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

Zones

BAFA		IDF	
BG		IMA	
BWBS		MH	
CDF		MS	
CMA		PP	
CWH		SBPS	
ESSF		SBS	
ICH		SWB	
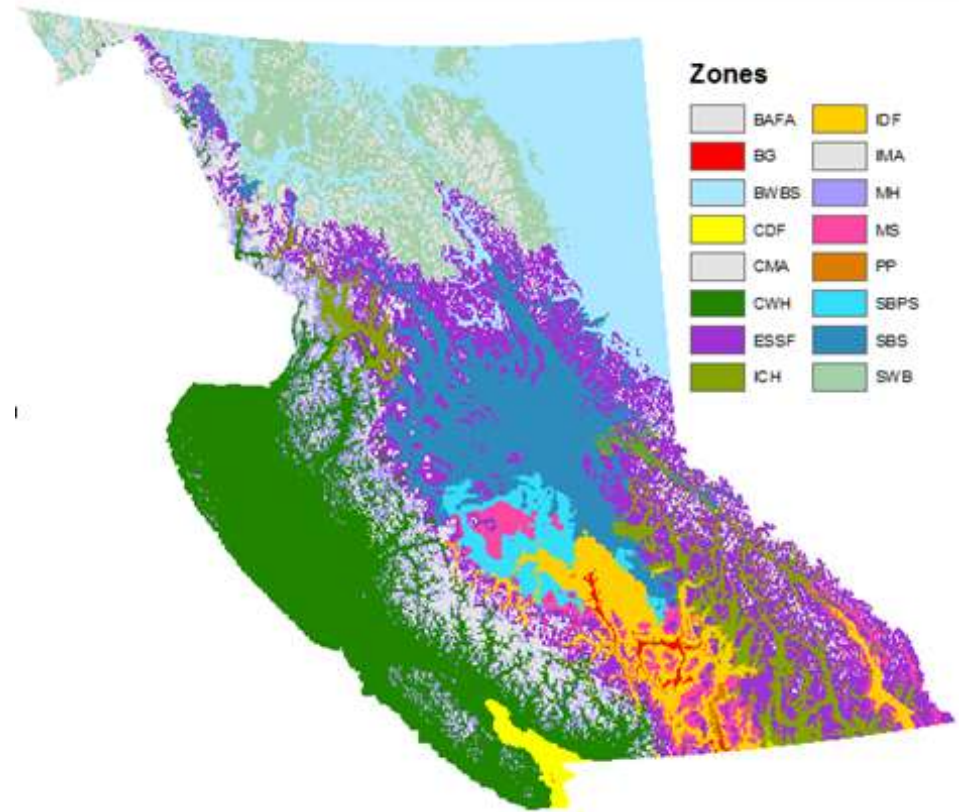
Ecological plot (E-Plot) data

Old E-Plot data
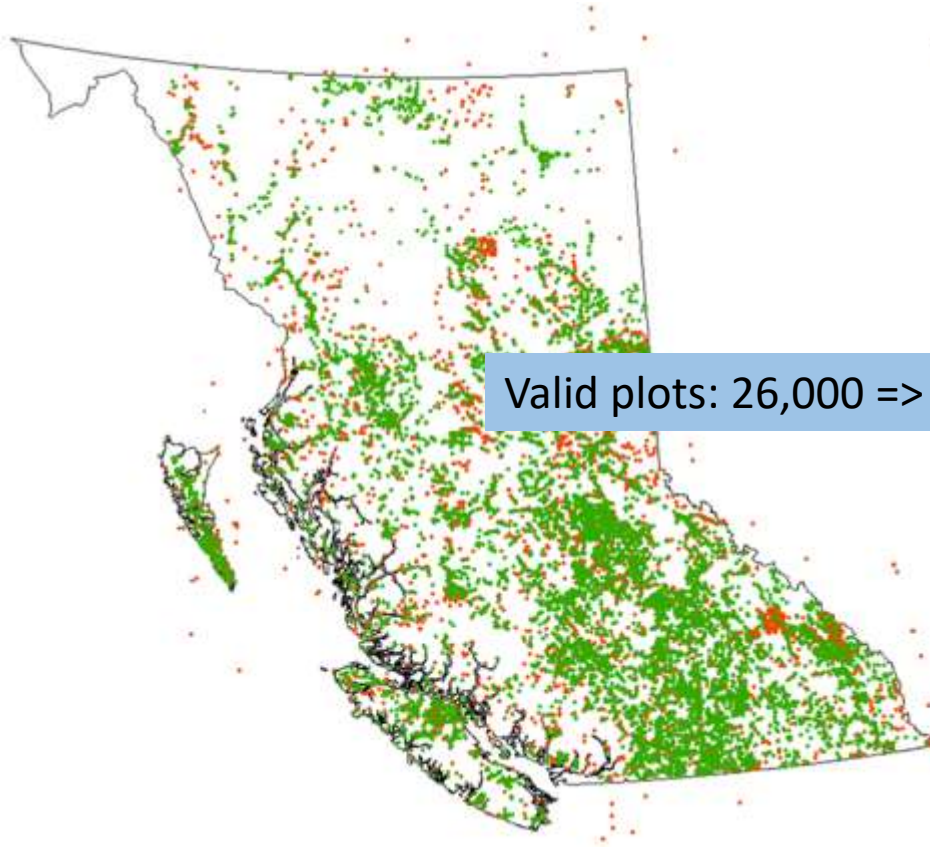
New E-Plot data
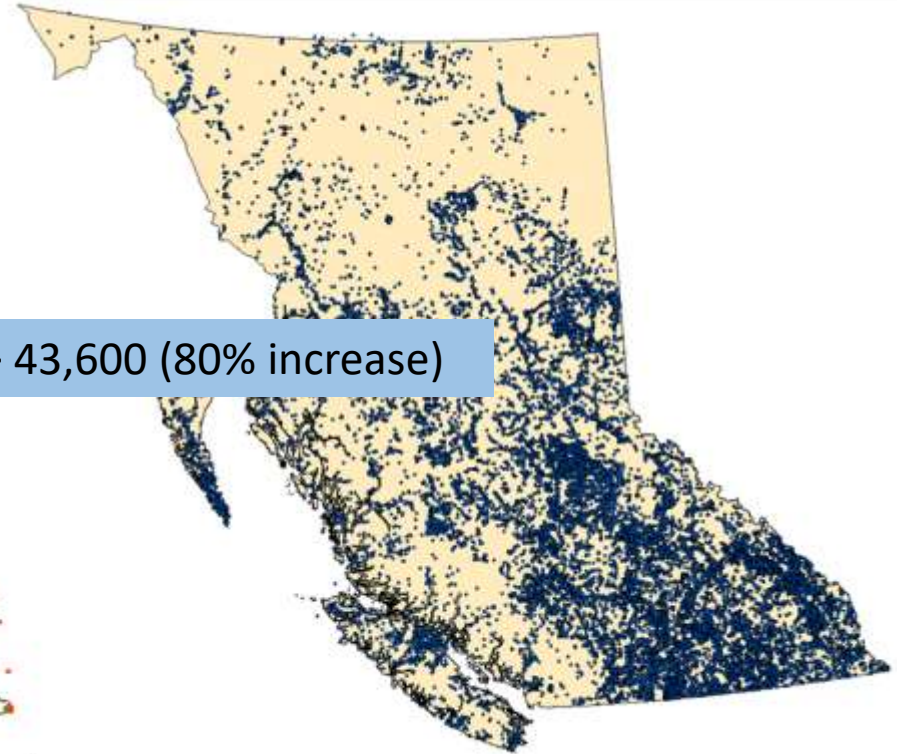
Valid plots: 26,000 => 43,600 (80% increase)

Subzone matching: . Matched . Not matched

Further cleaning

Percent crown cover of E-Plots for Pacific silver fir
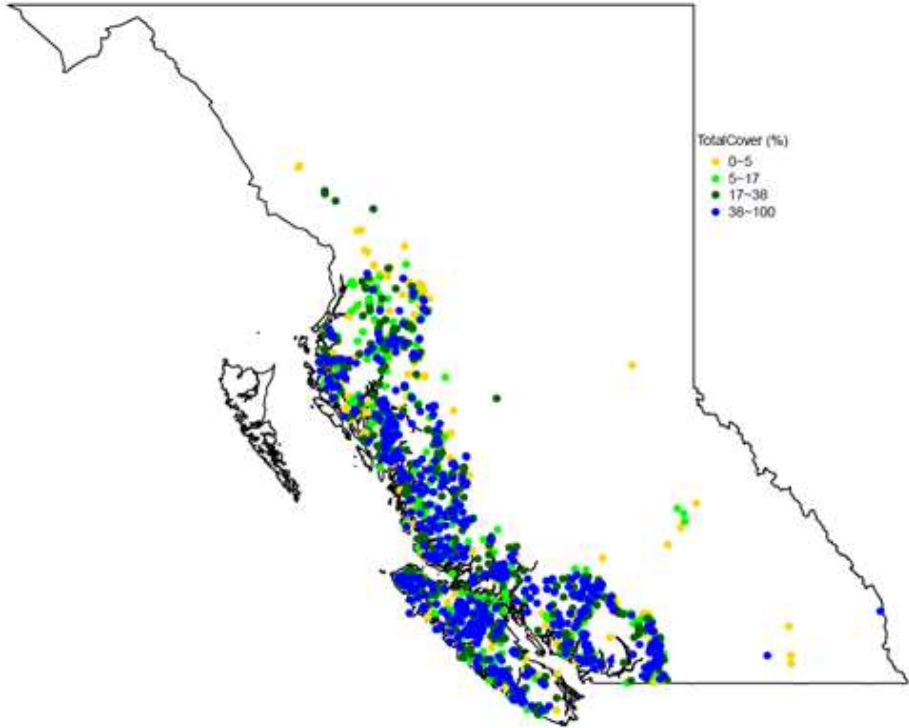
Before
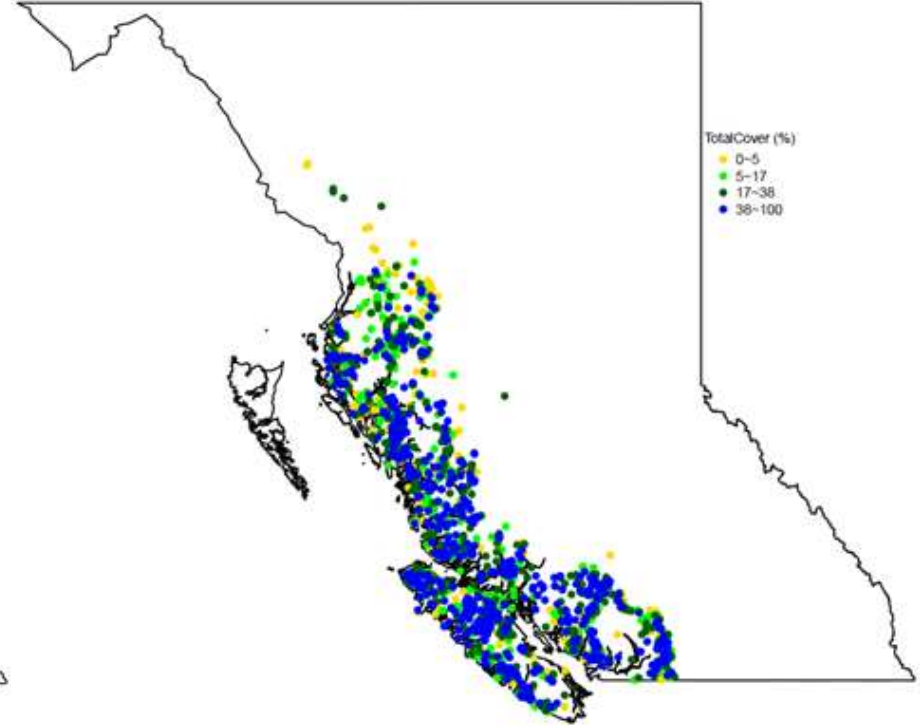
After

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
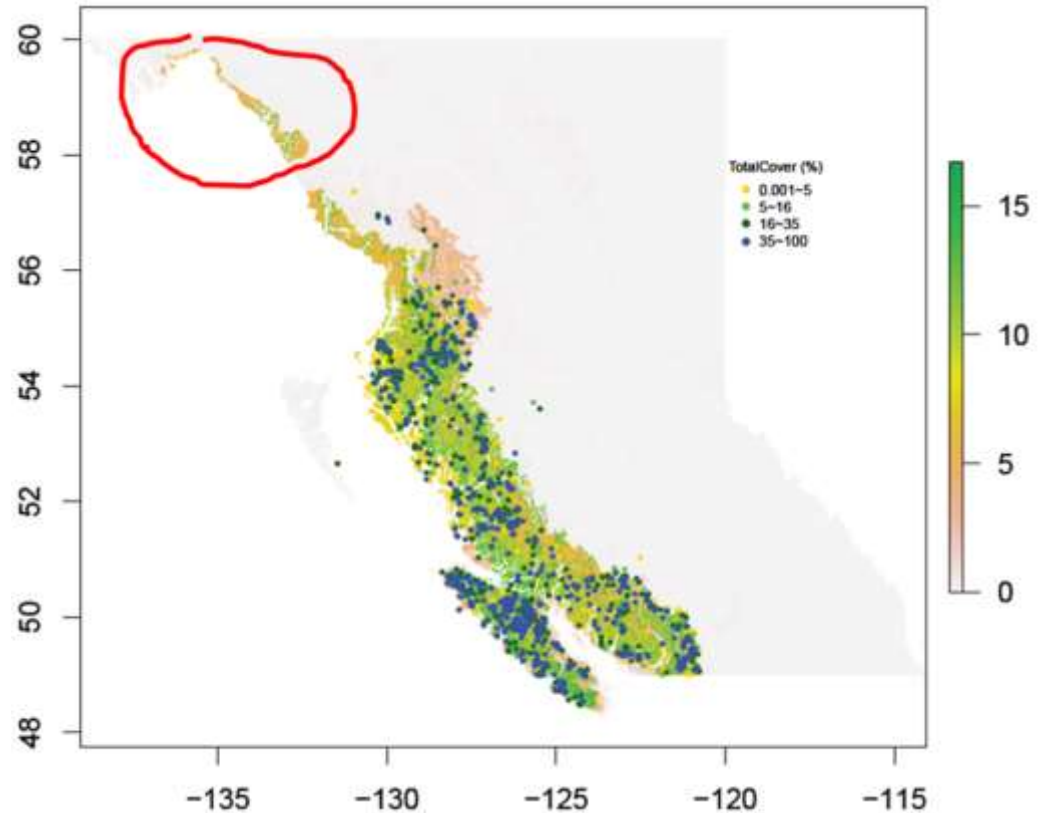
VRI data

- 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
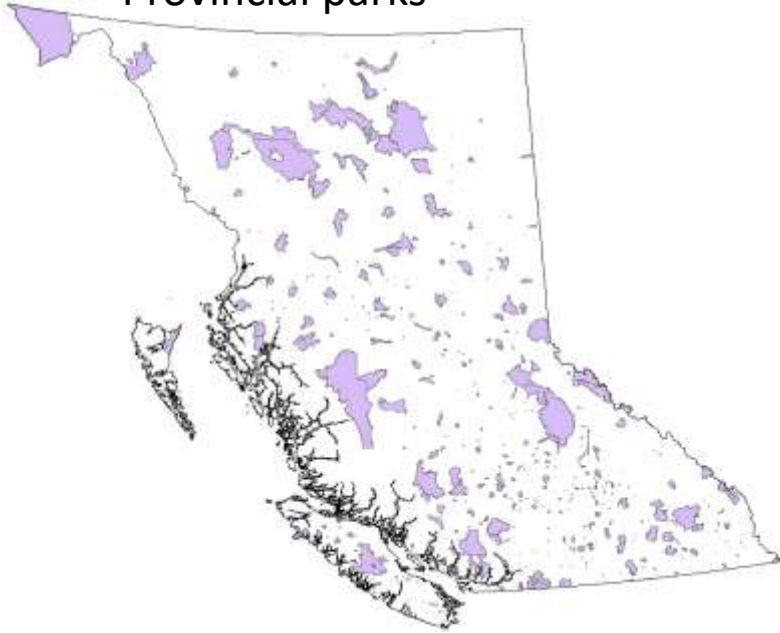
Protected areas
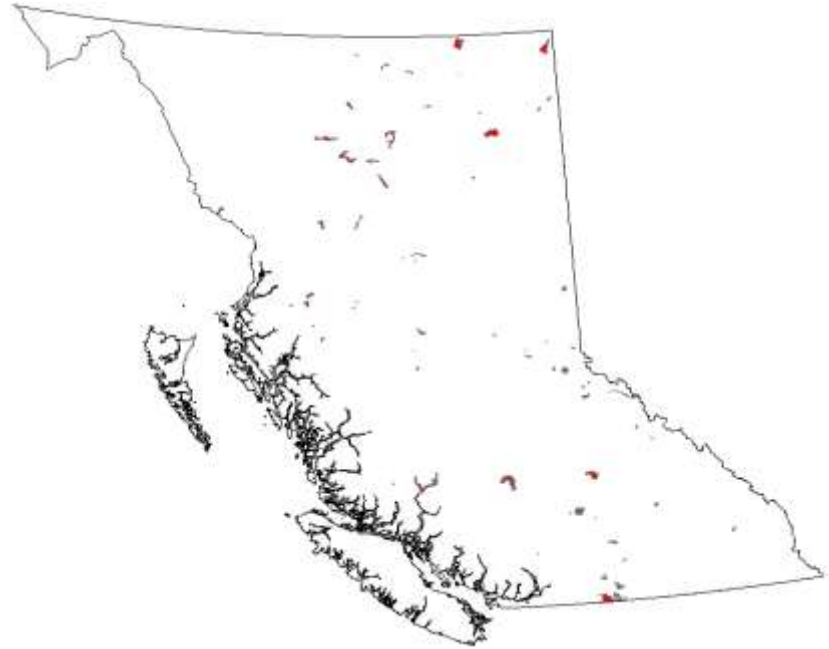
Ecological reserves

Conservancy Areas + recreation areas

Total protected areas – national parks included and water bodies removed
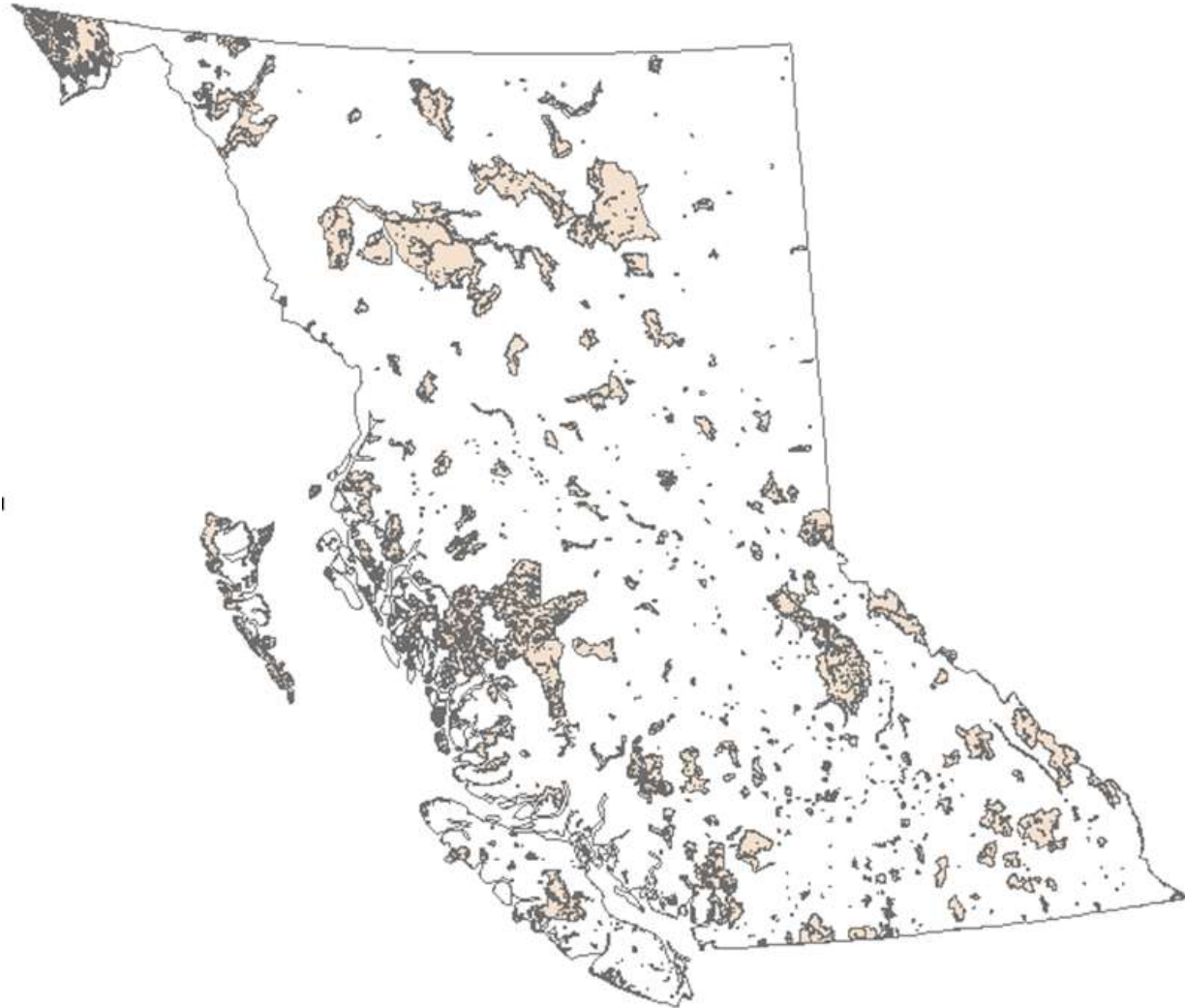
Gap analysis
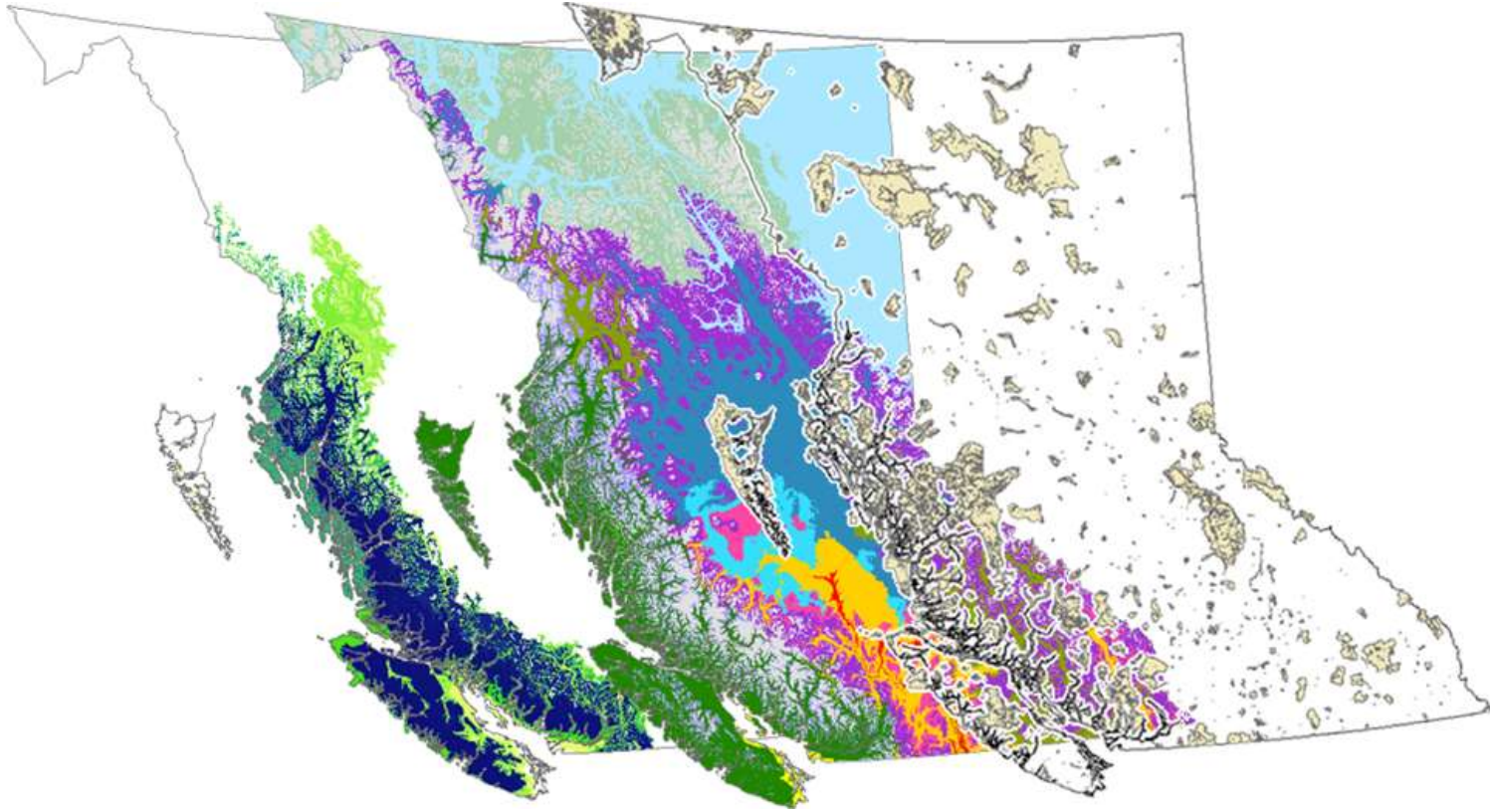
The scheme of the gap analysis that integrates information from species, BEC zones, and protected areas.

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)
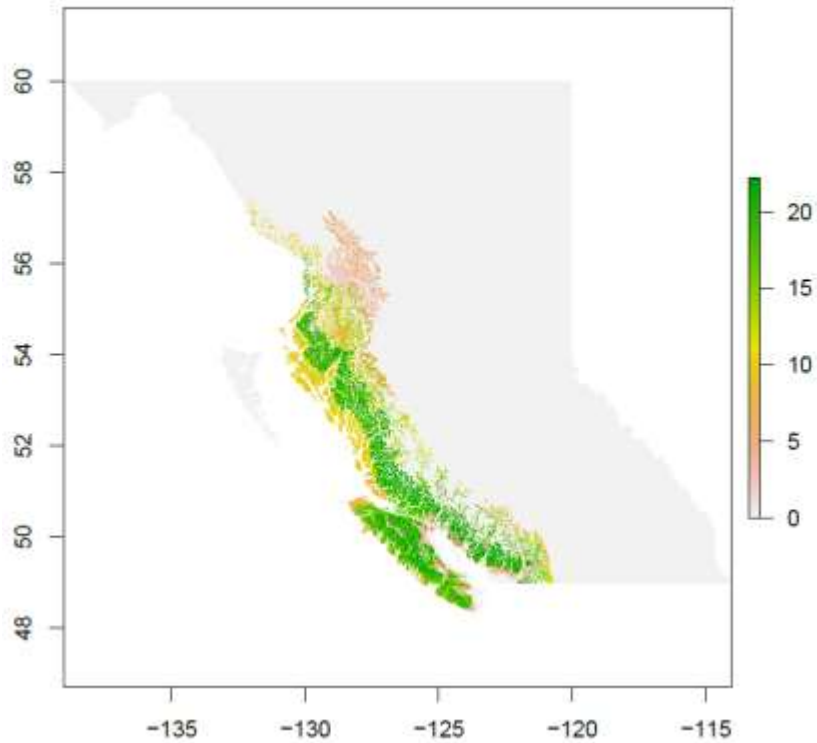
THUJ_PLI (Western redcedar)
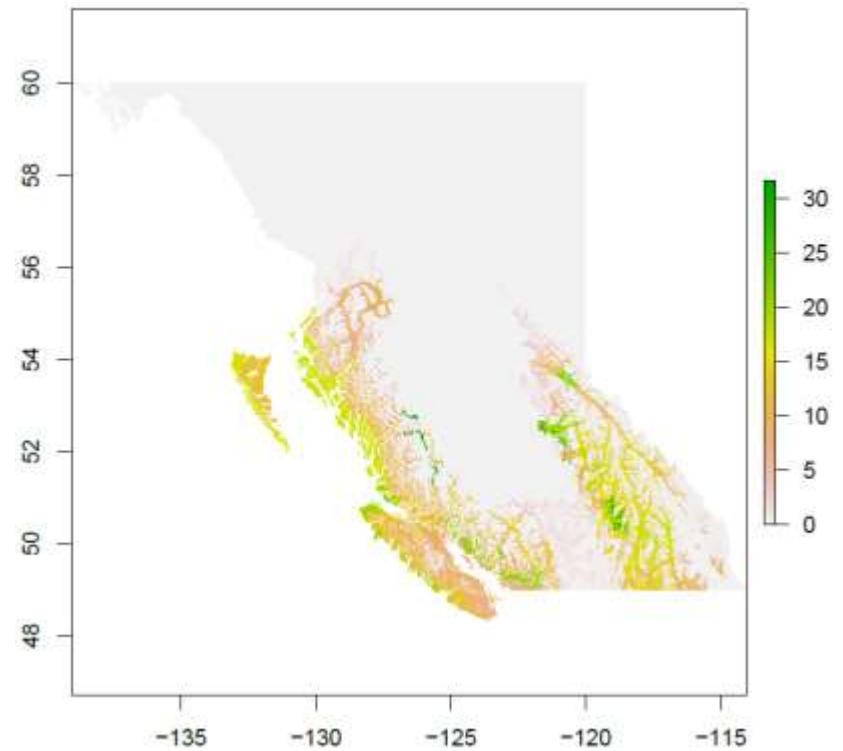
Species occurrence and percent crown cover maps

Results – total protected areas

- Increased from 11% in 2003 to 15% in 2017
- Varied among zones
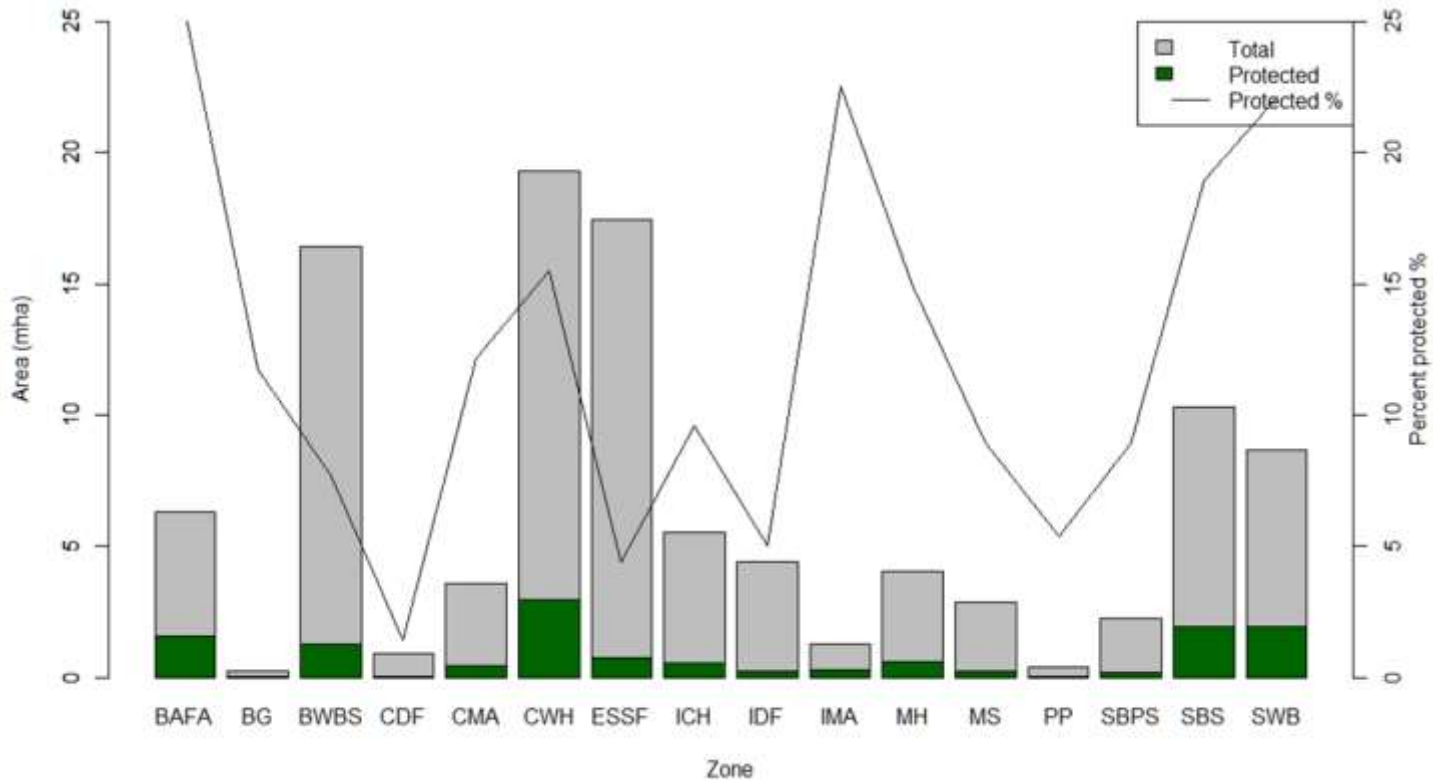
Protection status
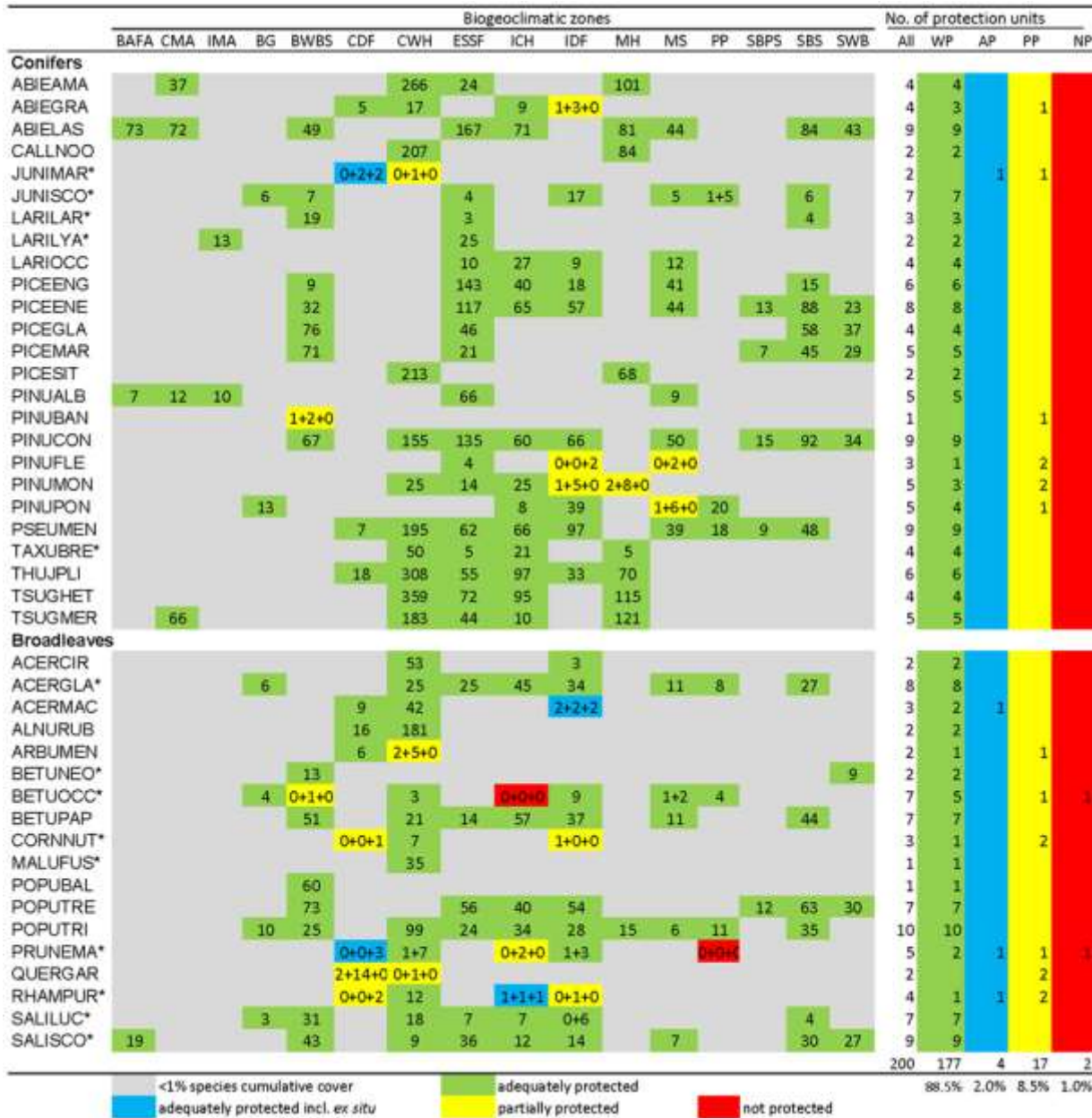
- 200 protection units – color cells
- 88.5% of the units well protected
- 2% ex situ protected, increased the total protected units to 91%
- 8.5% partially protected
- 1% not protected

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
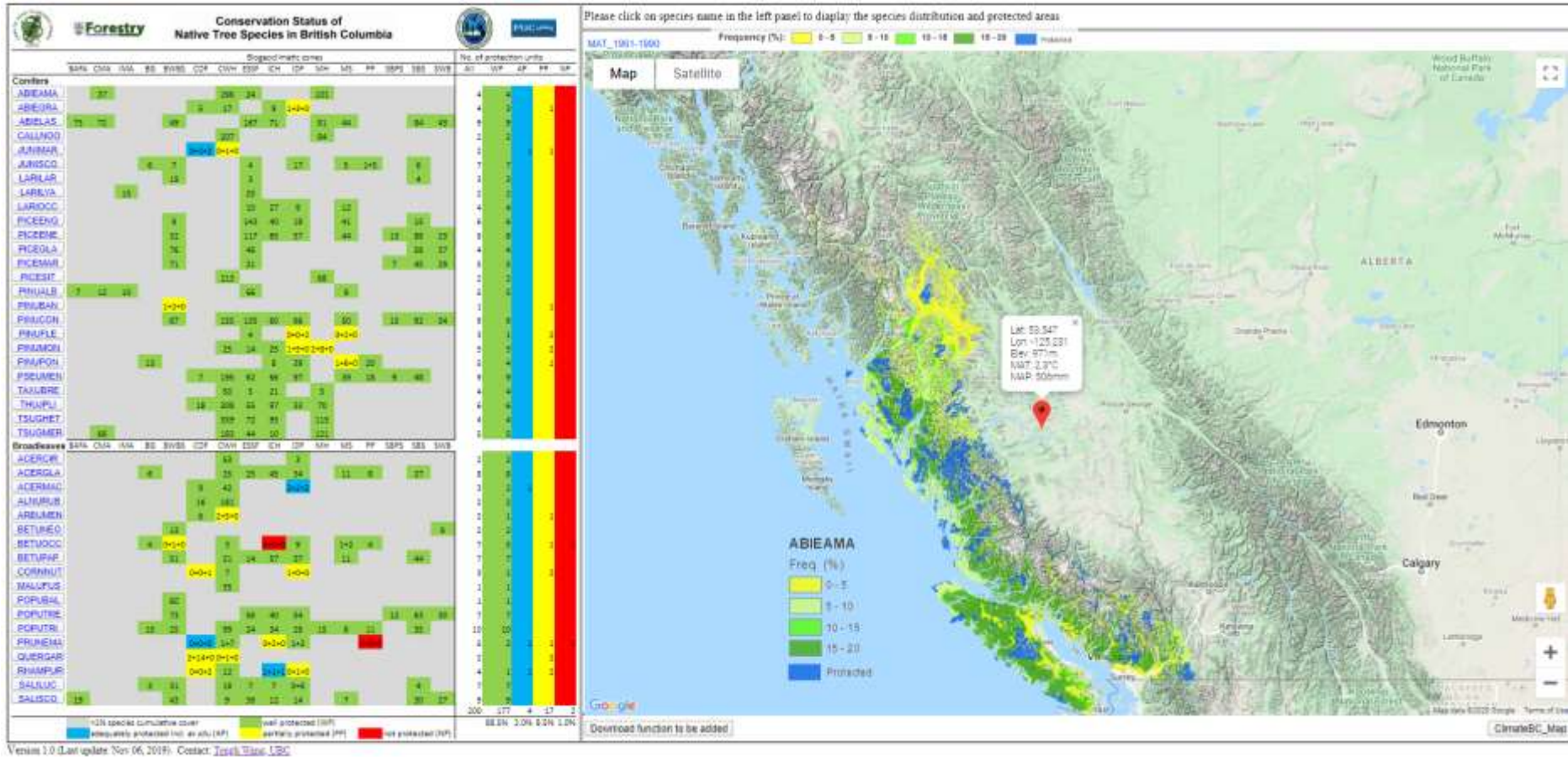
[Go to the tool](#)

ClimateBC update

Tongli Wang

CFCG, Department of Forest and Conservation Sciences, UBC

Applying Climate Change Information in Resource Management
User Needs Survey

2019

BRITISH
COLUMBIA

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

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.

| Satellite image | Prism baseline climate data | ClimateBC output | ClimateBC output (transparent) |
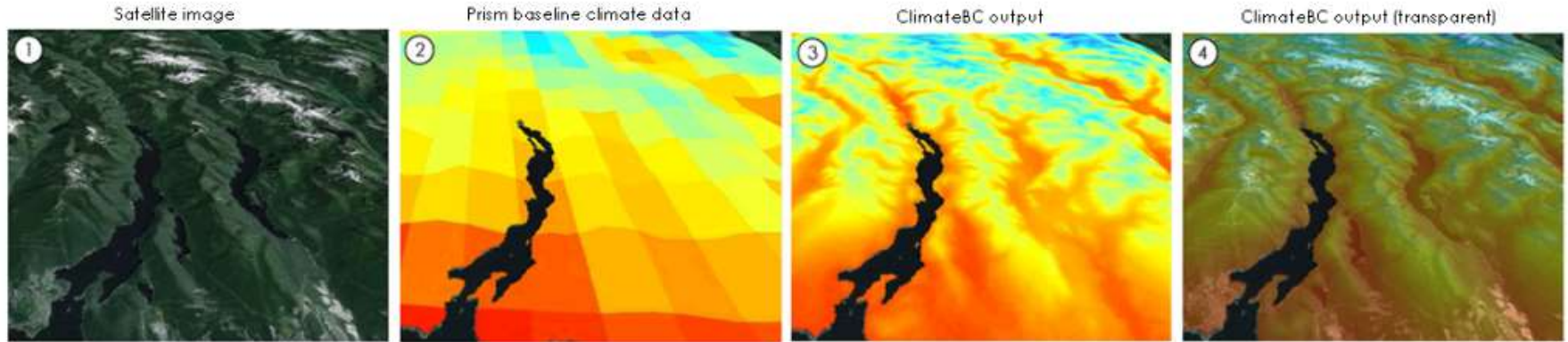
The scale-free climate data considerably outperform the PRISM data as shown in the following graphs. Please read the report and a recent publication for details.

Tmax04(°C) $r^2 = 0.962$ $p = 0$ $r^2 = 0.891$ $p = 0$

Tmax05(°C) $r^2 = 0.954$ $p = 0$ $r^2 = 0.867$ $p = 0$

Tmax06(°C) $r^2 = 0.954$ $p = 0$ $r^2 = 0.884$ $p = 0$

Obs. from weather stations

Predictions by ClimateBC and PRISM (800m x 800m)
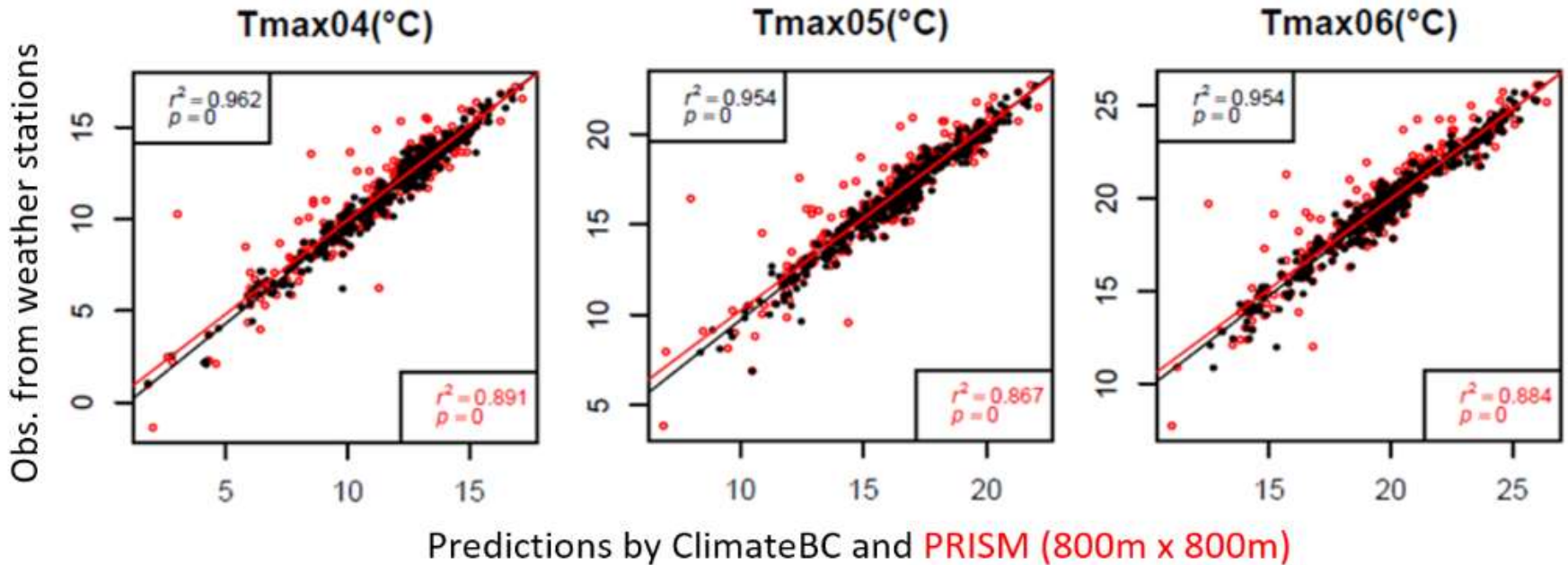
Climate niche models differ substantially in performance

Boiffin et al. (2017)

Probability of Douglas-fir presence
- 0.010–0.052
- 0.052–0.145
- 0.145–0.254
- 0.254–0.359
- 0.359–0.460
- 0.460–0.572
- 0.816–0.925
- 0.925–0.999

0 250 500 Km

Conclusion: SDMs can be misleading!

Our results

Prob. of occurrence

Conclusion: It is amazing!
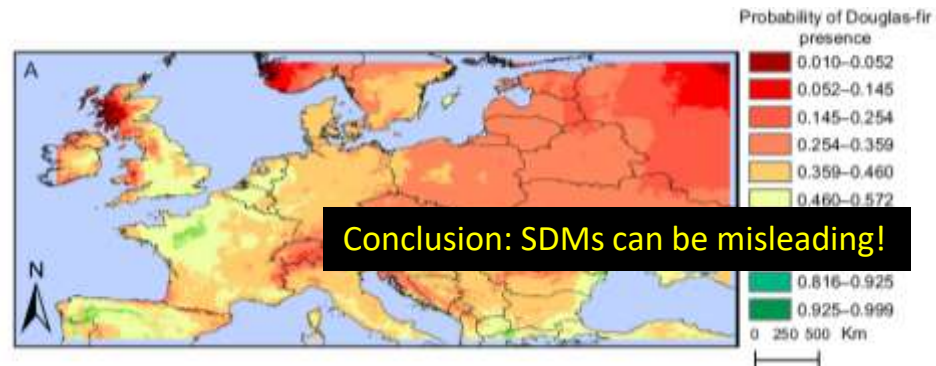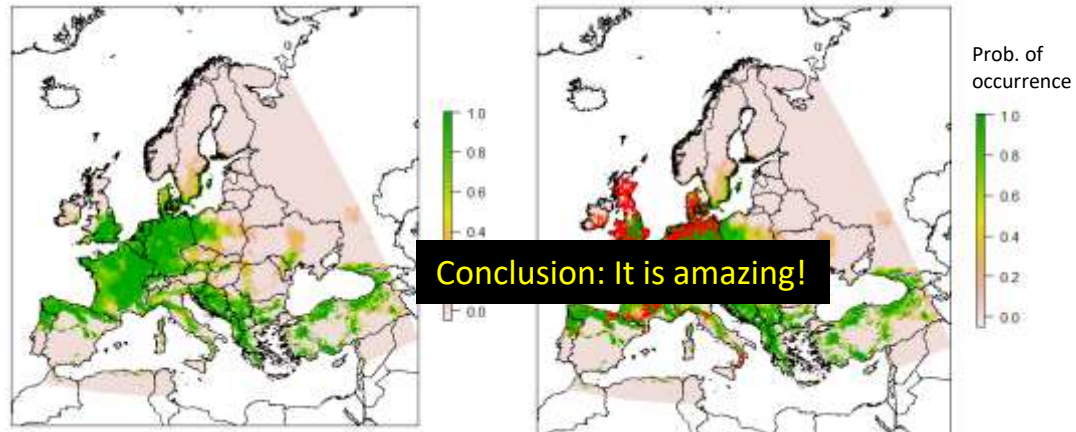
Accuracy = 88%

Climate data:
scale-free → 4x4 gridded as used in Boiffin (2017)
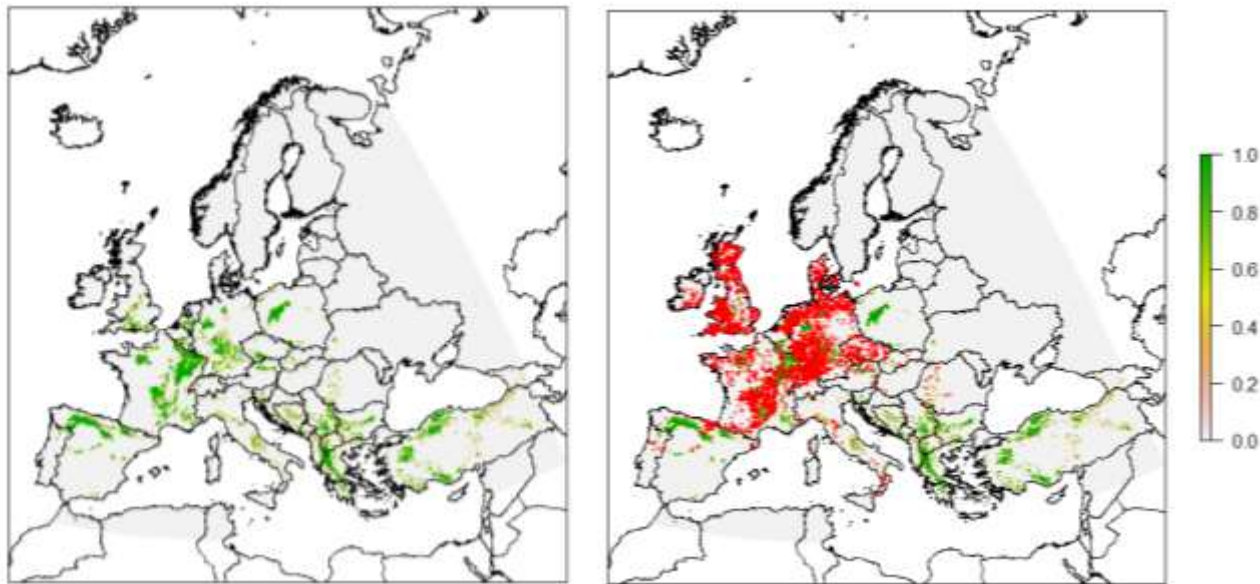
Accuracy: 88% → 20%

Gridded vs. scale-free climate data

PRISM at 4km x 4km
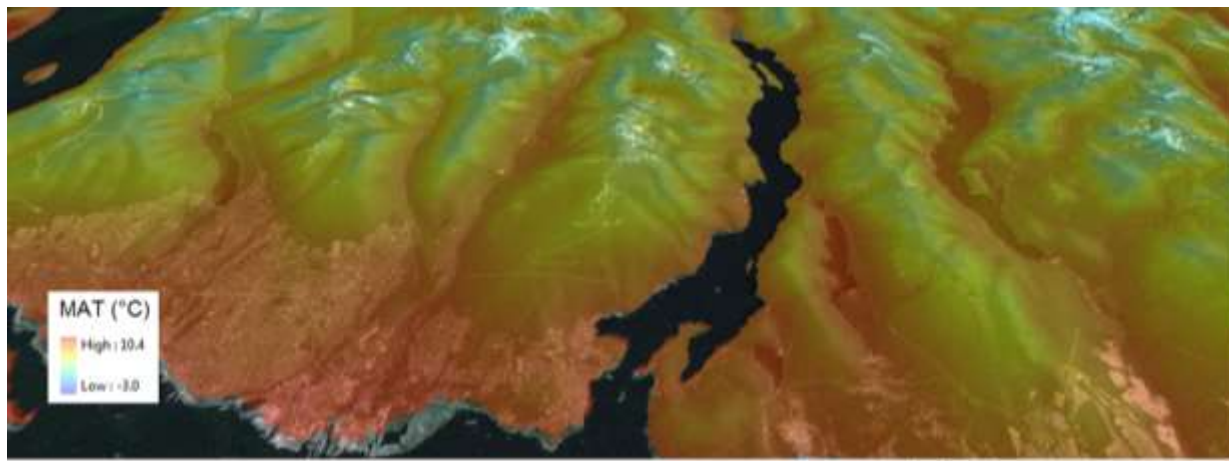
ClimateNA - scale-free

2. All-in-one package

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

Paleo periods   Historical years   Future periods

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.

Climate time-series for a historical period

Climate time-series for a future period

| | 1900 | 1920 | 1940 | 1960 | 1980 | 2000 | 2020 | | 2020 | 2040 | 2060 | 2080 | 2100 |

Year

Year
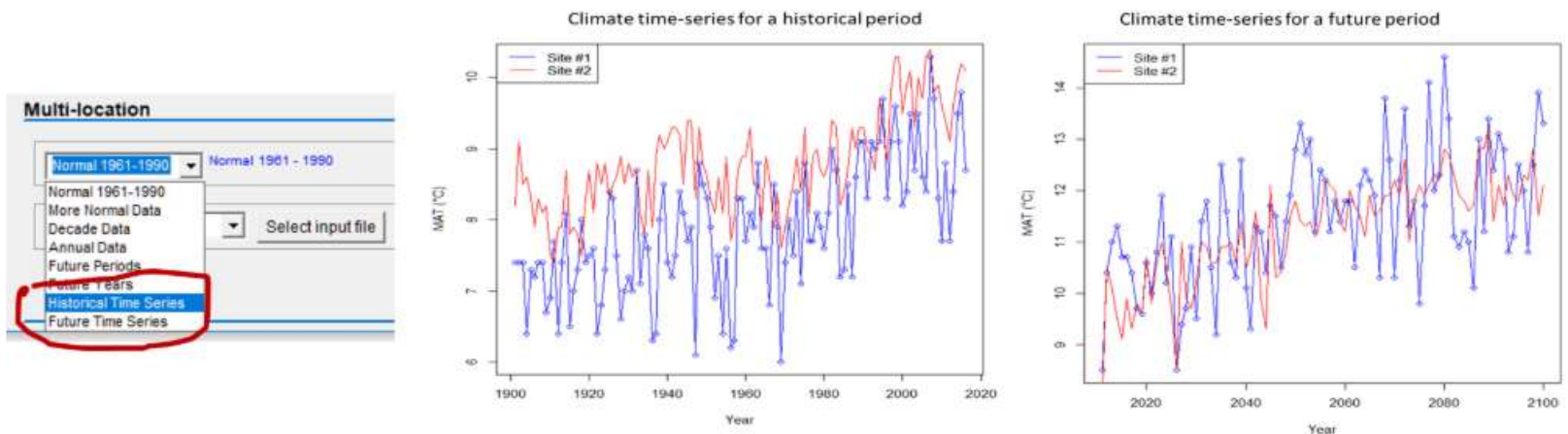
5. Map-in and map-out capacity

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

MAP

Eref

MAT
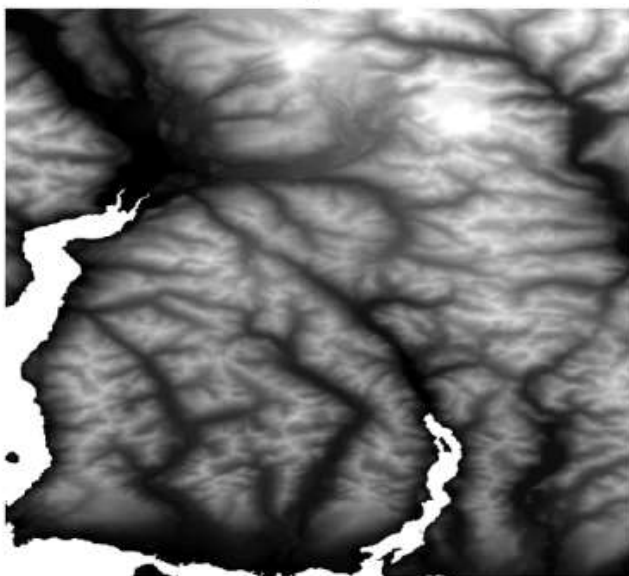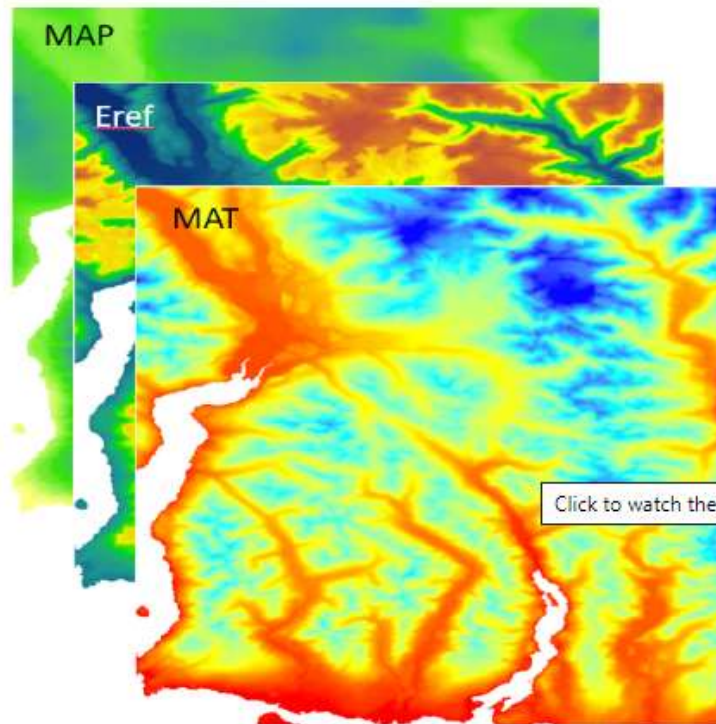
Click to watch the video tuto

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

ClimateBC version allows uses 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.

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
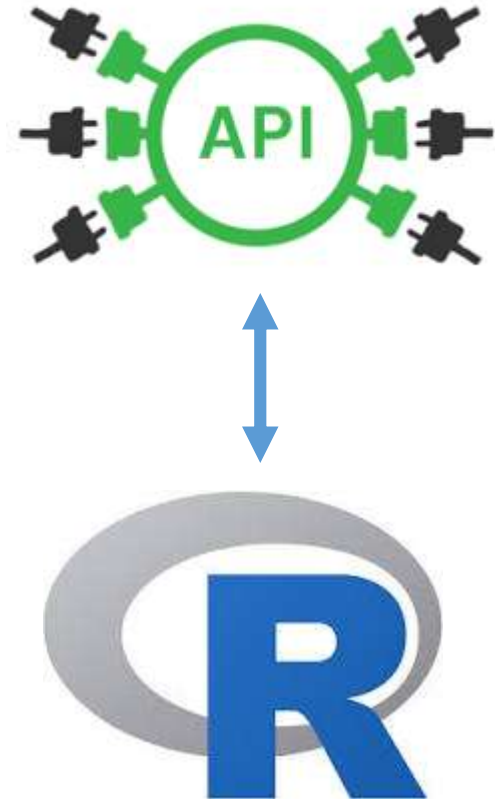
ClimateBC API application
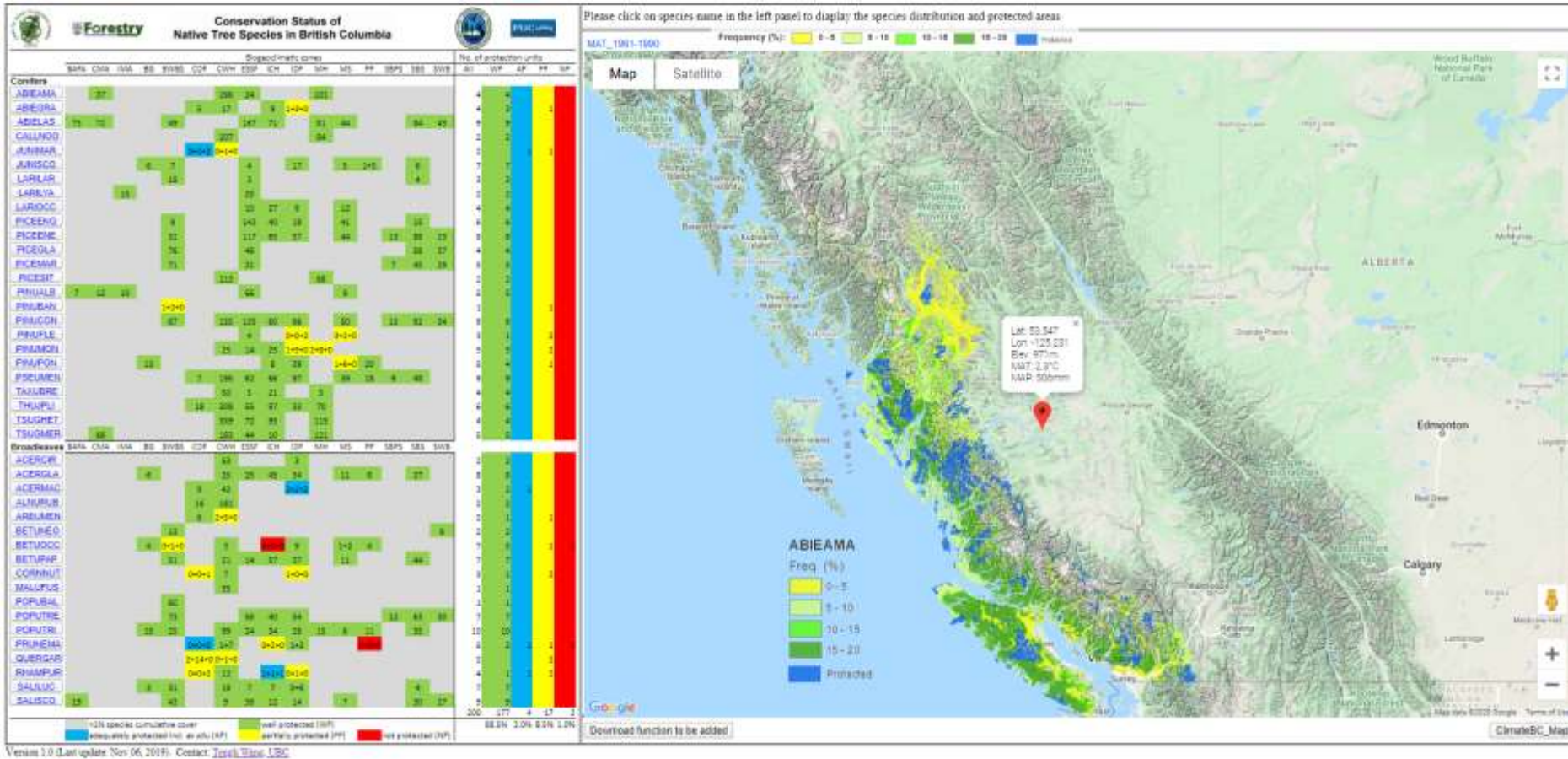
Go to the tool

New developments - ClimateBC API
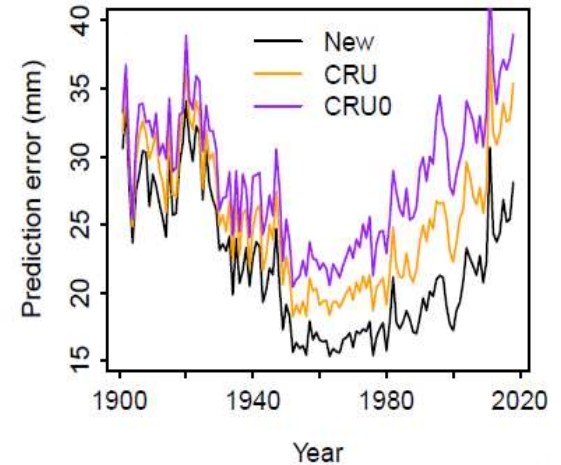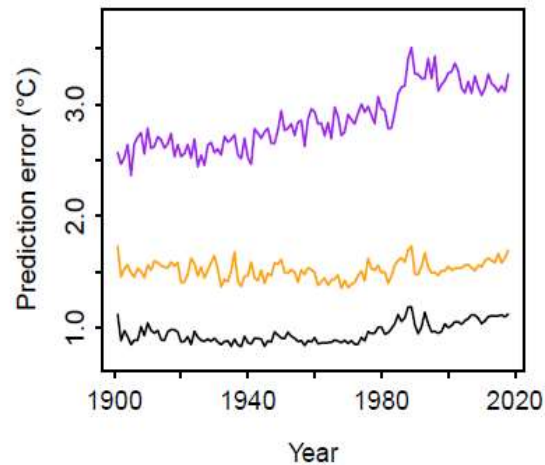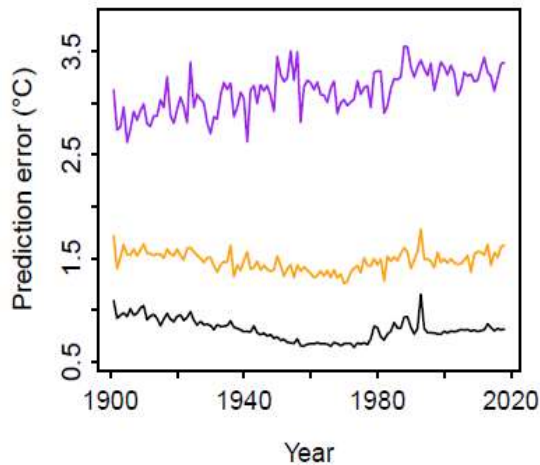
- To enable interactive integration with R environment

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