

Conservation status of native tree species in British Columbia

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Background

- Why conservation of genetic resources?
 - Natural evolution
 - Tree improvement
 - Adaptation to climate change
- Evaluation of conservation status
 - Critical to guide conservation activities
 - A framework developed – Hamann *et al.* 2005
 - Report (Tr053) - Chourmouzis *et al.* 2009 – *in situ* for all species
 - Report (Tr054) - Krakowski *et al.* 2009 – *in situ*+ *inter situ* + *ex situ* for commercial species only
 - All based on data of 2003.

TABLE 1 *In situ* conservation priorities for indigenous tree species in British Columbia. Priority ranking: x protection required, ? = verification required. The top priority zone for each species where there are multiple conservation concerns is outlined in bold; cells shaded in grey indicate that < 1% of the species' range (cumulative cover estimated from the data set) occurs in the zone.

	Biogeoclimatic zones ^a													
	AT	BG	BWB	CDF	CWH	ESSF	ICH	IDF	MH	MS	PP	SBP	SBS	SWB
Conifers														
ABIEAMA ^b														
ABIEGRA							?							
ABIELAS														
CHAMN00														
JUNISCO				?							x			
LARILAR														
LARILYA														
LARIOCC														
PICEENG														
PICEGLA														
PICEMAR														
PICESIT														
PINUALB														
PINUBAN			x											
PINUCON														
PINUFLE						?		?						
PINUMON														
PINUPON														
PSEUMEN														
TAXUBRE														
THUJPLI														
TSUGHET														
TSUGMER														
Broadleaves														
ACERCIR														
ACERGLA														
ACERMAC														
ALNUINC														
ALNURUB														
ALNUVIR														
ARBUMEN				?	?									
BETUNBO														
BETUOCC			?											
BETUPAP														
CORNNUT				?										
CORYCOR														
CRATDOU		?		?	?			?						
MALUFUS				?										
POPUBAL														
POPUTRE				?	?									
POPUTRI														
PRUNEMA								?						
PRUNPEN			?				?						?	
PRUNVIR							?			?				
QUERGAR														
RHAMPUR				?			?							
SALIBEB														
SALIDIS		?				?	?	x		?		?	?	
SALILUC								?						
SALISCO														
SALISIT														

Need to be updated for

- Increased *in situ* protected areas
- Improved species distribution data
 - Ecological plot data
 - VRI data
- Updated BEC versions
 - Version 4 was used
 - Version 10 is in use
- *Ex situ* protection to be considered for all species

Objectives

- Generate species occurrence maps based on improved ecological plot data
- Explore the suitability of VRI data for the analysis
- Conduct a gap analysis to assess the protection status of all native tree species
- Develop a web tool for easy data access and visualization

Table 1. The 25 coniferous and 18 broadleaf species.

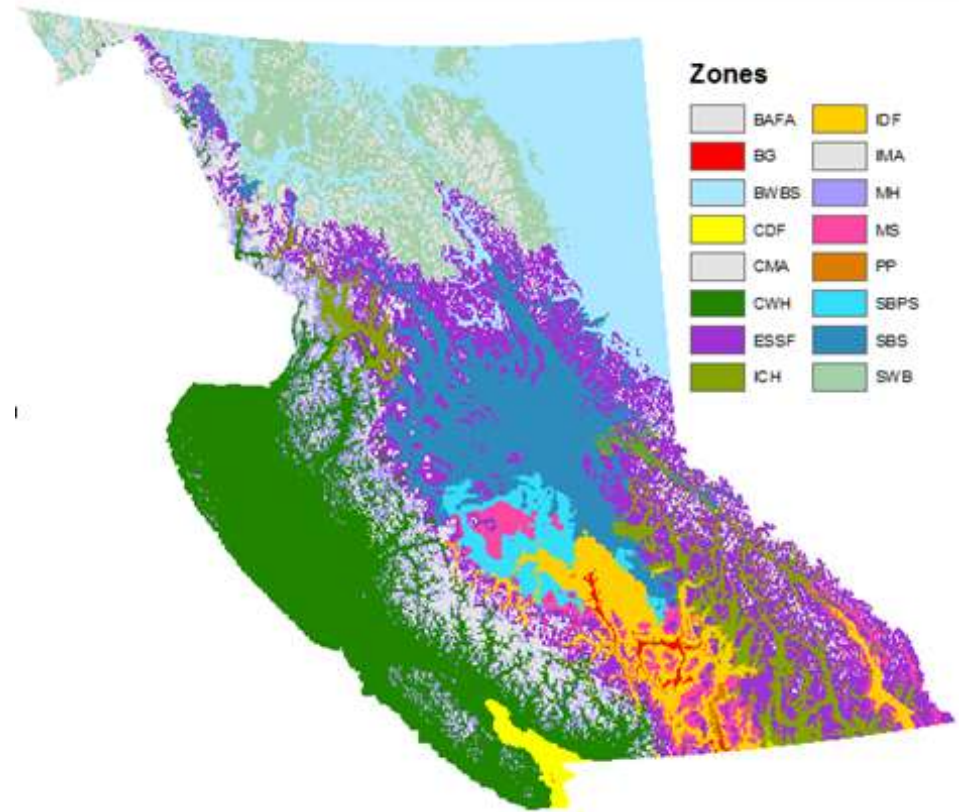
	Scientific name	common name	Code
conifers	<i>Abies amabilis</i>	Pacific silver fir	ABIEAMA
	<i>Abies grandis</i>	Grand fir	ABIEGRA
	<i>Abies lasiocarpa</i>	Subalpine fir	ABIELAS
	<i>Callitropsis nootkatensis</i>	Yellow-cedar	CALLNOO
	<i>Juniperus maritima</i>	Seaside Juniper	JUNIMAR
	<i>Juniperus scopulorum</i>	Rocky Mtn. juniper	JUNISCO
	<i>Larix laricina</i>	Tamarack	LARILAR
	<i>Larix lyallii</i>	Subalpine larch	LARILYA
	<i>Larix occidentalis</i>	Western larch	LARIOCC
	<i>Picea engelmannii</i>	Engelmann spruce	PICEENG
	<i>Picea glauca</i>	White spruce	PICEGLA
	<i>Picea glauca x Picea engelmannii</i>	Interior spruce hybrid	PICEENE
	<i>Picea mariana</i>	Black spruce	PICEMAR
	<i>Picea sitchensis</i>	Sitka spruce	PICESIT
	<i>Pinus albicaulis</i>	Whitebark pine	PINUALB
	<i>Pinus banksiana</i>	Jack pine	PINUBAN
	<i>Pinus contorta</i>	Lodgepole pine	PINUCON
	<i>Pinus flexilis</i>	Limber pine	PINUFLE
	<i>Pinus monticola</i>	Western white pine	PINUMON
	<i>Pinus ponderosa</i>	Ponderosa pine	PINUPON
	<i>Pseudotsuga menziesii</i>	Douglas-fir	PSEUMEN
	<i>Taxus brevifolia</i>	Pacific yew	TAXUBRE
	<i>Thuja plicata</i>	Western redcedar	THUJPLI
	<i>Tsuga heterophylla</i>	Western hemlock	TSUGHET
	<i>Tsuga mertensiana</i>	Mountain hemlock	TSUGMER
Broadleaves	<i>Acer circinatum</i>	Vine maple	ACERCIR
	<i>Acer glabrum</i>	Douglas maple	ACERGLA
	<i>Acer macrophyllum</i>	Bigleaf maple	ACERMAR
	<i>Alnus rubra</i>	Red Alder	ALNURUB
	<i>Arbutus menziesii</i>	Arbutus	ARBUMEN
	<i>Betula neoalaskana</i>	Alaska paper birch	BETUNEO
	<i>Betula occidentalis</i>	Water birch	BETUOCC
	<i>Betula papyrifera</i>	Paper birch	BETUPAP
	<i>Cornus nuttallii</i>	West. flowering dogwood	CORNNUC
	<i>Malus fusca</i>	Pacific crab apple	MALUFUS
	<i>Populus balsamifera</i>	Balsam Poplar	POPUBAL
	<i>Populus tremuloides</i>	Trembling aspen	POPUTRE
	<i>Populus trichocarpa</i>	Black cottonwood	POPUTRI
	<i>Prunus emarginata</i>	Bitter cherry	PRUNEMA
	<i>Quercus garryana</i>	Garry oak	QUERGAR
	<i>Rhamnus purshiana</i>	Cascara	RHAMPUR
	<i>Salix lucida</i>	Pacific willow	SALILUC
	<i>Salix scouleriana</i>	Scouler's Willow	SALISCO

There are 43 native tree species, including 25 coniferous and 18 broadleaf species

BEC

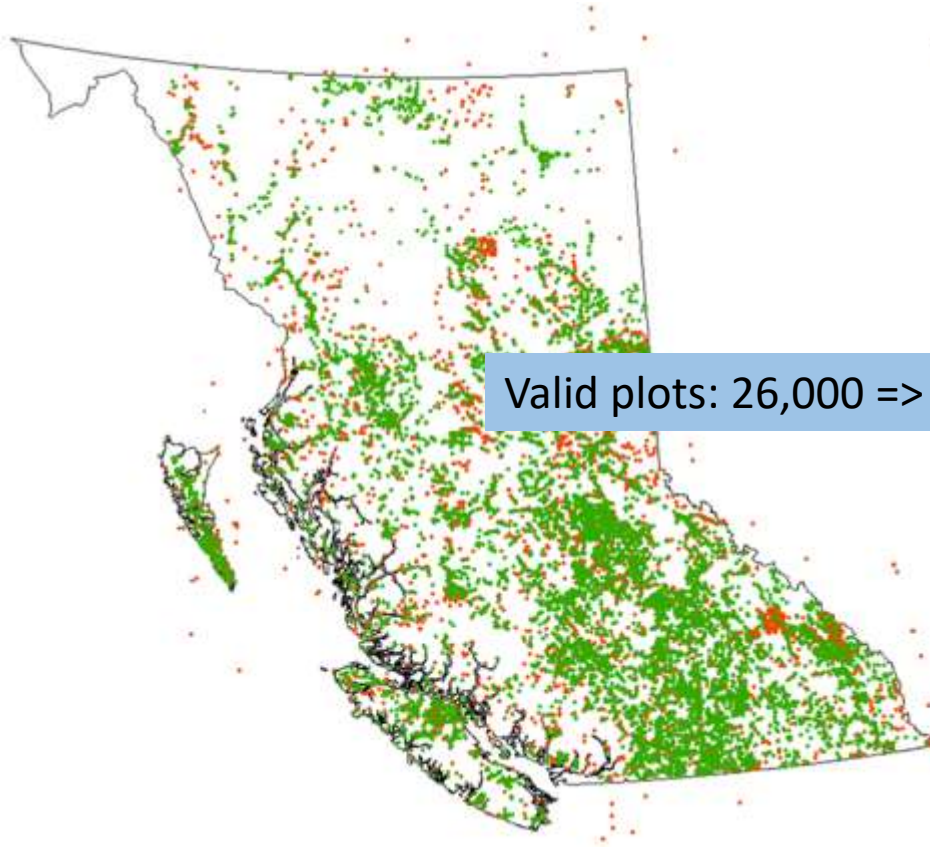
- BEC 10
 - 16 zones
 - 139 subzones
 - 208 subzone-variants

BEC 10

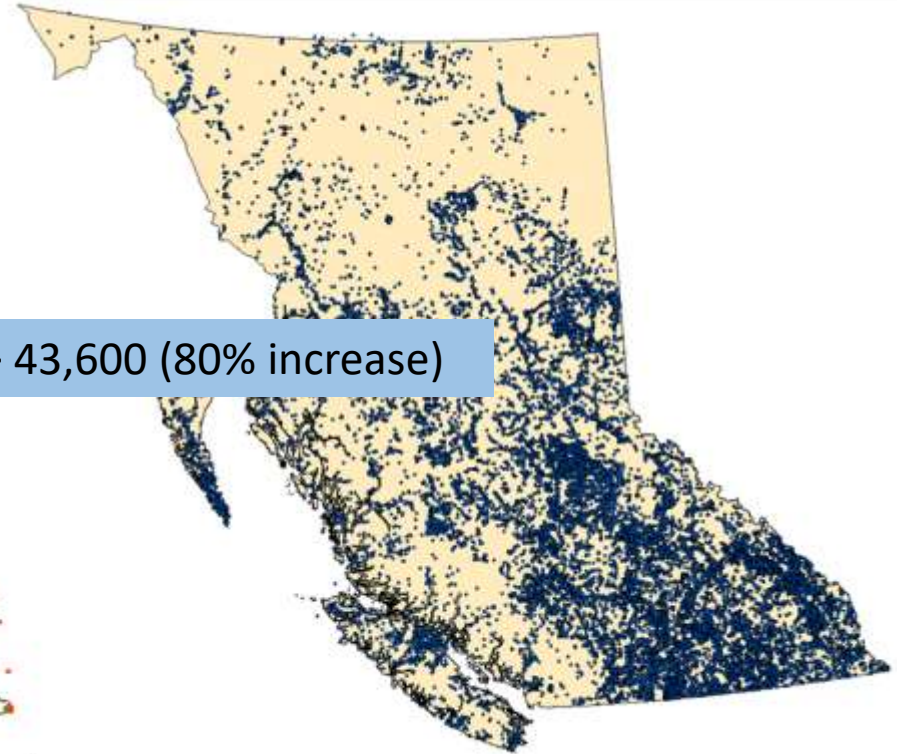


Ecological plot (E-Plot) data

Old E-Plot data



New E-Plot data

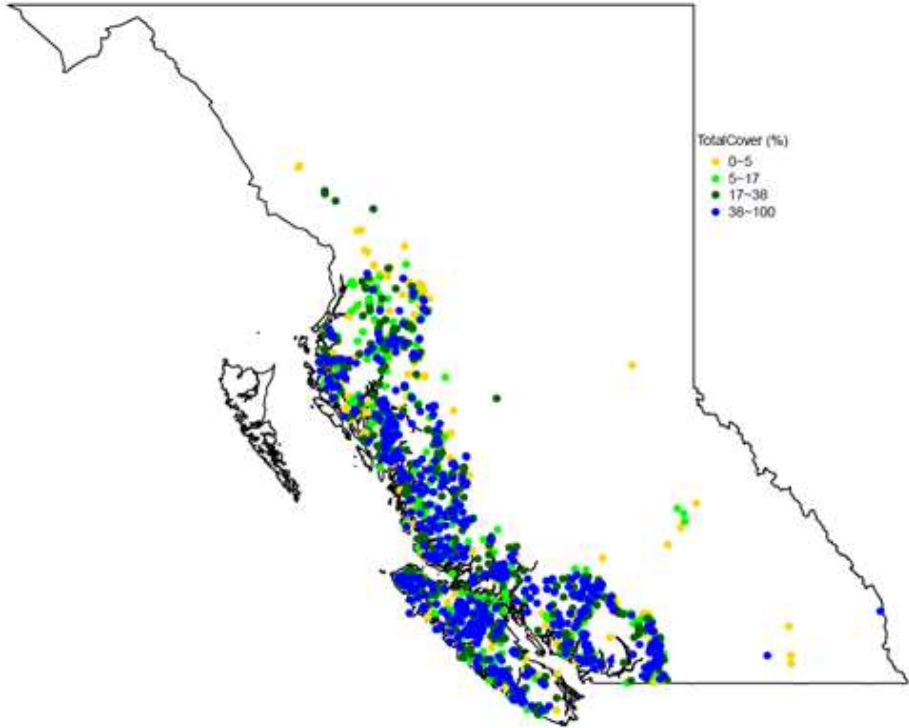


Valid plots: 26,000 => 43,600 (80% increase)

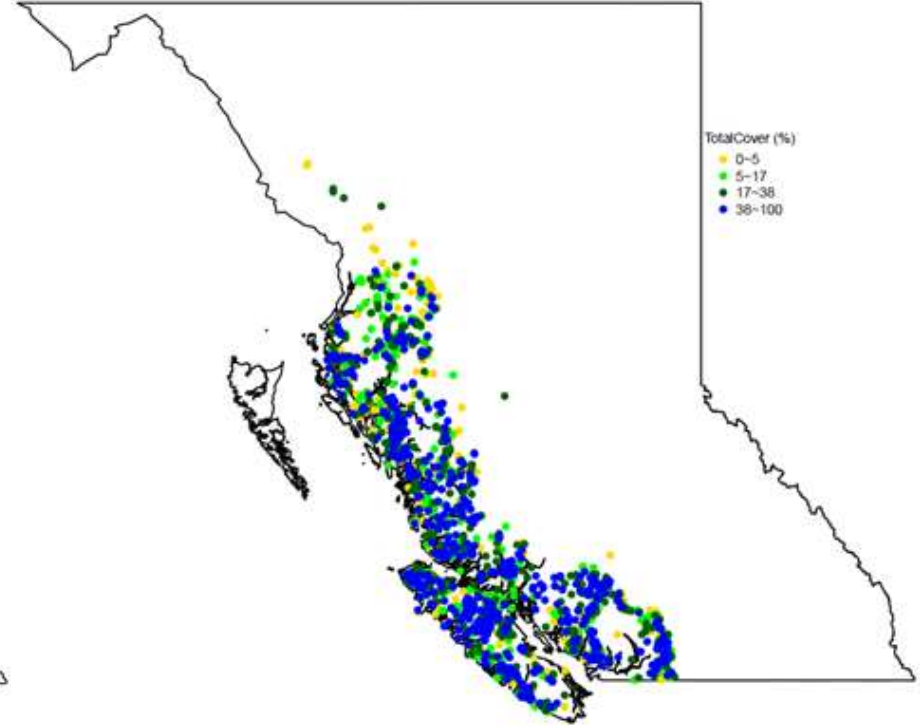
Subzone matching: ● Matched ● Not matched

Further cleaning

Percent crown cover of E-Plots for Pacific silver fir



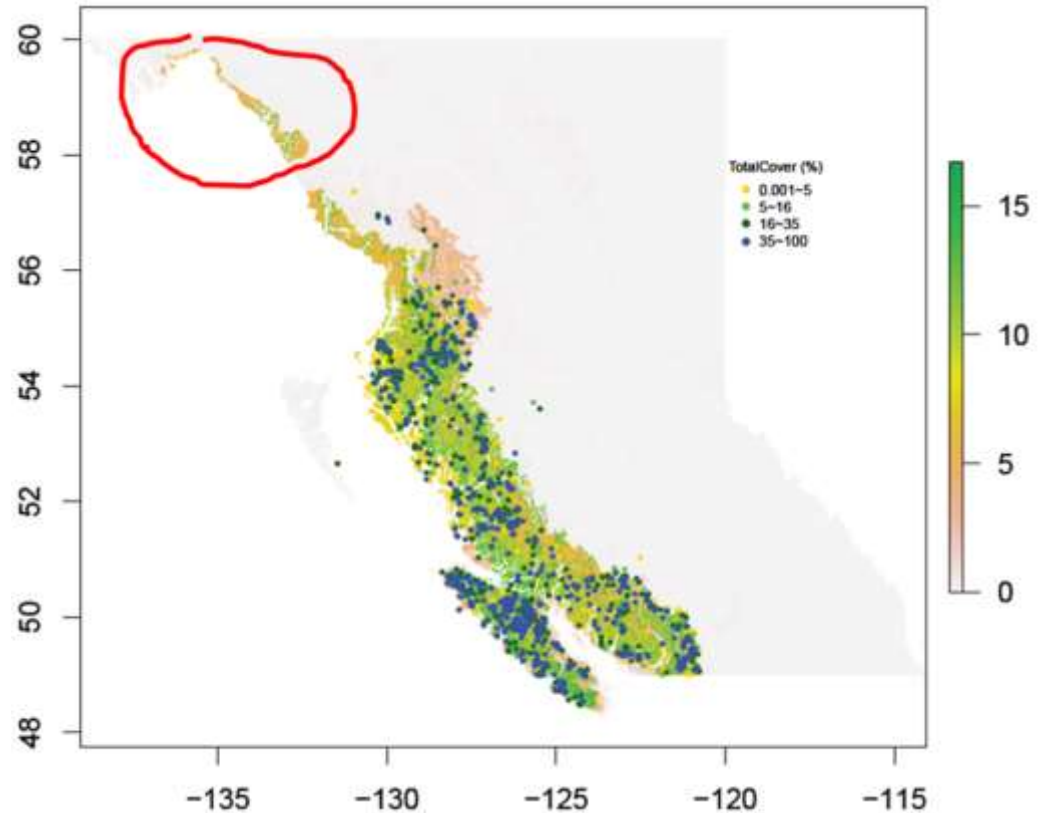
Before



After

From plots to BEC variants

- Percent crown cover for each species in each BEC variant was calculated based on the percent crown cover of all plots distributed within that BEC variant
- Adjusted for some BEC variants along the coast



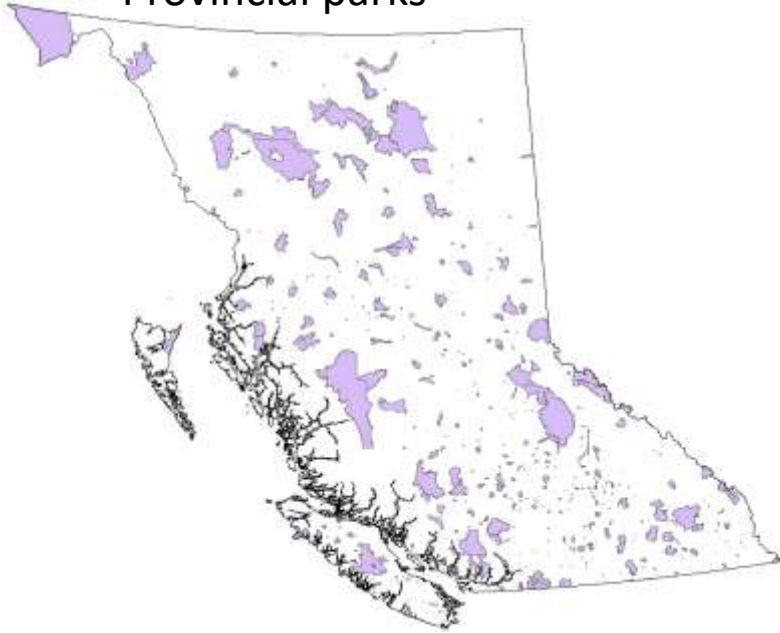
VRI data

- VRI dataset was explored and tested;
- It does not have the accuracy and additional information to support this evaluation.
 - Commercial species: comparable, but not in need
 - Non-commercial species: differences are large
 - Rare species: six species are missing

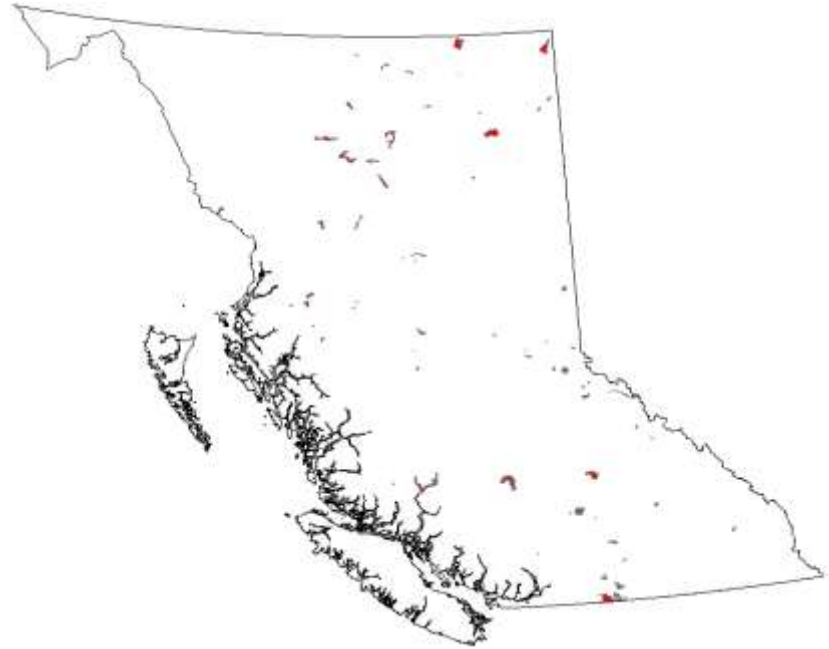
Protected areas

- Provincial protected areas
- National parks

Provincial parks



Protected areas



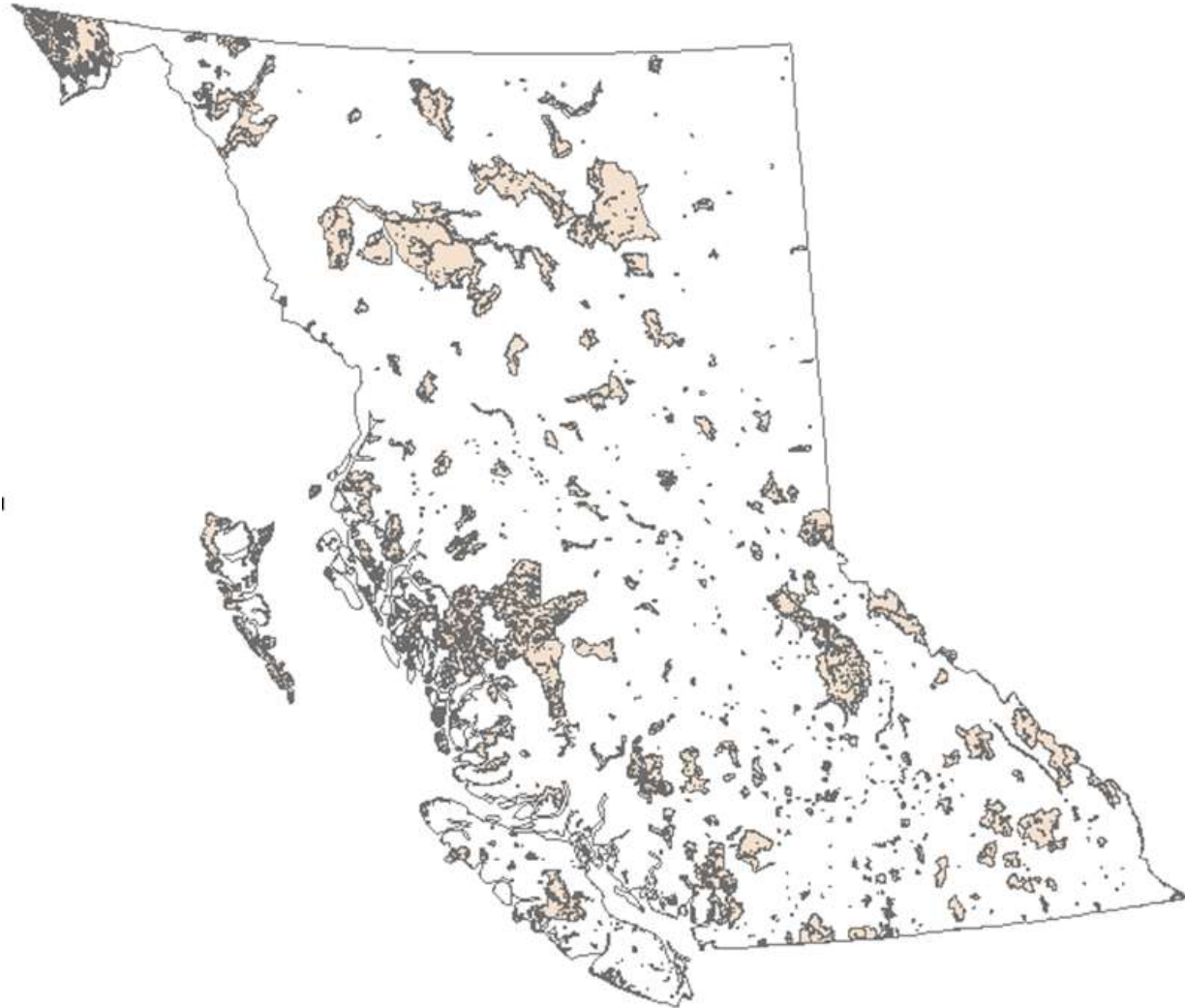
Ecological reserves



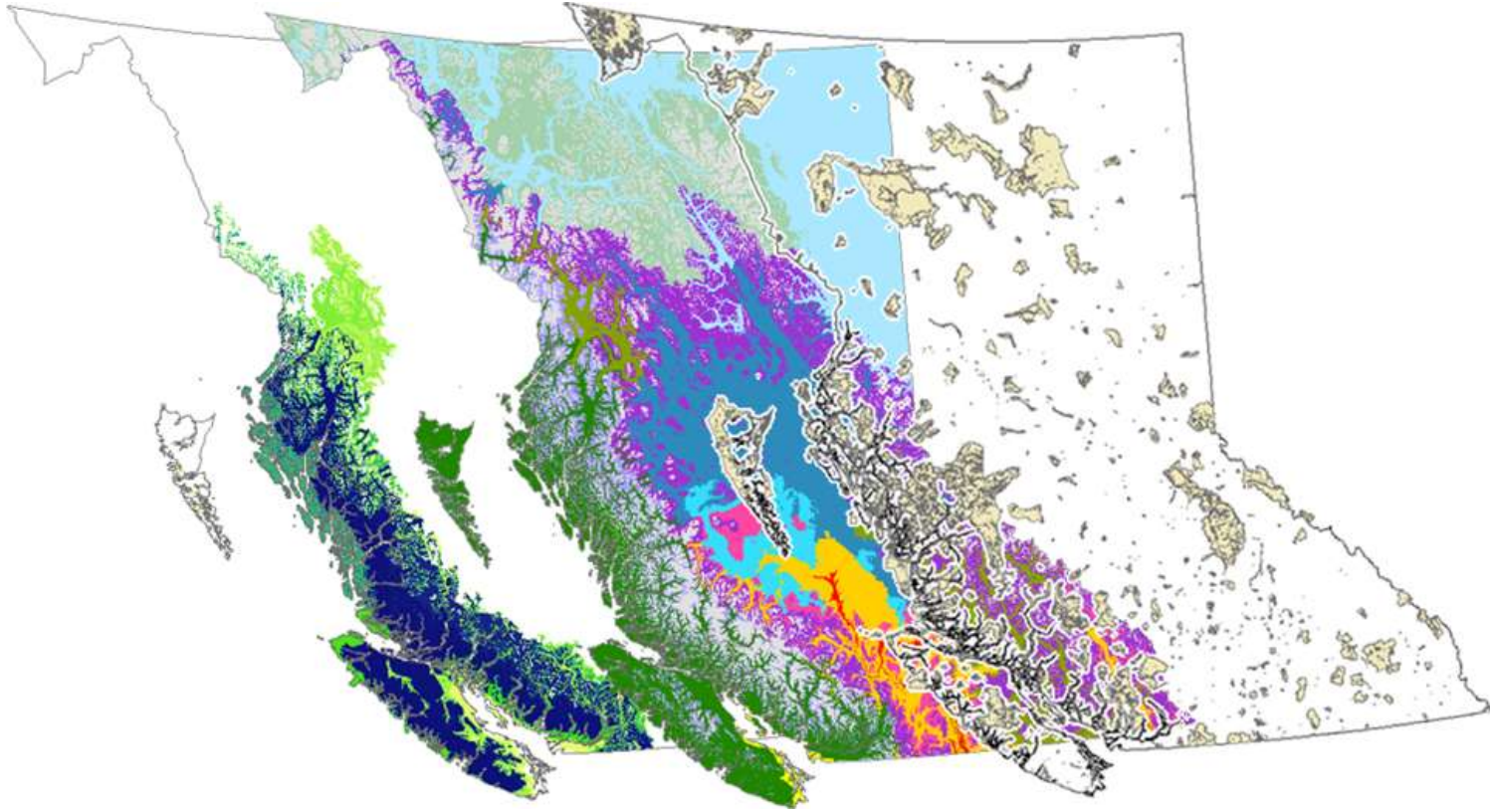
Conservancy Areas + recreation areas



Total protected areas – national parks included
and water bodies removed



Gap analysis



The scheme of the gap analysis that integrates information from species, BEC zones, and protected areas.

Gap analysis for each species

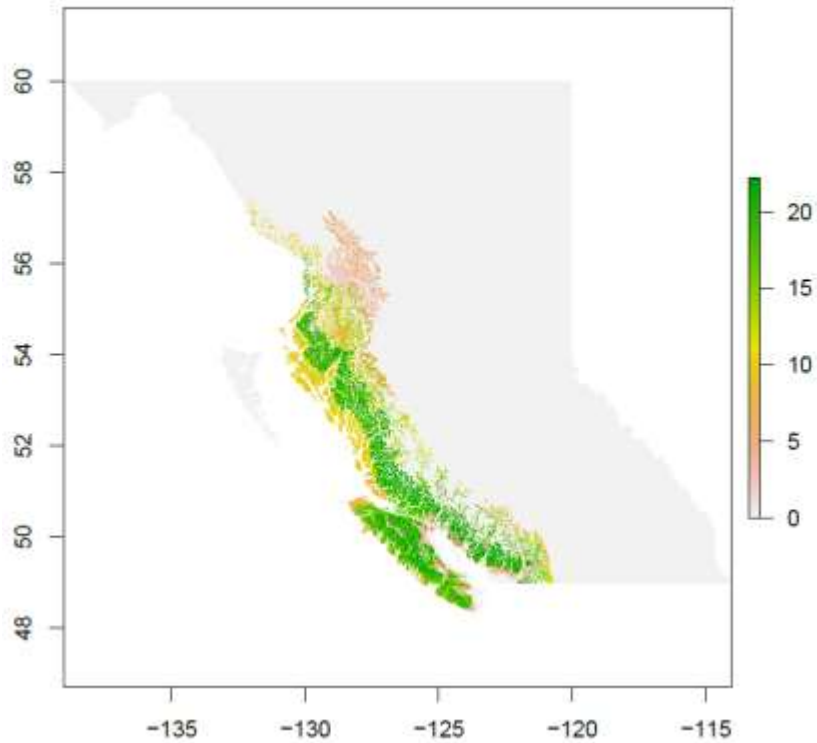
- Cumulative Crown Cover (CC) was calculated for each protected area in each zone
- The number of protected areas with CC greater than 10 ha was also calculated.
- A protected area meeting this criterion was considered containing “a viable population”.
- At least three viable populations protected in a zone was considered as well protected.
- The number of protected areas with CC greater than 2.5 ha was also calculated, and considered as partially protected.

Ex situ protected populations

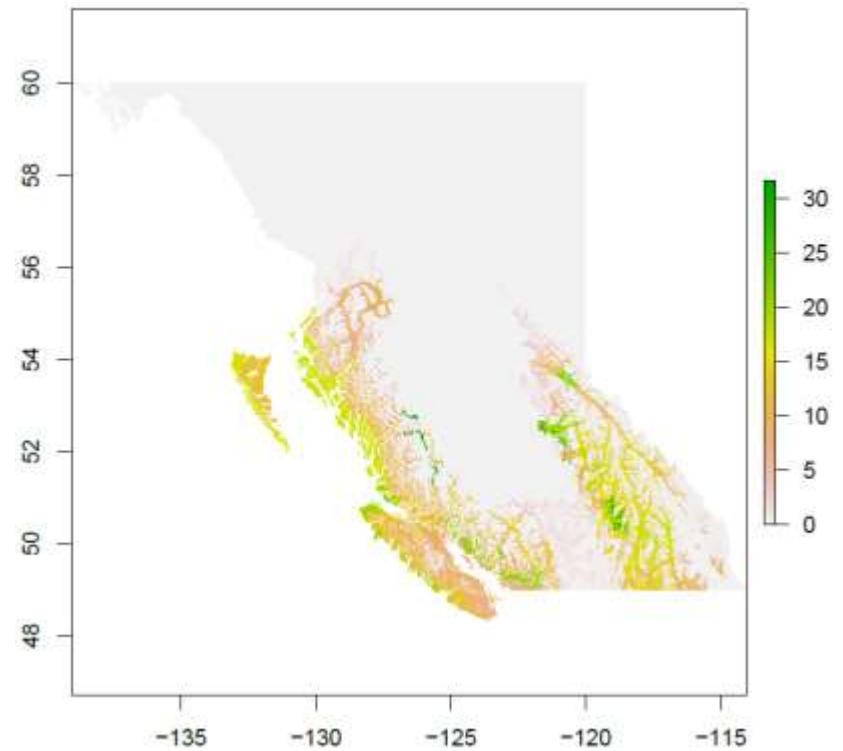
- Information provided by TSC.
- *Ex situ* protection only considered for the protection units where *in situ* protection was not adequate.
- A minimum of 20-tree collection is required for each population

Results – species maps

ABIE_AMA (Pacific silver fir)



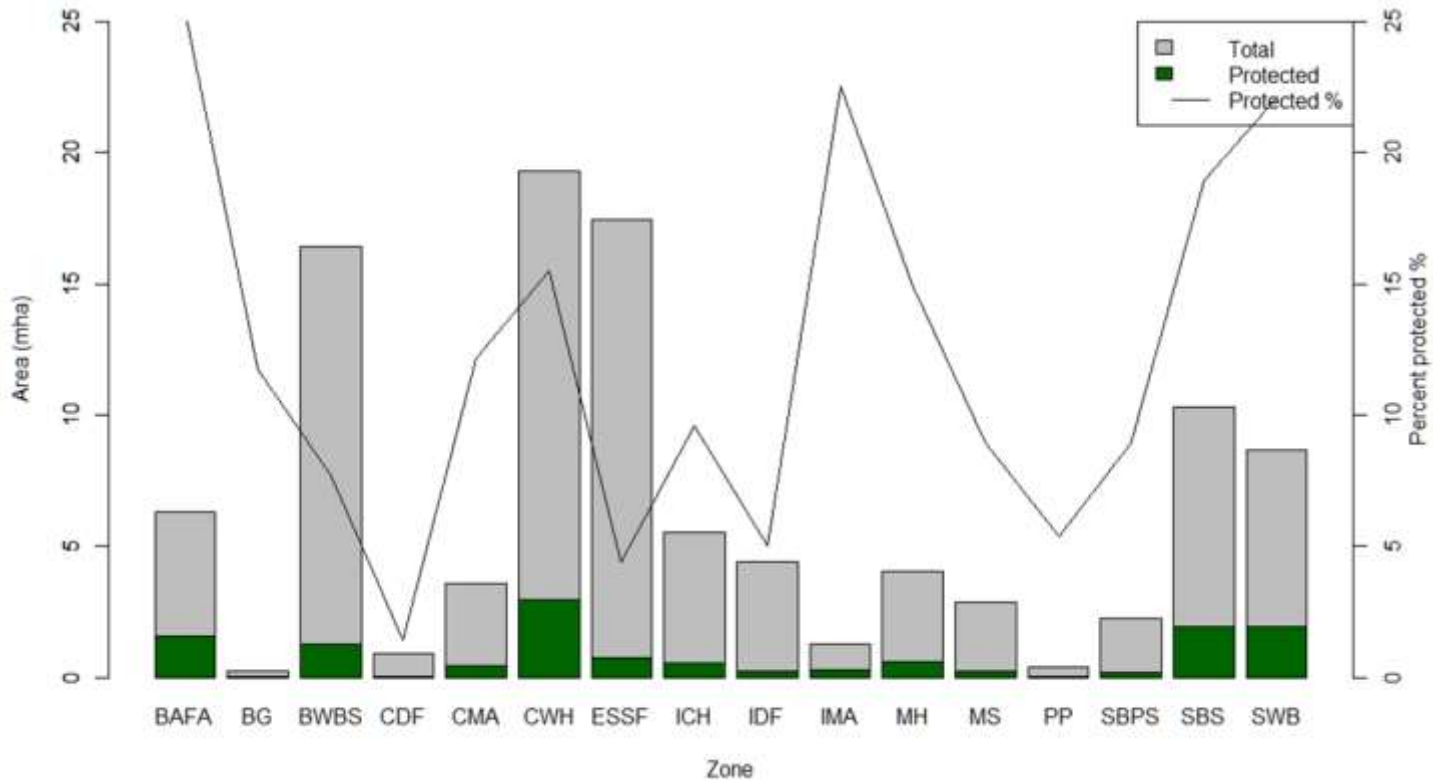
THUJ_PLI (Western redcedar)



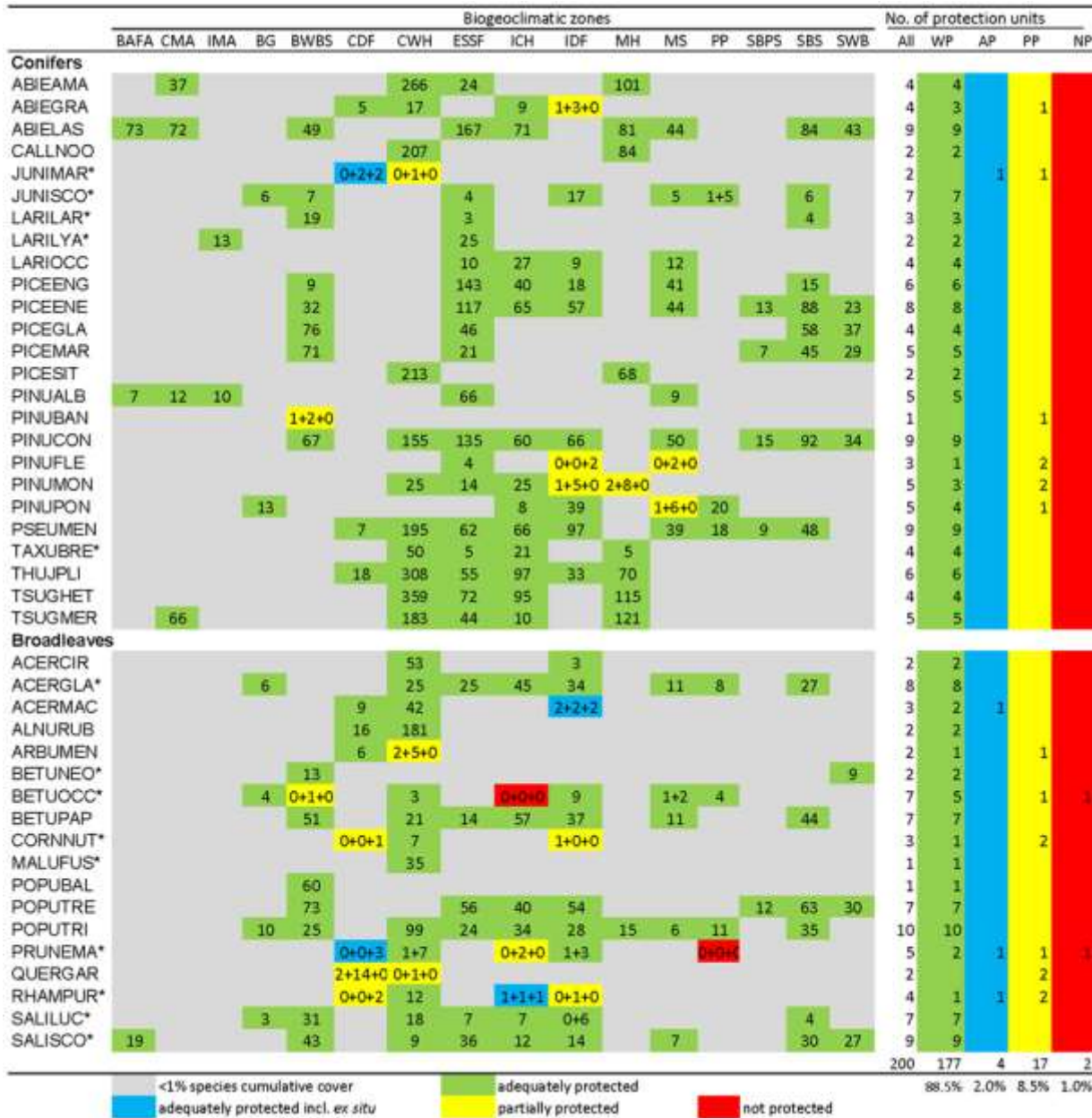
Species occurrence and percent crown cover maps

Results – total protected areas

- Increased from 11% in 2003 to 15% in 2017
- Varied among zones



Protection status

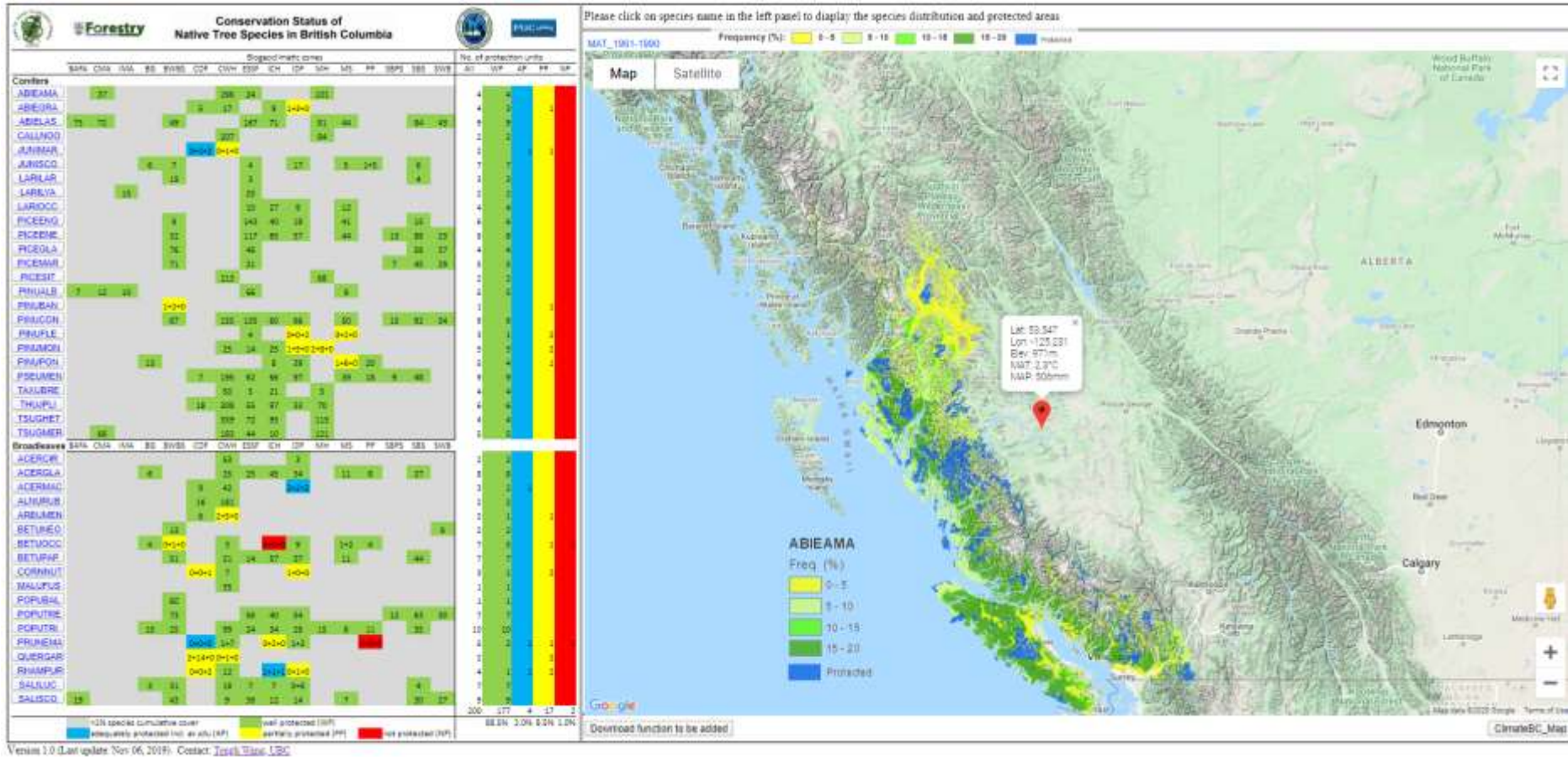


- 200 protection units – color cells
- 88.5% of the units well protected
- 2% ex situ protected, increased the total protected units to 91%
- 8.5% partially protected
- 1% not protected

Protection gaps

- There are 13 species with *in situ* conservation gaps
- They were divided into three categories:
 - Species with good conservation status (3 of 13)
 - Ponderosa pine, Gary oak, Arbutus
 - Low priority (6 of 13)
 - Ground fir, Western pine, Jack pine
 - Bigleaf maple, Cascara, Water birch
 - Top priority species (4 of 13) ofr ex situ protection:
 - Limber pine, seaside juniper
 - Dog wood, bitter cherry

A interactive web tool



[Go to the tool](#)

ClimateBC update

Tongli Wang

CFCG, Department of Forest and Conservation
Sciences, UBC

Applying Climate Change Information in Resource Management User Needs Survey

2019

Some highlights

*“Many respondents already use variables that are available in ClimateBC” – **widely used***

*“Expert users can extract spatial data from ClimateBC, but many lack the technical skill required.” – **the need for spatial data***

*“3.3.3 Existing websites: Many respondents have used ClimateBC and found it to be extremely useful.” – **the web version is useful***

Recommendation:

*“ClimateBC seems to be a well-known and used tool; rather than developing new tools, building on the existing website may be preferable.” – **worth of further development***

A brand new website has been built

ClimateBC

Raster files download

Web version

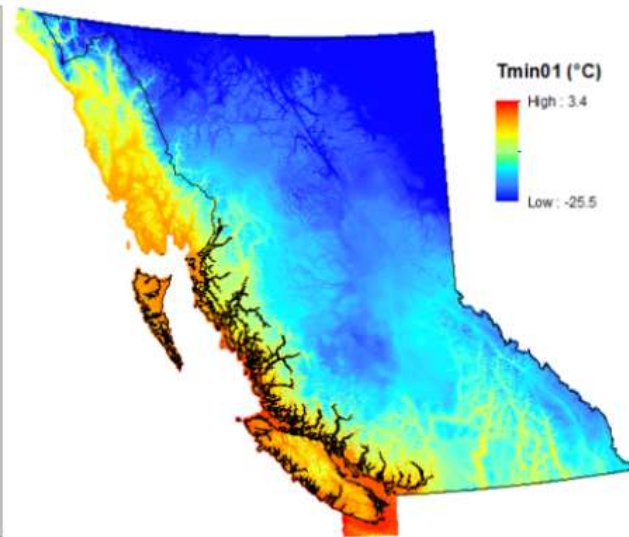
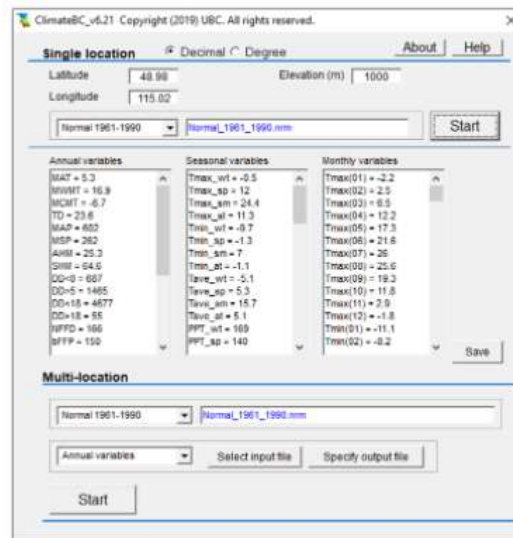
Conservation status

References

Contact

About ClimateBC

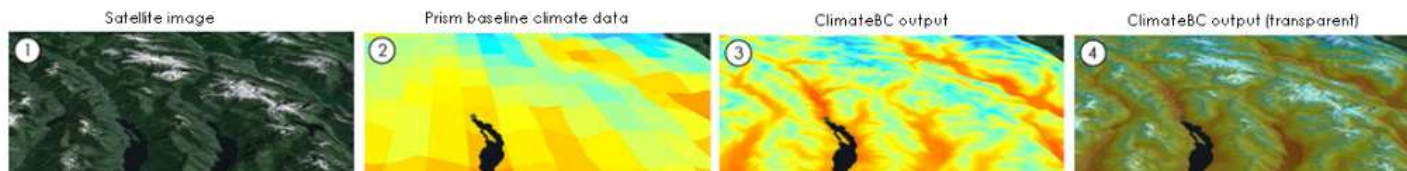
ClimateBC is a standalone MS Windows application that downscales PRISM (Daly et al. 2008) 1971-2000 gridded monthly climate normal data (800 x 800 m) to scale-free point locations. It calculates and derives many (>200) monthly, seasonal and annual climate variables. ClimateBC also uses the scale-free data as a baseline to downscale historical and future climate variables for individual years and periods between 1901 and 2100. ClimateBC covers entire British Columbia and some surrounding areas (shown below). To **download** the package, please click [here](#). For scale-free climate data beyond this coverage in North America, please visit [ClimateNA](#).



Main features

1. Scale-free climate data

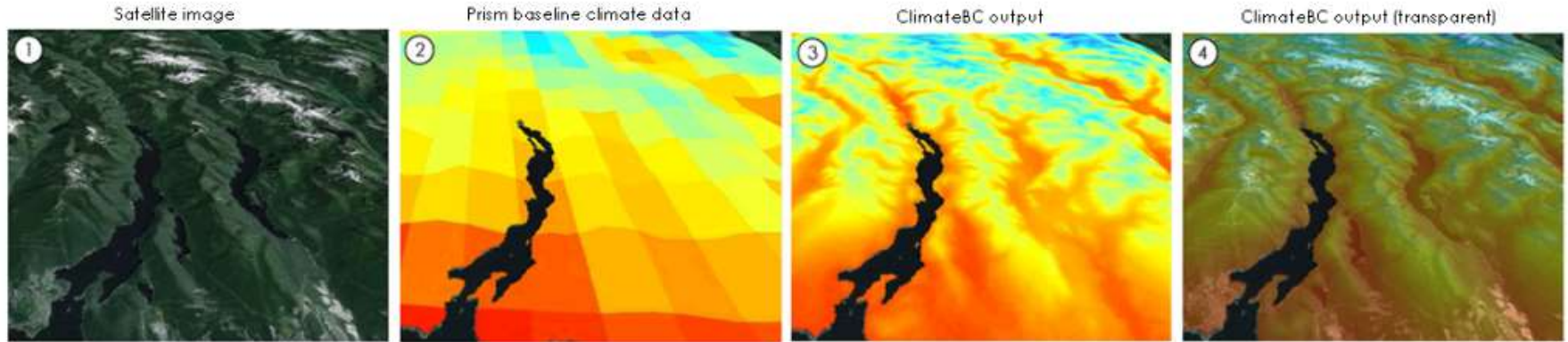
ClimateBC generates scale-free climate data that facilitates users to obtain climate data for specific locations (instead of grid averages) and climate surfaces at any spatial resolutions.



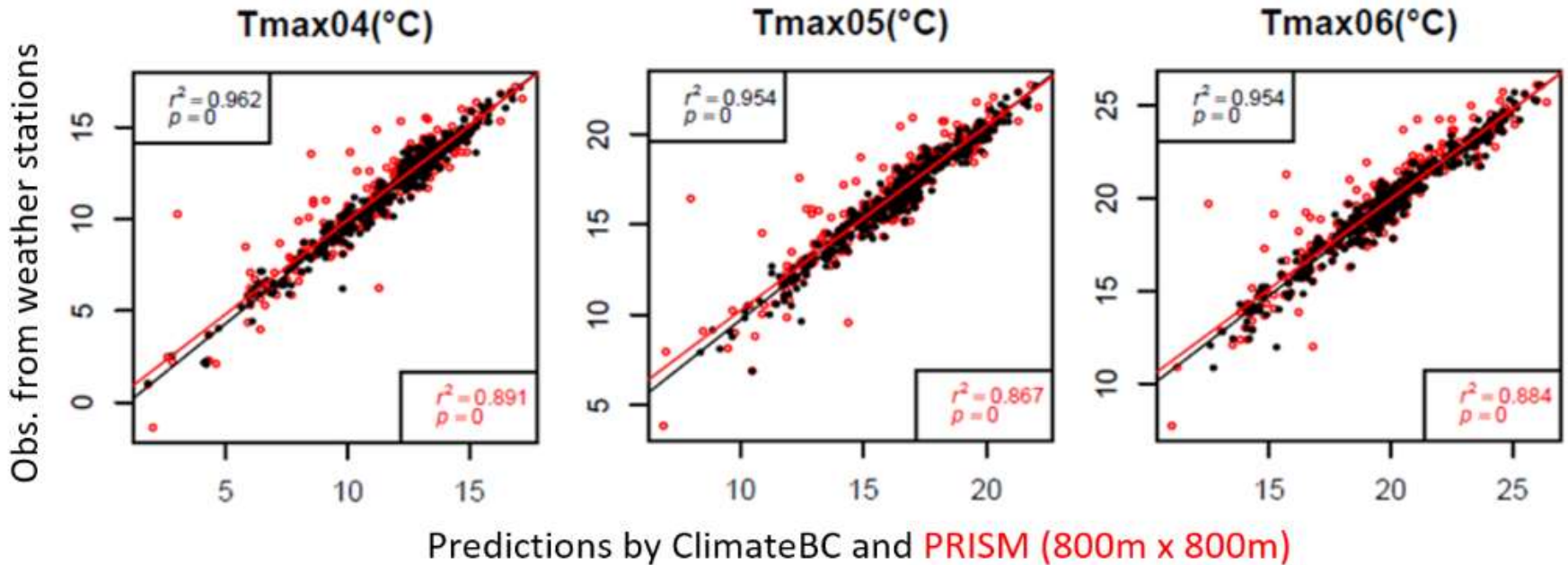
Main features

1. Scale-free climate data

ClimateBC generates scale-free climate data that facilitates users to obtain climate data for specific locations (instead of grid averages) and climate surfaces at any spatial resolutions.

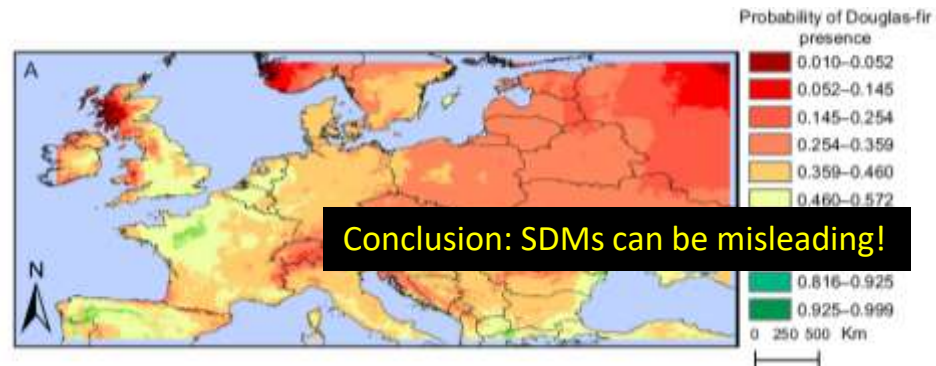


The scale-free climate data considerably outperform the PRISM data as shown in the following graphs. Please read the [report](#) and [a recent publication](#) for details.

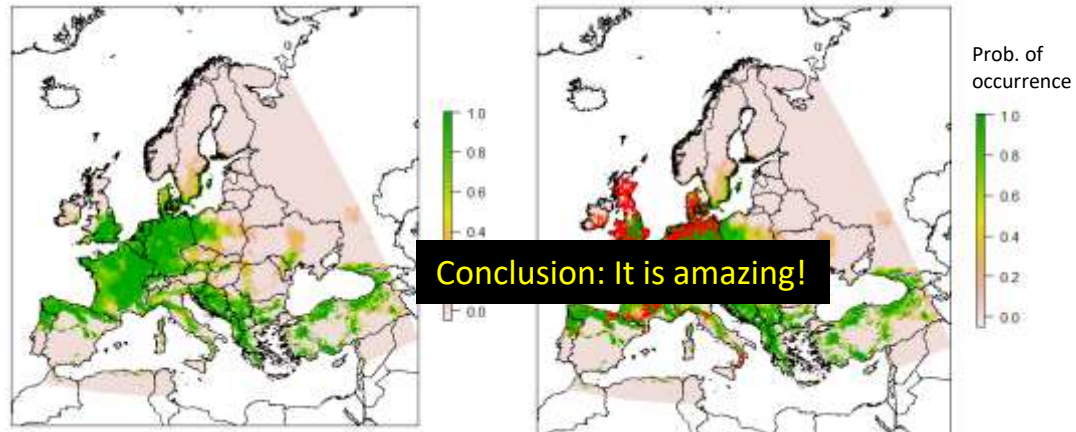


Climate niche models differ substantially in performance

Boiffin et al. (2017)



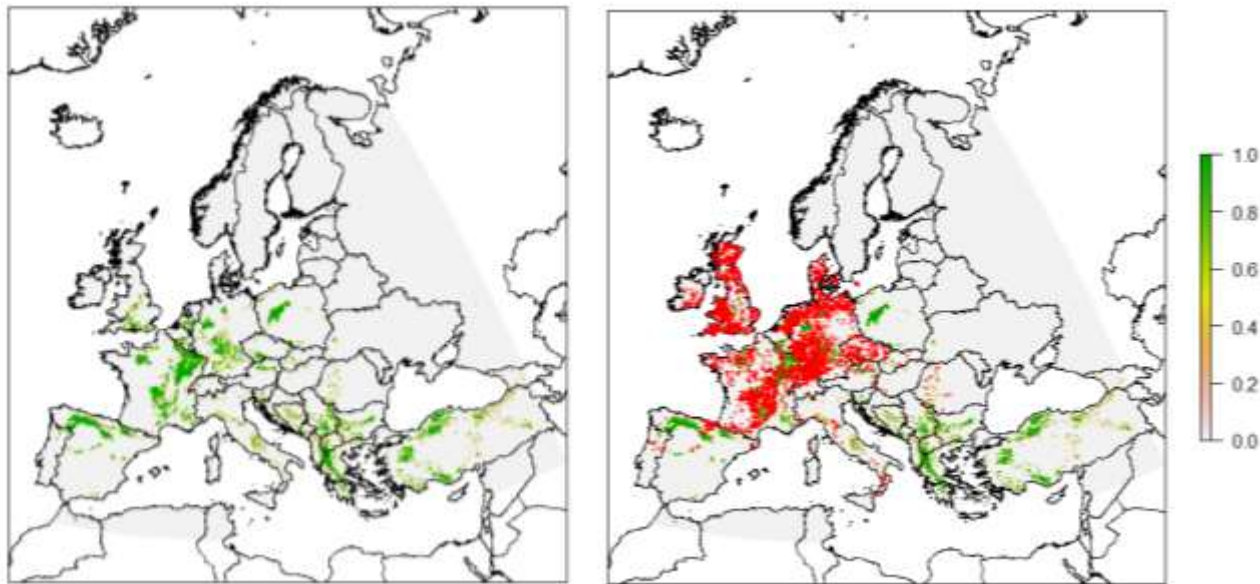
Our results



Accuracy = 88%

Climate data:

scale-free → 4x4 gridded as used in Boiffin (2017)

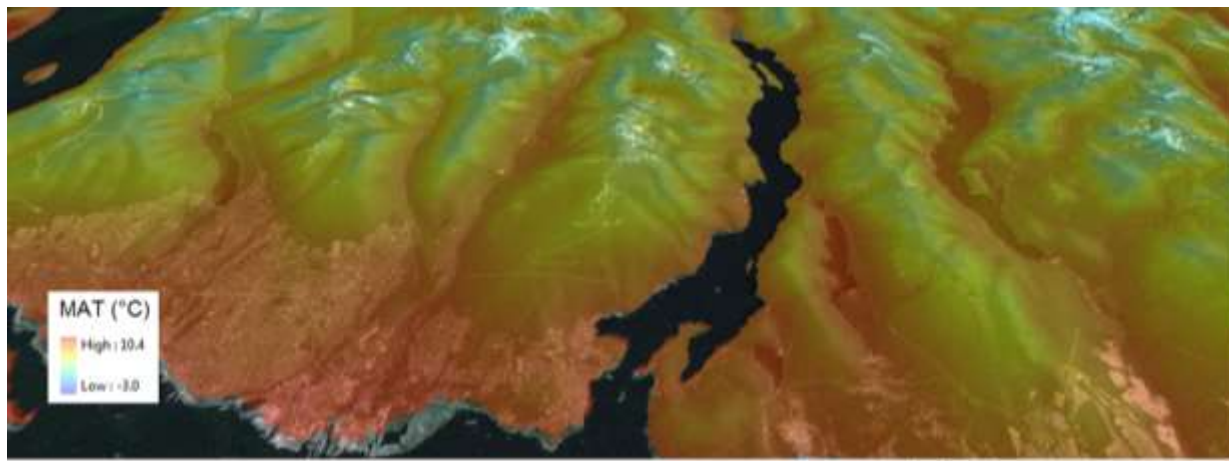


Accuracy: 88% → 20%

Gridded vs. scale-free climate data



PRISM at 4km x 4km



ClimateNA - scale-free

2. All-in-one package

ClimateBC integrates and downscales climate data for Paleo, historical and Future years and periods.

Paleo periods

Paleo Periods:

Annual variables:

- 4GCM-Ensemble_1gm.pal
- 4GCM-Ensemble_midHolocene.pal
- 4GCM-Ensemble_past1000.pal
- CCSM4_1gm.pal
- CCSM4_midHolocene.pal
- CCSM4_past1000.pal
- GISS-E2R_1gm.pal
- GISS-E2R_midHolocene.pal
- GISS-E2R_past1000.pal
- MIROC-ESM_1gm.pal
- MIROC-ESM_midHolocene.pal
- MIROC-ESM_past1000.pal
- MRI-CGCM3_1gm.pal
- MRI-CGCM3_midHolocene.pal
- MRI-CGCM3_past1000.pal

Multi-location

Historical years

Annual Data:

Annual variables:

- Year_1901.ann
- Year_1902.ann
- Year_1903.ann
- Year_1904.ann
- Year_1905.ann
- Year_1906.ann
- Year_1907.ann
- Year_1908.ann
- Year_1909.ann
- Year_1910.ann
- Year_1911.ann
- Year_1912.ann
- Year_1913.ann
- Year_1914.ann
- Year_1915.ann
- Year_1916.ann
- Year_1917.ann
- Year_1918.ann
- Year_1919.ann
- Year_1920.ann
- Year_1921.ann
- Year_1922.ann

Multi-location

Future periods

Future Periods:

- 13GCM-Ensemble_rcp26_2025.gcm
- 13GCM-Ensemble_rcp26_2055.gcm
- 13GCM-Ensemble_rcp26_2085.gcm
- 15GCM-Ensemble_rcp45_2025.gcm
- 15GCM-Ensemble_rcp45_2055.gcm
- 15GCM-Ensemble_rcp45_2085.gcm
- 15GCM-Ensemble_rcp85_2025.gcm
- 15GCM-Ensemble_rcp85_2055.gcm
- 15GCM-Ensemble_rcp85_2085.gcm
- ACCESS1-0_rcp45_2025.gcm
- ACCESS1-0_rcp45_2055.gcm
- ACCESS1-0_rcp45_2085.gcm
- ACCESS1-0_rcp85_2025.gcm
- ACCESS1-0_rcp85_2055.gcm
- ACCESS1-0_rcp85_2085.gcm
- CanESM2_rcp26_2025.gcm
- CanESM2_rcp26_2055.gcm
- CanESM2_rcp26_2085.gcm
- CanESM2_rcp45_2025.gcm

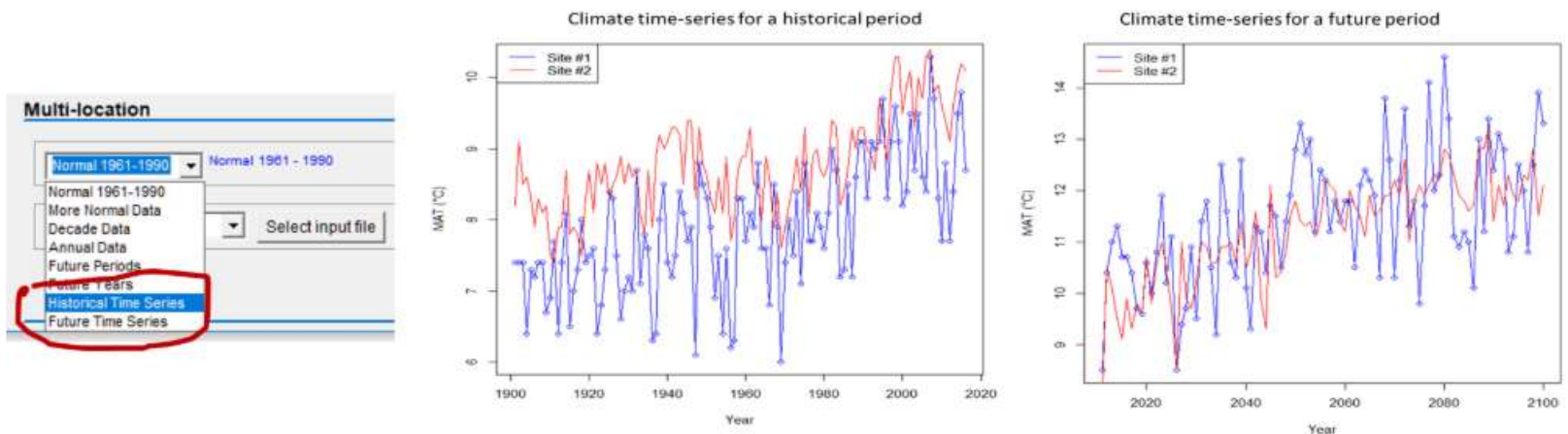
Finish selection

3. Multiple-location processing

ClimateBC can process almost unlimited number of locations in a single run.

4. Time-series functions

ClimateBC can generate time-series climate data for historical (1901-2018) or future years (2011-2100) for multiple locations in a single run.



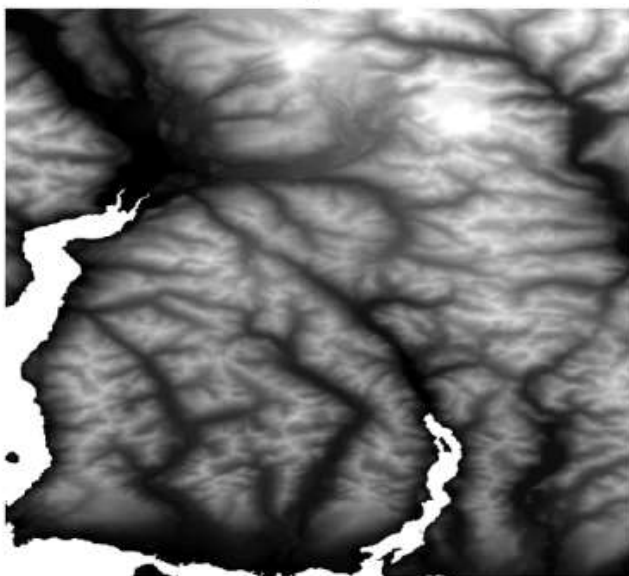


5. Map-in and map-out capacity

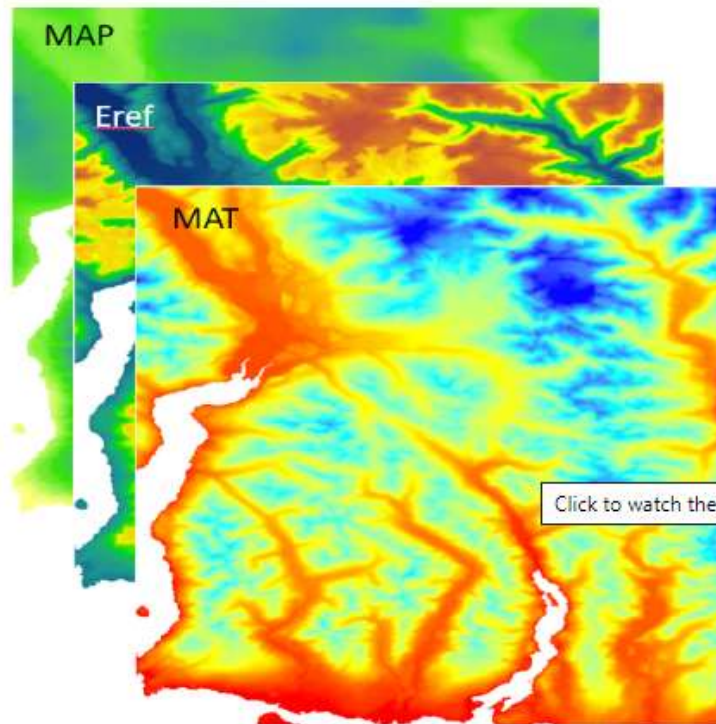
Since version 6.0, ClimateBC can read DEM raster file and generate climate variables in raster format for mapping. Tutorial videos are available on [Youtube](#).

Climate raster maps

A DEM raster map at 90 x 90 m




ClimateBC/NA
V6.00




[Click to watch the video tuto](#)

6. Map-based version for easy access and spatial visualization

ClimateBC version allows users to: 1) get climate data for a location by clicking on the map; 2) visualize the spatial distribution of main climate variables; 3) visualize BEC zones and their shift in future climates; and 4) Visualize forest tree species distributions. Please click on the map to access the web version.



ClimateBC_Map
— A Interactive Platform for Visualization and Data Access



Coordinates Input (click on the map or type in coordinates)

Latitude: Longitude:

Elev (m): Historical:


Future:

Annual Variables	Seasonal Variables	Monthly Variables
MAT = 2.5	Tmax_wt = -3.5	Tmax(01) = -5.3
MWMT = 13.8	Tmax_sp = 9.3	Tmax(02) = -0.3
MCMT = -10.1	Tmax_sm = 19.7	Tmax(03) = 3.8
TD = 23.9	Tmax_at = 8.4	Tmax(04) = 9.4
MAP = 533	Tmin_wt = -13.5	Tmax(05) = 14.6
MSP = 271	Tmin_sp = -3.7	Tmax(06) = 18.1
AHM = 23.4	Tmin_sm = 5.8	Tmax(07) = 20.7
SHM = 51	Tmin_at = -2.6	Tmax(08) = 20.2
DD<0 = 1097	Tave_wt = -8.5	Tmax(09) = 16
DD>5 = 1016	Tave_sp = 2.8	Tmax(10) = 9.4
DD<18 = 5645	Tave_sm = 12.8	Tmax(11) = -0.1
DD>18 = 16	Tave_at = 2.9	Tmax(12) = -5
NFFD = 142	PPT_wt = 133	Tmin(01) = -14.9
bFFP = 164	PPT_sp = 85	Tmin(02) = -11.6
eFFP = 248	PPT_sm = 187	Tmin(03) = -8.1

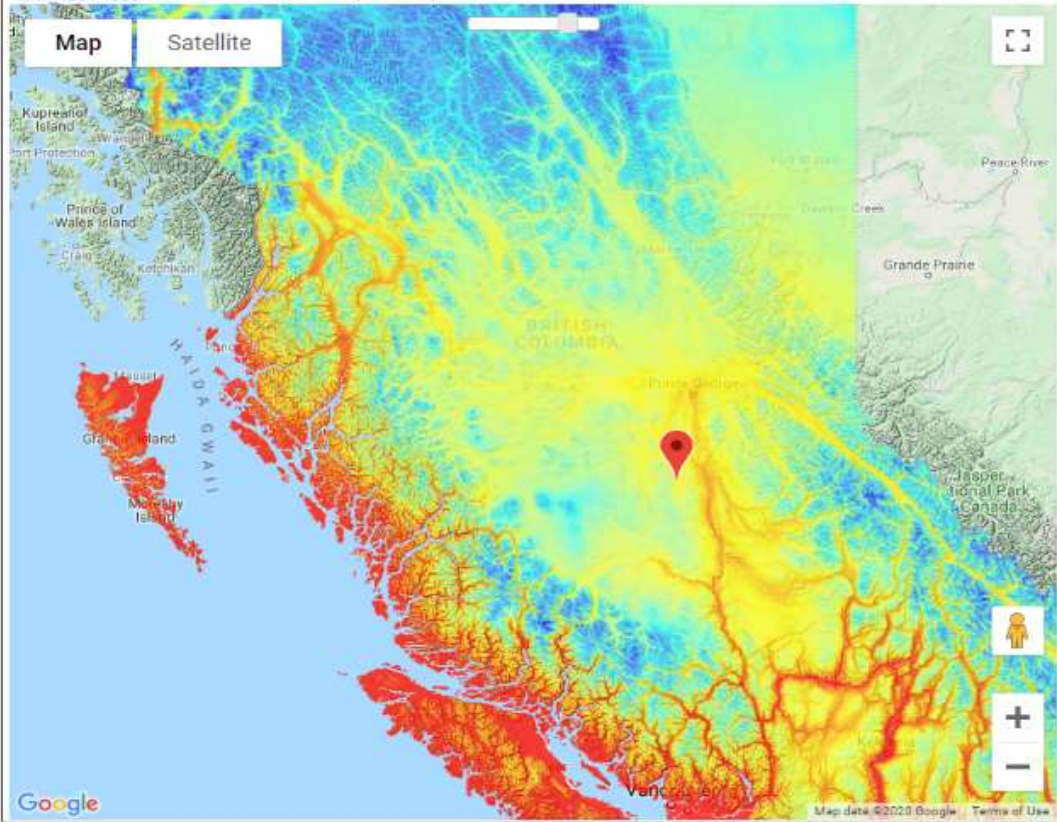
Copyright(2019) University of British Columbia. All right reserved.
 Disclaimer: Predictions of historical and future climates are based on the methodologies described in Wang et al. 2016. Authors do not bear any liability for financial or other losses due to the use of this program.

Overlays:

Transparency(%):



MAT 1961-1990 -15.0 10.2 °C







































































RasterFiles

1. Meta Data

- 1) ClimateBC version: ClimateBC v5.10
- 2) File format: ArcGIS raster file, zip compressed
- 3) Spatial resolution: 0.0083333 x 0.0083333 (about 800 x 800 meter)
- 4) Projection: geographic coordinate system: GCS_WGS_1984
- 5) Coverage: British Columbia
- 6) Periods covered: normal periods for 1961-1990, 1981-2010, 2011-2040, 2041-2070 and 2071-2100
- 7) IPCC AR5 GHG emission scenarios: RCP 4.5 and RCP 8.5
- 8) IPCC AR5 GCMs: CanESM2, CCSM4 and HadGEM2-ES
- 9) Data format: the following [variables](#) were multiplied by 10
 - Annual: MAT, MWMT, MCMT, TD, AHM, SHM, EMT, EXT and MAR;
 - Seasonal: Tmax, Tmin, Tave and Rad;
 - Monthly: Tmax, Tmin, Tave and Rad.

2. Data download

GCM-Scenario-Period Annual variables (23) Seasonal variables (56) Monthly variables (60) Monthly derived variables (108)

1961-1990 normals:				
1981-2010 normals:				
CanESM2_RCP45				
2011-2040 (2025)				
2041-2070 (2055)				
2071-2100 (2085)				
CanESM2_RCP85				
2011-2040 (2025)				
2041-2070 (2055)				
2071-2100 (2085)				
CCSM4_RCP45				
2011-2040 (2025)				
2041-2070 (2055)				
2071-2100 (2085)				
CCSM4_RCP85				
2011-2040 (2025)				
2041-2070 (2055)				
2071-2100 (2085)				
HadGEM2-ES_RCP45				
2011-2040 (2025)				
2041-2070 (2055)				
2071-2100 (2085)				

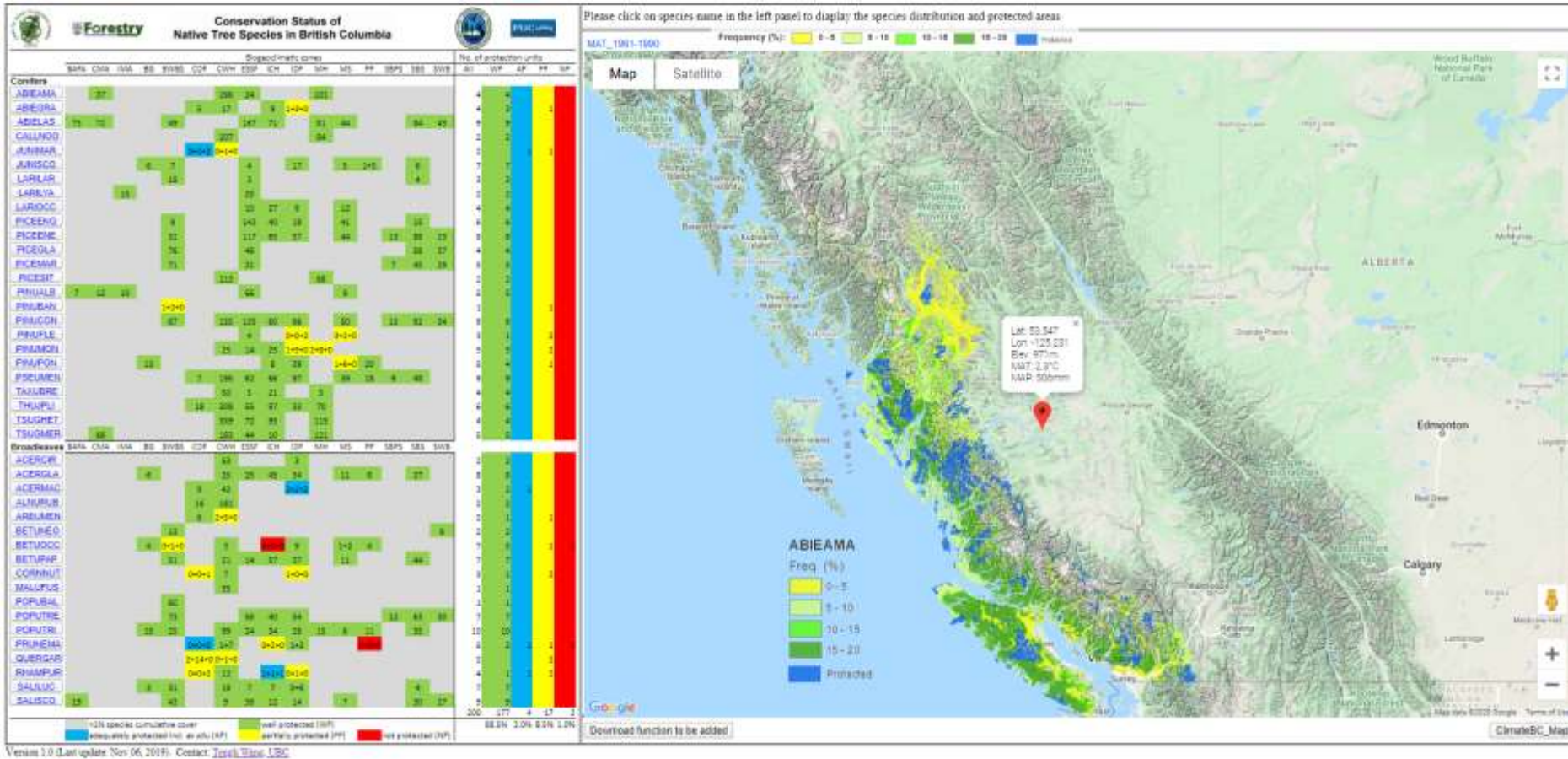
New developments - ClimateBC API

- To facilitate integration to other web-based applications



A screenshot of a web browser displaying the 'Tree Species Suitability' website. The browser's address bar shows the URL 'tree-suitability.foundryspatial.com'. The page has a navigation bar with various icons for Gmail, CFGC, Computing, Data, fn, Meetings, Music, News, Projects, Resources, shp, UBC, Home, Courses, Keep, StackOverflow, and a search icon. The main content area is divided into a left sidebar and a right map area. The sidebar contains a 'MAP STYLE' section with 'BEC Zones' selected and 'Satellite' as an alternative. Below this is a 'COORDINATES' section with input fields for 'Latitude' (55.68672) and 'Longitude' (-125.84567), and an orange 'Query Coordinates' button. At the bottom of the sidebar, it says 'GENERATING (0)' and 'READY (0)'. The map area shows a map of British Columbia with various regions highlighted in purple and green. Labels on the map include 'Blackler Bay National Park and Preserve', 'Juneau', 'Chichagof Island', 'Admiralty Island', 'Sitka', 'Dahl Island', 'Ketchikan', 'Shastah Plateau Wilderness Provincial Park', and 'Northern Rocky Mountains Provincial Park'. The text 'BRITISH COLUMBIA' is visible in the bottom right corner of the map.

ClimateBC API application



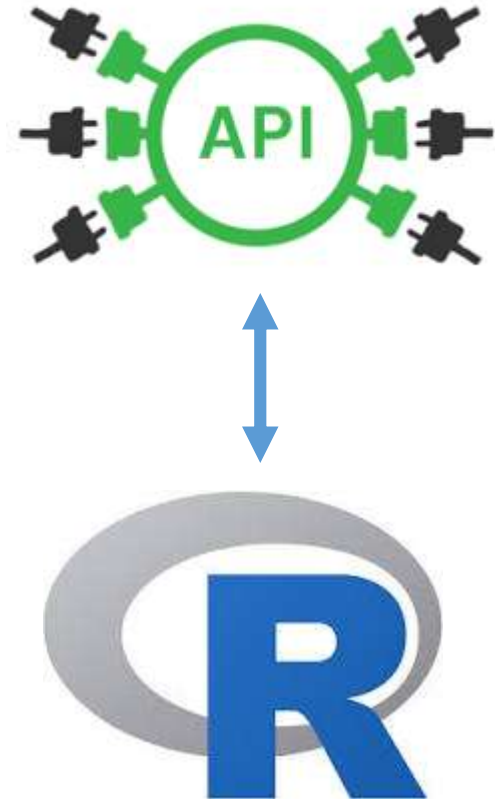
[Go to the tool](#)

New developments - ClimateBC API

- To enable interactive integration with R environment

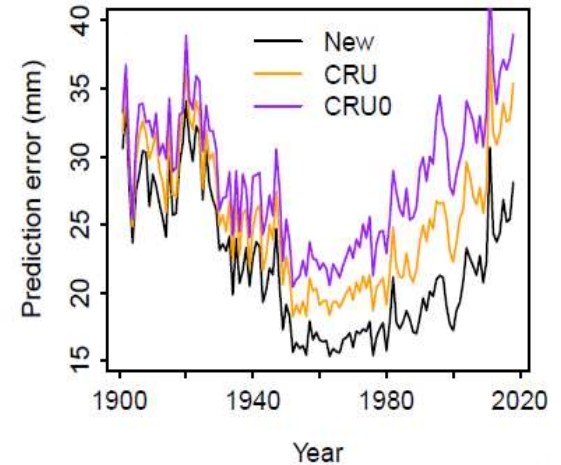
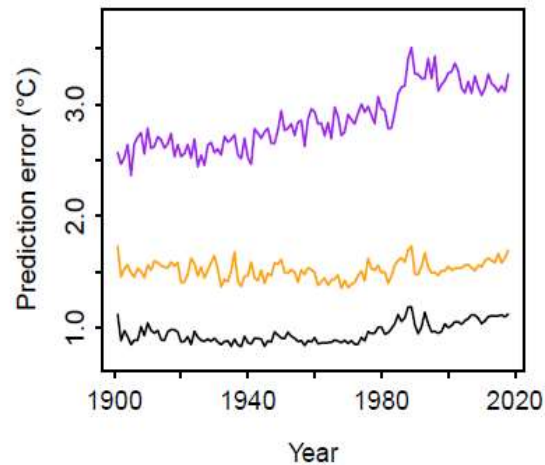
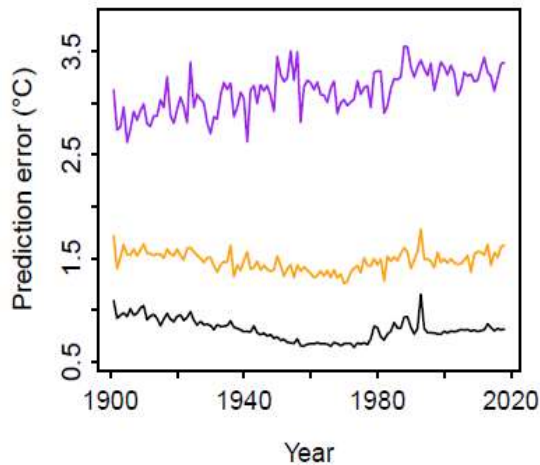
Almost all modeling works are using R!

```
library(climatebcAPI)  
clm <- climatebcAPI(x,ysm='Y')
```



New historical climate data

- ClimateBC substantially improved the accuracy of historical climate data (yellow) over the original CRU data (purple). Our new historical data (black) are better than both.



ClimateBC has become an essential tool for many users

- Over 1,600 citations
- Over 1,300 subscribers
 - 151 from gov.bc.ca
 - 795 from Canada
- Significant applications in BC
 - Climate-Based Seed Transfer system
 - Climate change informed species selection tool

My graduate students' work

- Yue Yu, MSc – Using landscape genomics to predict the genetic variation and growth performance of lodgepole pine
- Yueru Zhao, MSc – Modeling realized and fundamental niches of lodgepole pine
- Eva Wang, MSc – Genecology analysis of white spruce for climate-based seed transfer.
- Kate Peterson, PhD – Optimization of mixed seedlots for a changing climate using TASS simulations

Acknowledgement



Land Based Investment



Forest Enhancement
Society of British Columbia