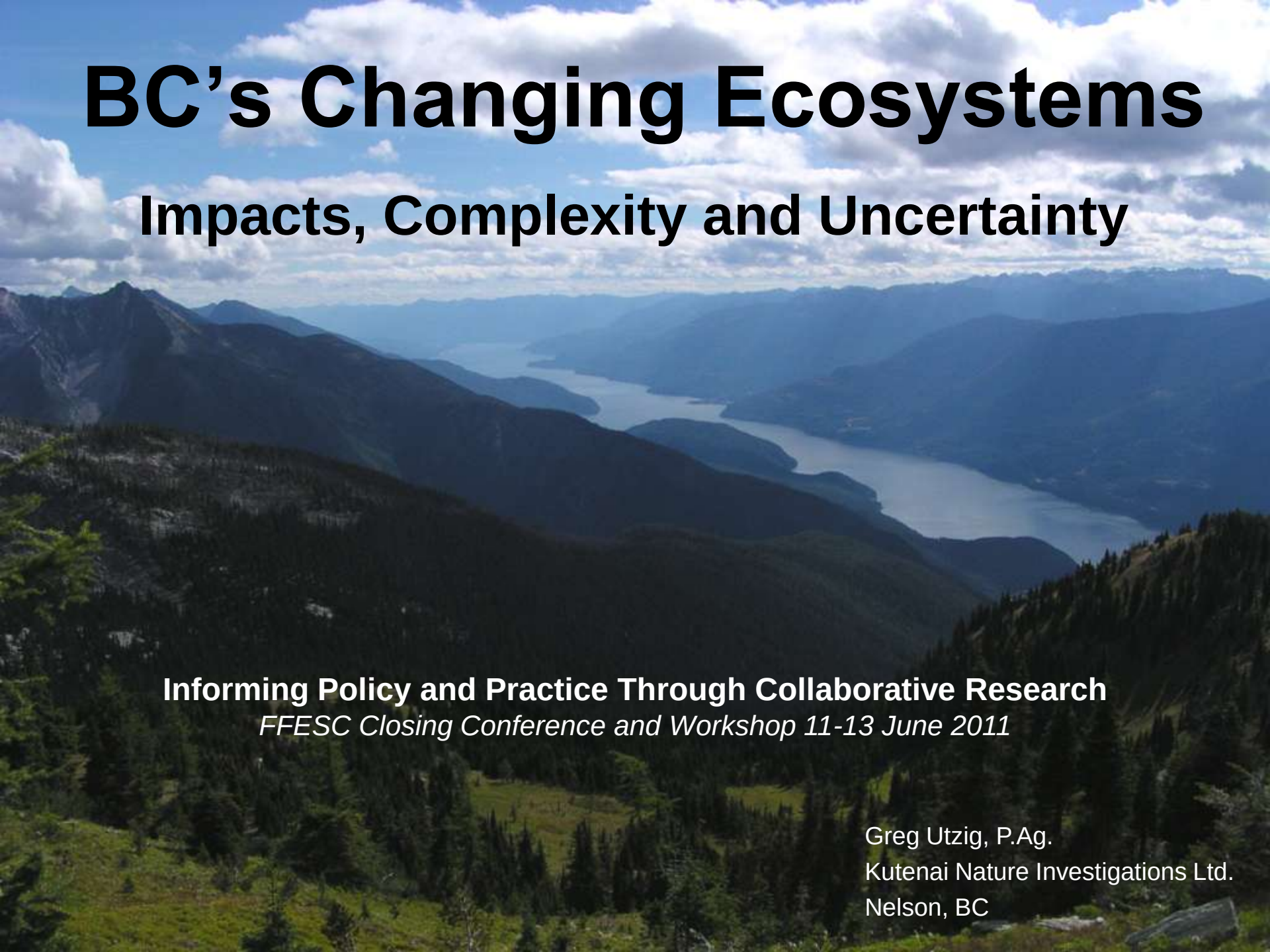




BC's Changing Ecosystems

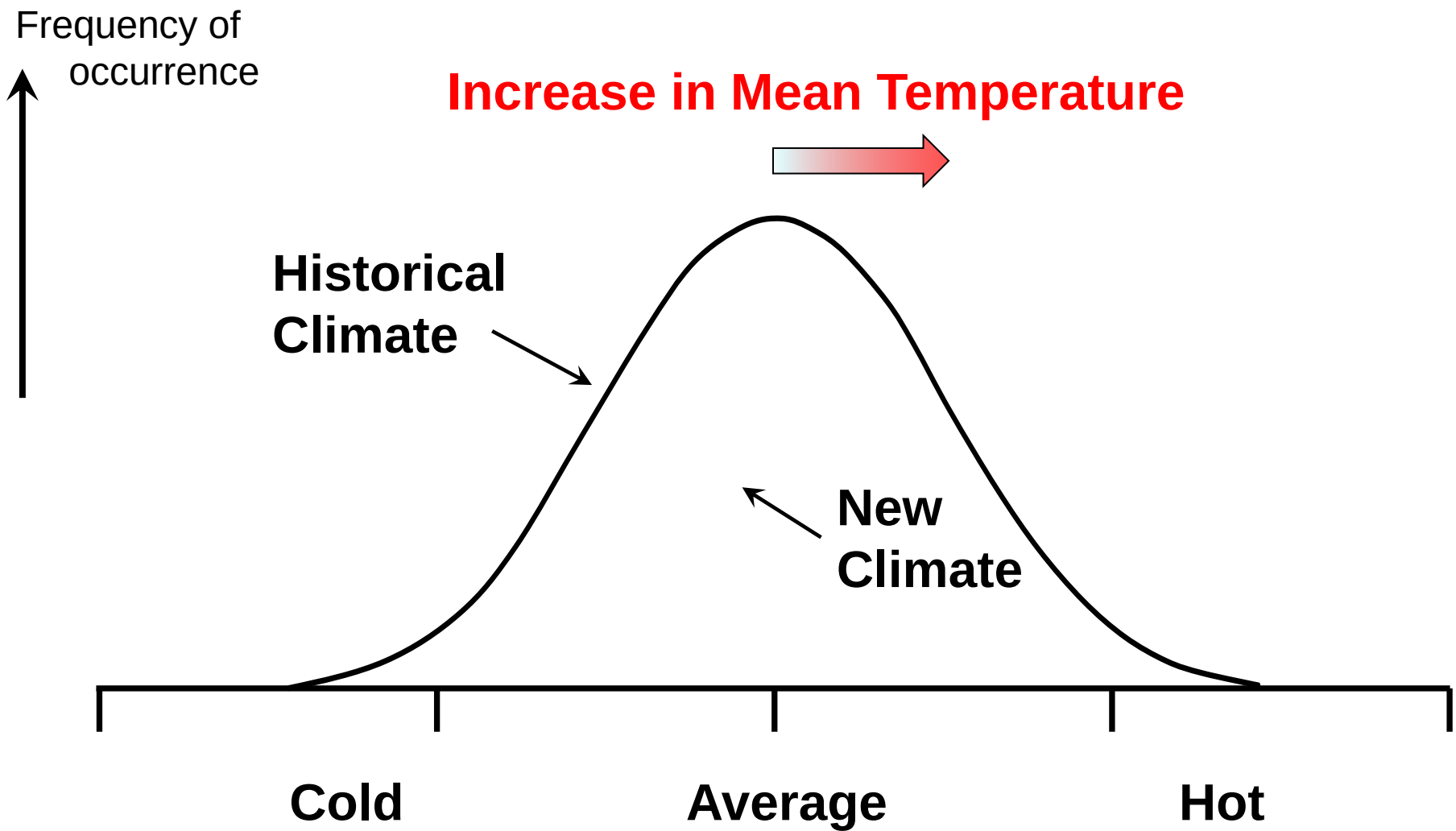
Impacts, Complexity and Uncertainty

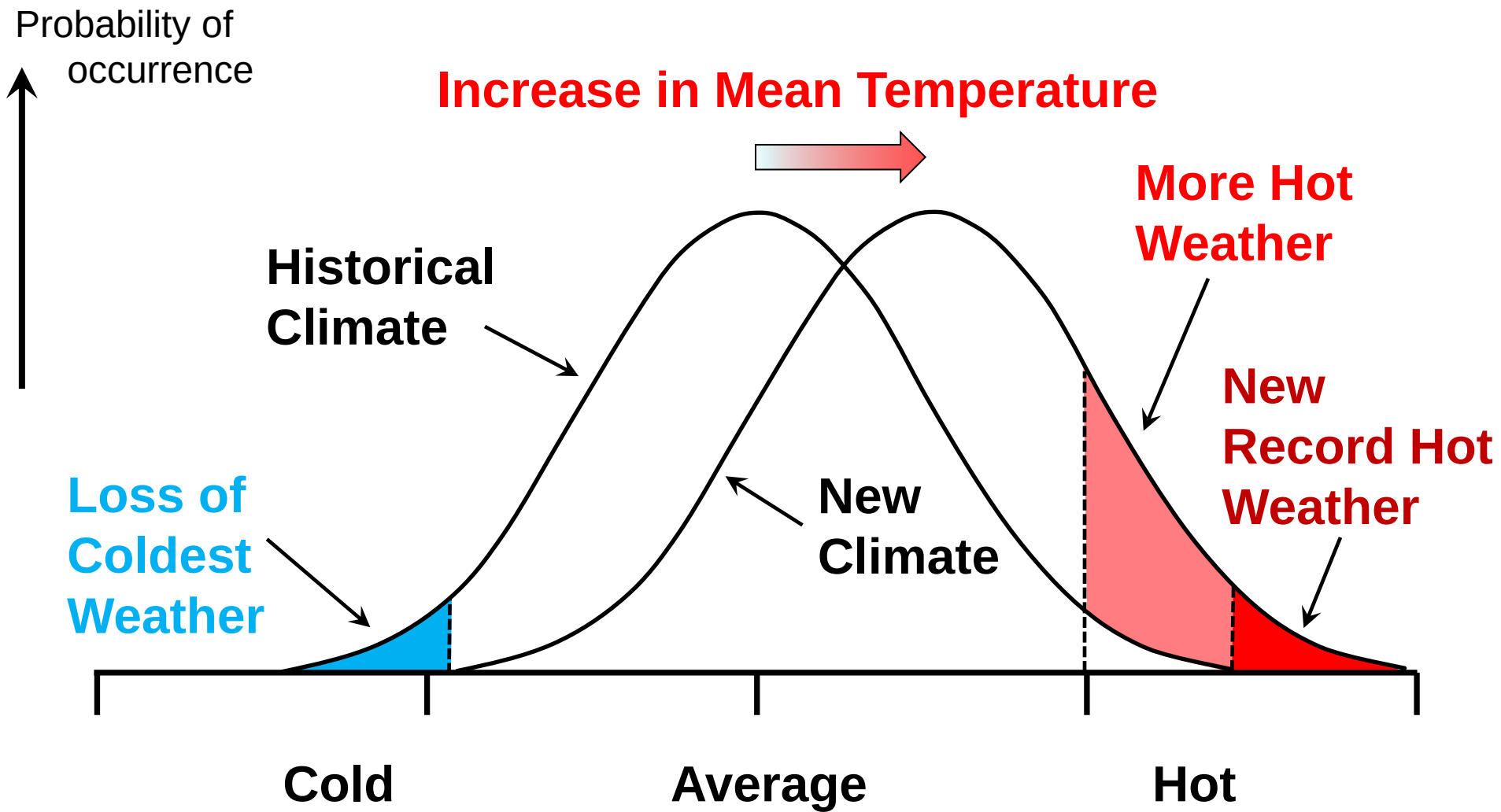
Informing Policy and Practice Through Collaborative Research
FFESC Closing Conference and Workshop 11-13 June 2011

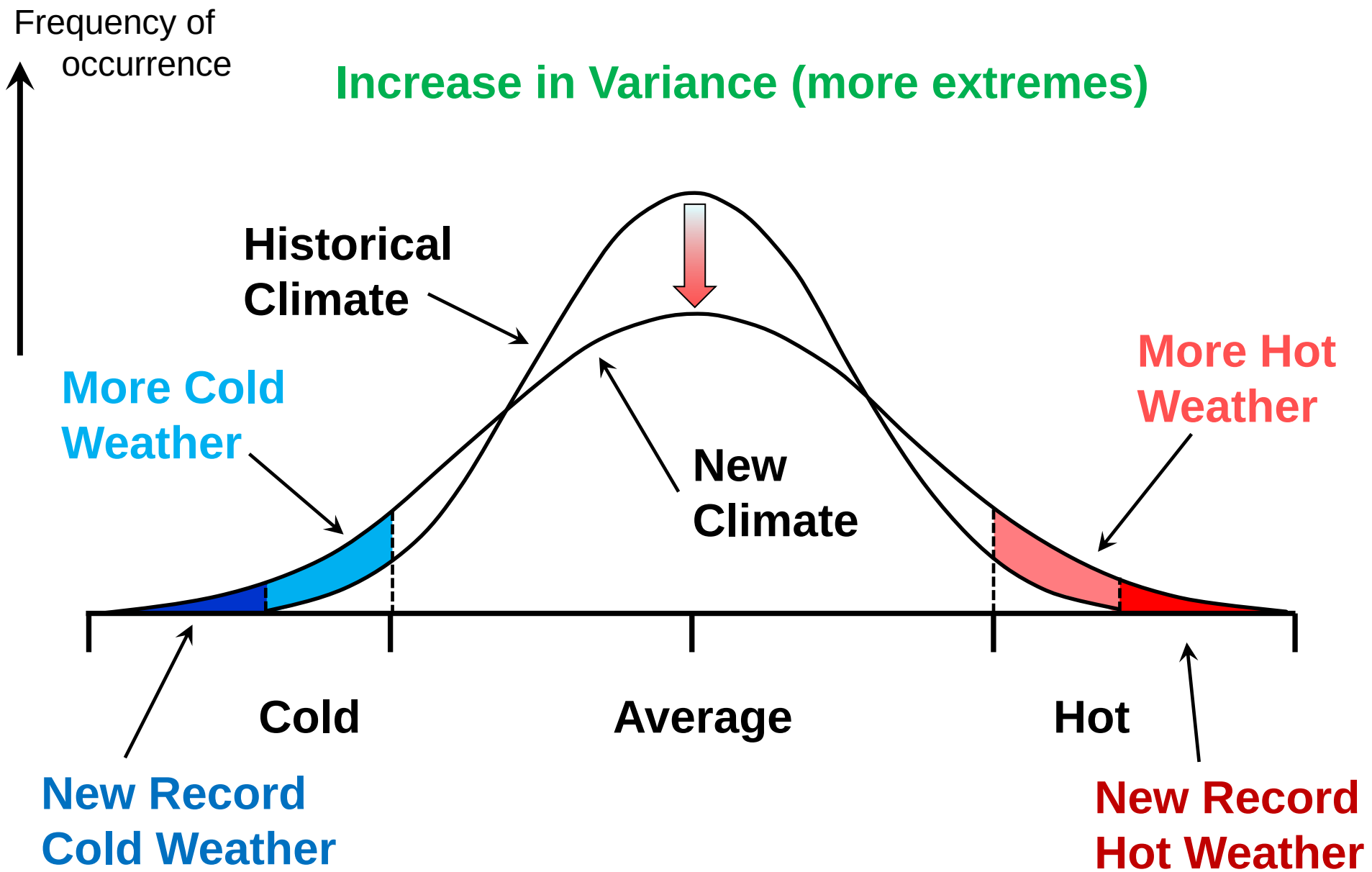
Greg Utzig, P.Ag.
Kutenai Nature Investigations Ltd.
Nelson, BC

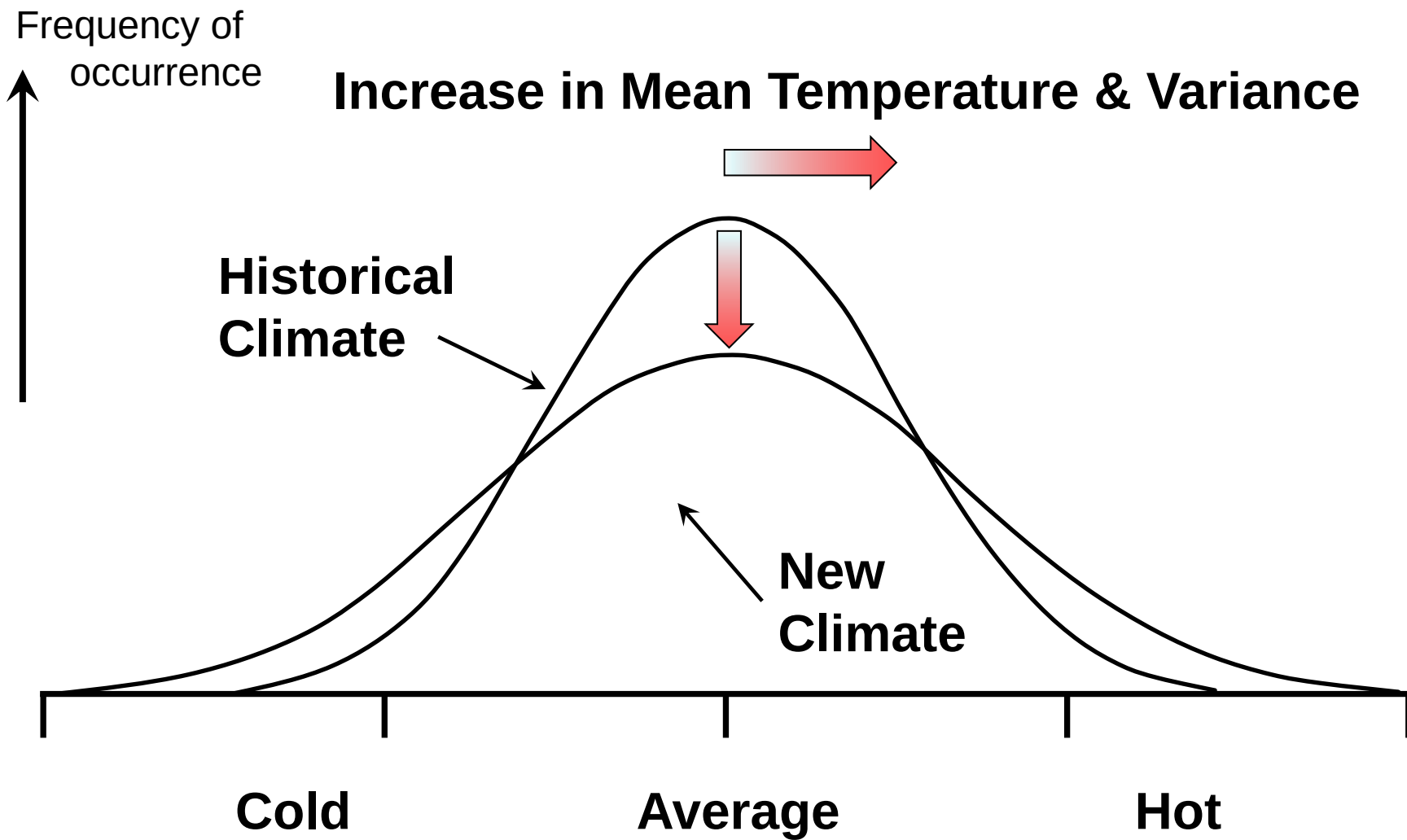
Outline

- Climate change drivers
- Uncertainty – incomplete knowledge
- Impacts – direct and indirect
- Ecosystem Change – species / individuals
- Complexity – multi-scale, multi-dimensional
- Conclusions









Frequency of
occurrence

Increase in Mean Temperature & Variance



Historical
Climate

Reduced, but
Continuing
Cold
Weather

New
Climate

Much
More Hot
Weather

and Record
Hot Weather

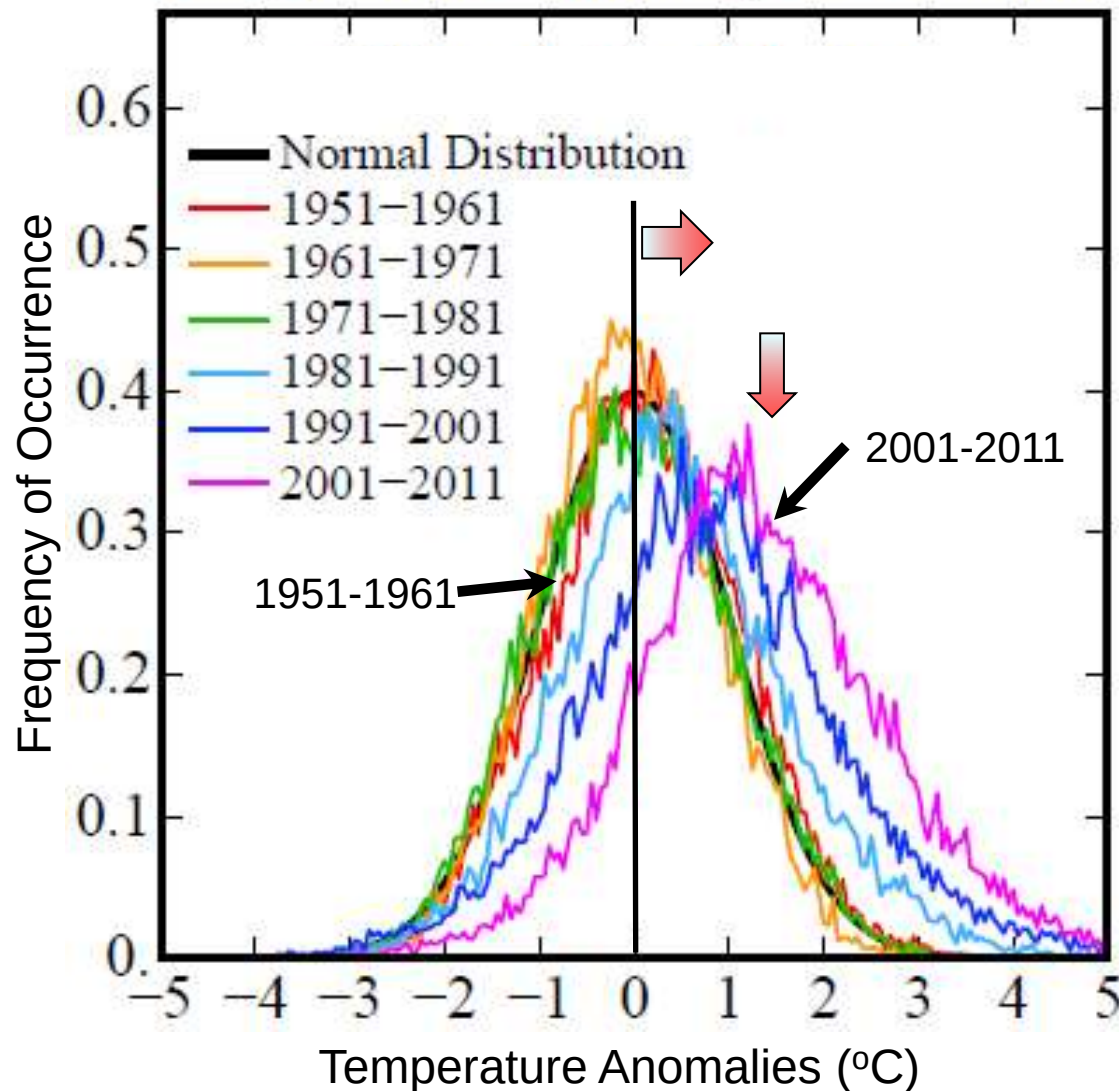
Cold

Average

Hot

Decadal Summer Temperature Anomalies

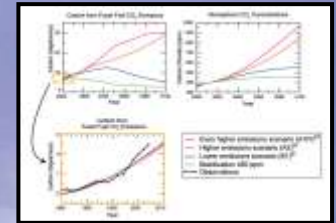
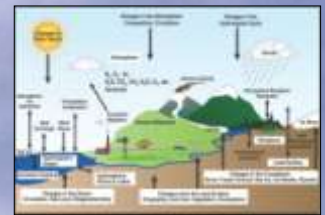
Northern Hemisphere Land (1951-61 reference period)



Adapted from:
Hansen et al. 2012

● Uncertainty – incomplete knowledge

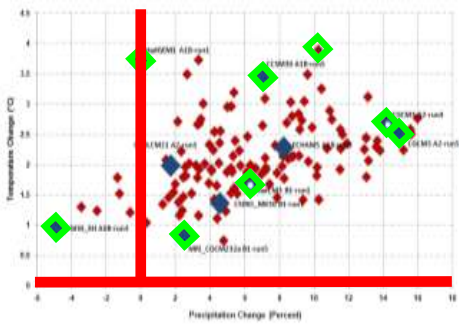
- GHG emissions
- Global and local climate responses
- Timing and intensity of climate change
- Species and ecosystem responses
- Future changes in social/ economic context



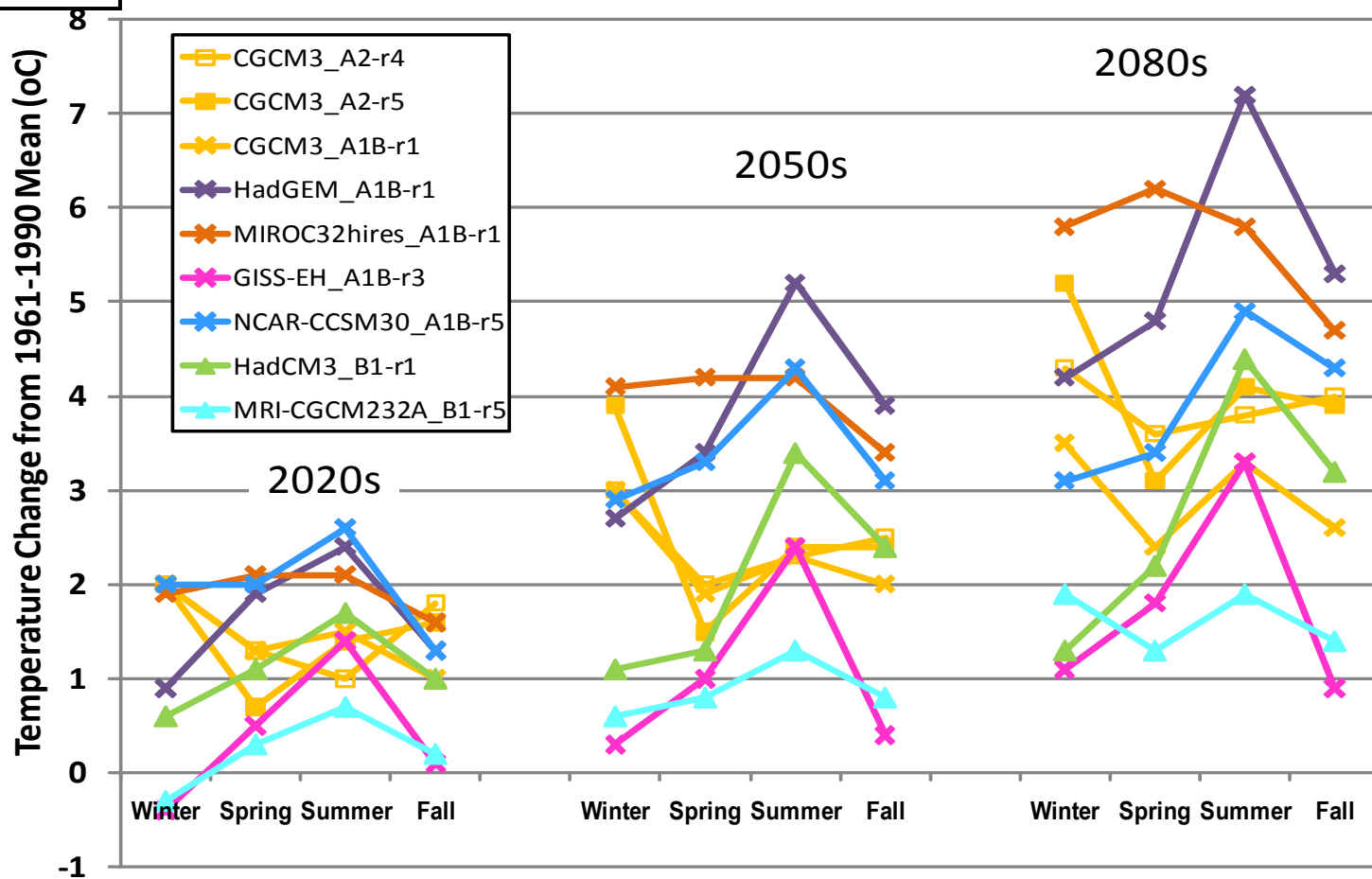
● Levels of Uncertainty

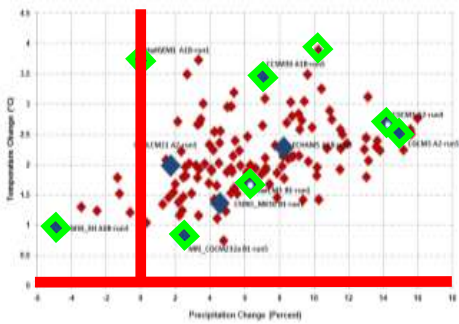
- A lack of precision, vs. a range of futures vs. true ambiguity
- Known unknowns and “unknown unknowns”



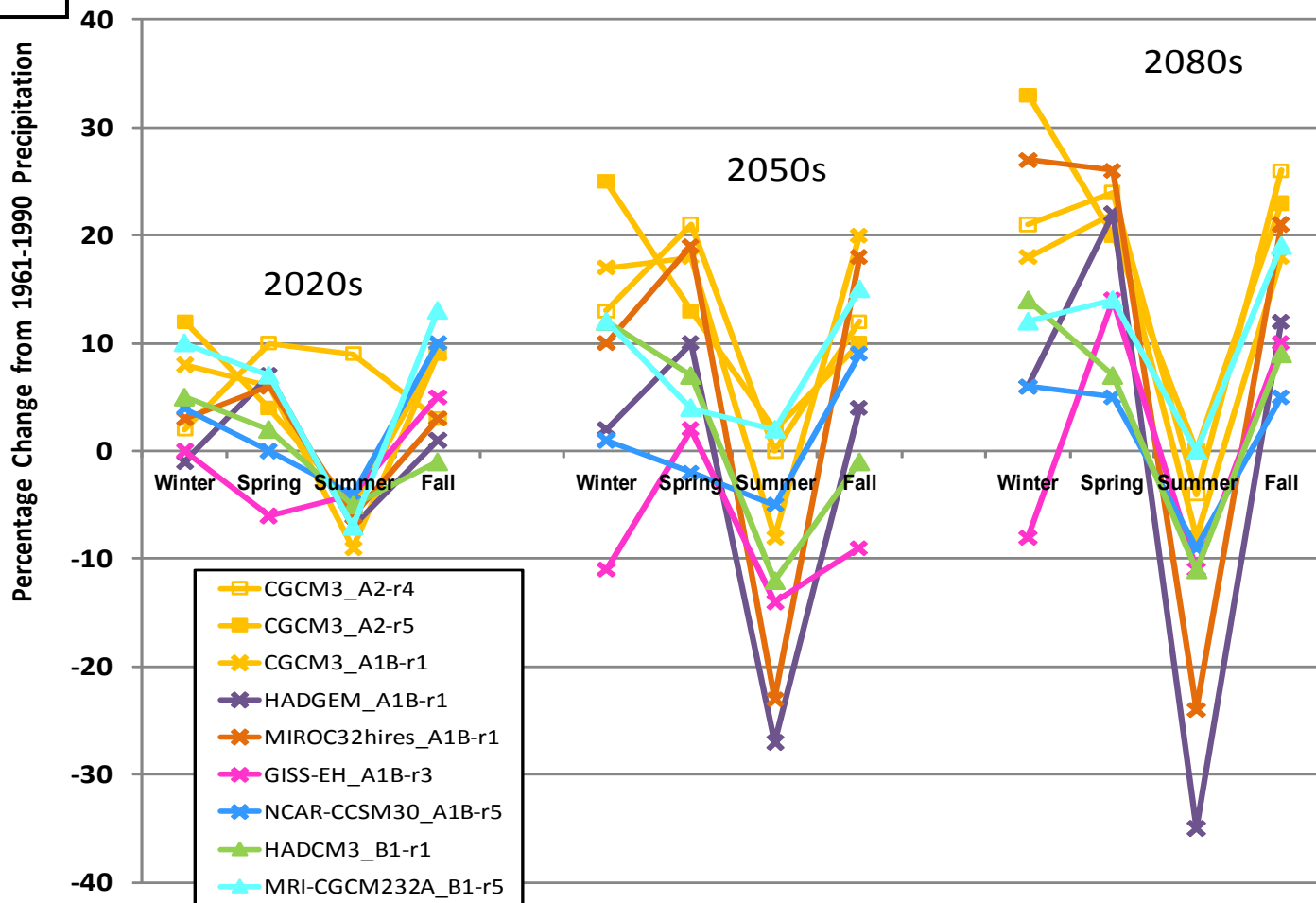


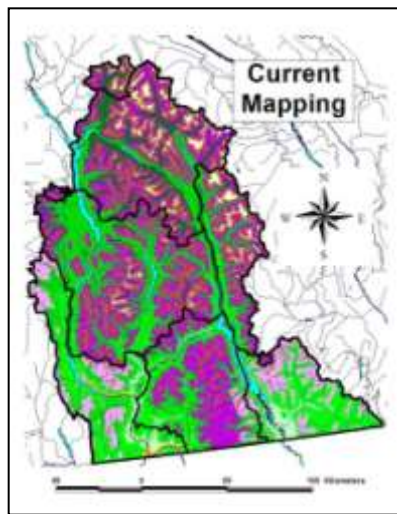
West Kootenay Mean Seasonal Temperature Projections



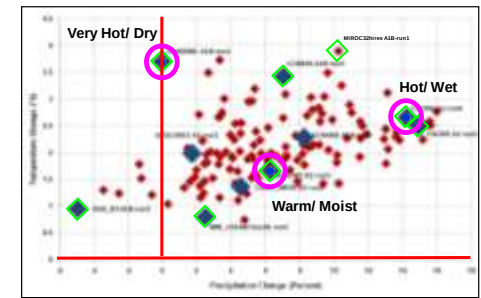


West Kootenay Mean Seasonal Precipitation Projections

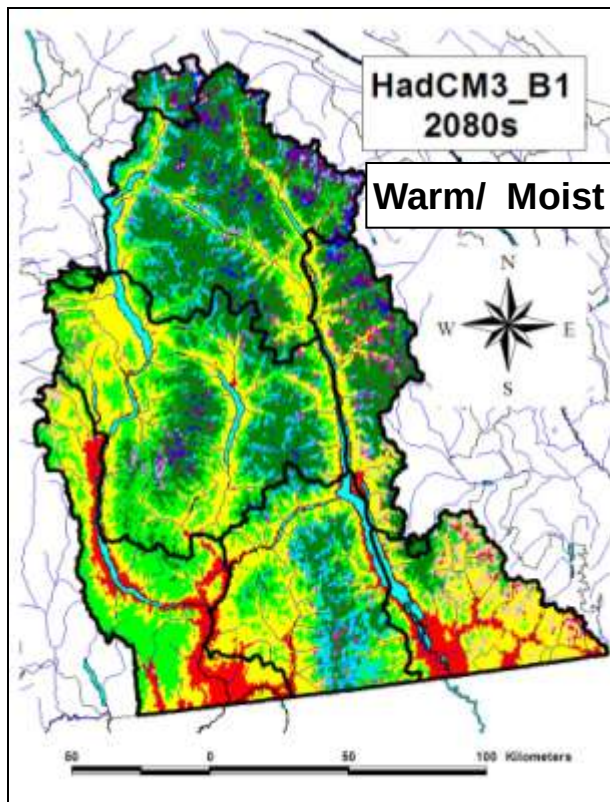
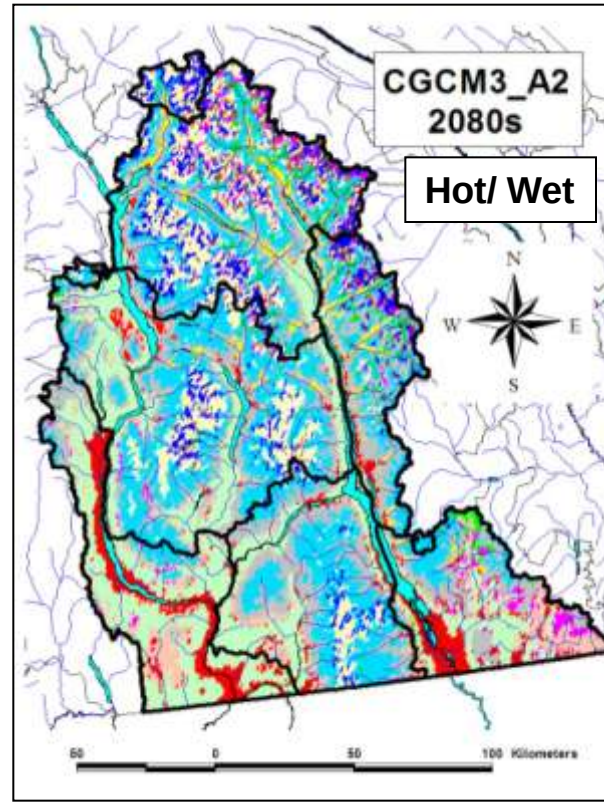
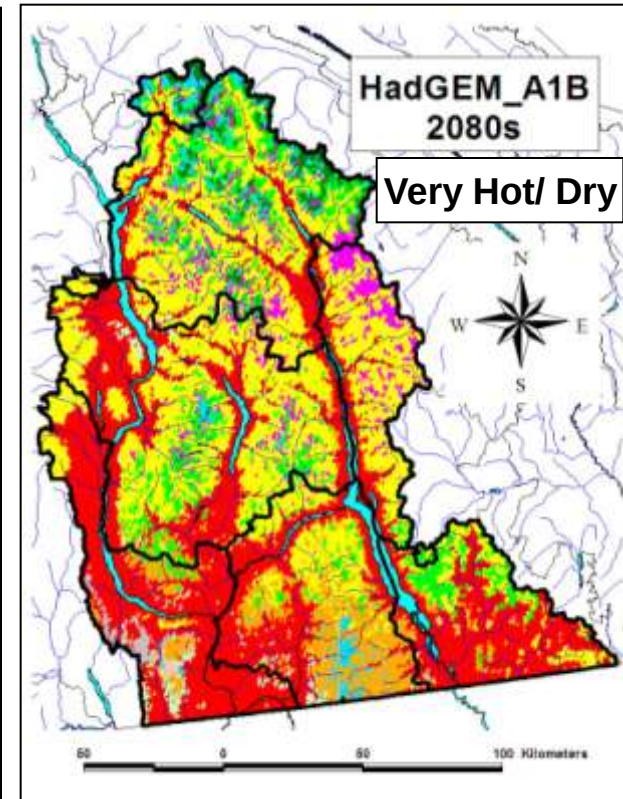




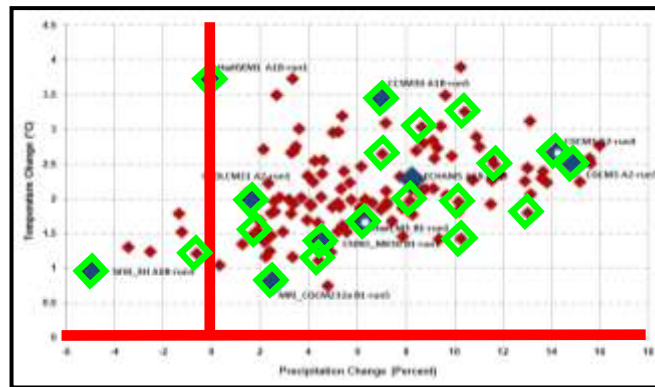
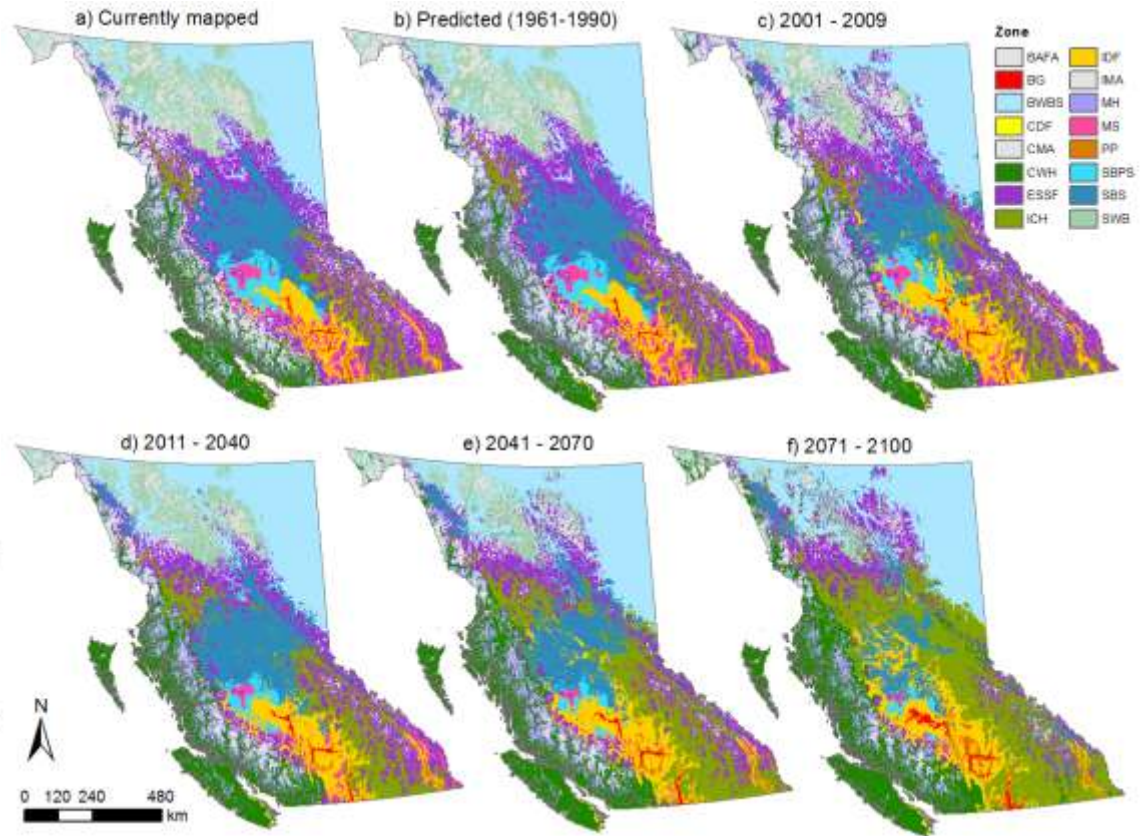
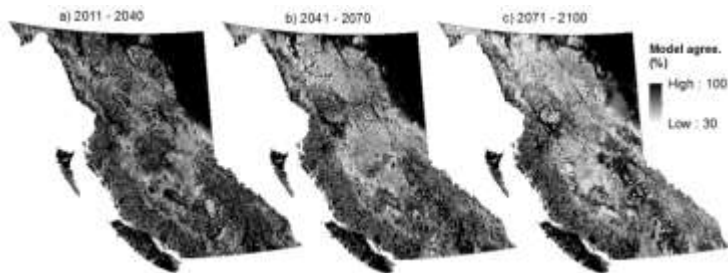
- Alpine
- Alpine transition
- Wet ESSF
- Dry ESSF
- CWH
- Coast transition
- MSD
- Wet ICH
- Moist ICH
- Dry ICH
- Grand fir
- Wet IDF
- Dry IDF
- PP
- Grassland-steppe



A Range of Projected Bioclimate Envelopes



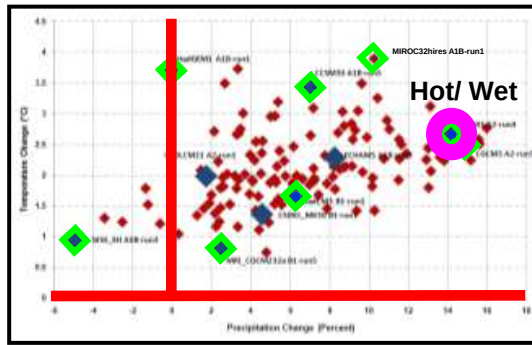
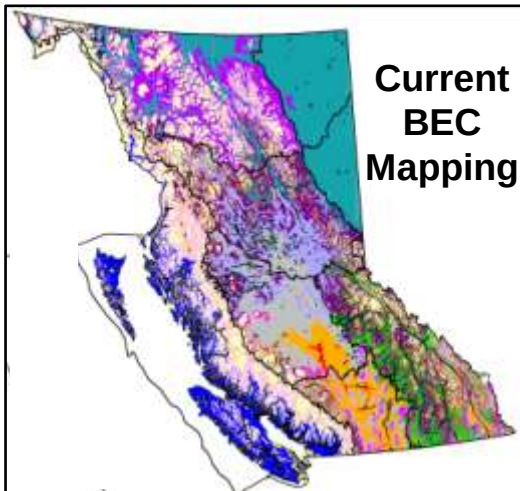
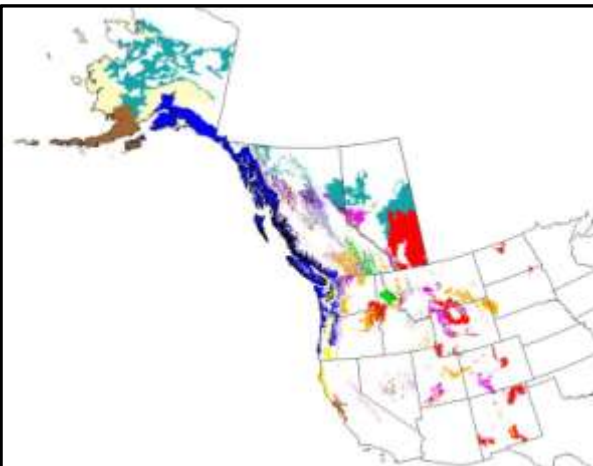
An Ensemble Projection of Bioclimate Envelopes



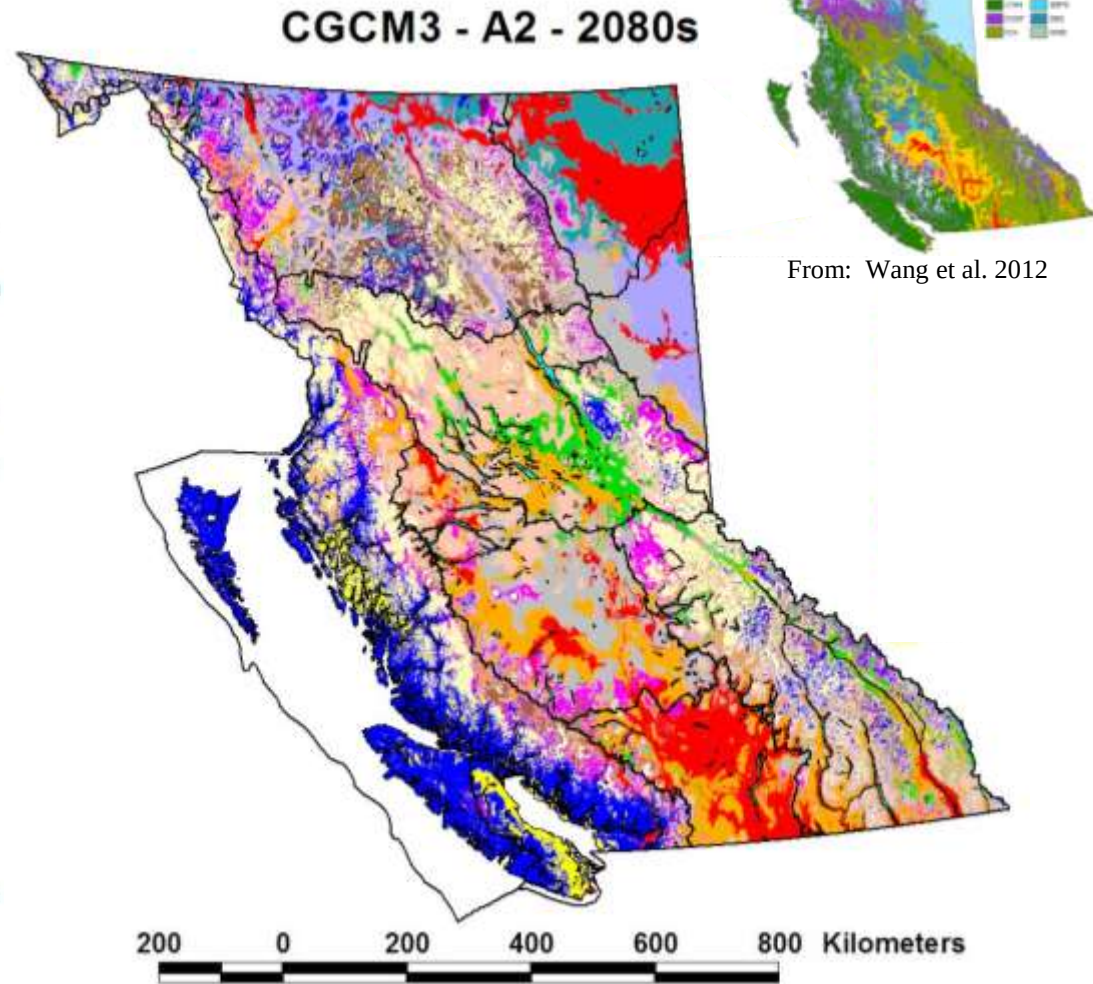
● Ecosystem Change

- Climatic “niches” will change in multi-dimensional time and space
- Impacts will develop organism by organism and species by species – culminating in ecosystem change
 - Individual species / genotypes in the same ecosystem have differing sensitivity (i.e., tolerances to changes in climate variables)
 - Individual species in the same ecosystem vary with regard to adaptive capacity (e.g., reproductive rate, dispersal distances)
- Novel climates and novel ecosystems will emerge

Bioclimate Envelope Projections



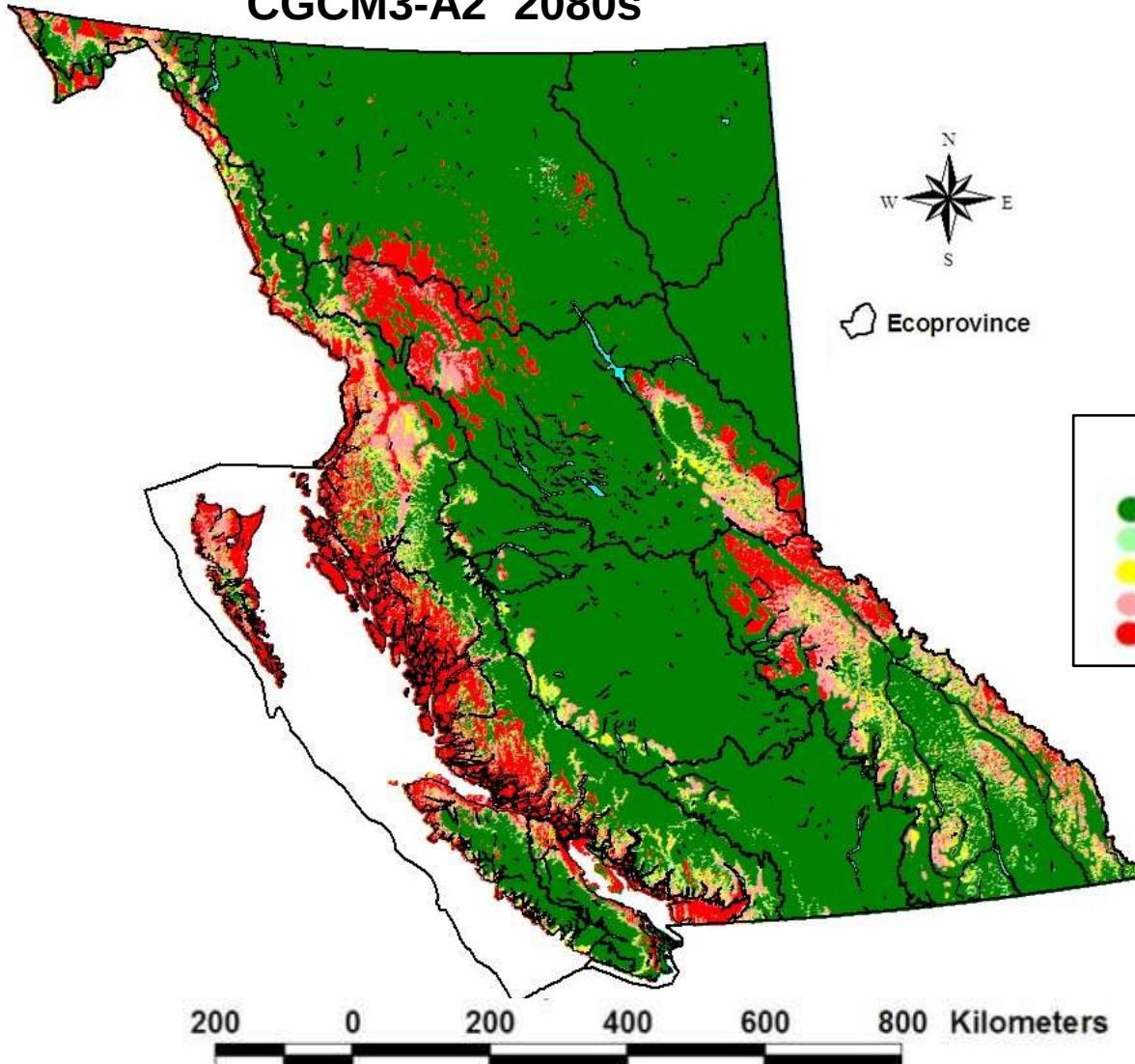
- BL
- BH
- CDL
- CWL
- Ctran
- CH
- MSD
- MSW
- GS
- IDL
- IML
- IWL
- IDH
- IWH
- Atran
- Alp



Original data from: Roberts and Hamann, U of A

Novel or Non-analogue Bioclimate Envelopes

CGCM3-A2 2080s

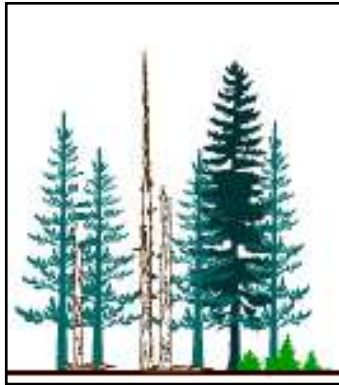


Legend

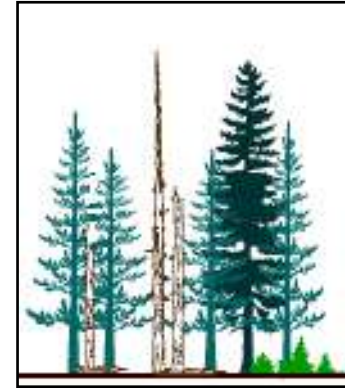
- Existing WNA Climate Envelope
- Transitional
- Non-analogue Climate Envelope

Original data from:
Roberts and Hamann, U of A

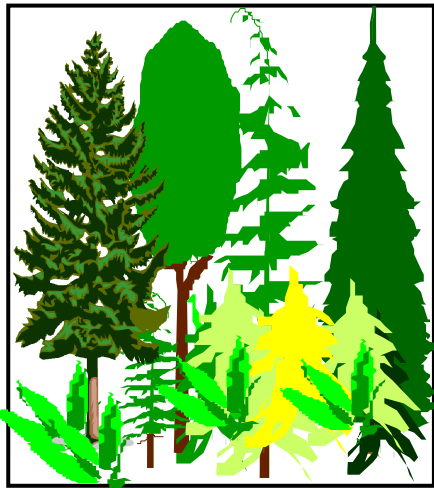
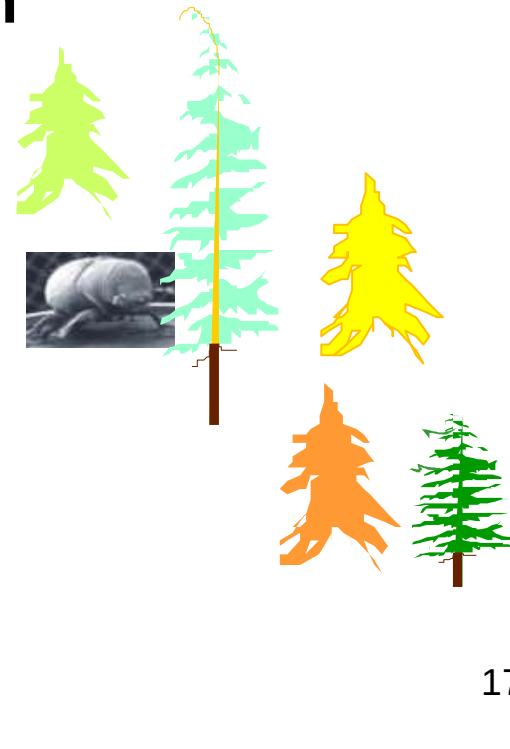
Ecosystem Response



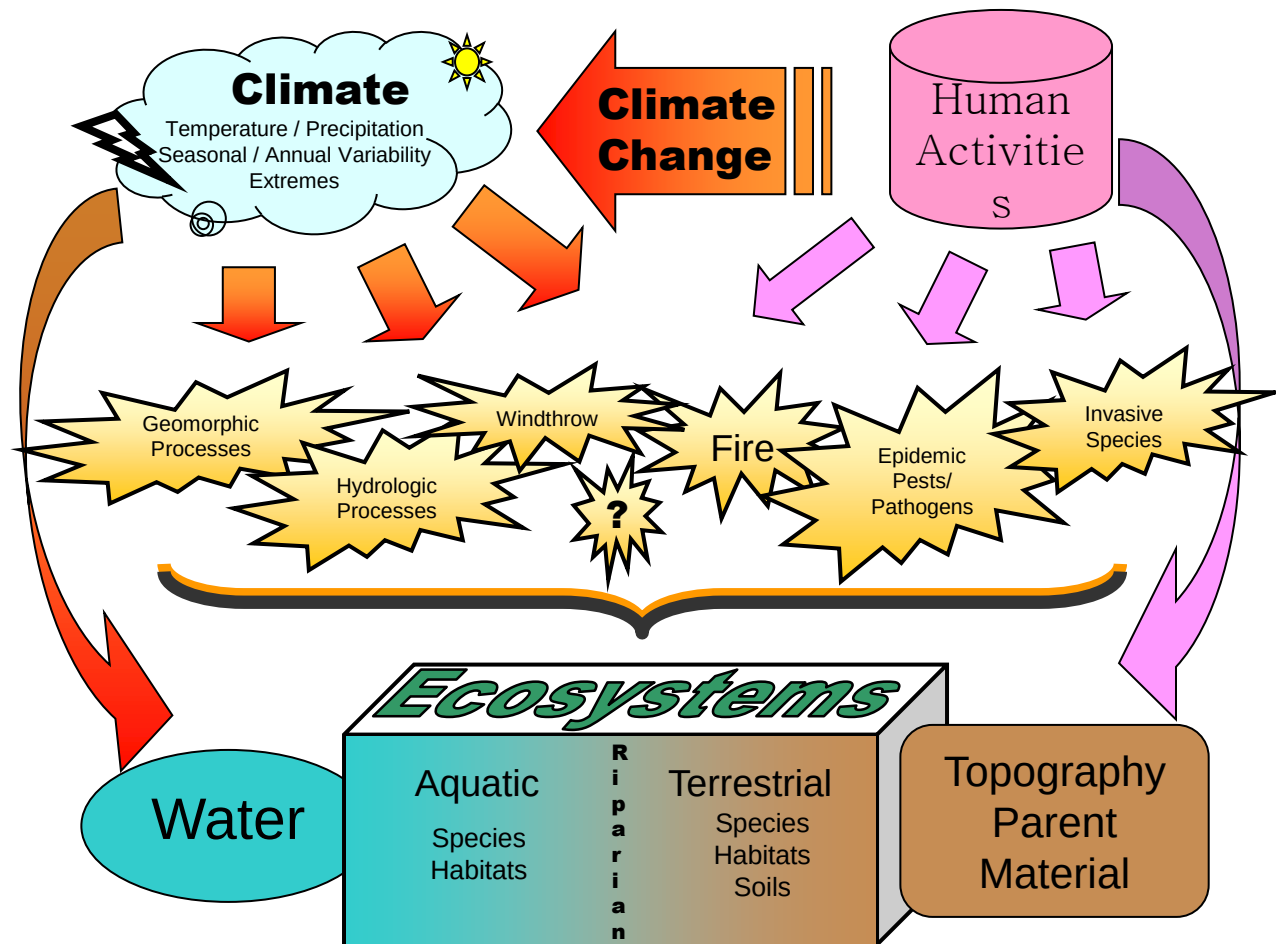
**Ecosystem
Range Shifts**



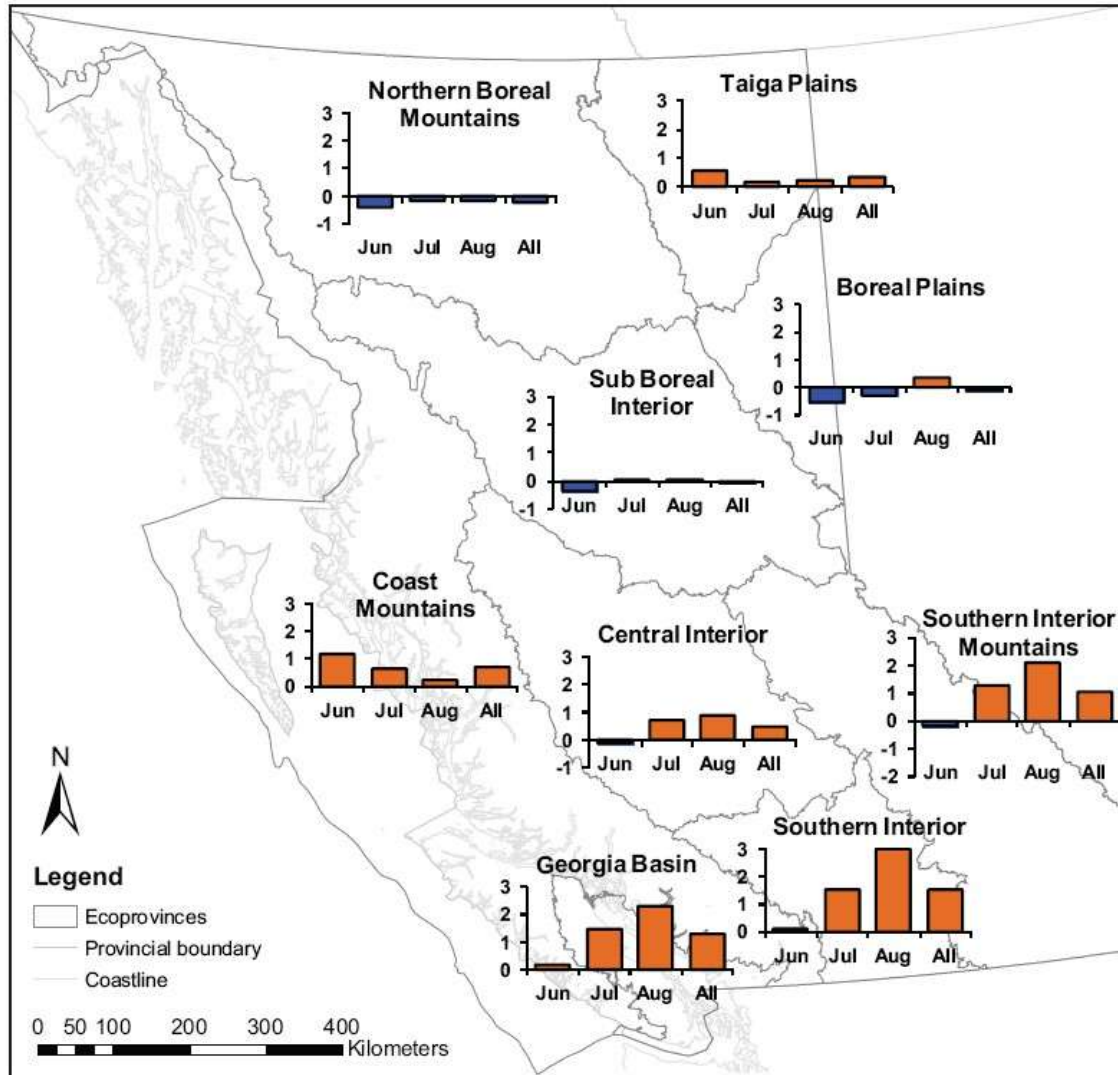
Ecosystem Re-organization



- Ecosystem impacts will be direct, indirect and episodic – sometimes catastrophic
 - Climate extremes will be significant drivers – heat waves, droughts, high intensity precipitation events, late frosts, and windstorms
 - Disturbance events will play key roles in ecosystem shifts – fire, windstorms, insect/pathogen outbreaks



Projected Changes in Monthly and Seasonal Fire Severity Ratings



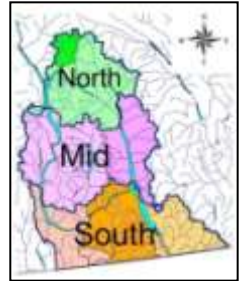
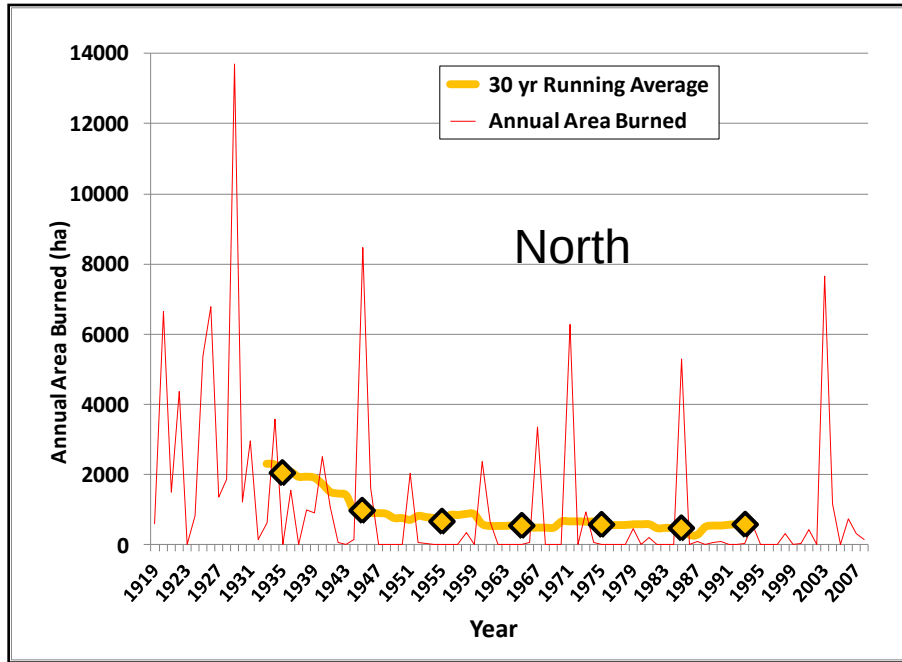
Calculated from modeling of the Canadian Fire Weather Index (FWI) based on climate projections from the Canadian Regional Climate Model (CRCM_A2)



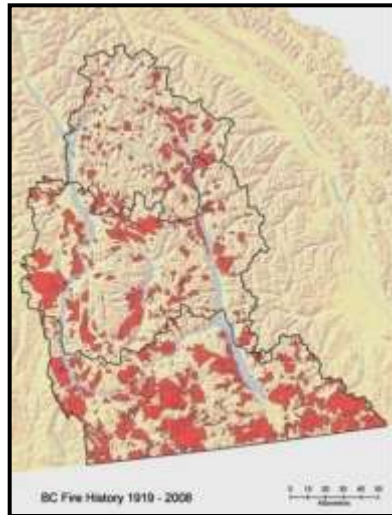
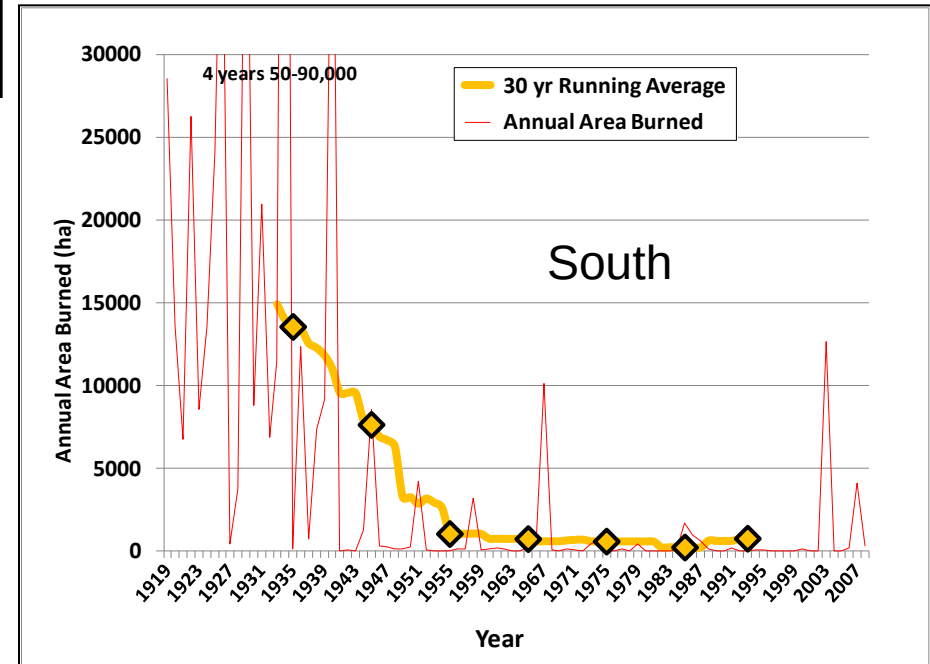
From:
Haughian et al. 2012

West Kootenay Fire History

Area Burned



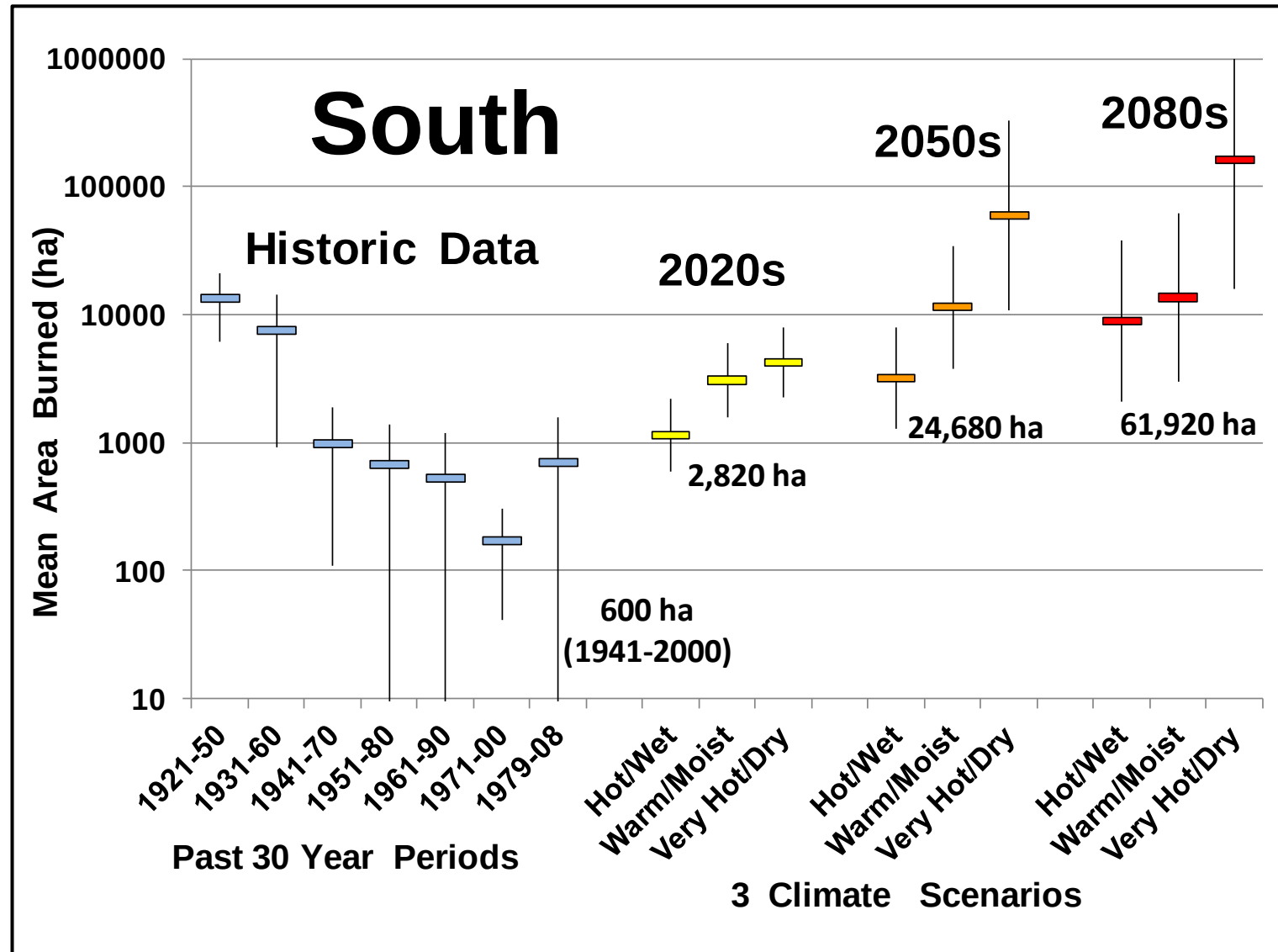
Touchstones Archives, Nelson



Multiple Regression Analysis

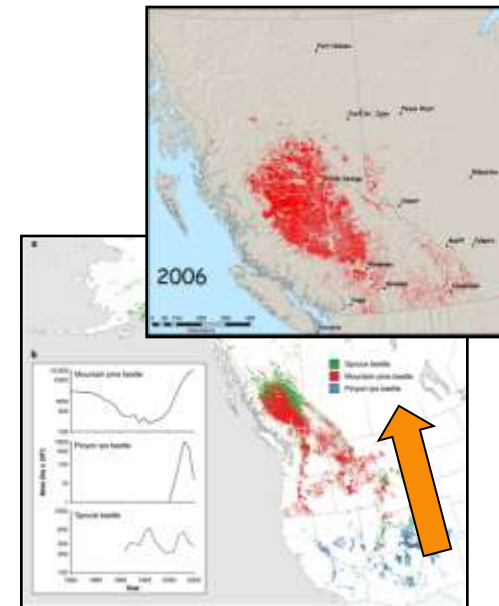


Jordan 2007

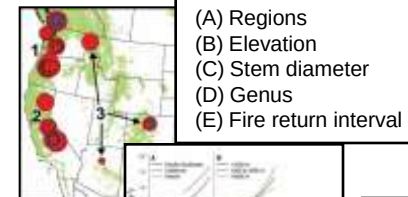


Insects/ Pathogens /Decline Syndromes

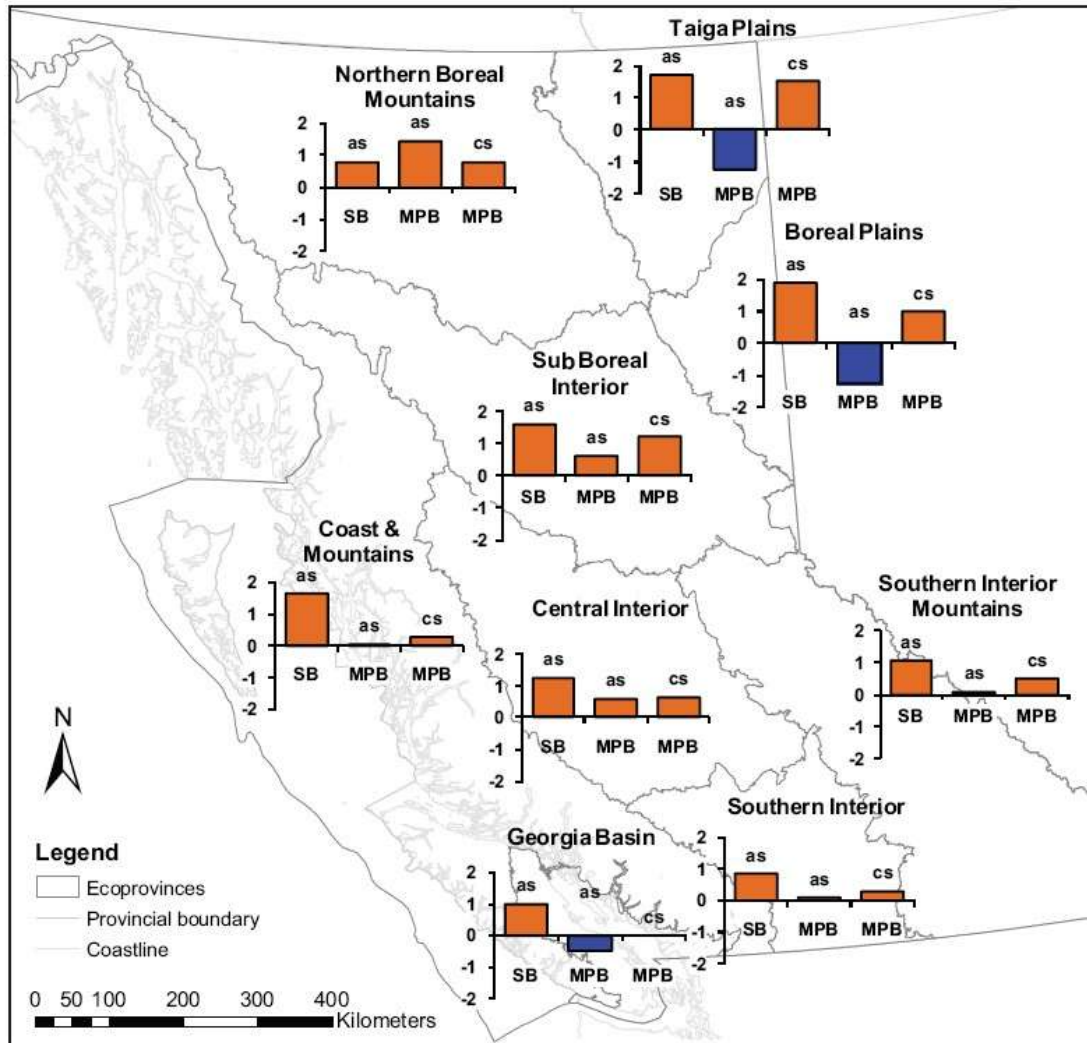
- Tree decline – drought/ loss of resistance
- Bark Beetles
 - Mountain pine beetle, spruce bark beetle, Ips beetles, Douglas-fir beetle
- Defoliators, blights, pathogens
 - Spruce budworm, dothistroma, larch needle cast, root disease
- Complex Interactions
 - Birch die-back, yellow cedar, 5-needle pines



From: Raffa et al. 2008



Projected Changes in Risk of Beetle Outbreaks



SB – spruce beetle
MPB – mountain pine beetle

as – adaptive seasonality
cs – cold survival

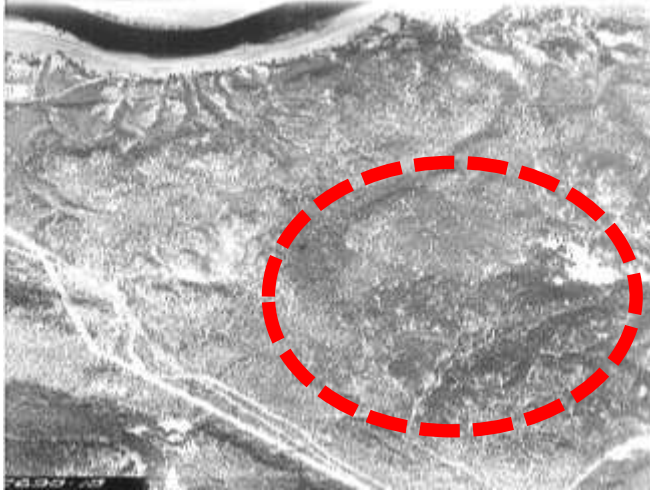


From:
Haughian et al. 2012

Forest – Grassland/ Shrub Conversion

Robbins Range – ESE of Kamloops

Historic Forest
Condition (1959)



2004 Open Condition
Following 1960 Fire



Current Vegetation



Courtesy of:
Walt Klenner

● Complexity

- ❑ Change will vary spatially – in rate, intensity and specific characteristics
- ❑ Ecosystem and species impacts will be amplified and/or moderated by inter-species relationships (competition, predator/prey, host/pest, interdependence)
- ❑ Climate change impacts will depend on stress from non-climatic drivers (cumulative impacts from human activities)
- ❑ Cross-scale interactions

PREDICTED CHANGE

EFFECTS ON SPECIES

Phenology:

- spring arrival
- autumn arrival
- growing season length

Temperature:

- means
- extremes
- variability
- seasonality
- sea level rises

Rainfall:

- means
- extremes
- variability
- seasonality

Extreme events:

- storms
- floods
- droughts
- fires

CO2 concentrations:

- atmospheric
- ocean
- ocean pH

Desynchronization of migration or dispersal events

Uncoupling of mutualisms (incl. pollinator loss and coral bleaching)

Uncoupling of predator-prey relationships

Uncoupling of parasite-host relationships

Interactions with new pathogens and invasives

Changes in distribution ranges

Loss of habitat

Increased physiological stress causing direct mortality and increased disease susceptibility

Changes in fecundity leading to changing population structures

Changes in sex ratios

Changes in competitive ability

Inability to form calcareous structures and dissolving of aragonite

Complexity

- Yellow Cedar

- Increasing temperatures leading to decreased snowpack and frozen roots

- Birch

- Increasing freeze/ thaw and drought events leading to stress, and leaf miners and bronze birch borer infestations

- Lodgepole pine

- Loss of extreme cold temperatures and fire exclusion contributing to mountain pine beetle epidemic; increasing precipitation/ temperatures contributing to Dothistroma epidemic and increased rusts



From: Hennon et al. 2005



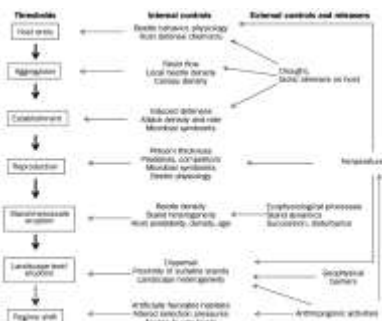
From: Buxton et al. 2011



From: Woods et al. 2010

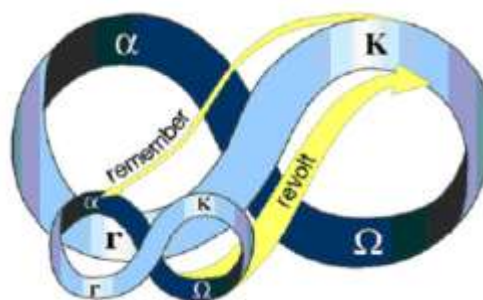


From: Woods et al. 2010



From: Raffa et al. 2008

Multiple Scales



From: www.resalliance.org

● Vulnerabilities

- ❑ Changing disturbance regimes
- ❑ Potential for climate change to amplify cumulative impacts of past development
- ❑ Diminished research and monitoring capacity
- ❑ Shortage of field-based, ecologically-grounded decision-makers
- ❑ Shortage of locally targeted research with integrated extension
- ❑ Lack of public interest and political will

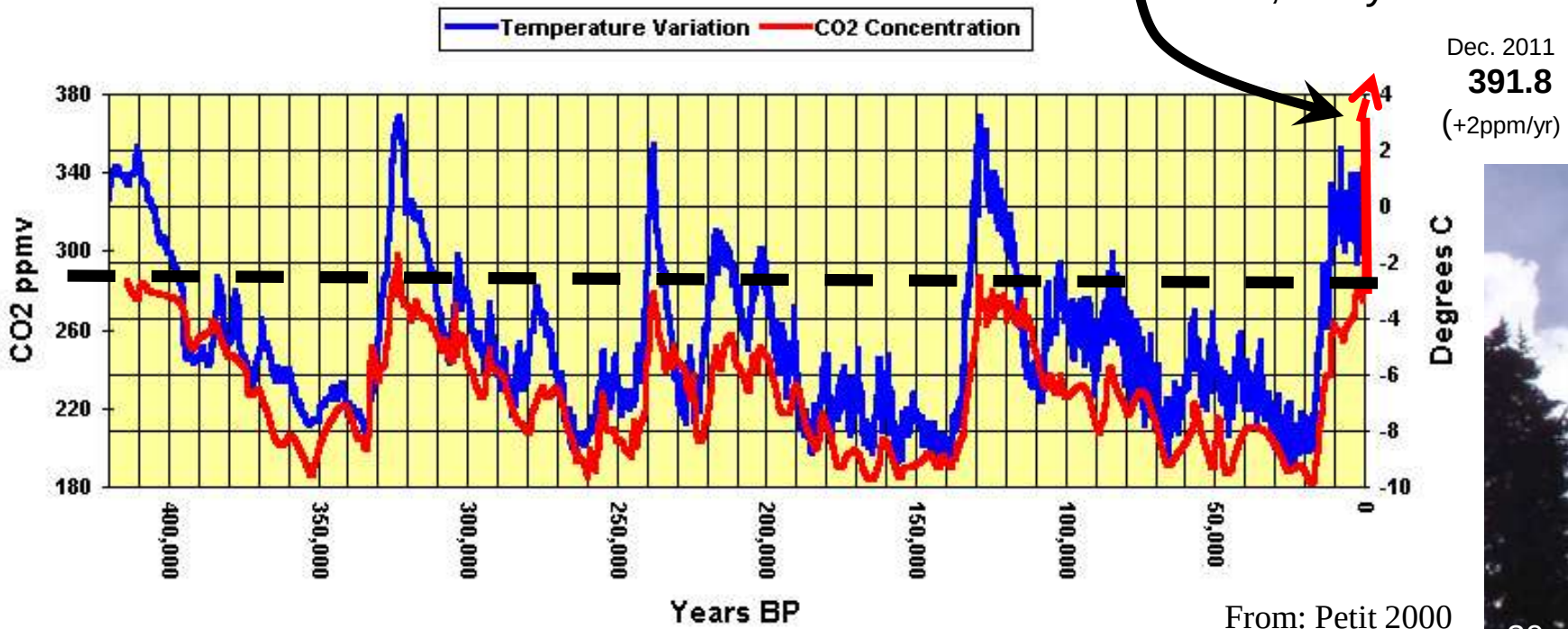
● Opportunities

- ❑ Coordinated adaptation/ mitigation projects (e.g., fuel for schools)
- ❑ Shifting management from “command and control” to resilience-based adaptive management
- ❑ Potential to reduce GHG emissions and reduce impacts

● Unknowns

- Thresholds for species loss and catastrophic regime shifts
- How close we are to the big threshold – GHG emissions leading to irreversible run-away climate change

Antarctic Ice Core Data 1



Thank You

“We have options, but the past is not one of them”

Sauchyn and Kulshreshtha

2008, p.295

“Times have changed – no longer is our goal sustainable development ... our goal must now be sustainable survival”