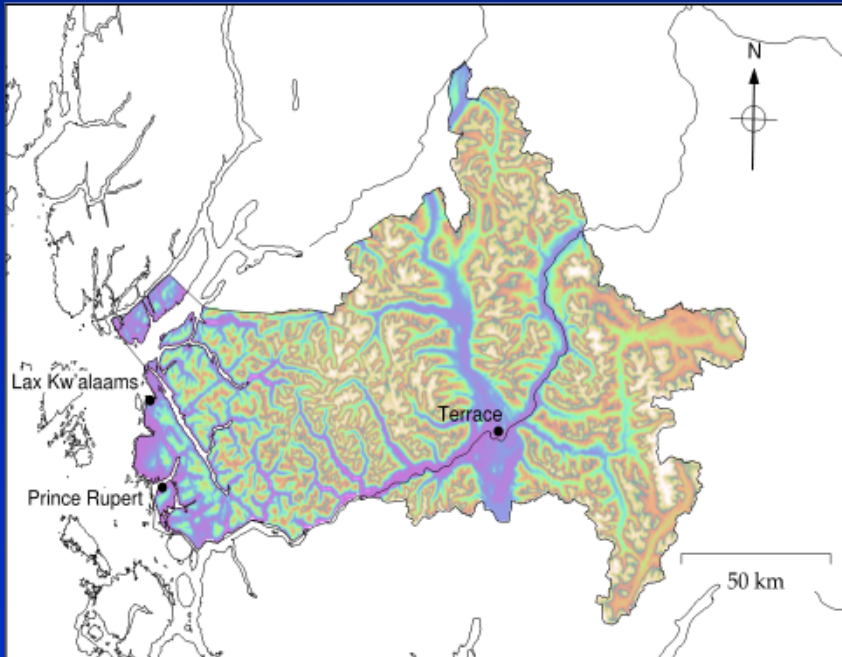


Climate Change Adaptation Planning for Northwest Skeena Communities

Projected Vegetation Changes



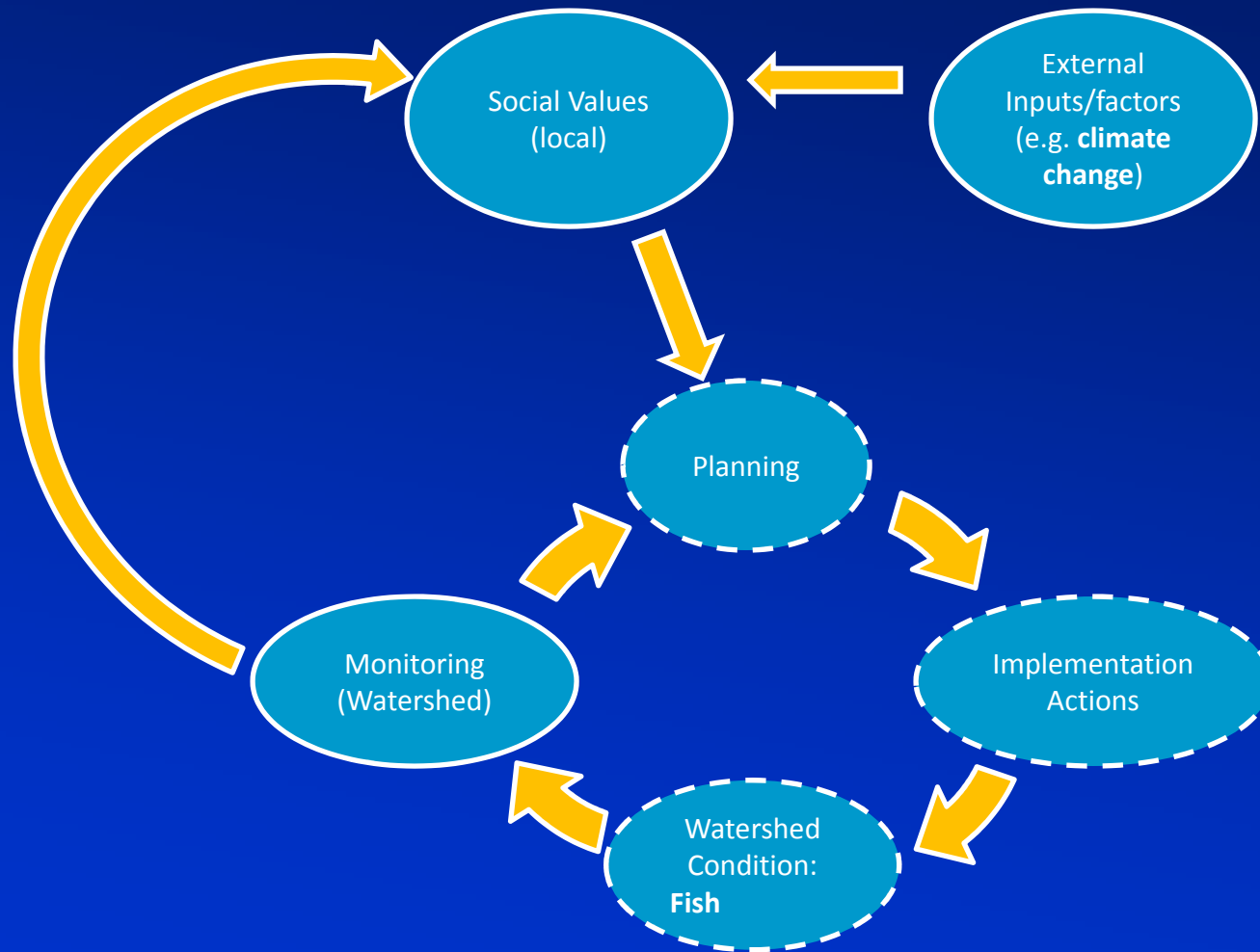
Joe Melton¹, Don Robinson², Jed Kaplan¹ & Dave Marmorek²

¹ ARVE Group, École Polytechnique Fédérale de Lausanne, Switzerland

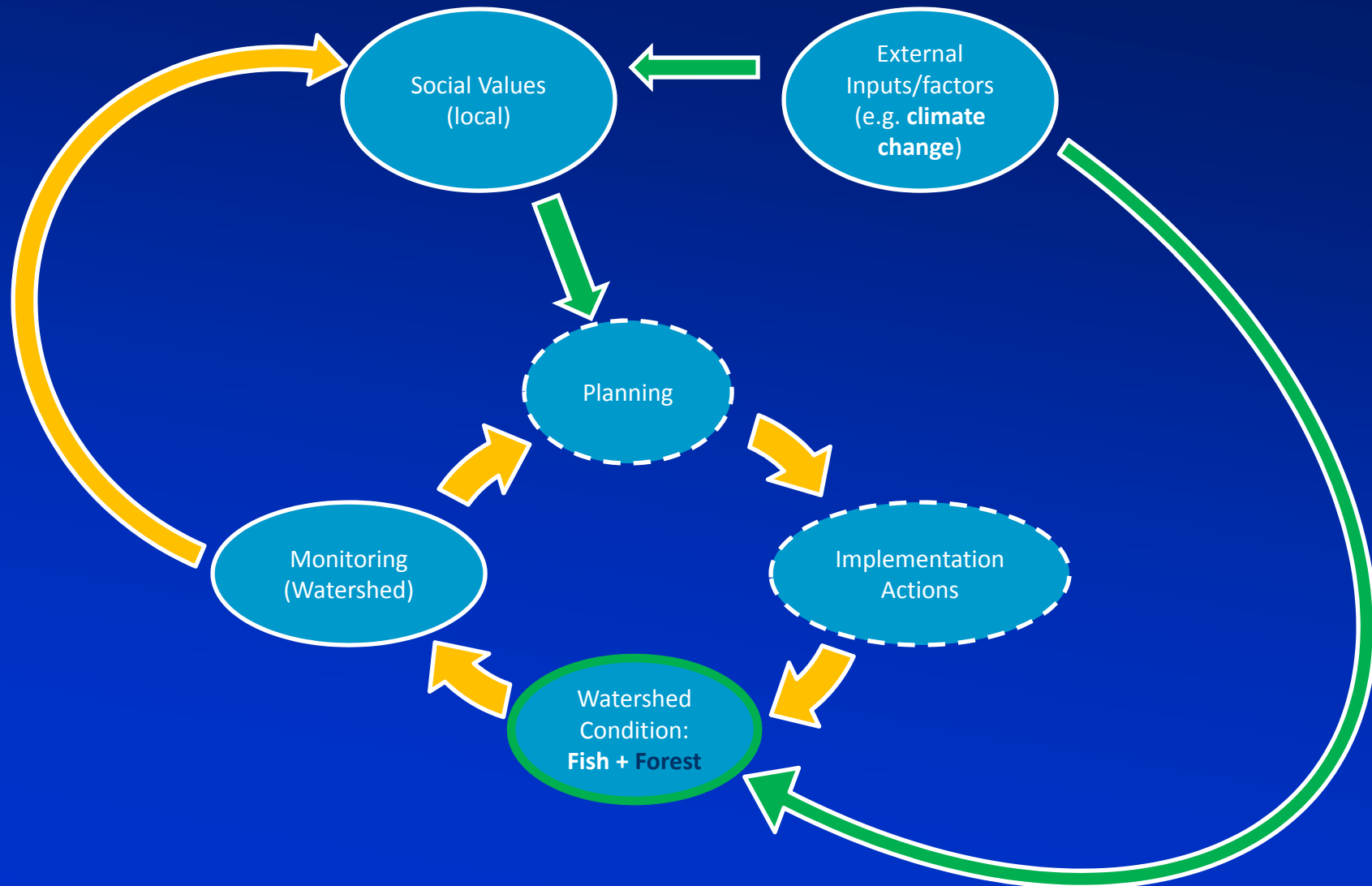
² ESSA Technologies, Vancouver



Planning... Where Does "Vegetation Change" Fit?



Planning... Where Does "Vegetation Change" Fit?



Why Use a Simulation Model?

Simulation models can help to...

- organize the thinking of many people in a consistent way
- combine, test and refine scientific knowledge
- provide possible answers to “what if” questions
about the future ***when past experience may not be enough***

Can use current information and knowledge, to cautiously extrapolate to conditions that may not have been seen before

Every time you read a tide-table, check the weather forecast or look at a stand growth curve, you're checking with a simulation model. You might not trust it totally, but you check it anyway and then make up your own mind.

Introducing... Global Climate Models

simulate the process of heating, cooling & air movement over entire globe: *GHGs*
multiple air layers & ocean layers
can include sea ice, clouds, vegetation
about 300 km resolution

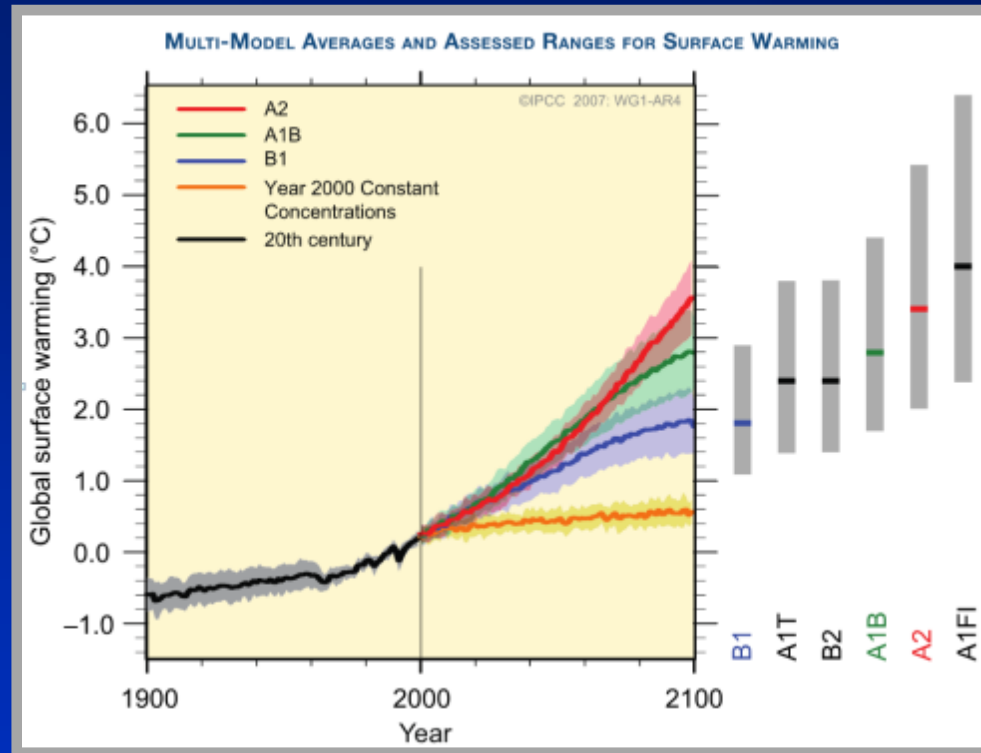
numerous GCMs: different governments,
laboratories and universities involved

United Nations (IPCC) a major contributor: scenarios of future
human development, analysis & communication

*No one knows which GCM is the best, or which human
development-industrialization scenario will actually happen*



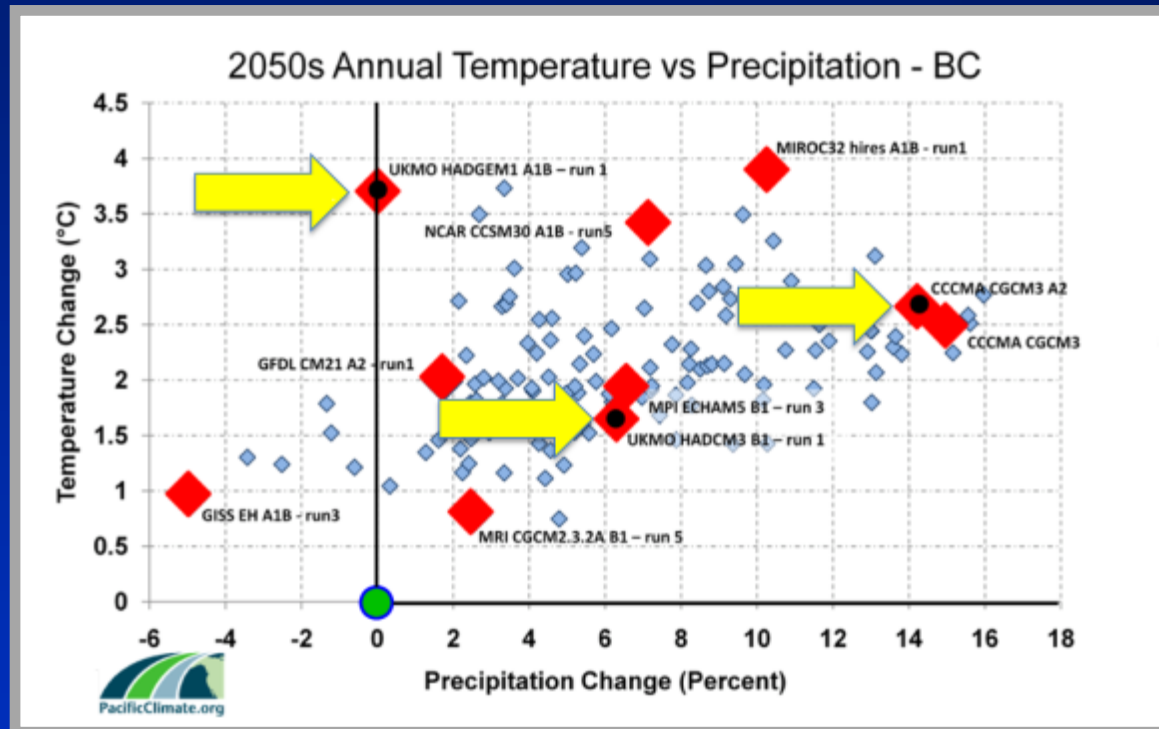
Introducing... Global Climate Models



No one knows which GCM is the best, or which human development-industrialization scenario will actually happen

Solution 1: use an **average** from multiple GCMs and look for adaptation and mitigation options that do some good under many development scenarios

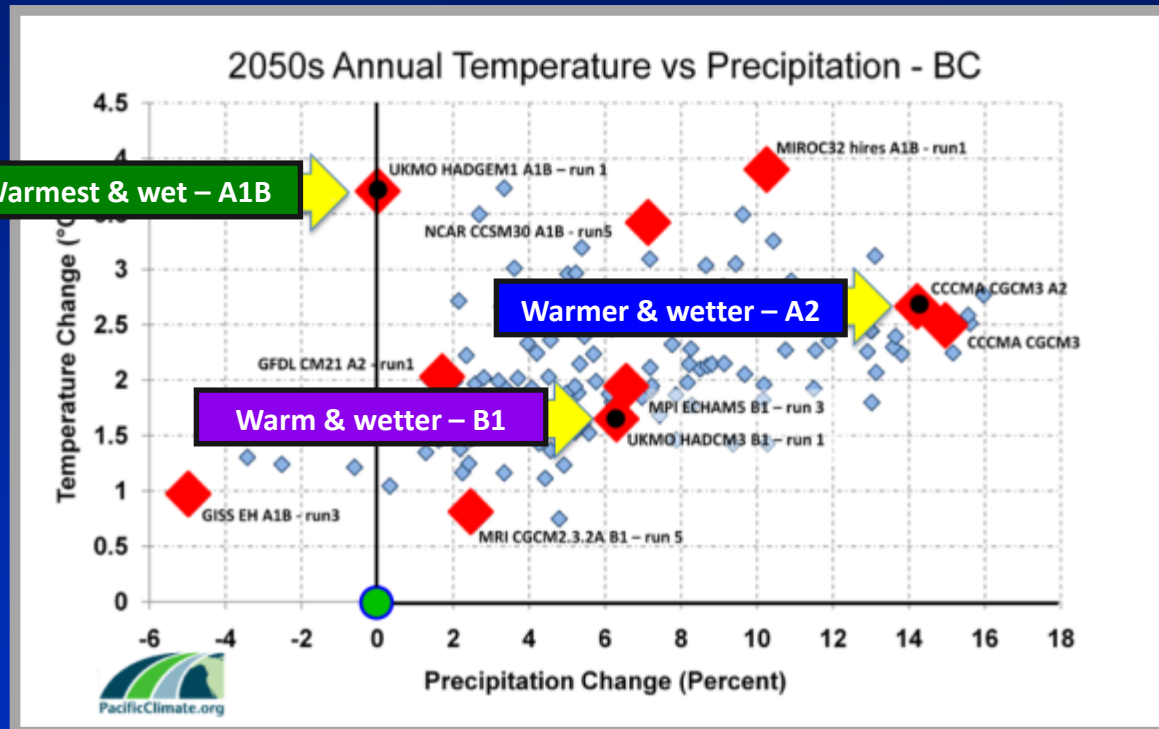
Introducing... Global Climate Models



No one knows which GCM is the best, or which human development-industrialization scenario will actually happen

Solution 2: use predictions from a **range of models & scenarios** and look for adaptation and mitigation options that do some good under many development scenarios

Introducing... Global Climate Models

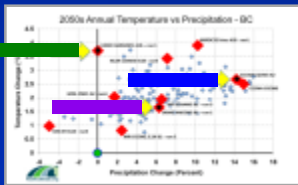


No one knows which GCM is the best, or which human development-industrialization scenario will actually happen

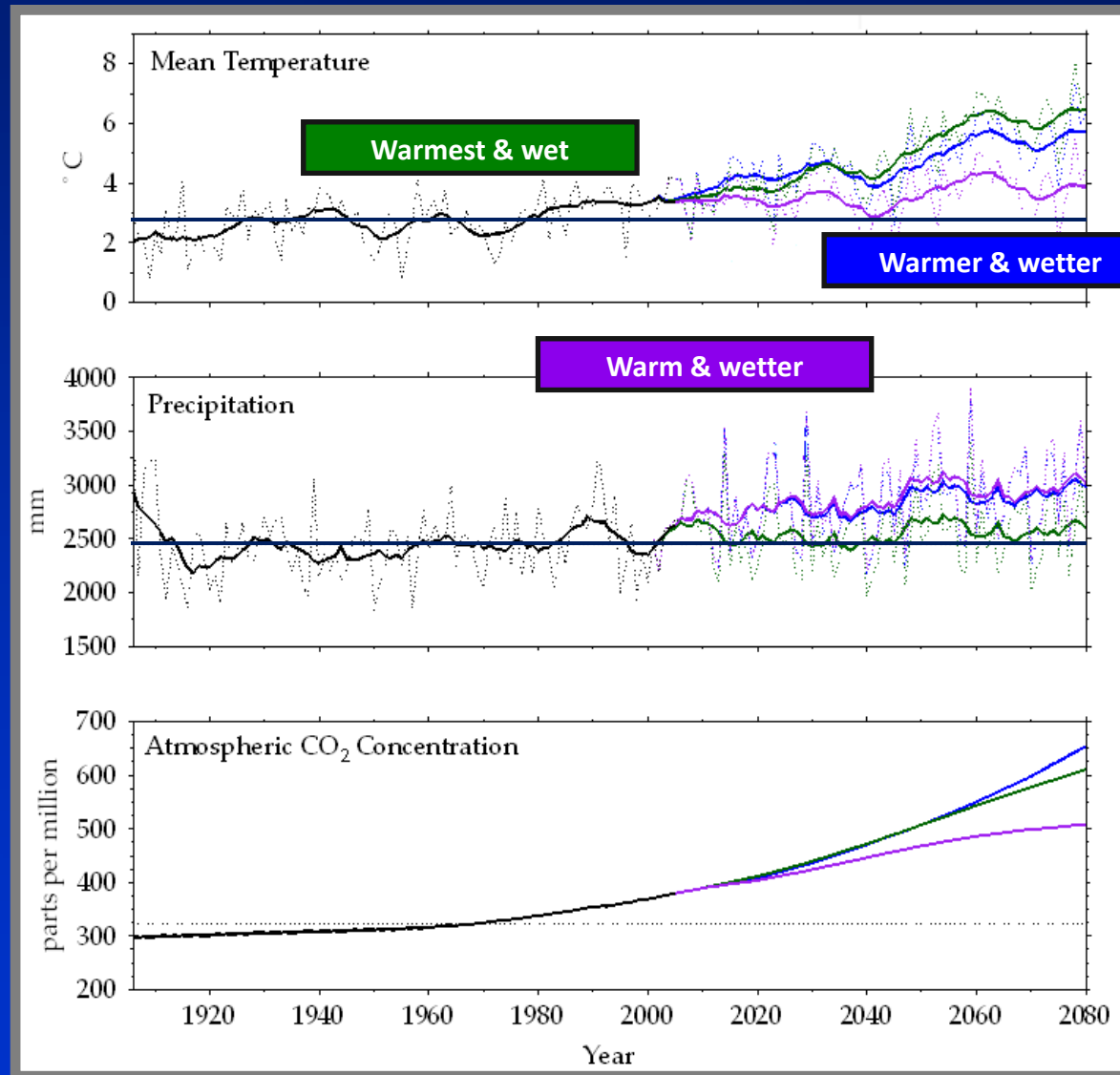
Solution 2: use predictions from a **range of models & scenarios** and look for adaptation and mitigation options that do some good under many development scenarios

Introducing... Global Climate Models

average
values
over entire
region

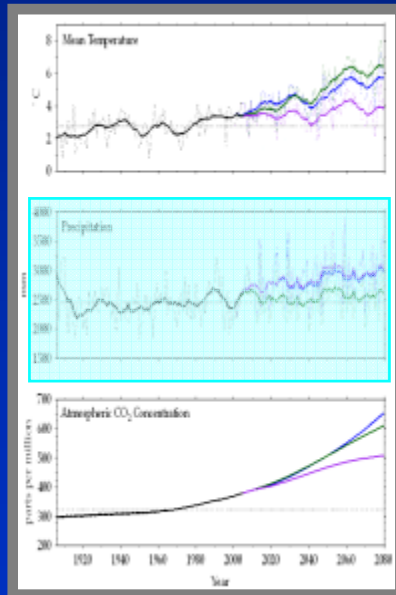
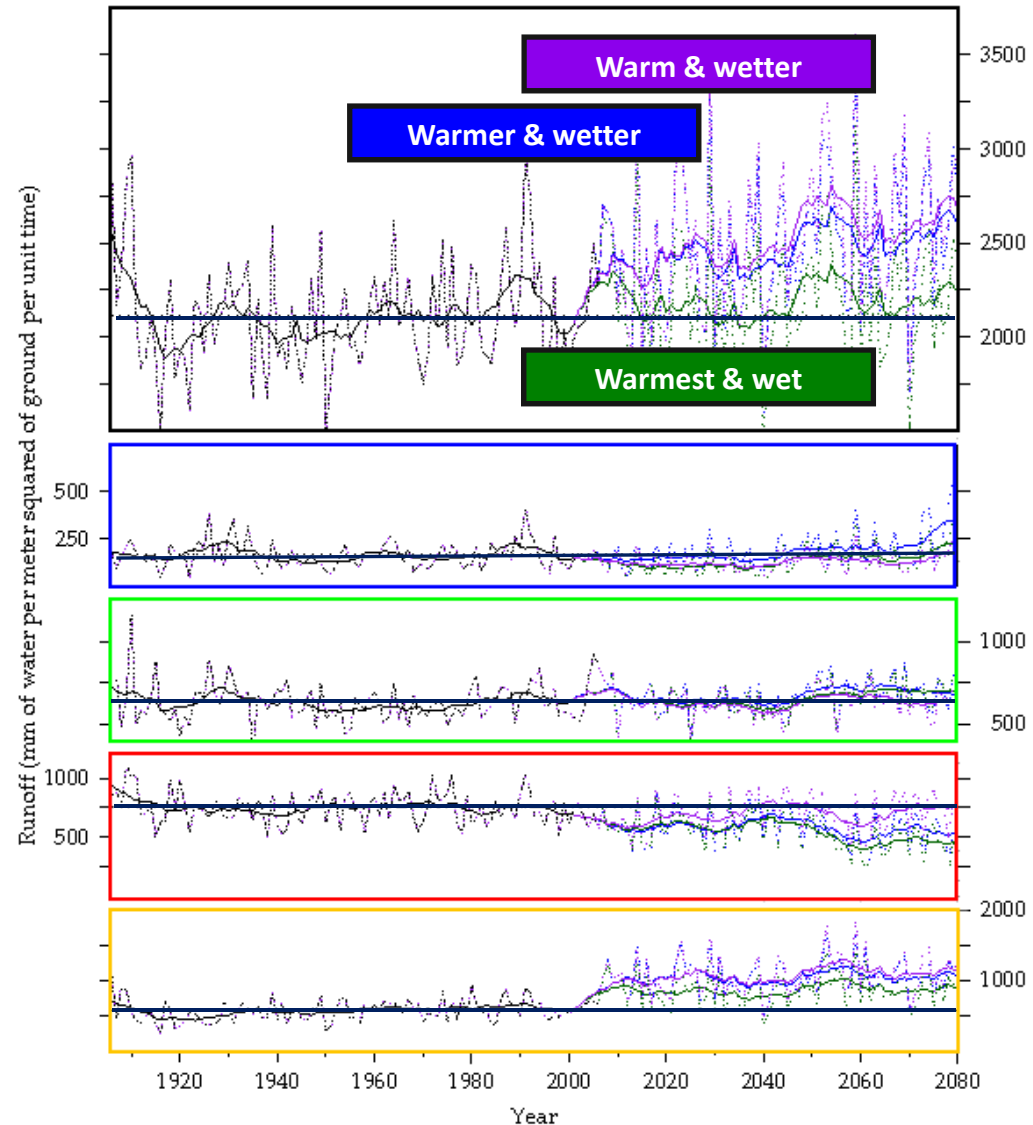


temperature,
precipitation,
& CO₂
are all fed
into the
vegetation
model



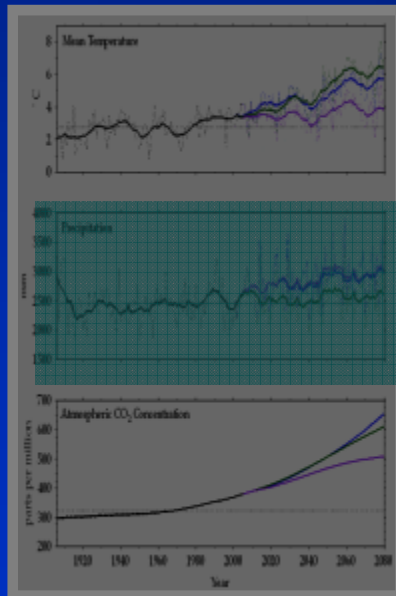
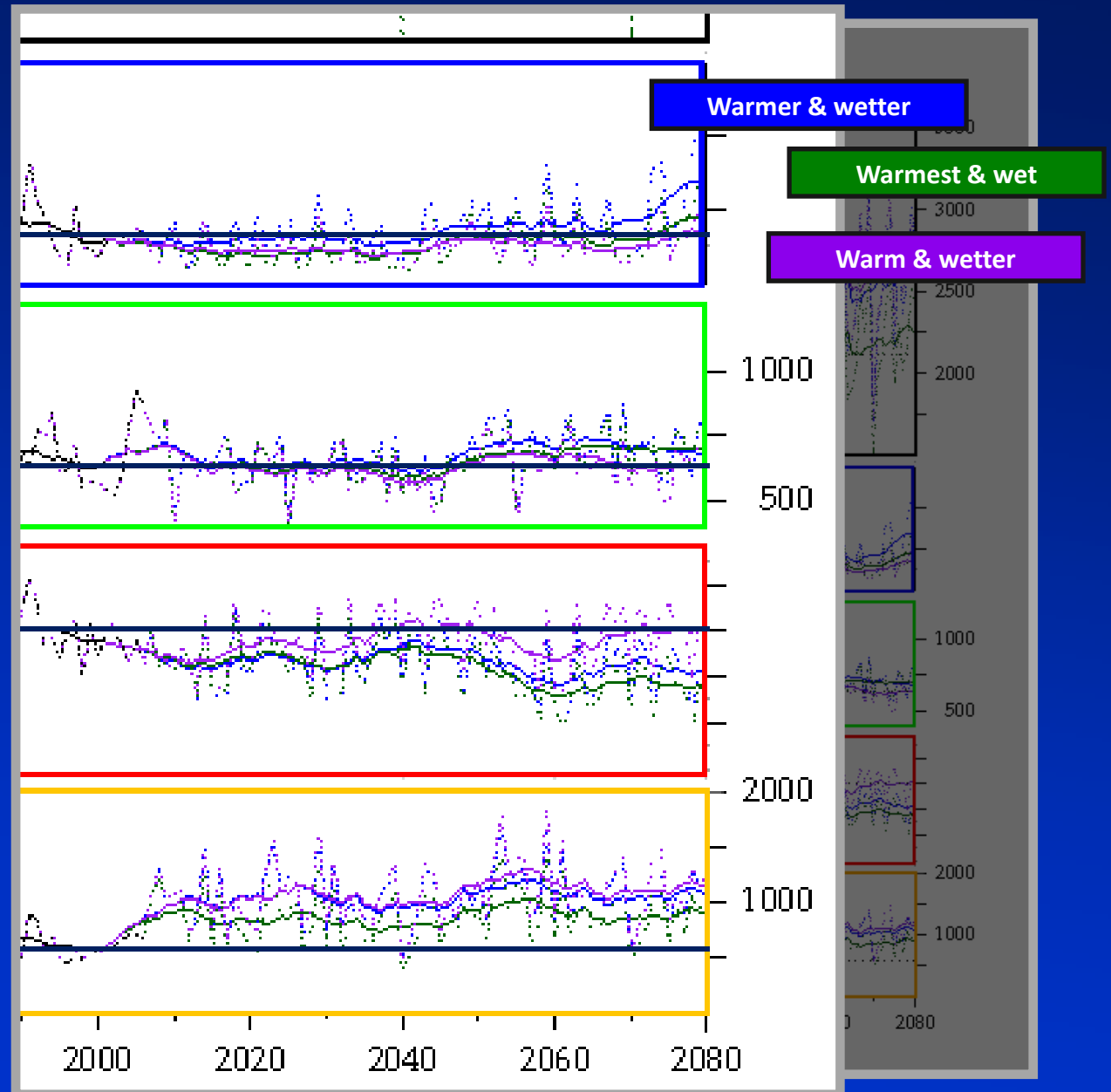
Introducing... Global Climate Models

changes in
runoff timing



Introducing... Global Climate Models

changes in
runoff timing



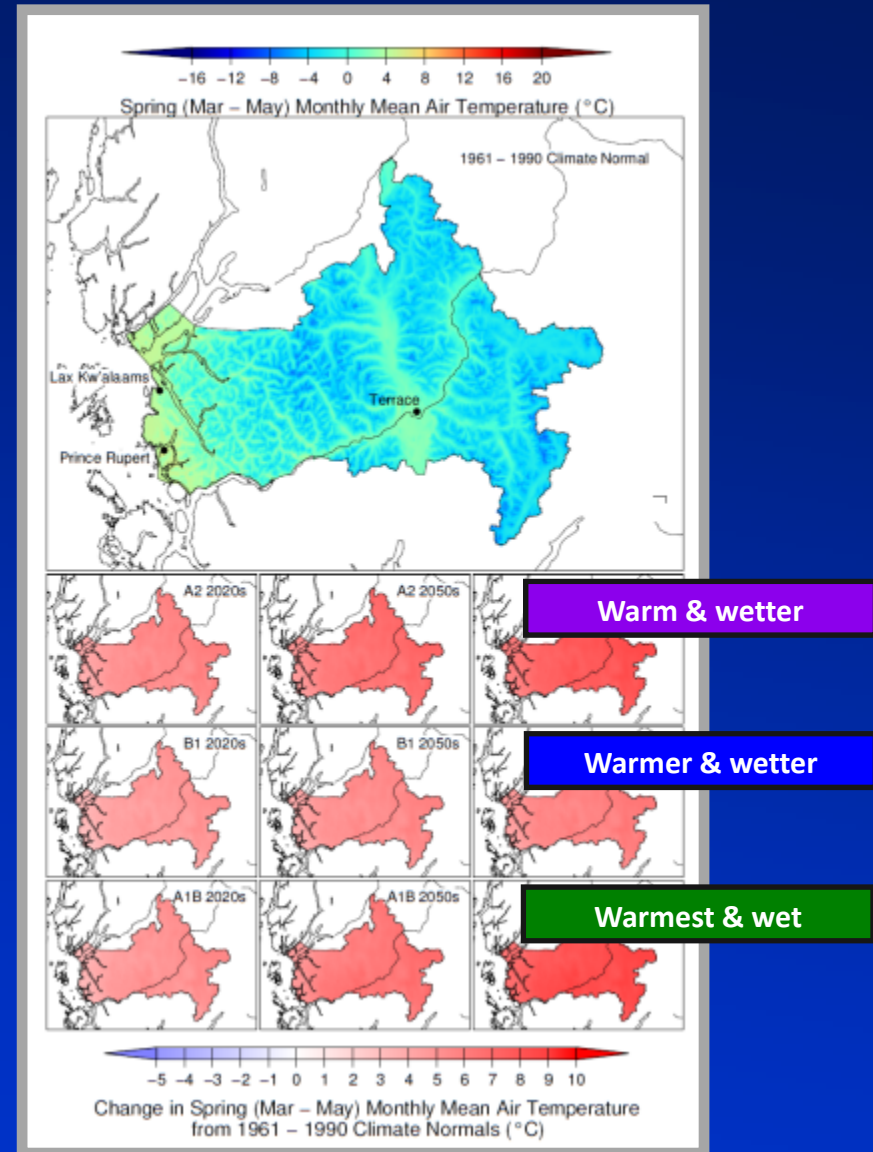
Introducing... Global Climate Models

local conditions “downscaled”
from large-scale simulation
models

daily pattern based on
monthly averages

may not capture the full range
of future conditions

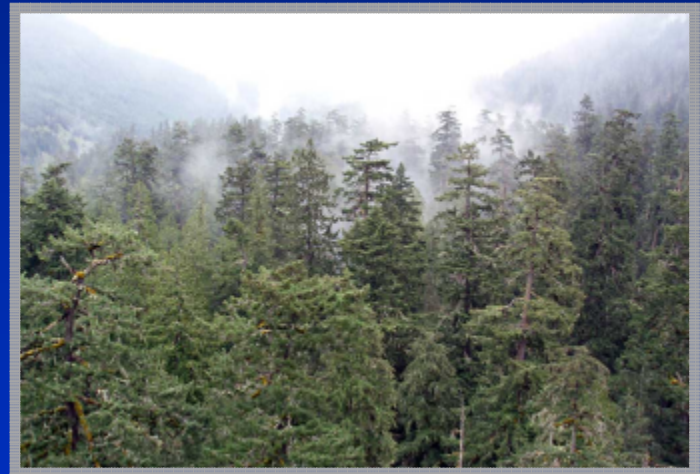
may not capture changes in
localized intense weather
events like storms, heavy rain
or snow, ocean conditions



Introducing... The LPJ-Guess vegetation model

responsive to light, heat, moisture & CO₂
calibrated for about 20 northwest tree species
grows cohorts of trees, plus grass
tree growth sensitive to surrounding stand conditions
allows clearcut and stand-replacing fire with limited
spatial detail

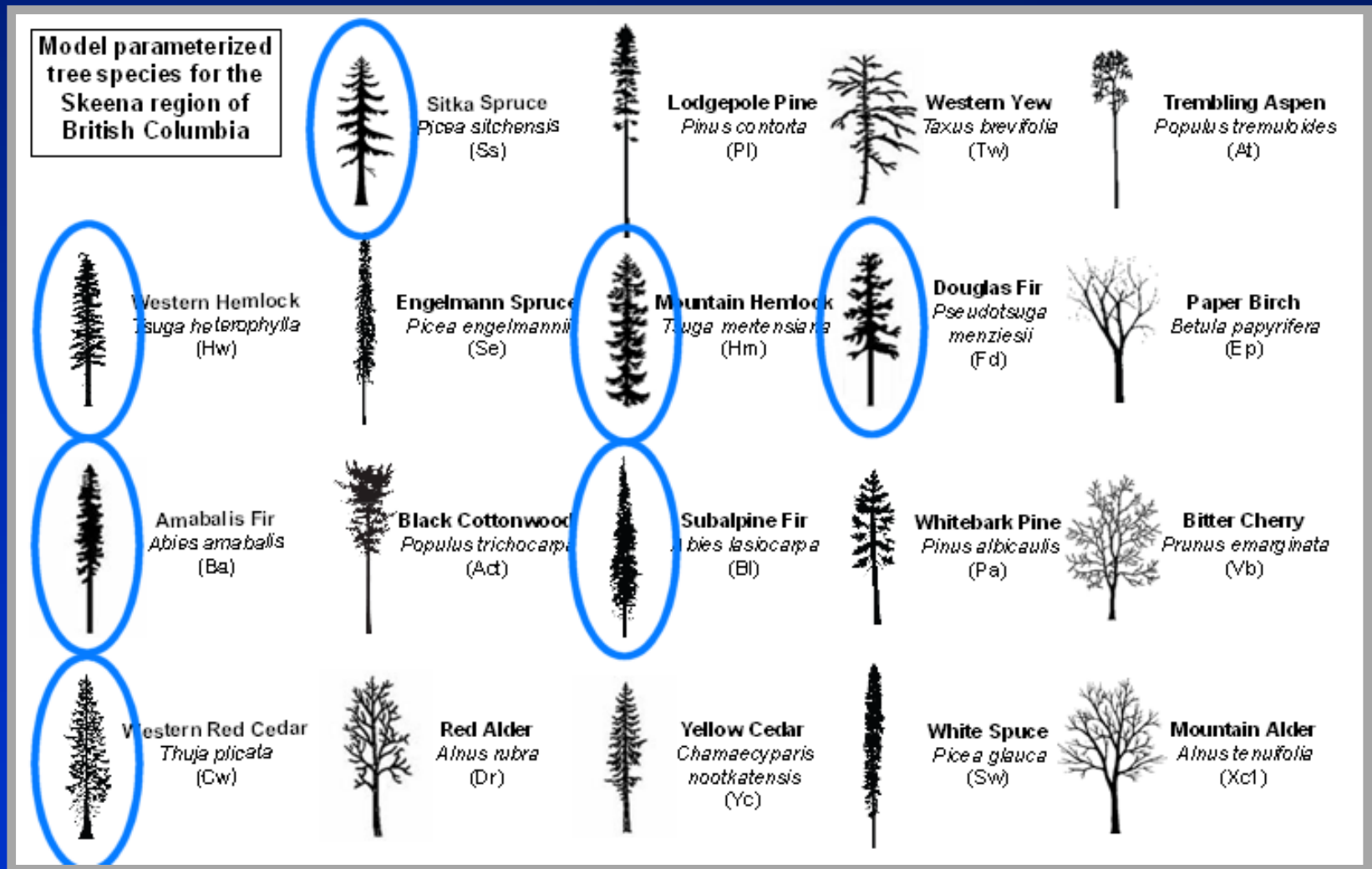
works on a 1 km² patch of land
uses simulated daily weather data
local weather is downscaled from
large-scale models
daily time is based on monthly
averages



each year...

predicts amount of each species in each patch
calculates amounts ("pools") of biomass as Carbon
calculates changes ("fluxes") among the pools

LPJ-Guess and Trees



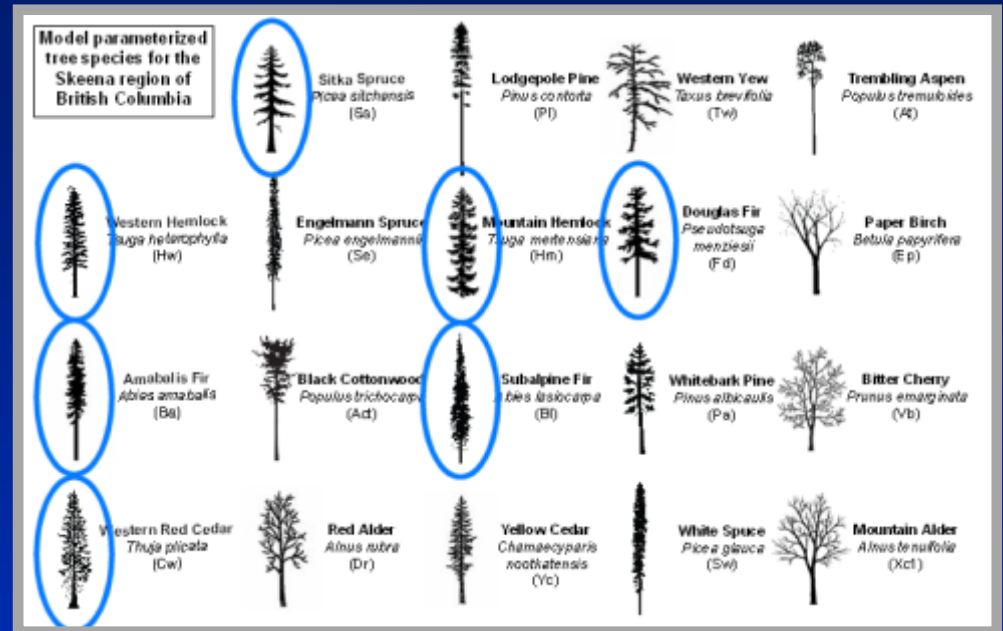
LPJ-Guess and **Trees**

responsive to light, heat,
moisture & CO₂

calibrated for main BC
northwest tree species
plus grass

tree growth sensitive to
surrounding stand
conditions

allows clearcut and
stand-replacing fire with
limited spatial detail



Main species...

western & mountain hemlock
Douglas-fir
western red-cedar
Sitka spruce
subalpine & silver fir

LPJ-Guess and Climate

daily pattern based on **monthly** averages

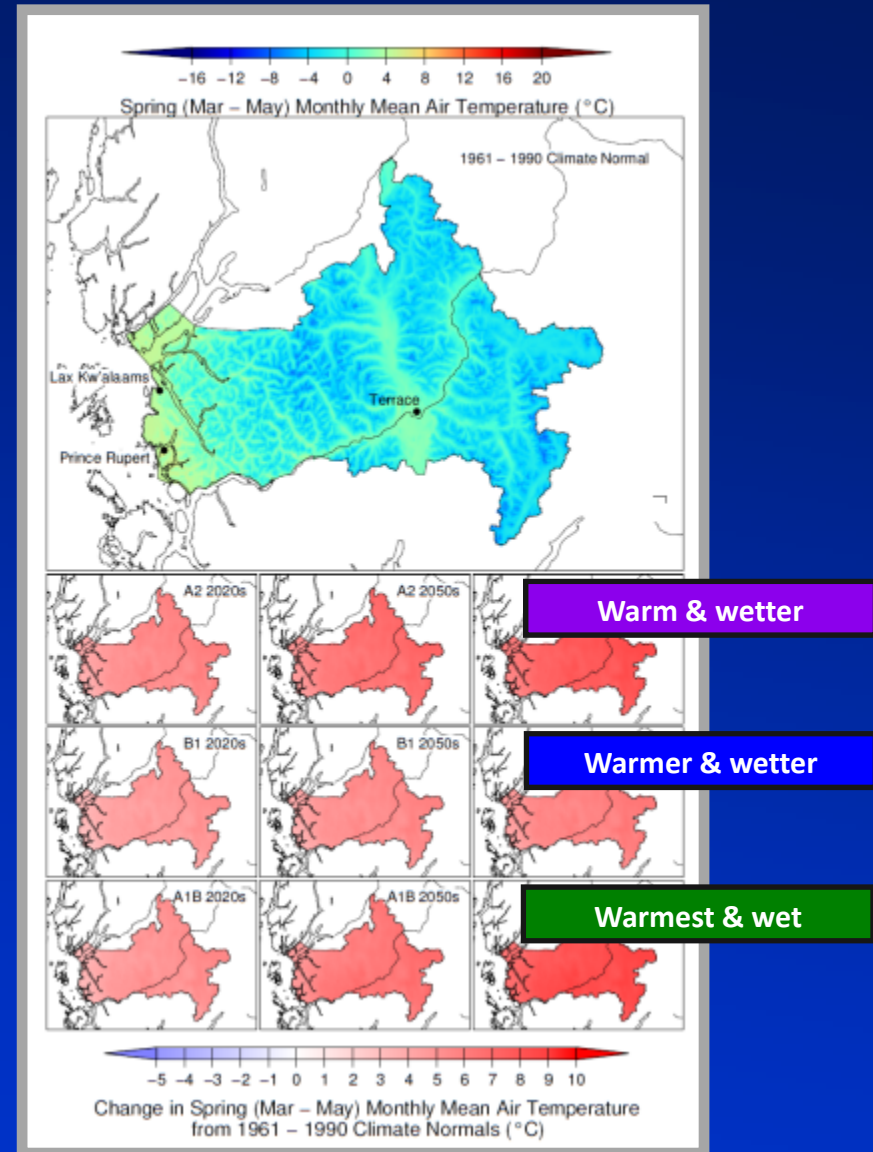
may not capture the full range of future conditions

works on a 1 km² patch of land

uses **simulated** daily weather data

local weather is downscaled from large-scale models

daily time is based on monthly averages



LPJ-Guess and Shifts in Tree Species

The following 4 animated cartoons show shifts in suitability for 3 common species, and grasses

subalpine fir – spreads west and up slopes

mountain hemlock – is displaced by balsam fir

grass – alpine grass displaced by trees

western redcedar – eastward migration possible

Note that orange-yellow colours signal a very small proportion of occupancy: “just arrived” or “just leaving”

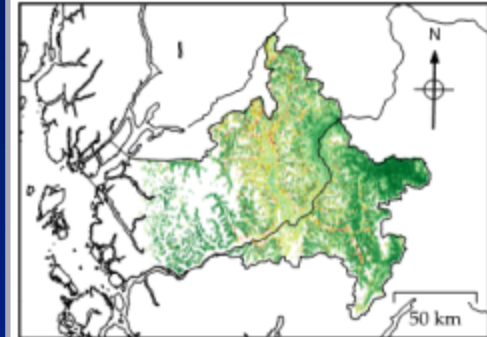
LPJ-Guess and movies don't actually simulate **migration** or what is on the ground: they show changes in potential or suitability...

- “subalpine fir would grow well here”
- “trees would do well here and could replace meadows”
- “should we replant after harvest with something different?”

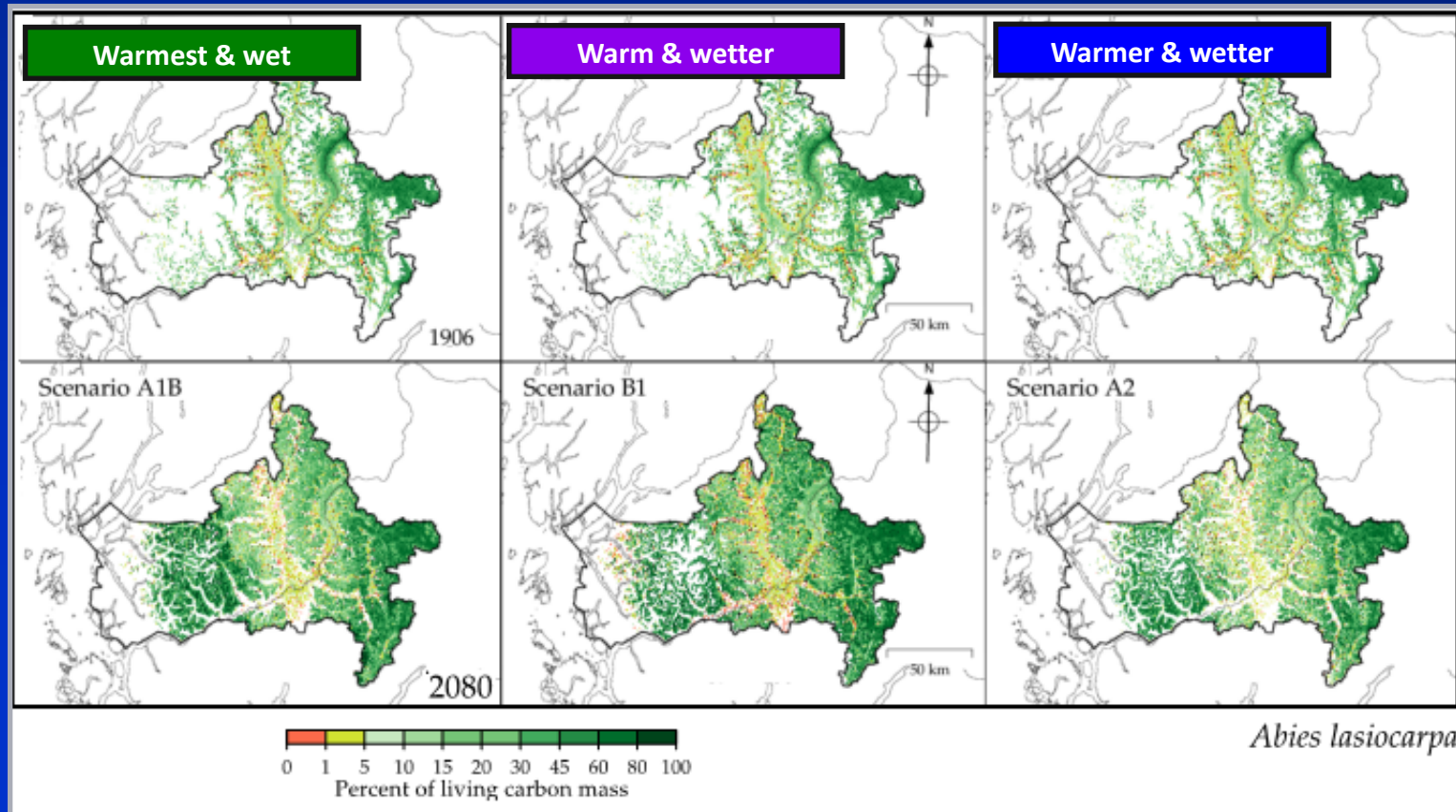
LPJ-Guess and subalpine fir

- reduced in valley bottoms
- moves upslope

Year 2006

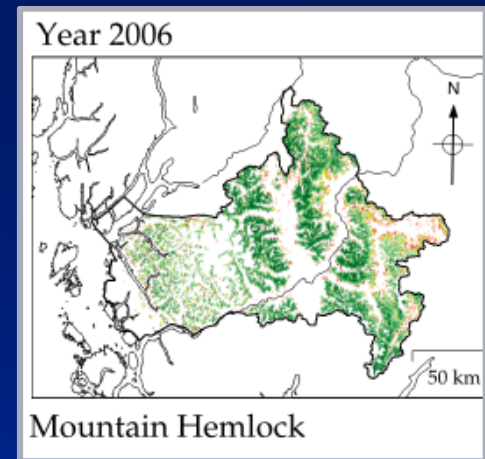
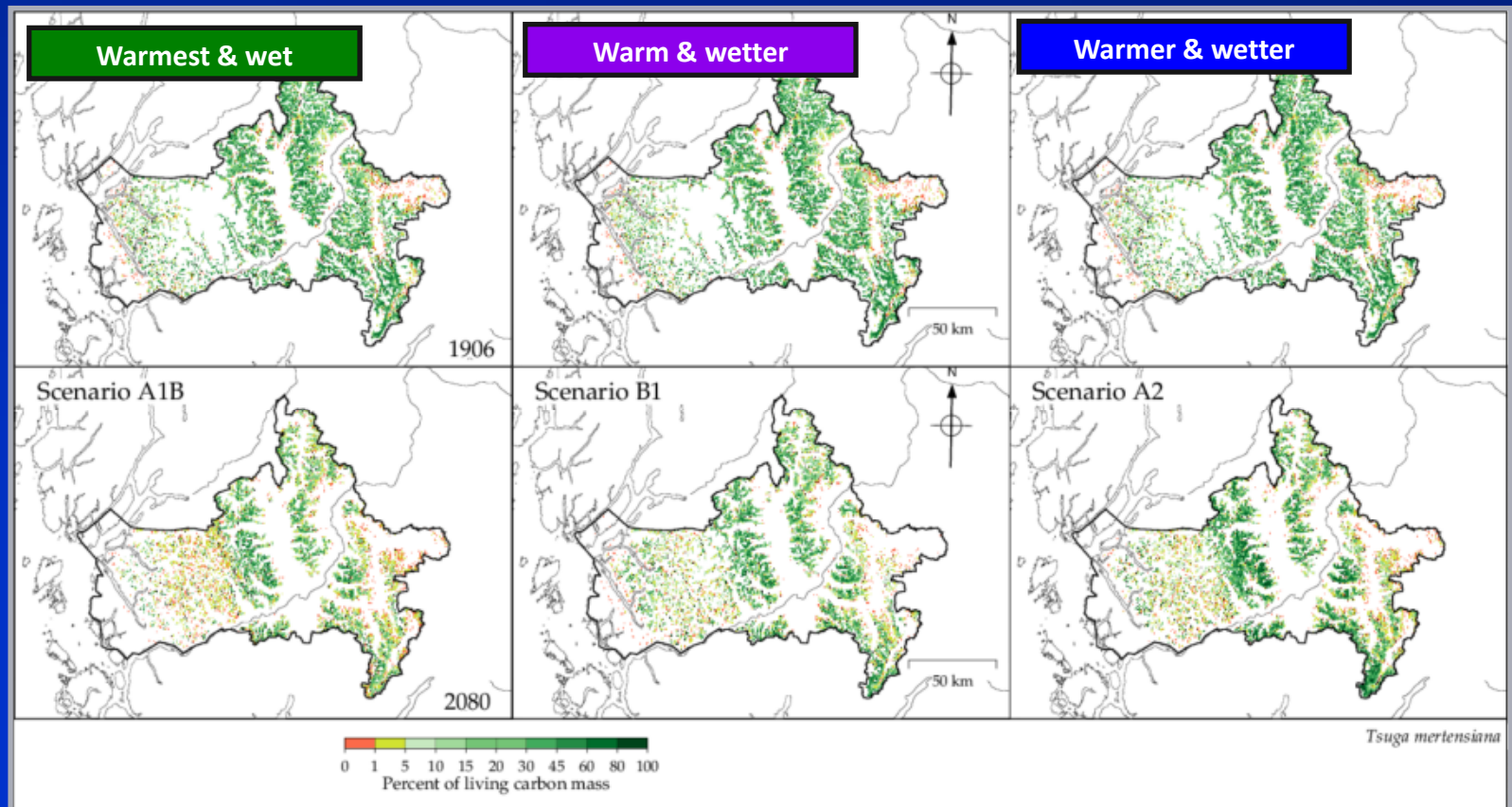


Subalpine Fir



LPJ-Guess and mountain hemlock

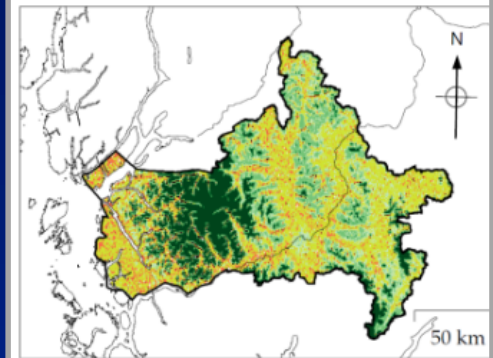
- reduced at middle and high elevations



LPJ-Guess and grasses

- Losses at high elevation to shifting trees
- Small losses at low elevation to increased trees

Year 2006



Warmest & wet

Warm & wetter

Warmer & wetter

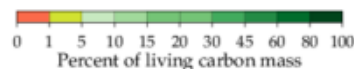
1906

Scenario A1B

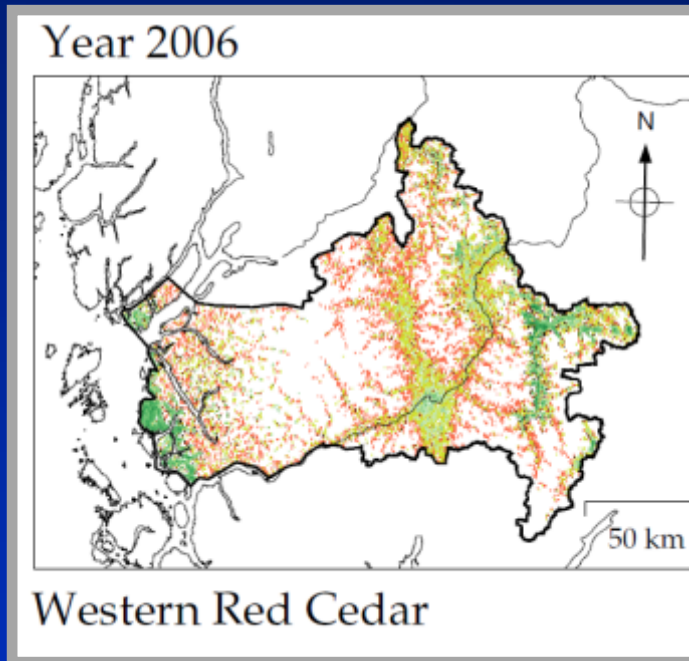
Scenario B1

Scenario A2

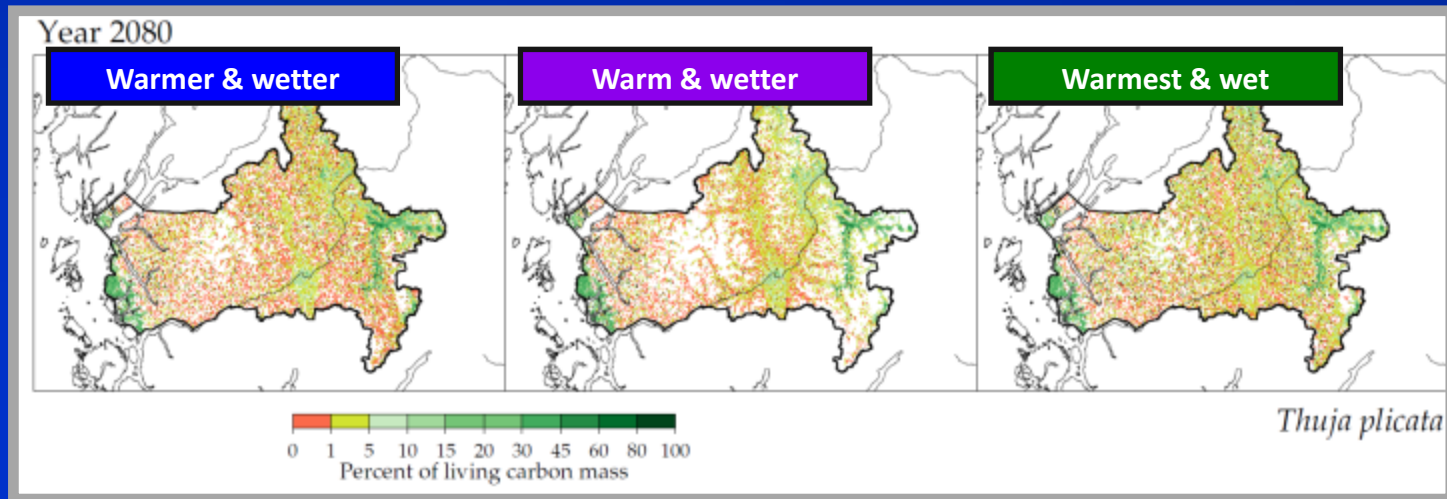
2080



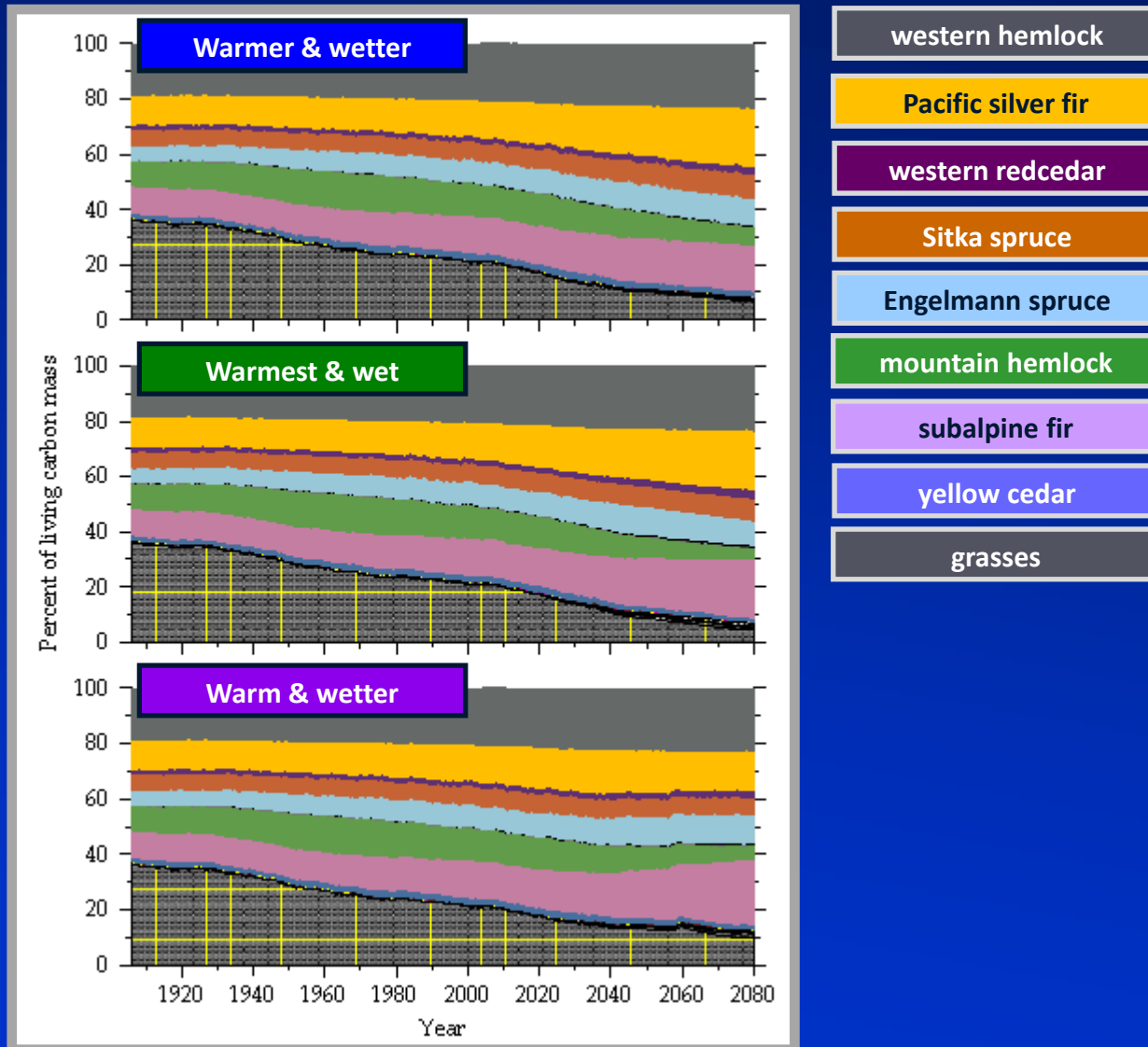
LPJ-Guess and western redcedar



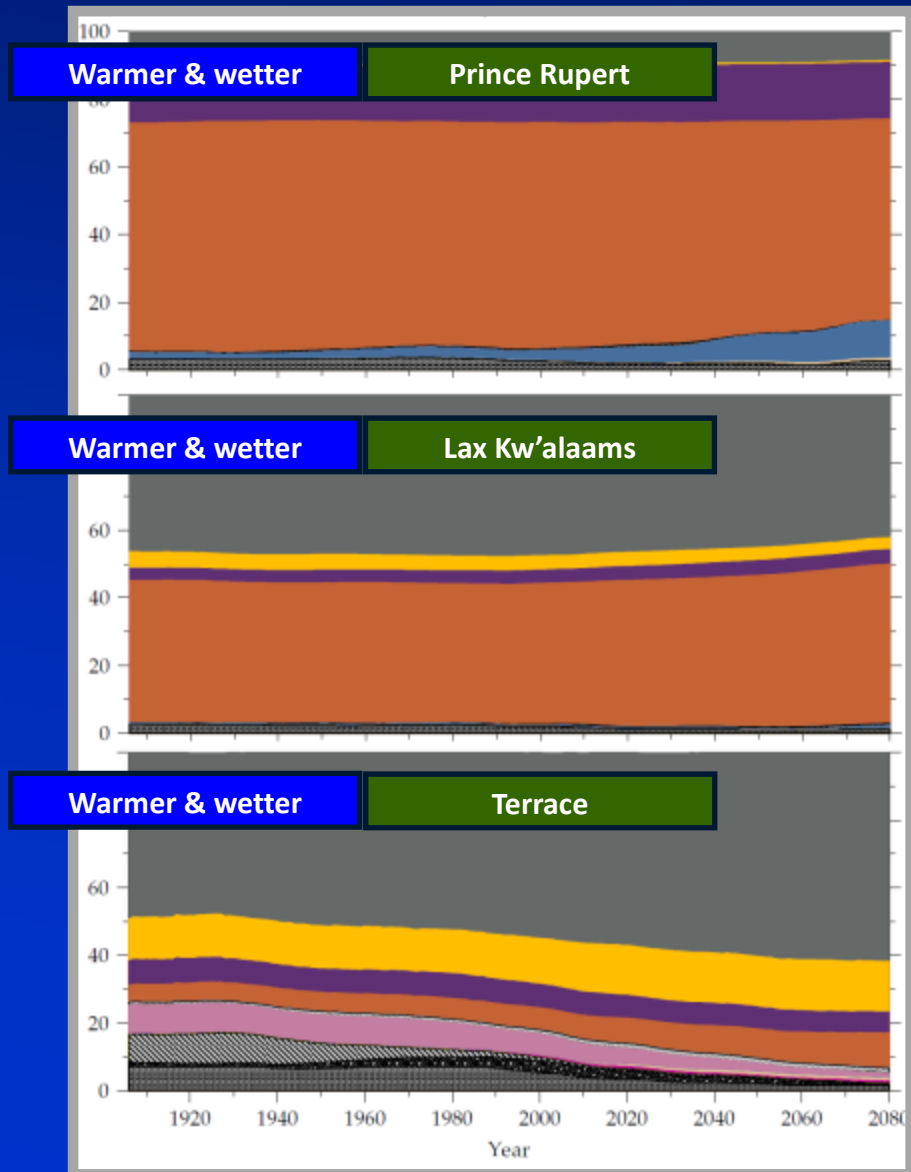
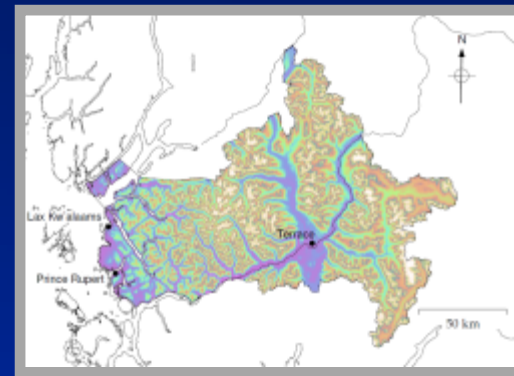
- slight expansion over time
- remains prevalent on coast



LPJ-Guess and Species Shifts across Study Area

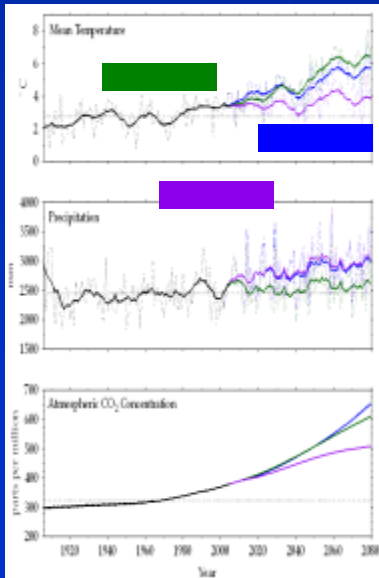
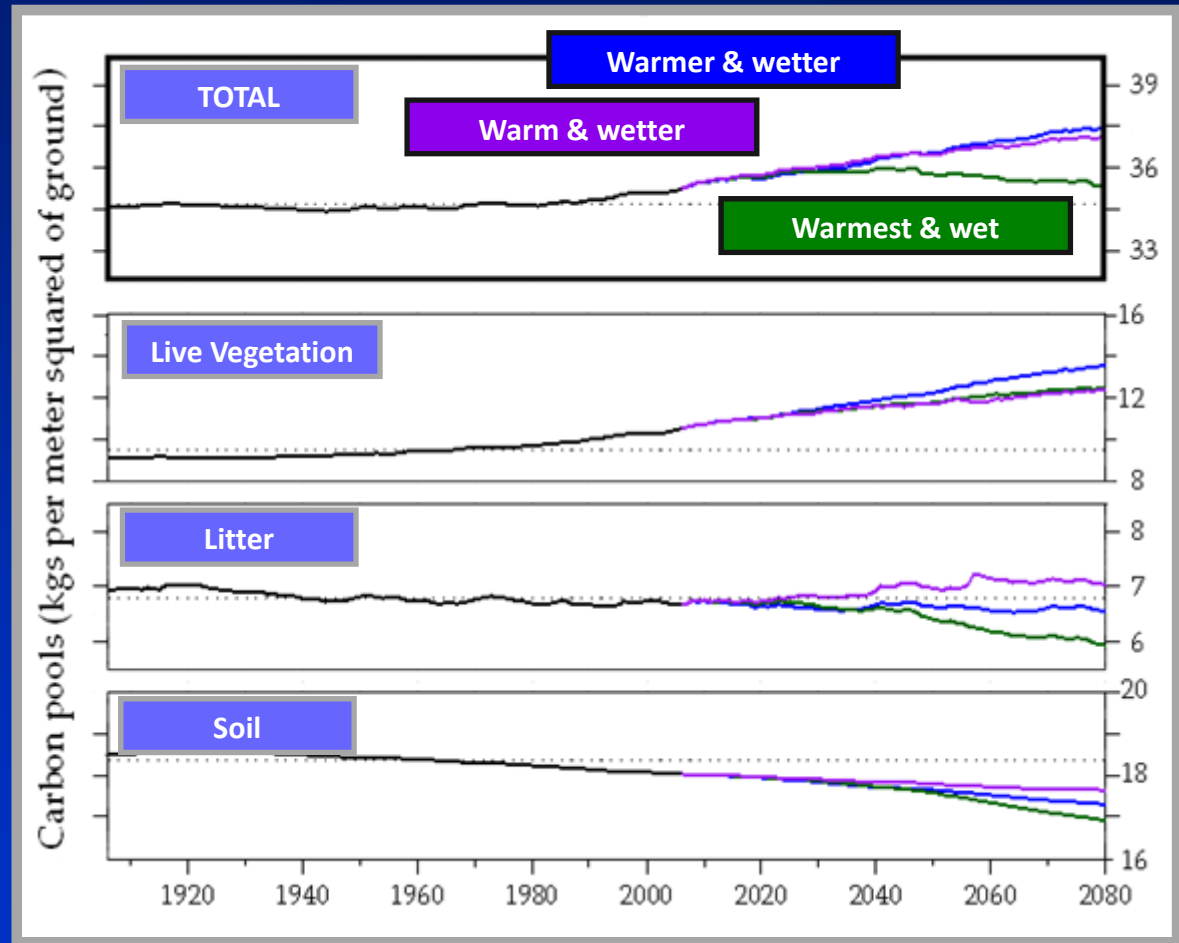


LPJ-Guess and Shifts around Communities



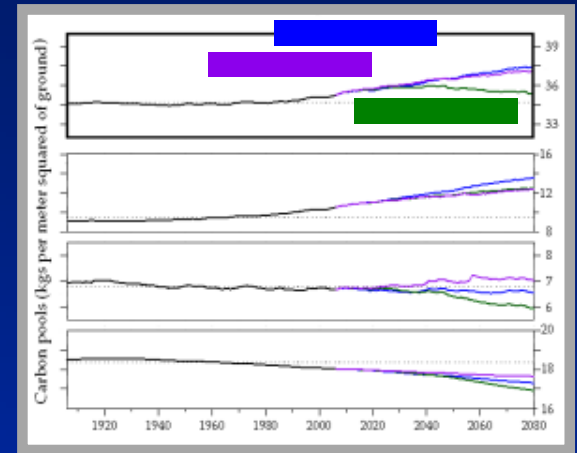
LPJ-Guess and Carbon

smoothed
average
values
over entire
region;
no harvest



LPJ-Guess and Carbon

- future increase in live C stocks from CO₂ fertilization and warmer growing season
- Carbon sequestration could become a management option
- faster decomposition rates reduce soil and litter pools
- interplay between faster growth/litter and faster decomposition
- total C increases until about 2040, Possibly declining after that in “warmest wet” scenario



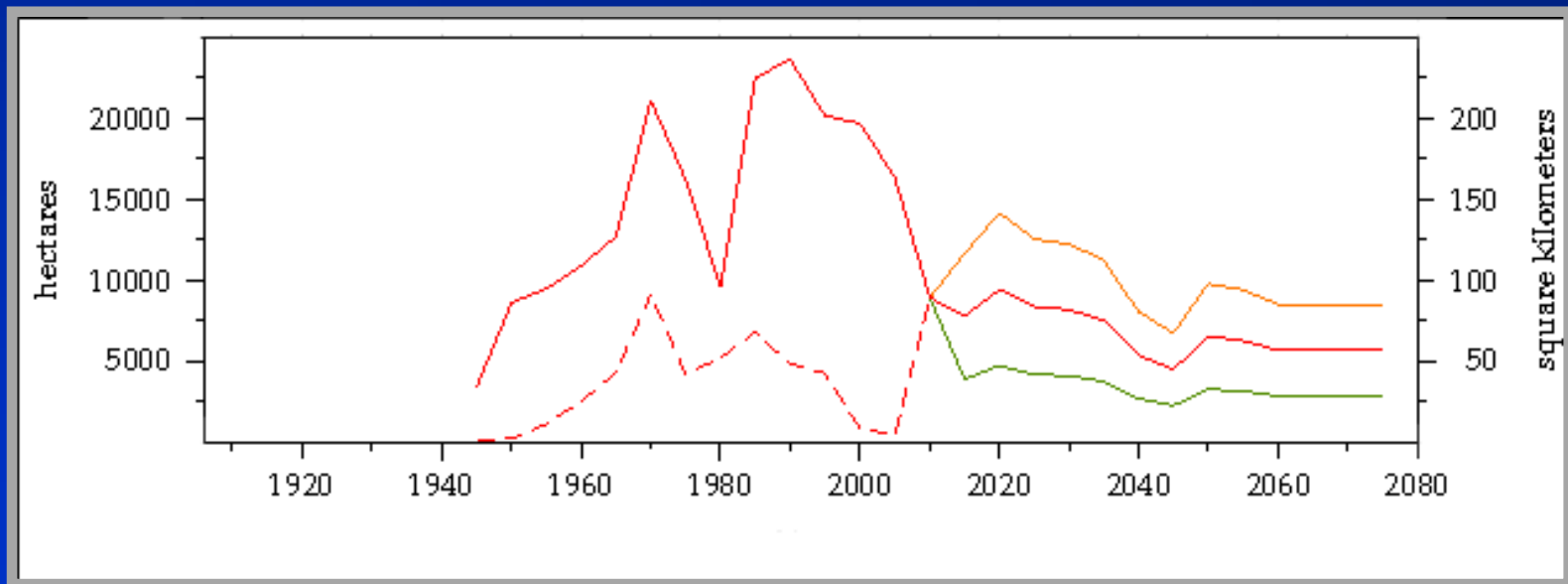
What about Fire?

- fire is infrequent in much of the study area, and remains that way under all 3 climate scenarios
- most fires caused by people
- regionally, future fire conditions will be similar to (unsuppressed) early 1900s levels
- increased fire risk for ~750 km² eastern side of study area



What about Harvesting?

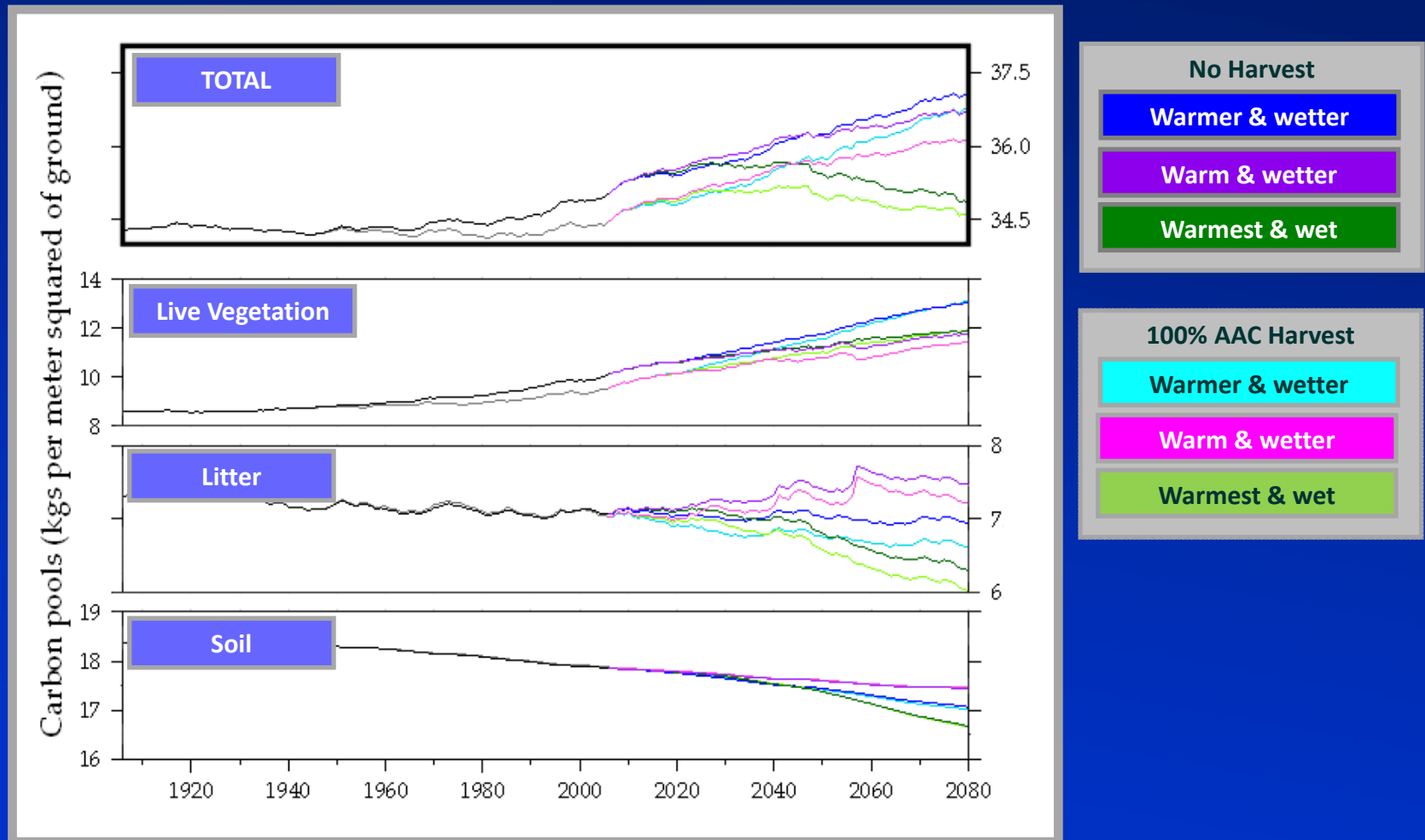
- some simulations include historic and estimated historic harvest in TFL1
- 3 scenarios... **50%**, **100%**, **150%** of 2010 AAC, converted to hectares



- Annual harvest in figure is reported every 5 years

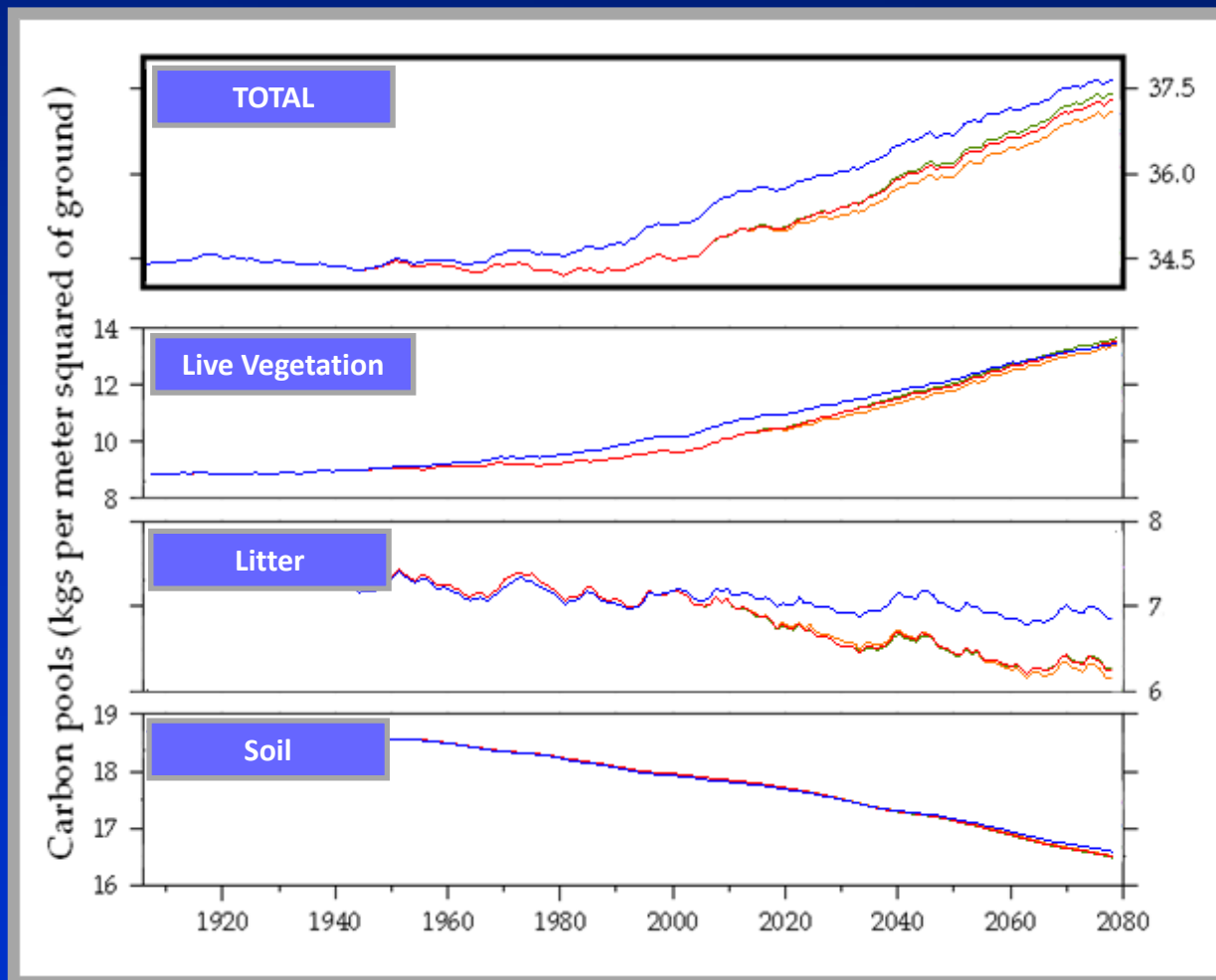
What about **Harvesting**?

Comparison 1: Across Climate Scenarios



What about **Harvesting**?

Comparison 2: Across AAC Scenarios



Warmer & wetter

No Harvest

150% AAC

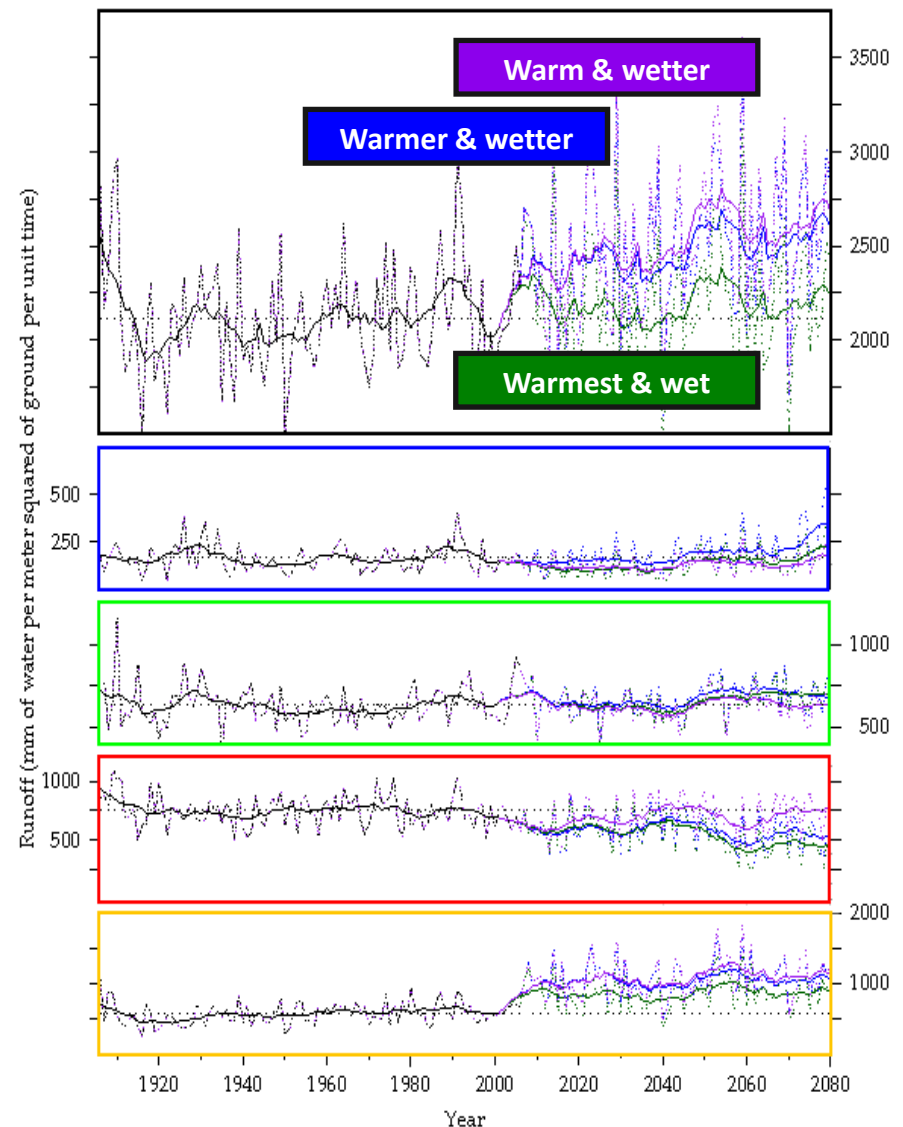
100% AAC

50% AAC

What about Harvest & Runoff?

Harvest is <1% annually over 32,000 km² study area

At this scale, harvesting has a very small effect on runoff



Why Use a Simulation Model?

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- provide possible answers to “what if” questions
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Can use current information and knowledge, to cautiously extrapolate to conditions that may not have been seen before

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What Can We Take Away?

1. Change in runoff timing: 70 years from now...
-20% summer, +100% autumn
2. Lots of weather variation year-to-year, but consistent warming trend; usually wetter
3. Landscape is greener: grass replaced by trees
4. Alpine tree species replaced by mid-slope species
5. Climate change scenarios have much bigger impact on vegetation or carbon than harvesting or fire
6. Regional results (runoff) don't scale down to the site level in simplified LPJ-Guess hydrology
7. Uncertainty about reliability of scaling: **monthly** and **regional** temperature and runoff don't automatically predict **daily** and **local** temperature and rainfall patterns