

Mark Johnston
Saskatchewan Research Council
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TREE SPECIES VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

Background

- Council of the Federation meeting, January 2008
- Decreed that climate change was a major national challenge
- One of the pressing needs was information on tree species vulnerability and adaptation to climate change
- Also requested work on a national forest carbon quantification standard

Background

- Canadian Council of Forest Ministers given the mandate to deliver on CoF direction
- Formed the Climate Change Task Force
- CCTF to oversee the work
- Structure in place by April 2008
- Work started in June 2008
- Majority of funding provided by BC MOFR

Approach

- ⦿ Audience - practitioners and policy makers
- ⦿ Extensive involvement by jurisdictions
- ⦿ Literature review and extensive consultation with experts
- ⦿ Commissioned several pieces
- ⦿ Report and development of web-based tools
- ⦿ Also to develop roadmap for subsequent phases

Approach

- ⦿ Identified several main topics:
 - Genetics: migration and adaptation
 - Seed transfer zone modification
 - Physiology and G&Y
 - Species geographical distribution
 - Forest health (insects and disease)
- ⦿ Assumed large data gaps

Genetics: migration and adaptation

- ⦿ Natural migration will not keep up with the pace of climate change (by 10X)
- ⦿ Intervening habitat is not suitable
- ⦿ Assisted migration is a likely option
- ⦿ But – which populations, and where?
- ⦿ Use provenance test data to determine the climatic distance required to match future climate
- ⦿ Transfer functions have been developed for LP, WS, BS, JP and larch (BC, AB and ON-QC)

Genetics: **migration** and adaptation

- ⦿ But: doesn't account for effects of increased CO₂
- ⦿ May not sample full range of climate or species' range
- ⦿ Most tests use artificial establishment
- ⦿ Tests expensive and slow to yield results
- ⦿ Trees will have to grow now in the new location as well as later as the climate changes – how to manage that trade-off?

Genetics: migration and adaptation

- Large amount of genetic variation within species provides potential for adaptation
- But pace of change is the main concern
- Likely that species with high fecundity, long distance pollen flow and short generation may be successful
- Describes pioneer species - which may be enhanced by higher disturbance rates

Vulnerability index

- ⦿ Judy Loo (CFS) and colleagues developed an index of vulnerability based on:
 - Ability to adapt in place
 - Ability to migrate
 - Phenotypic plasticity
- ⦿ Ranked 9 species

Vulnerability index

Species	Vulnerability Score	Ranking
Trembling aspen	0.00	low
Sugar maple	0.20	low
White pine	0.35	low-medium
Western larch	0.40	medium
Red oak	0.40	medium
Beech	0.40	medium
Red spruce	0.55	medium
Butternut	0.60	medium-high
Red pine	0.75	medium-high

Modified from J. Loo et al., unpublished manuscript

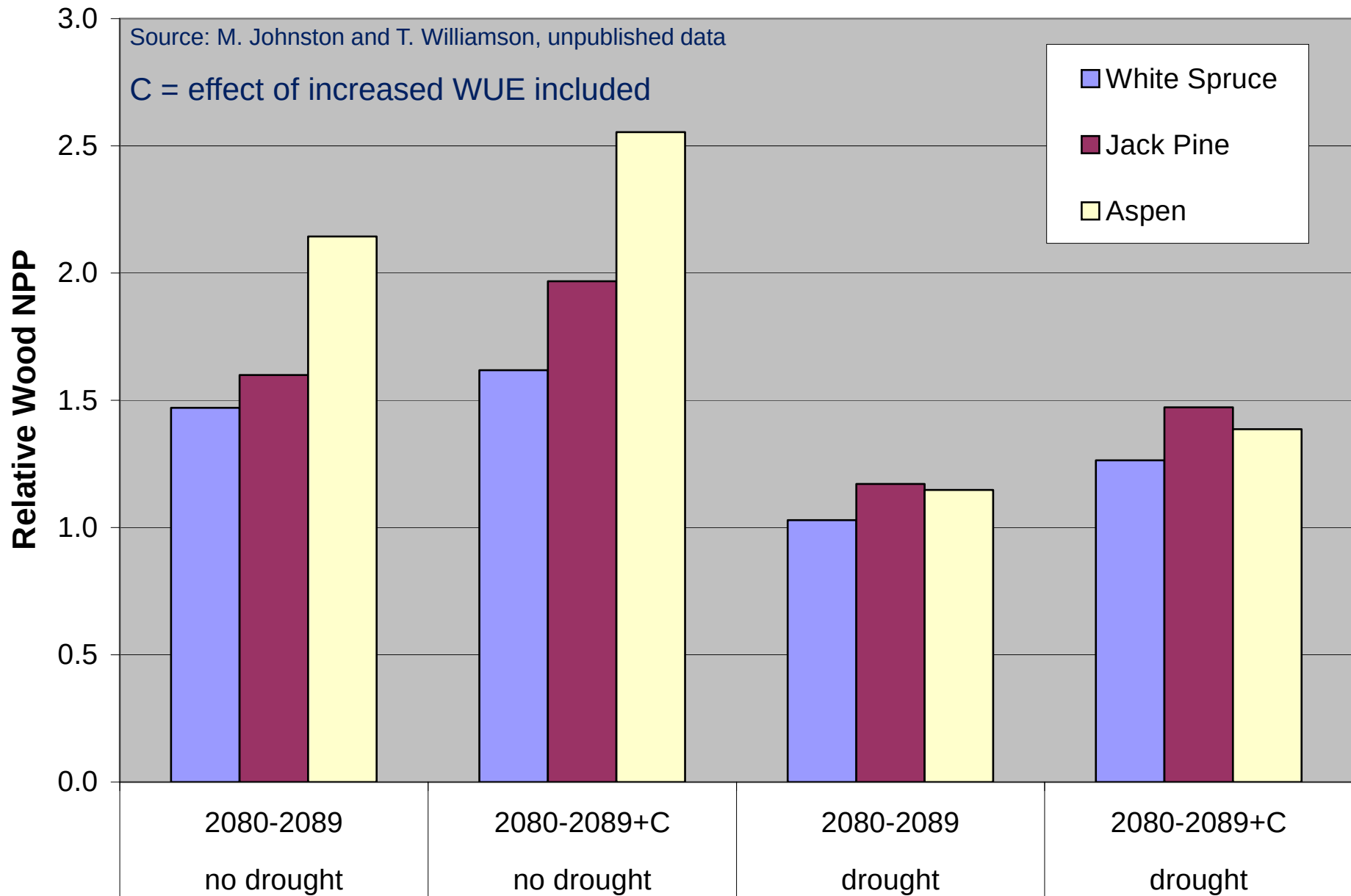
Seed Transfer Zones

- ⦿ Jurisdictions moving toward climate-based STZs (BC, AB, ON, QC?)
- ⦿ BC altered elevational limits this year; other changes being contemplated
- ⦿ Maybe single biggest management option at the species level
- ⦿ But – how much of the forest landscape can we really affect?

Tree growth

- Trees will be responding to changes in temperature, moisture and nutrient availability and CO₂
- Lab studies show growth increases with higher temperatures and CO₂
- But this potential is not realized if other resources are limiting
- May be reasonable to conclude that good sites will get better and bad sites worse

Climate Change and Forest Productivity



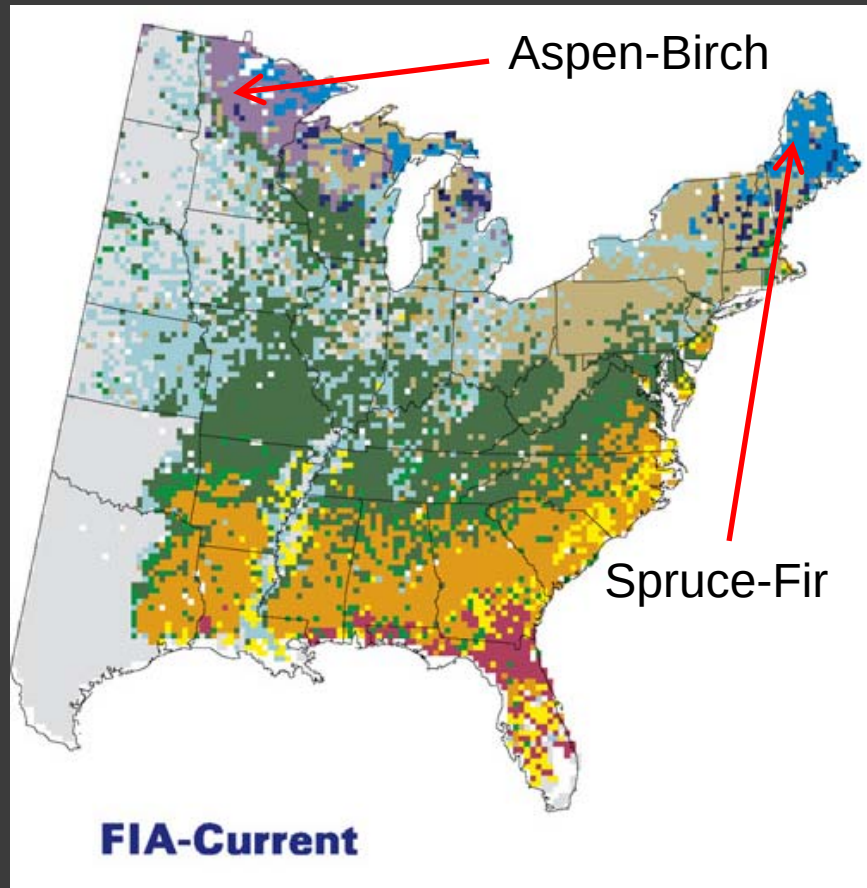
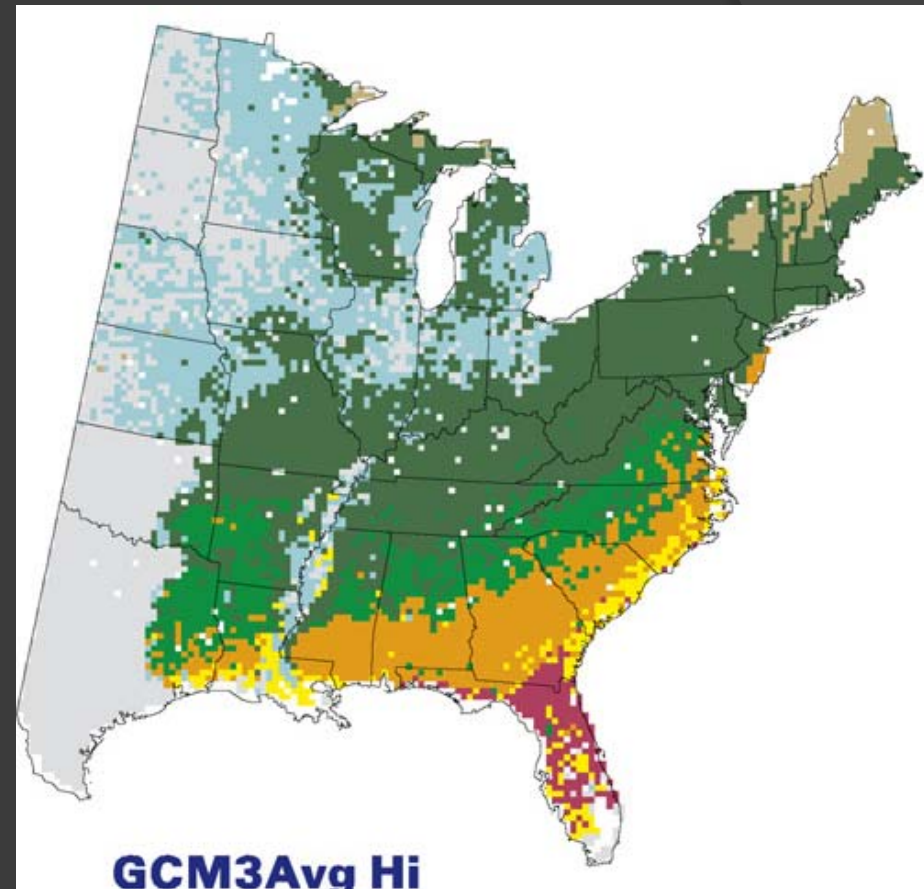
Species distributions

- ⦿ Most work done with climate envelope models
 - Correlate climate variables with current distribution
 - Re-map climate and assume that represents new distribution
- ⦿ May or may not take dispersal into account
- ⦿ Doesn't account for effects of changes in CO₂
- ⦿ Assumes climate influence on species will remain the same

Species distributions

- McKenney et al 2007: species ranges shift by 300-700 km north by 2100 depending on dispersal scenarios
- Hamman and Wang 2006 suggest 100 km north per decade

Shift in forest types in eastern USA, based on average of three GCMs and the A1FI SRES Scenario



Source: Iverson, L.R., A.M. Prasad, S.N. Matthews and M. Peters. 2008. Estimating potential habitat for 134 eastern US tree species under six climate scenarios. *Forest Ecology and Management* 254: 390–406

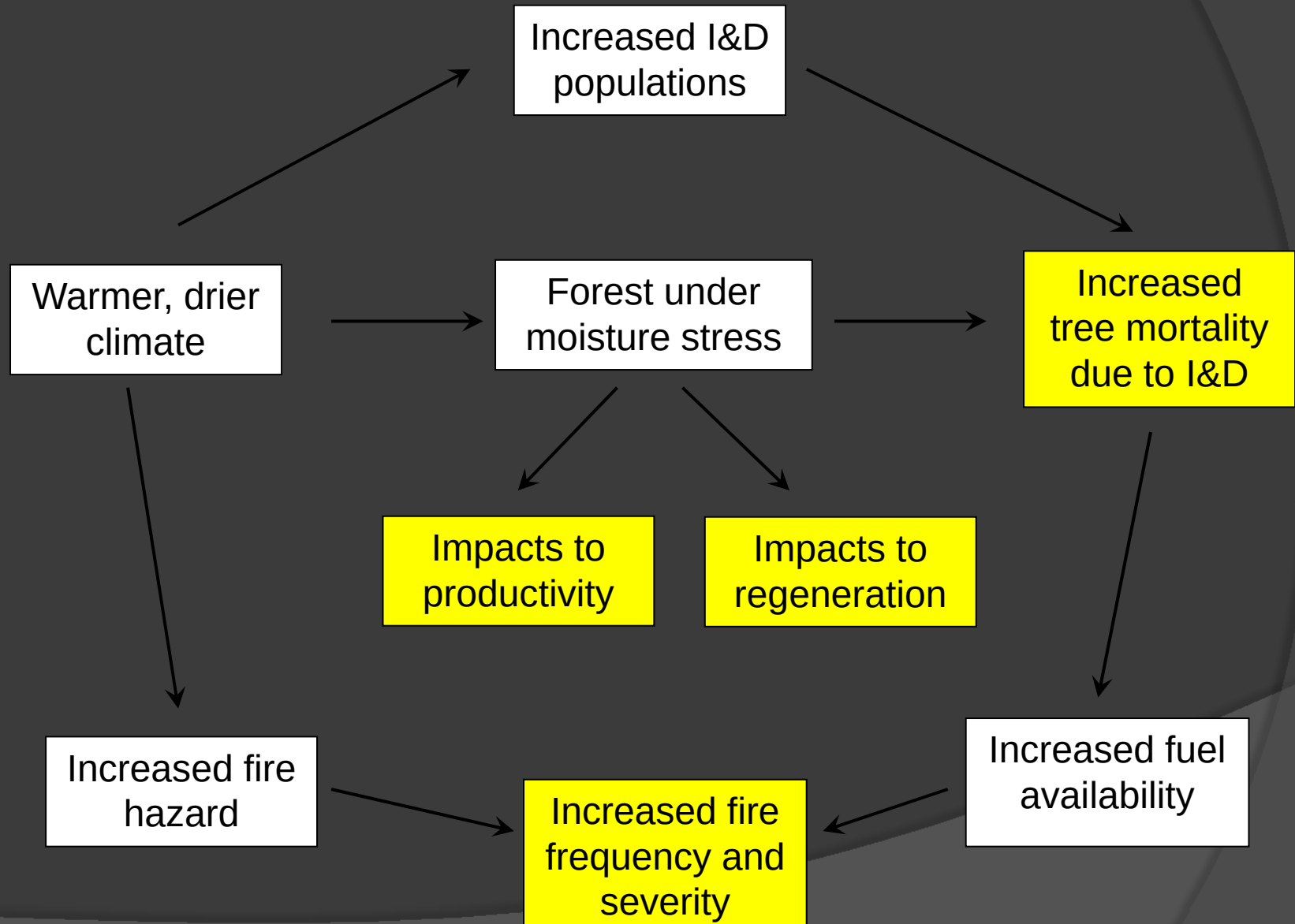
Forest Health: Insects

- ⦿ Higher temperatures generally beneficial to insects
- ⦿ Hosts may be stressed by e.g. drought, increased susceptibility
- ⦿ Decoupling of phenological development
- ⦿ Introduction of new pests

Forest Health: Disease

- ⦿ Warmer drier conditions may encourage some species, discourage others
- ⦿ Stressed trees more susceptible
- ⦿ Interaction between host, insect vectors and disease organisms
- ⦿ Increased overwinter survival of inoculum, mistletoe

Forest Ecosystem Vulnerability to Climate Change



General principles (Peterson 2008)

- Adaptation strategy #1: Increase landscape diversity
- Adaptation strategy #2: Maintain biological diversity
- Adaptation strategy #3: Plan for post-disturbance management, e.g. reforestation
- Adaptation strategy #4: Implement early detection & rapid response

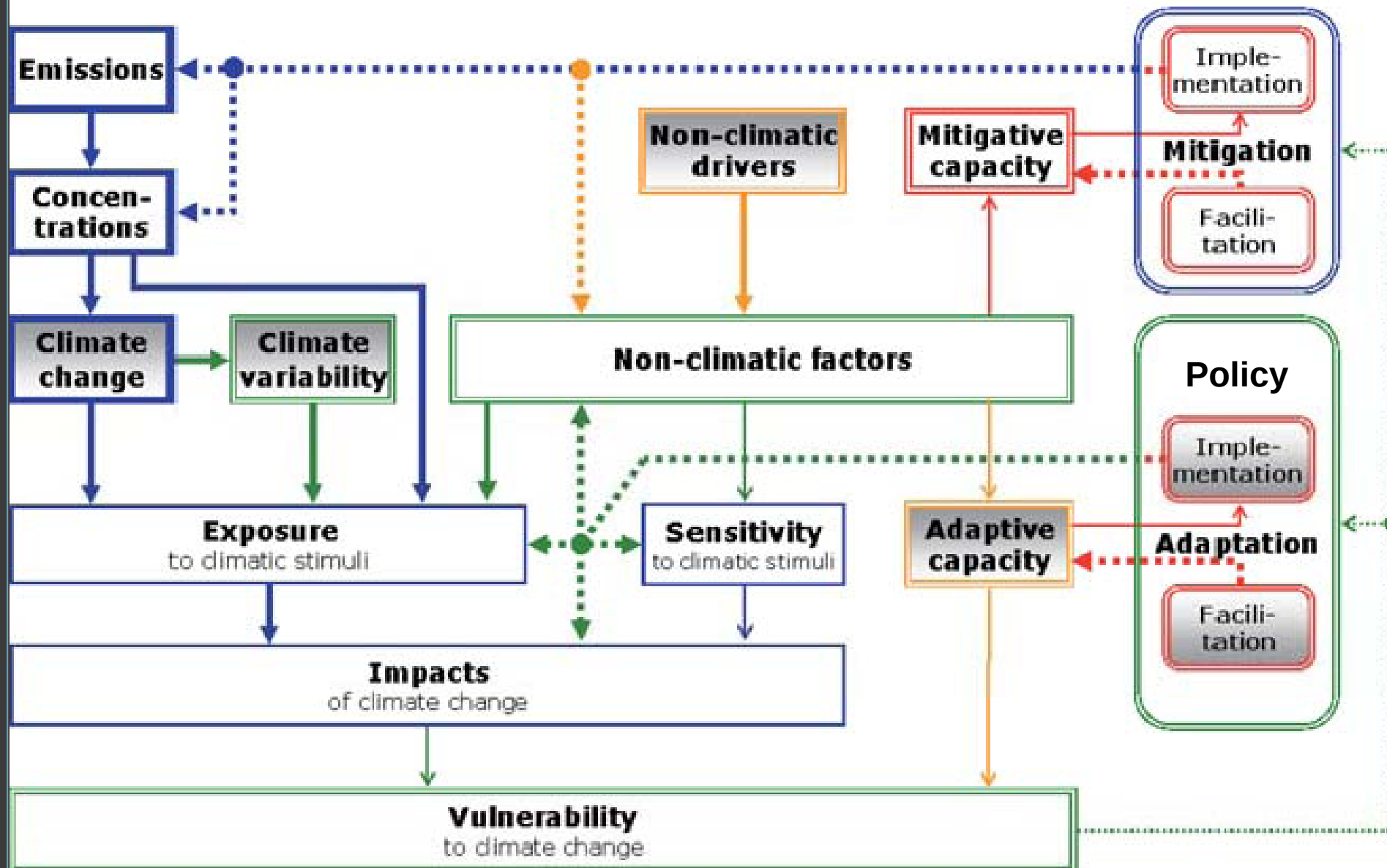
General principles (Peterson 2008)

- Adaptation strategy #5: Manage for realistic outcomes (Prioritize projects with high probability of success; abandon hopeless causes)
- Adaptation strategy #6: Incorporate climate change in restoration (reduce emphasis on historical references; reduce use of guidelines based on static relationships, e.g., plant associations)
- Adaptation strategy #7: Develop climate-smart regulations, policies
- Adaptation strategy #8: Anticipate big surprises (expect longer droughts, larger fires, species extirpations, major changes in ecosystem function; use scenario planning to develop potential responses)

Roadmap for Part 2

- Adopted framework from Füssel and Klein (2006)
- Will result in a National Adaptation Policy Assessment
- Includes ecosystem-level impacts, adaptive capacity and guidance for adaptation implementation

Adaptation policy assessment



Source: Füssel, H. and R. Klein. 2006. Climate Change Vulnerability Assessments: An evolution of conceptual thinking. *Climatic Change* 75: 301-329.

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