests to improve their resilience in the face of climate change. Planning now for the adaptation of community tree management to climate change will ensure the longevity of this important community resource.

*Slocan.*