Metro Vancouver Urban Forest Climate Adaptation

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Canadian Urban Forest Conference

September 28th, 2016

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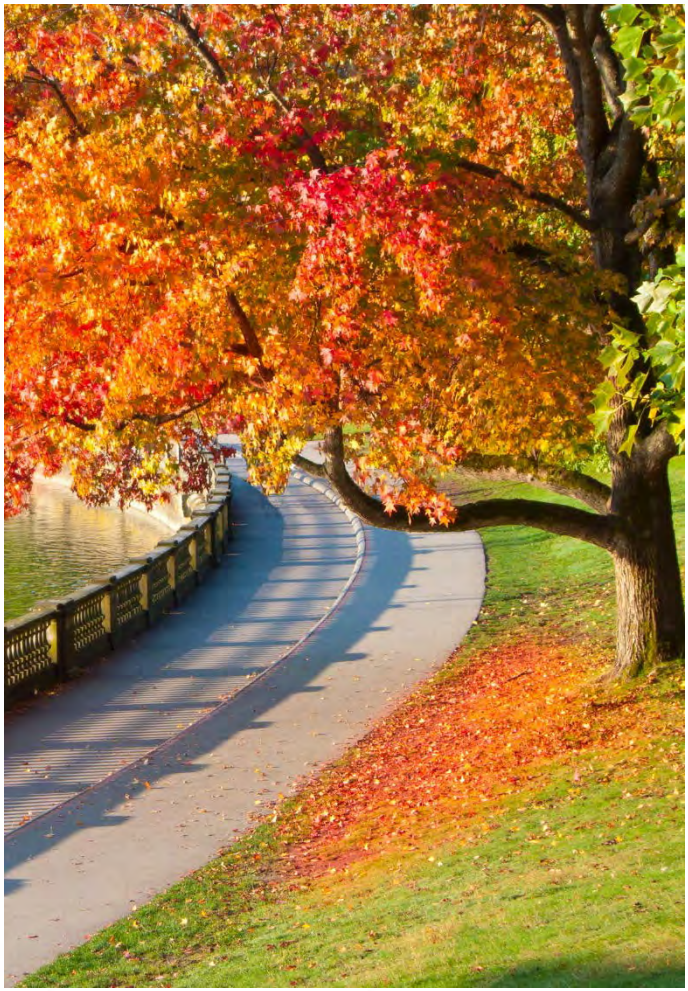
Today's presentation

- Why this project?
- The process
  - A system already under stress?
  - Future climate and impacts
  - Risk and vulnerability assessment
- The tools
  - Practices to reduce vulnerability
  - Species selection framework
  - Design guidebook



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Why this project?

Metro Vancouver's Plans identify climate adaptation as an important piece of building and maintaining a livable region

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Why this project?

- How is our urban forest vulnerable?
- How can we use our urban forest for climate adaptation?

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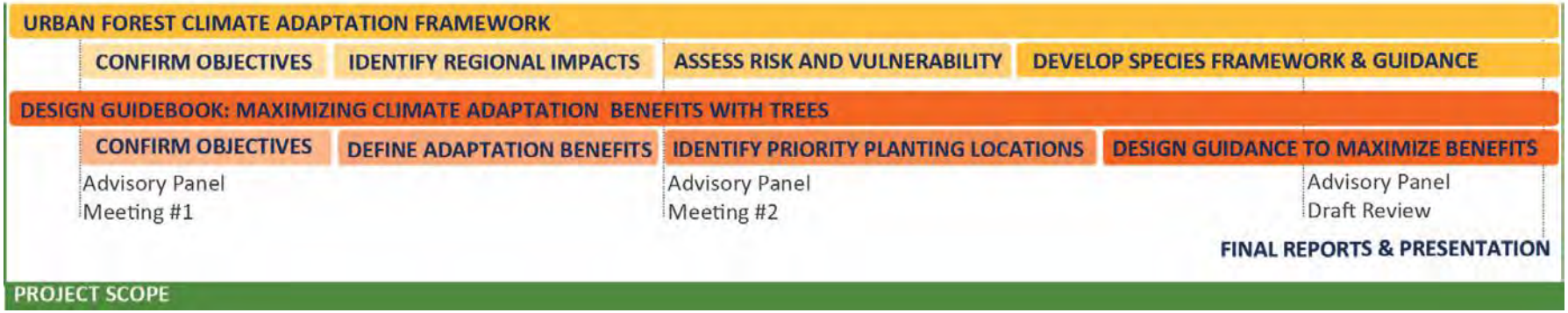
Why this project?



Advisory Panel

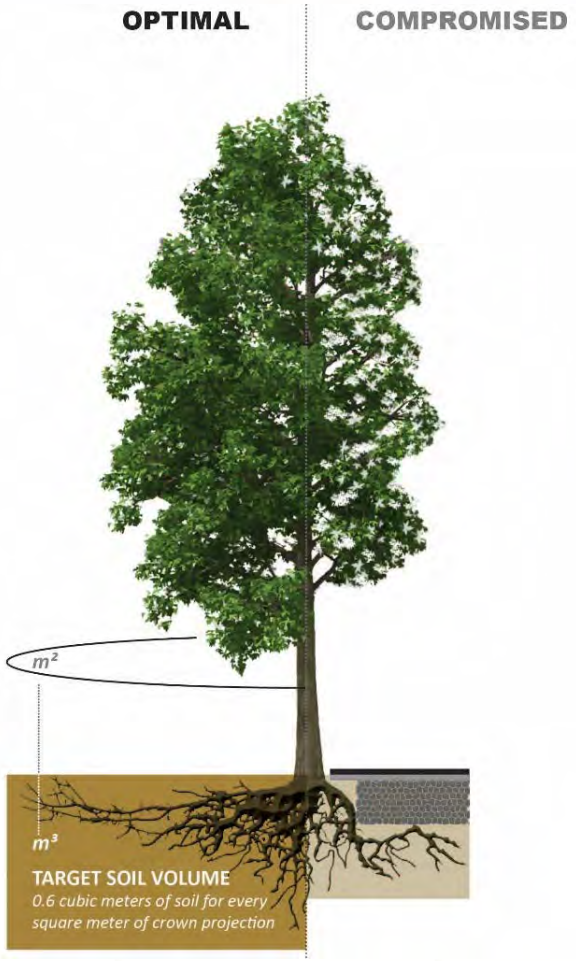
Name	Organization	Name	Organization
Alison Evely	Metro Vancouver	Kimberly Armour	City of Richmond
Angela Danyluk	Corporation of Delta	Kristie Goodman-Rendall	Metro Vancouver
Bill Stephen	City of Vancouver	Lanny Englund	City of Coquitlam
Conor Reynolds	Metro Vancouver	Lillian Zaremba	Metro Vancouver
Debora Harford	Simon Fraser University	Neal Aven	City of Surrey
Erika Mashig	City of New Westminster	Rod Stott	City of Maple Ridge
Gordon Jaggs	City of Richmond	Sara Barron	University of British Columbia
Jason Emmert	Metro Vancouver	Sinead Murphy	District of North Vancouver
Jonathan Budgell	City of North Vancouver	Stephen Sheppard	University of British Columbia
Josephine Clark	Metro Vancouver	Tamsin Mills	City of Vancouver
Julie Pavey	District of North Vancouver	Tom Lancaster	Metro Vancouver

The process

A system already under stress?

Sources of continuous stress

- Below ground
  (e.g., soil volume, soil quality, utilities)
- At ground
  (e.g., permeability)
- Above ground
  (e.g., utilities, structures)



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A system already under stress?

Sources of transient stress

Transient stressors include: seasonal moisture deficit, drought and heat; extreme wind and rainfall; urban activity and air pollution; pests and disease; and wildfire and flood events

Future climate + impacts

Regionally adjusted climate change projections (Pacific Climate Impacts Consortium) Historical baseline 1971-2000 compared to 2080s Coupled Model Intercomparison Project 5 following the "business as usual" GHG emissions, RCP8.5.

Variable	Season				Range of Magnitude/ Direction of Change
	Winter	Spring	Summer	Fall	
Warmer temperatures			●		↑ from 30°C to 37°C maximum temperature
	●				↑ from -13°C to -5°C minimum temperature
Heat days (above 30°C)			●		↑ from 2 to 29 days above 30°C (on average)
Precipitation		●			↑ 12% (from 400 mm to 447 mm)
			●		↓ 29% (from 206 mm to 147 mm)
				●	↑ 20% (from 580 mm to 693 mm)
Maximum length of dry spell	Annual				↑ 37% increase in the length of dry spells (from 21 to 29 days)
Frost days	Annual				↓ 79% (from 79 to 17 days)
Growing season length	Annual				↑ 31% (from 252 to 331 days)

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Future climate + impacts

CLIMATE PROJECTIONS.....**EXPECTED URBAN FOREST IMPACTS**

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- ↓ Water
- ↑ Wildfire
- ↑ Heat
- ↑ Fresh-water flooding
- ↑ Insects, disease and invasive plants
- ↑ Air pollution
- ↑ Maladaptation
- ↑ Saltwater inundation
- ↑ Growing season
- ↑ Atmospheric CO2
- -- Windstorms

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Risk + vulnerability assessment

ICLEI's workbook for municipal climate adaptation

WATER: *warmer, drier summers, intensifying urban heat island effect (Impact Statement 1)*

Projected effect:

- Reduced plant available soil moisture
- Reduced reservoir water supply
- Increased length of drought

Potential impact:

- Widespread decline in tree growth and natural regeneration, and an increase in tree mortality

Scientific literature:
Robust evidence

Models:
Medium agreement

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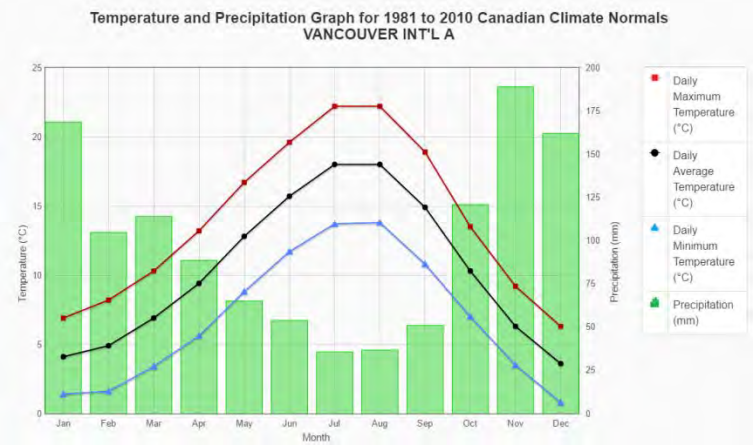
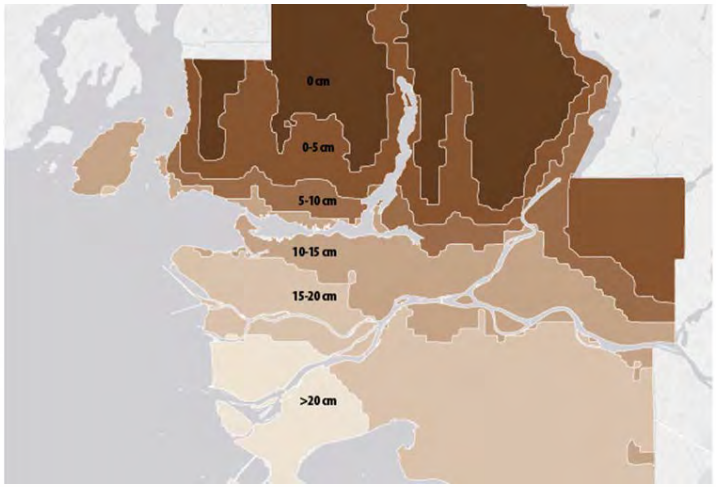
Risk + vulnerability assessment





Current zones of annual climatic moisture deficit

- ↓ Water
- ↑ Wildfire
- ↑ Heat
- ↑ Fresh-water flooding
- ↑ Insects, disease and invasive plants
- ↑ Air pollution
- ↑ Maladaptation
- ↑ Saltwater inundation

Decision-making under uncertainty

- Lack of quantitative data to estimate probability of impact or regional magnitude of impact
- Climate projections from models with inherent uncertainty

THEREFORE

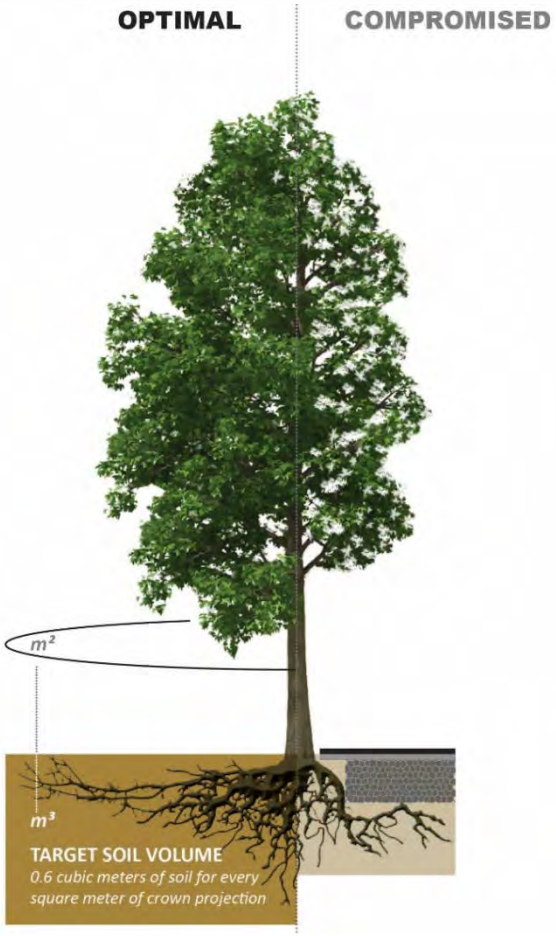
Risk and vulnerability assessments are subjective but record our current understanding and provide a baseline for continuous improvement

The Tools

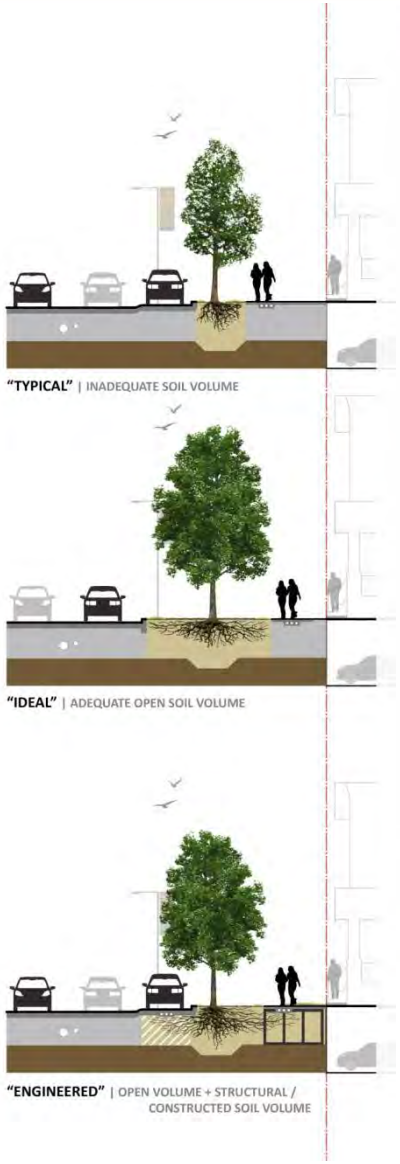
Tools for climate adaptation

1. Reduce Vulnerability Now
    1. Soil and Planting Infrastructure Guidelines
    2. Water Management Guidelines
    3. Tree Management Guidelines
2. Plan to Adapt to Future
    1. Tree adaptation: species selection
    2. Community adaptation: design guidebook

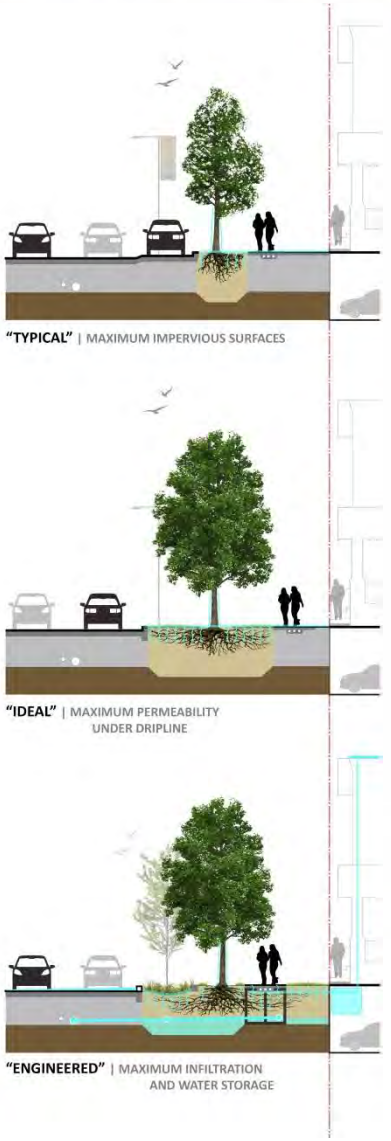
Reduce vulnerability now



Soil + Planting Infrastructure



Water Management



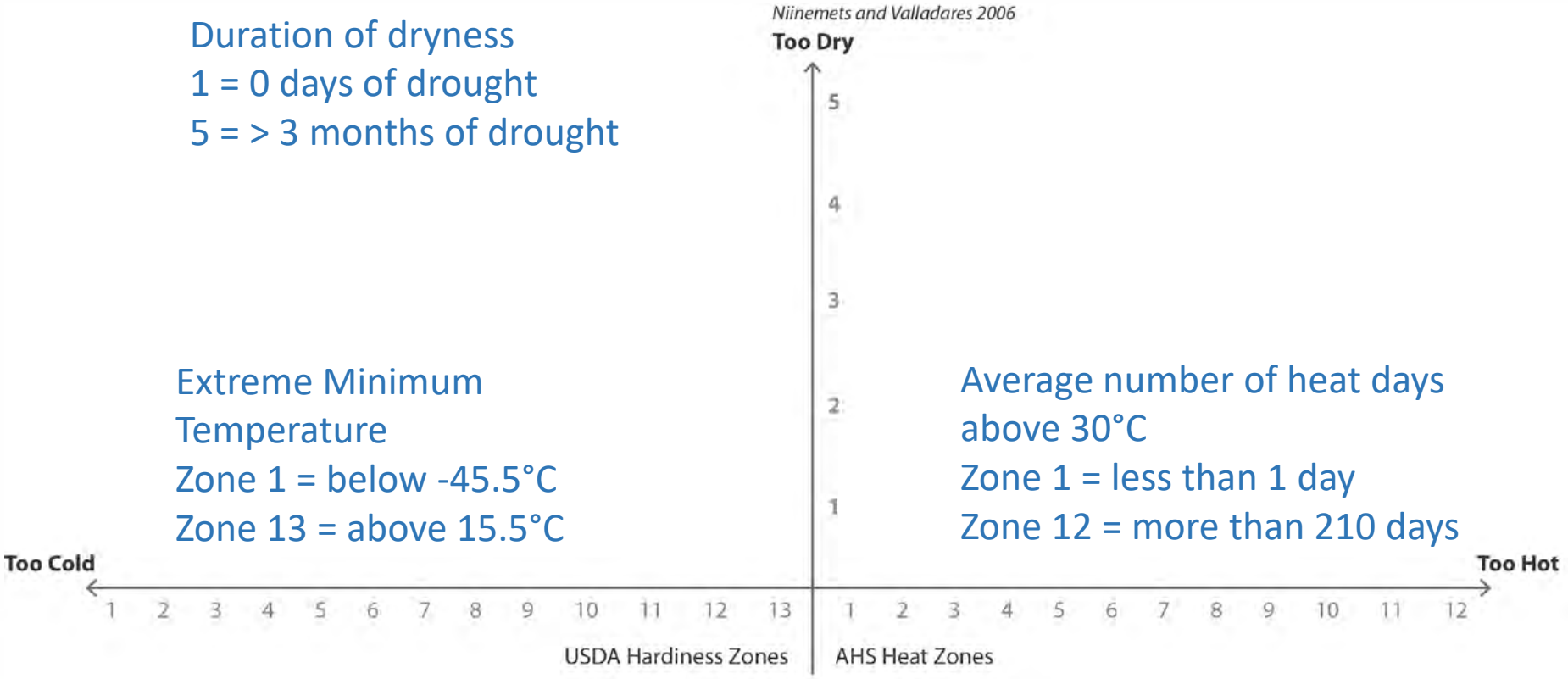
Species selection framework

At a regional scale, what do we need for a planted tree to establish and grow in our urban forest?

- Not too cold -> USDA Hardiness Zones
- Not too hot -> AHS Heat zones
- Not too dry -> Drought tolerance scale (Niinemets and Vallardes 2006)

Species selection framework

Duration of dryness
1 = 0 days of drought
5 = > 3 months of drought



Extreme Minimum Temperature
Zone 1 = below -45.5°C
Zone 13 = above 15.5°C

Average number of heat days above 30°C
Zone 1 = less than 1 day
Zone 12 = more than 210 days

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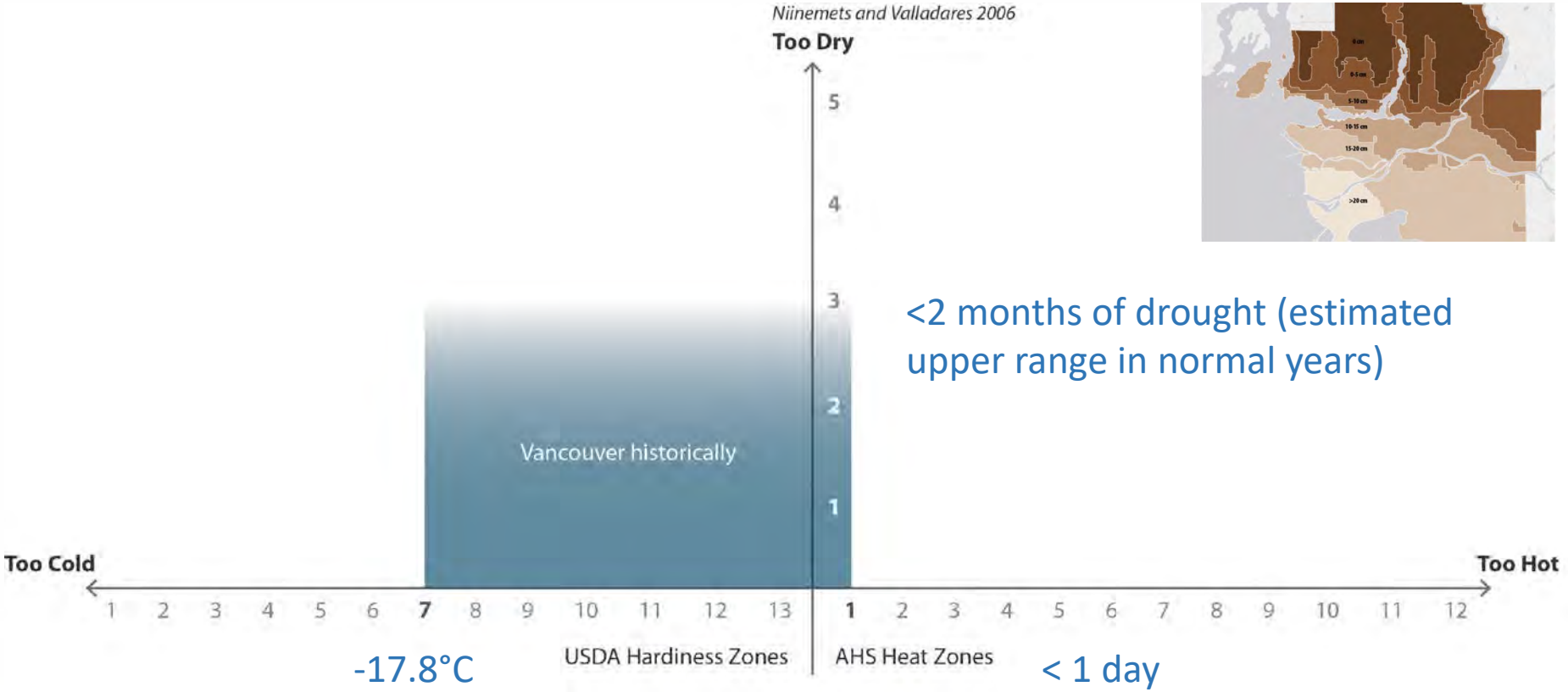
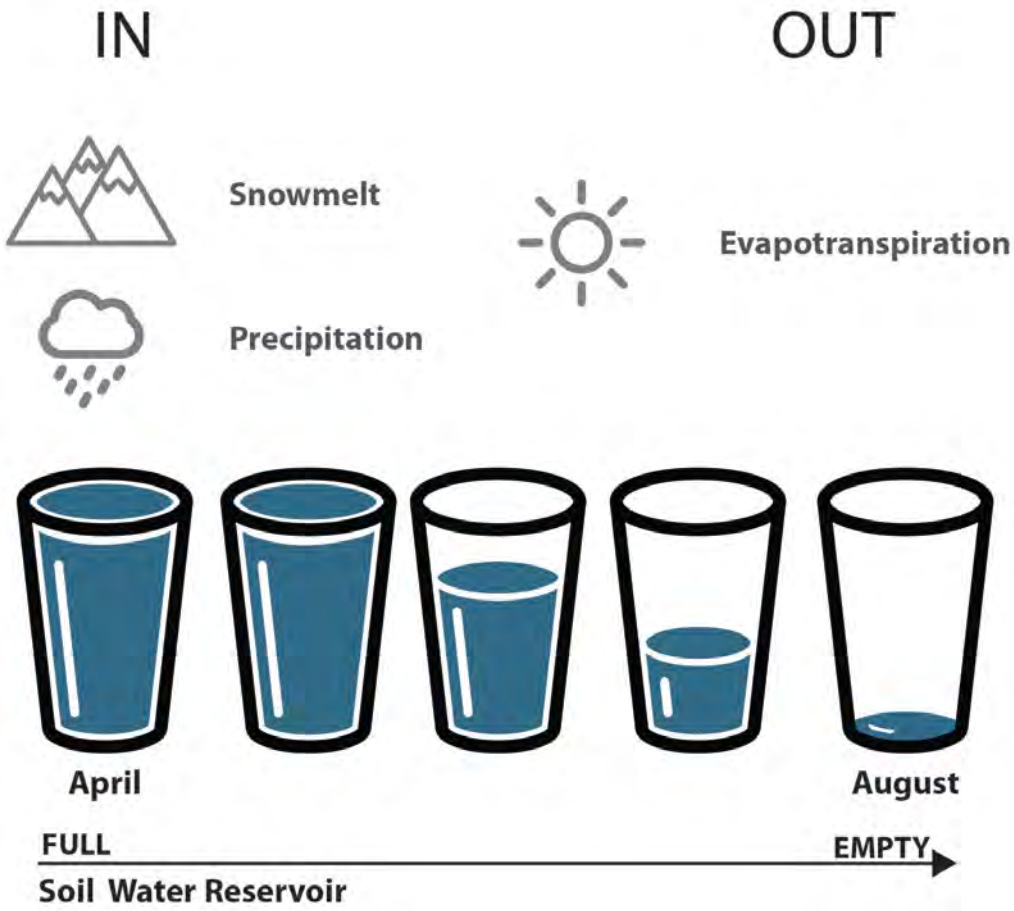
Species Selection Framework



<2 months of drought (estimated upper range in normal years)

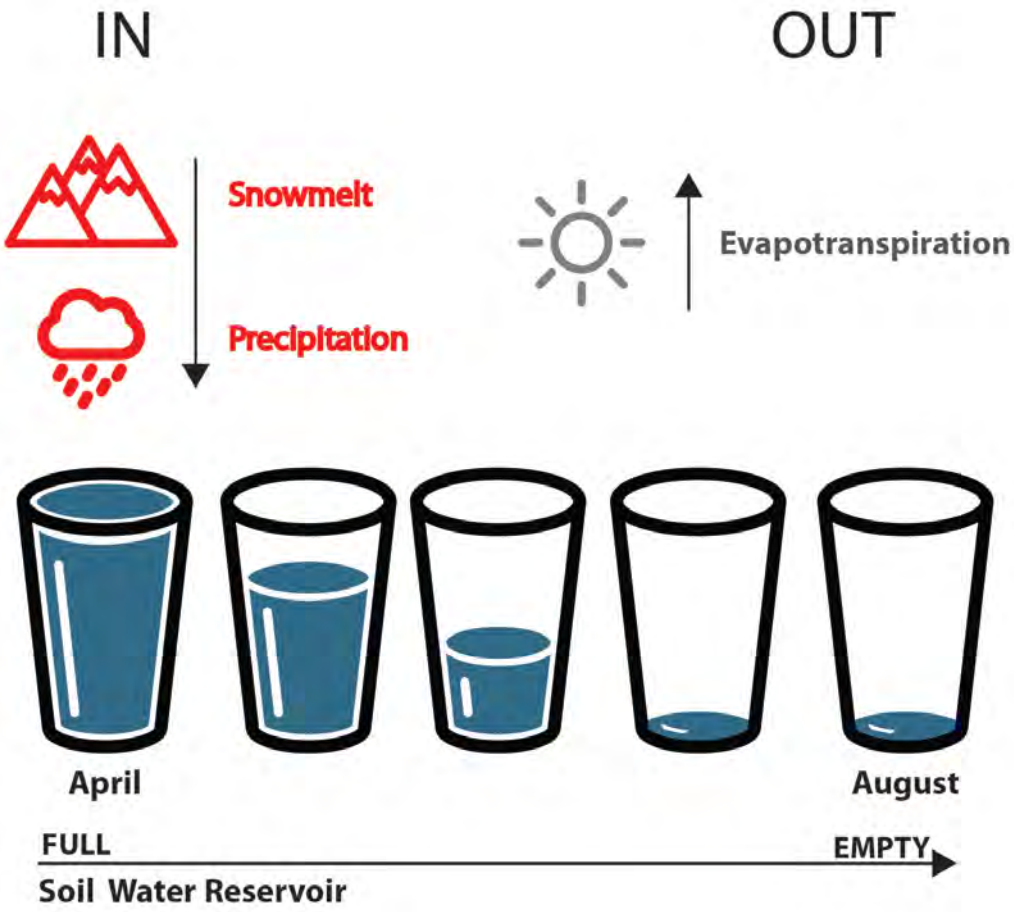
Species selection framework

Current concept of soil-water budget

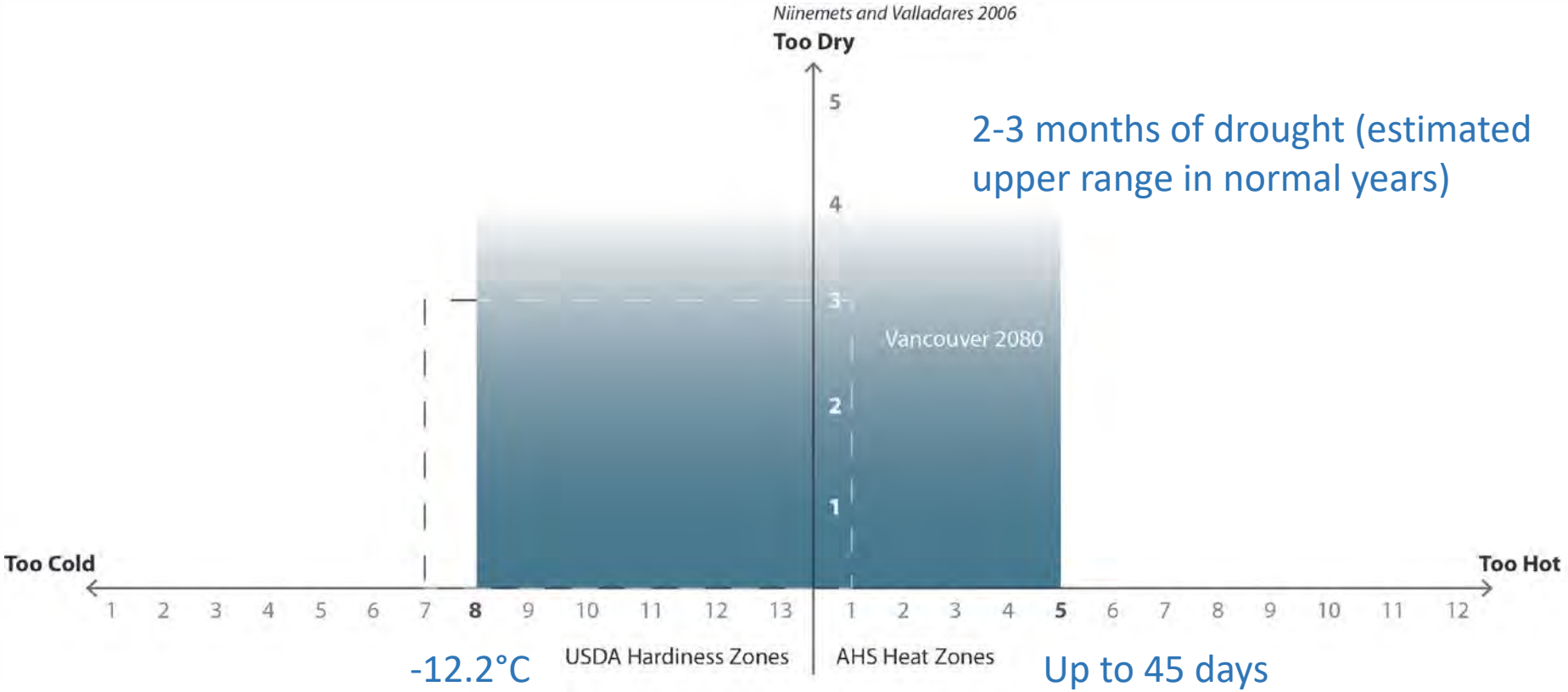


Species selection framework

Future concept of soil-water budget



Species selection framework



2-3 months of drought (estimated upper range in normal years)

-12.2°C

Up to 45 days

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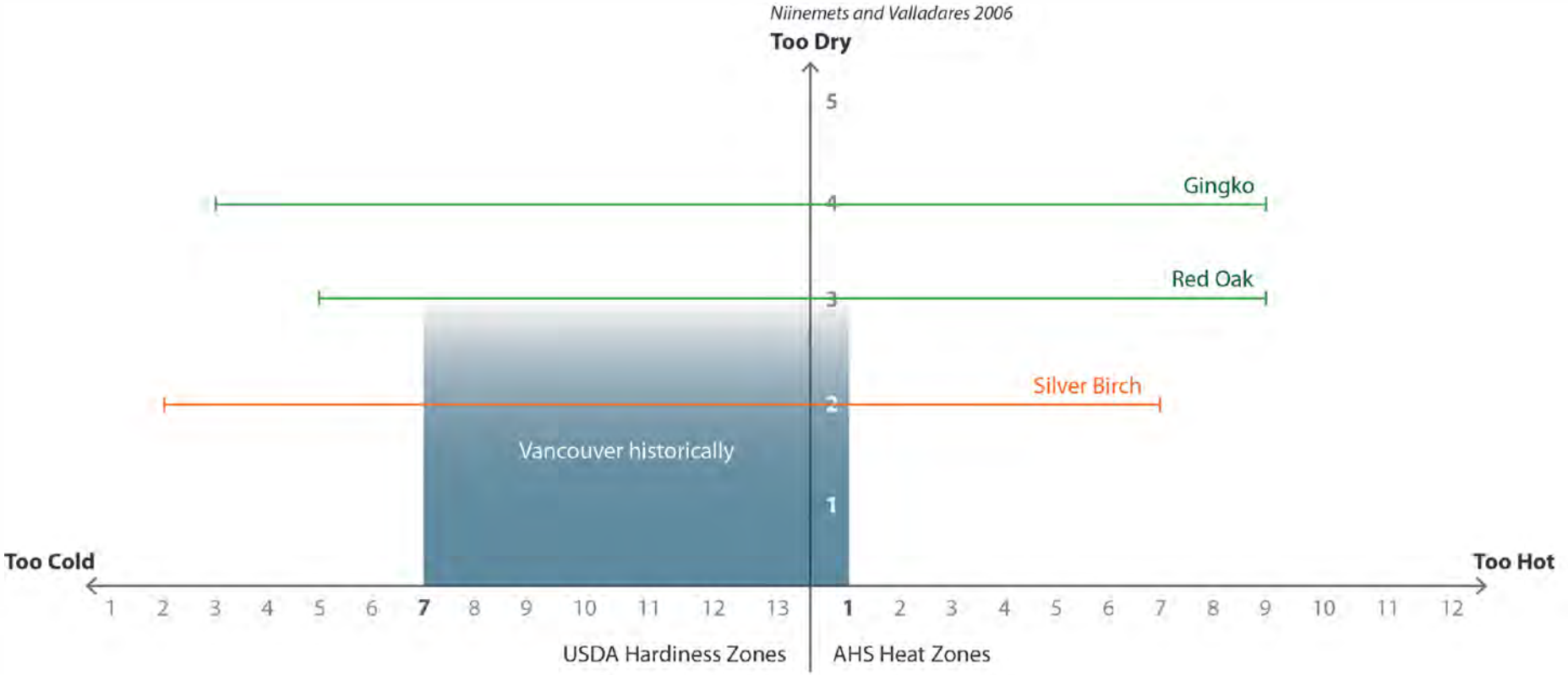
Species selection framework



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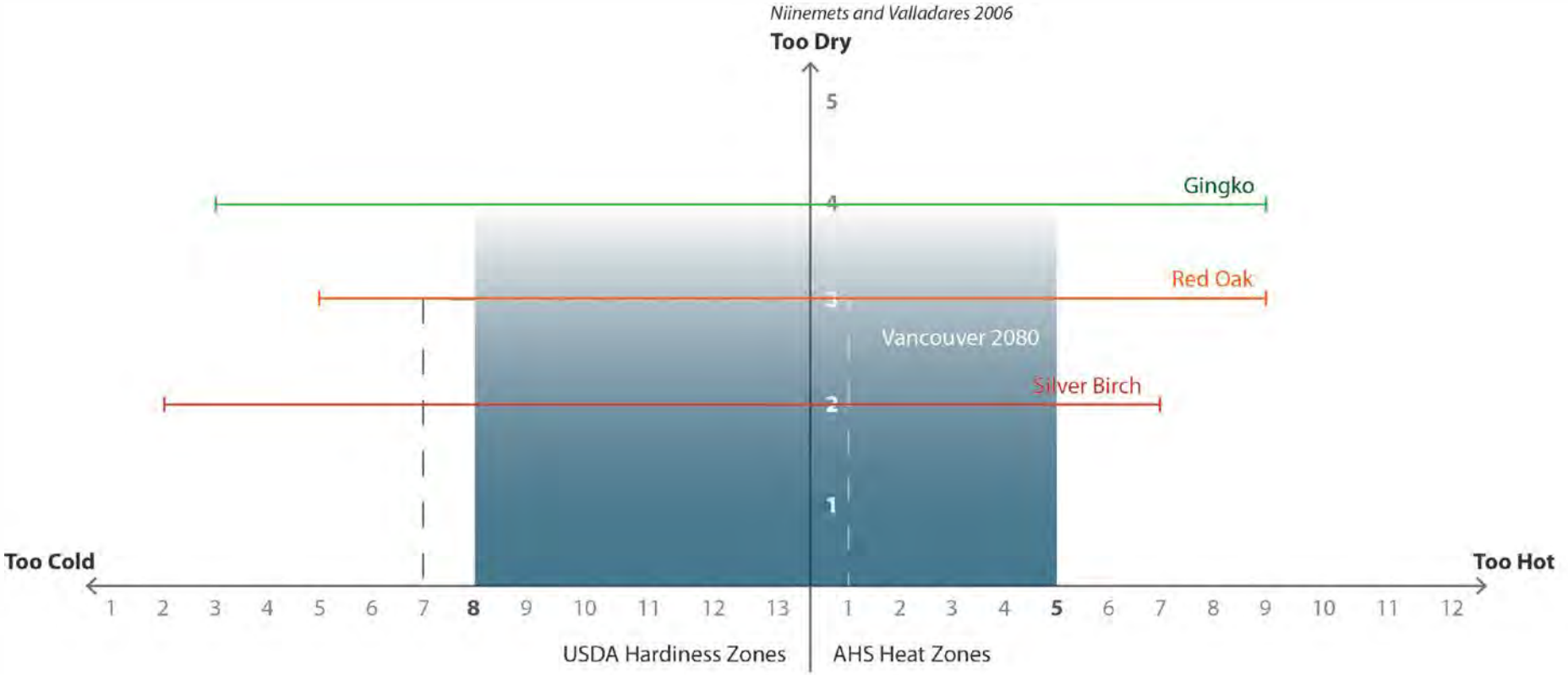
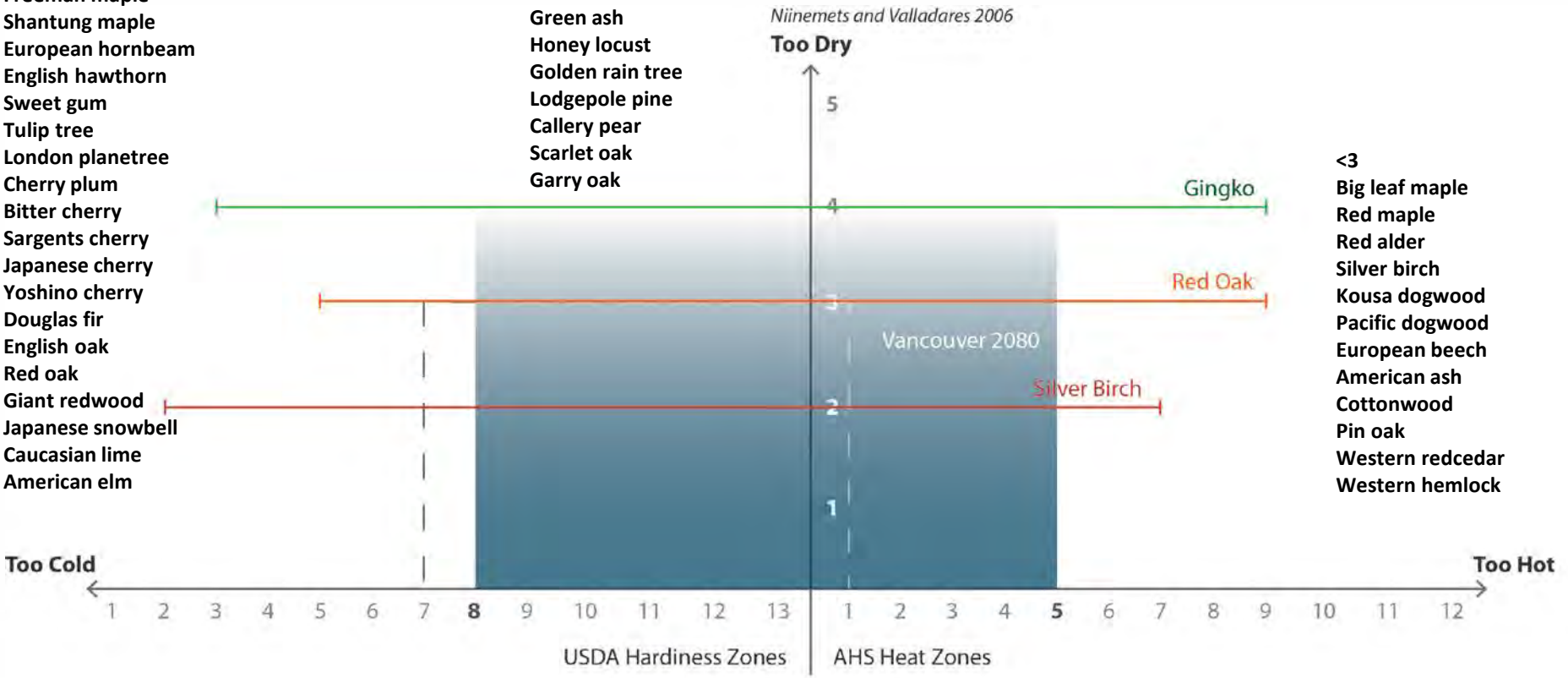
2. Species selection framework



2. Species selection framework

3
Field Maple
Freeman maple
Shantung maple
European hornbeam
English hawthorn
Sweet gum
Tulip tree
London planetree
Cherry plum
Bitter cherry
Sargents cherry
Japanese cherry
Yoshino cherry
Douglas fir
English oak
Red oak
Giant redwood
Japanese snowbell
Caucasian lime
American elm

>4
Eastern redbud
Manna ash
Green ash
Honey locust
Golden rain tree
Lodgepole pine
Callery pear
Scarlet oak
Garry oak



<3
Big leaf maple
Red maple
Red alder
Silver birch
Kousa dogwood
Pacific dogwood
European beech
American ash
Cottonwood
Pin oak
Western redcedar
Western hemlock

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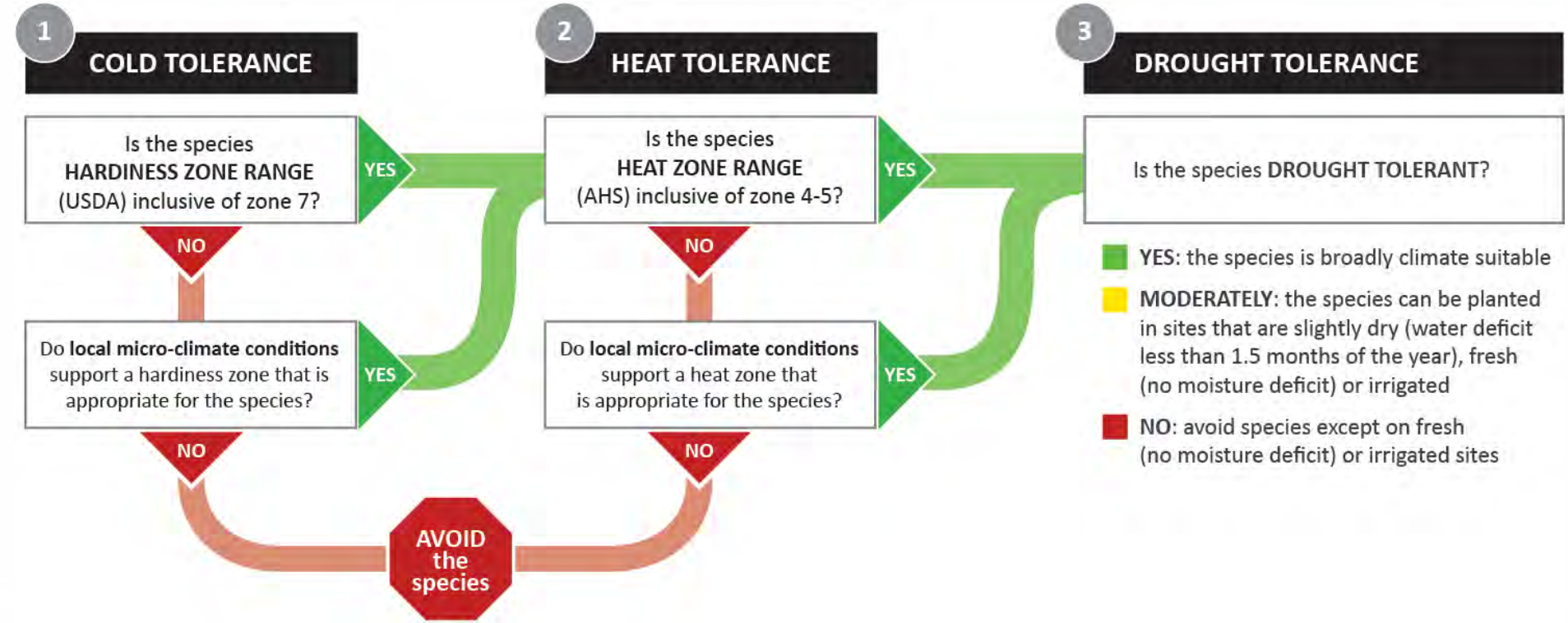
Species selection framework



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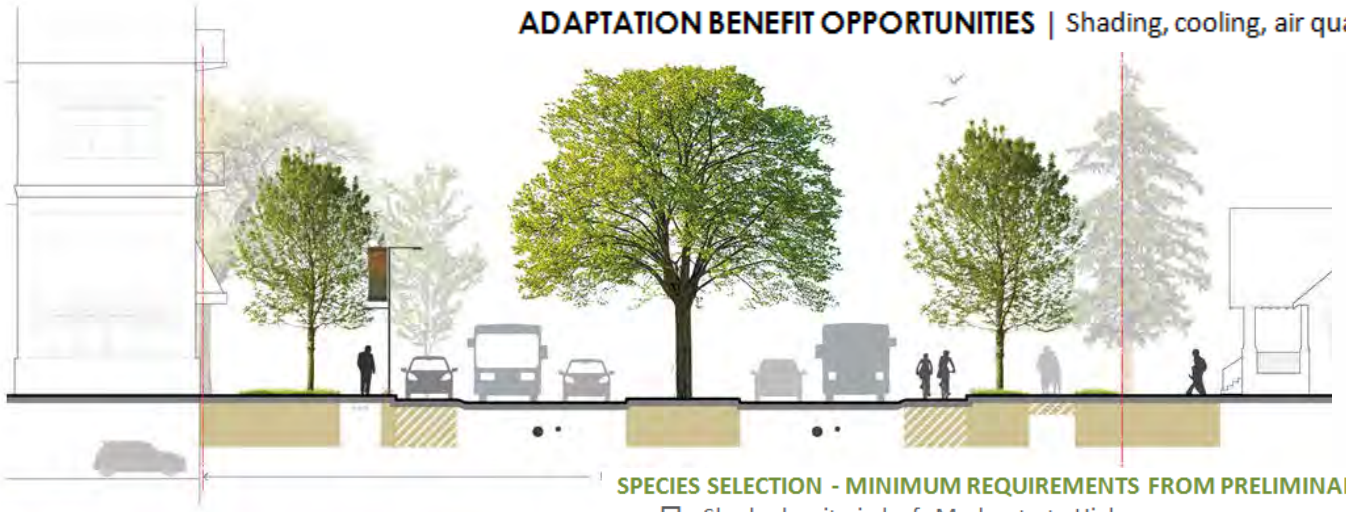
Design guidebook



ADAPTATION BENEFIT OPPORTUNITIES | Shading, cooling, air quality and stormwater management

1 Major Roads (Arterials)

SPECIES SELECTION - MINIMUM REQUIREMENTS FROM PRELIMINARY SPECIES DATABASE (APPENDIX A):

- ☐ Shade density in leaf: Moderate to High
- ☐ Evergreen: No
- ☐ Suitable location: street tree pits/boulevards/medians < 3 m
- ☐ Drought tolerance: Moderate to High
- ☐ VOC rating: Low to Moderate
- ☐ Wind breakage: Low to Moderate
- ☐ Noted public sources of complaints: None

*Prior to making a selection, refer back to the **site considerations** checklist (pg.10)*

EXAMPLES | trees that meet the above requirements

refer to the Preliminary Species Database (Appendix A) or other resources for additional options

LARGE TREES • Ginkgo (*Ginkgo biloba*) – male trees only
MEDIUM TREES • Manna ash (*Fraxinus ornus*)
SMALL TREES • Japanese snowbell (*Styrax japonicus*)

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Ongoing work

- Metro Vancouver expanding species database to 140 tree species
- Content conversion to online searchable database and design guidebook tools
- Municipalities incorporating content into their own plans

Merci! Thank you!

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Urban Forest Climate Adaptation Framework:

http://www.metrovancouver.org/services/regional-planning/PlanningPublications/UrbanForestClimateAdaptationFrameworkTreeSpeciesSelection.pdf

Design Guidebook:

http://www.metrovancouver.org/services/regional-planning/PlanningPublications/DesignGuidebook-MaximizingClimateAdaptationBenefitswithTrees.pdf

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