Forest harvest management as a climate change mitigation to sustain biodiversity in Alaska boreal forest

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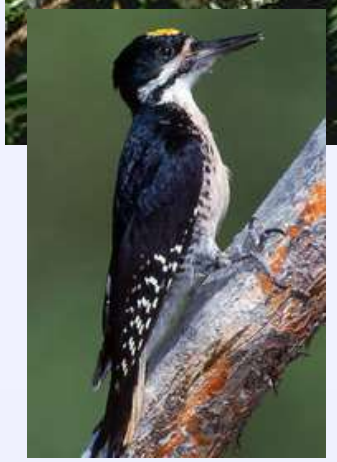

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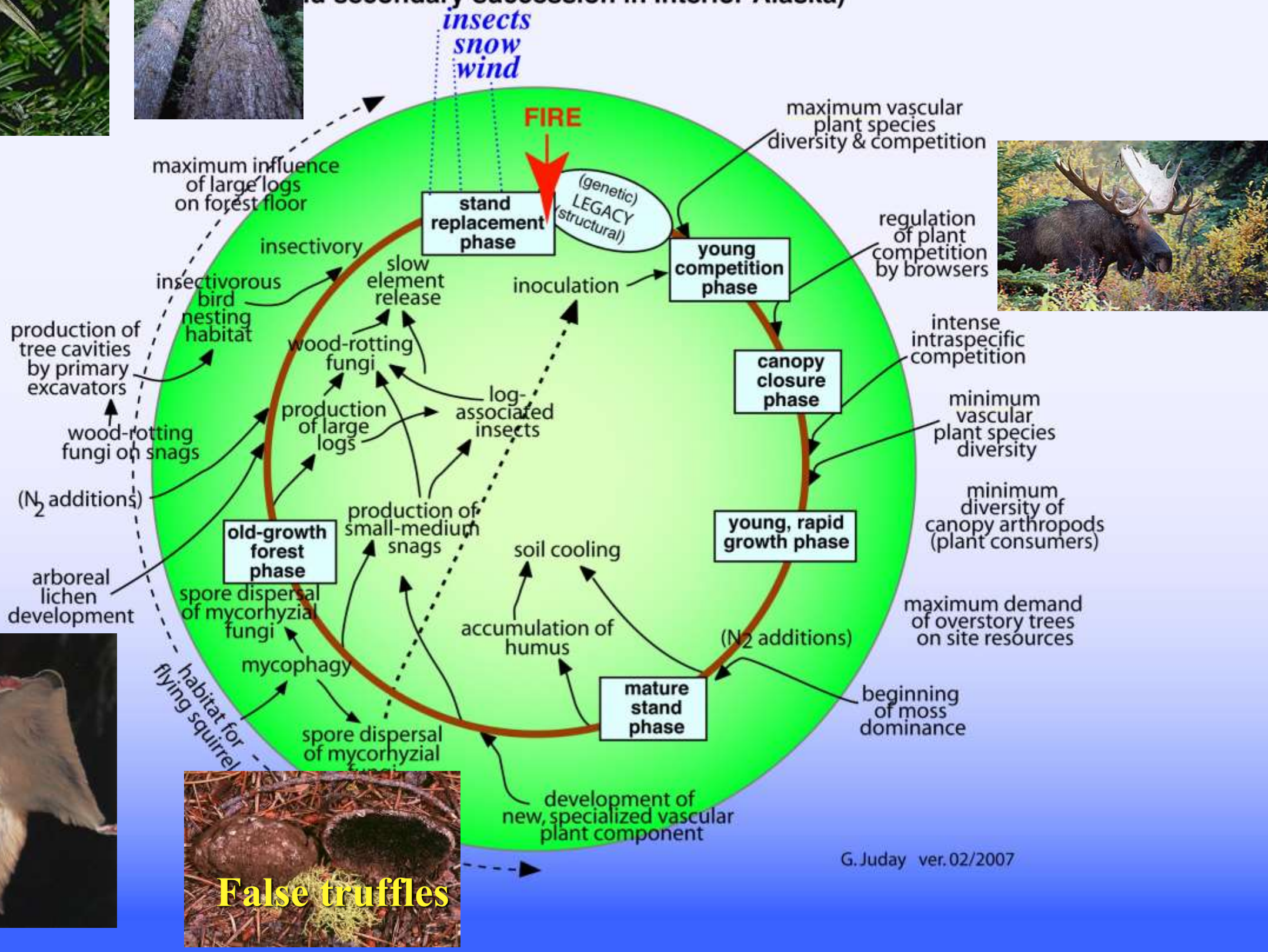
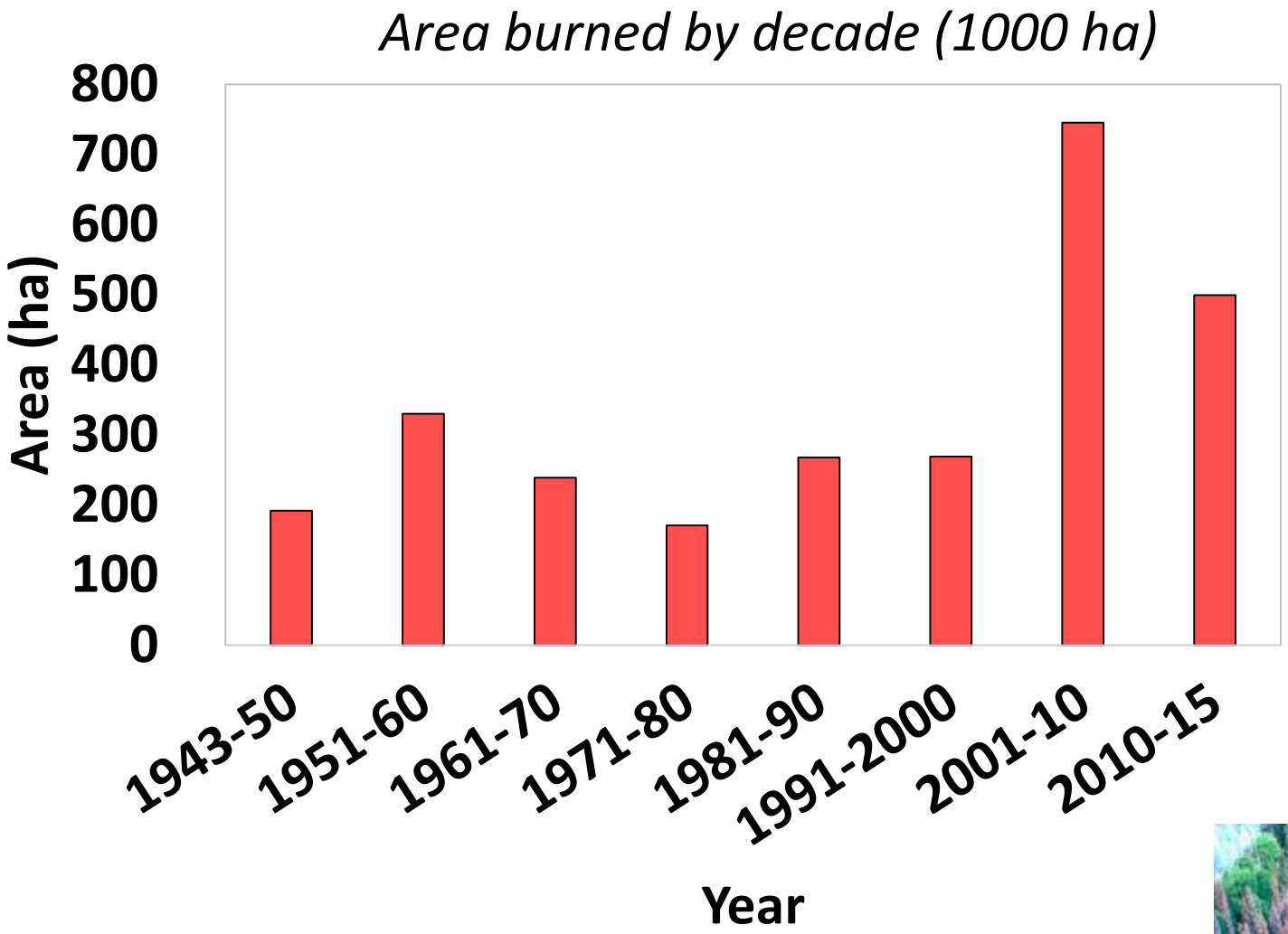
nd secondary succession in Interior Alaska)



False truffles

Changes in the Alaska Boreal Forest

- **Increasing fire**



- **Insect outbreaks**
- **Drought stress**

Source: http://www.fs.fed.us//

Life cycle (structural stages) of the white spruce forest ecosystem:
key stages and processes affecting biodiversity and ecosystem function

(upland white spruce succession in Interior Alaska)

ELIMINATED

ELIMINATED

ELIMINATED

Eliminated by repeated short cycle disturbances

maximum vascular plant species diversity & competition

(genetic) LEGACY (structural)

young competition phase

regulation of plant competition by browsers

intense intraspecific competition

canopy closure phase

minimum vascular plant species diversity

young, rapid growth phase

minimum diversity of canopy arthropods (plant consumers)

maximum demand of overstory trees on site resources

(N_2 additions)

beginning of moss dominance

G. Juday ver. 02/2007

Historical Timber Harvest in Interior Alaska

(state and other ownerships)

Harvest in the study area (1969-2012)

13,000 ha harvested out of

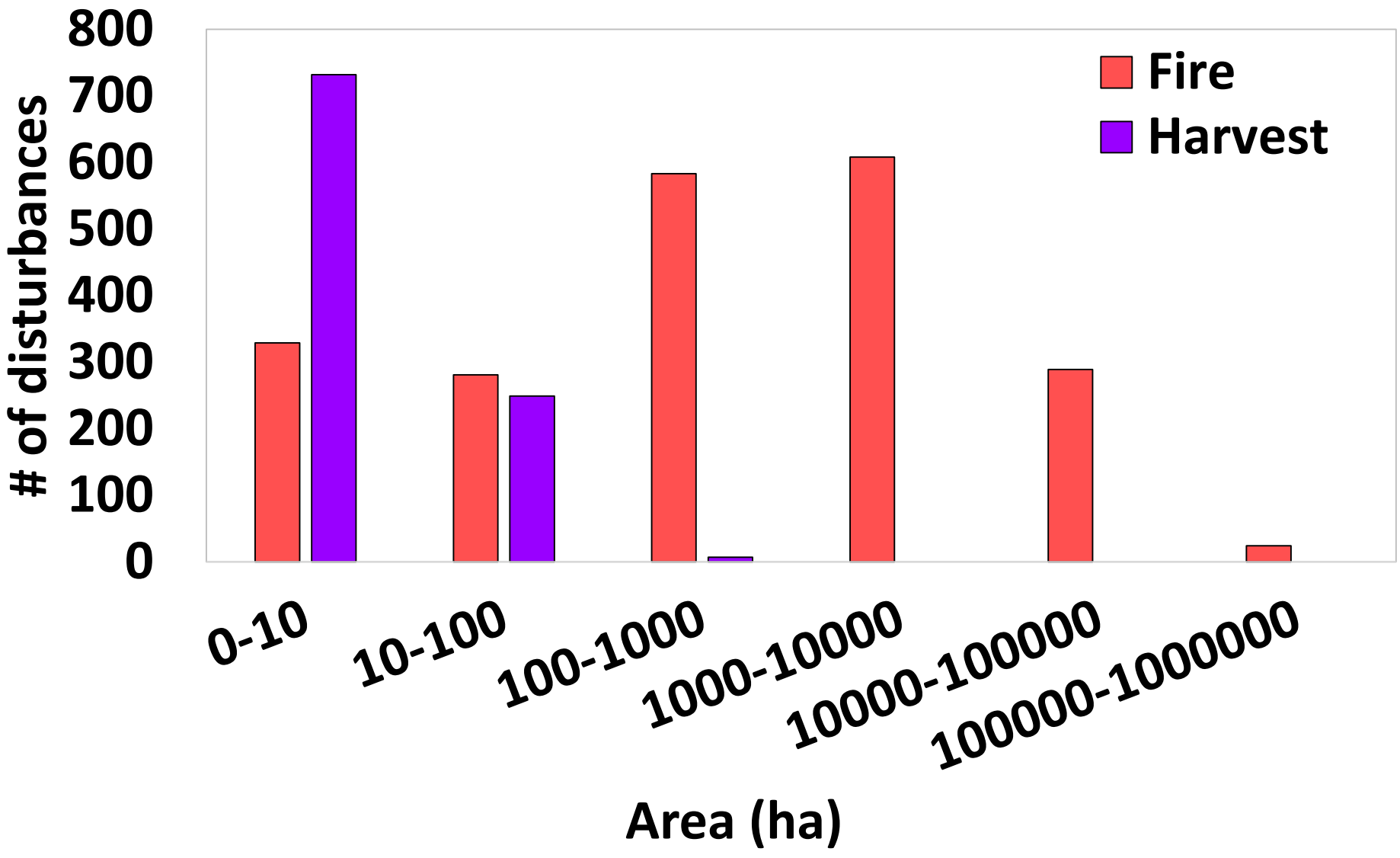
1.2 million ha of total forest area (1%)

N
W
E
S
0 15 30 60 km

State forest harvest units
Other forest harvest units
State forest lands
Rivers, lakes, and ponds
Highways
Developed area not covered by AKDOF

Comparison of fire and harvest disturbance

Size of continuous area harvested vs. fire perimeter (1969-2012)



Harvests (to date) are only small.
Fires are small to very large

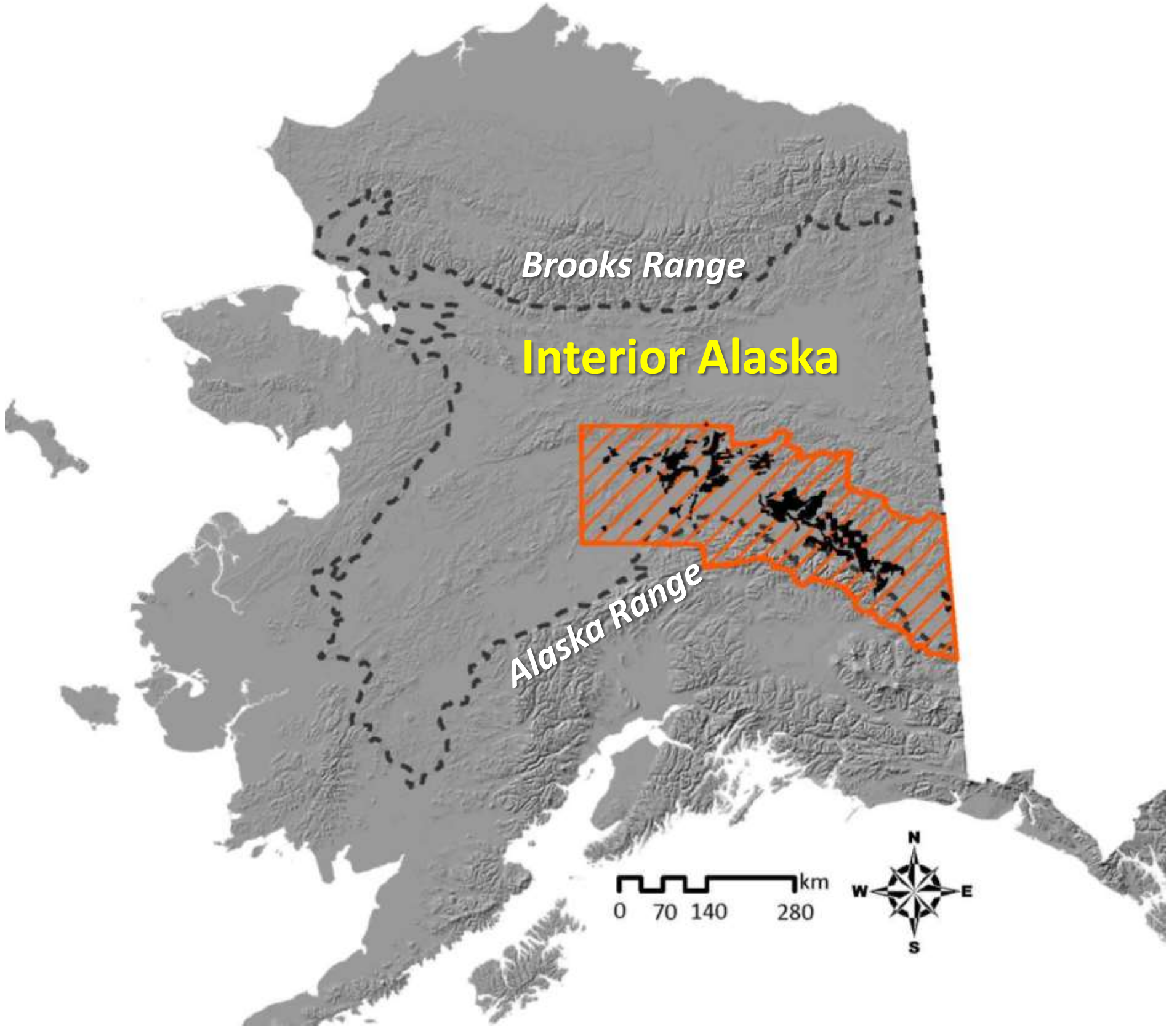
Comparison of fire and harvest disturbance

Fire leaves <u>coarse woody debris</u>
Conventional harvest <u>does not</u>

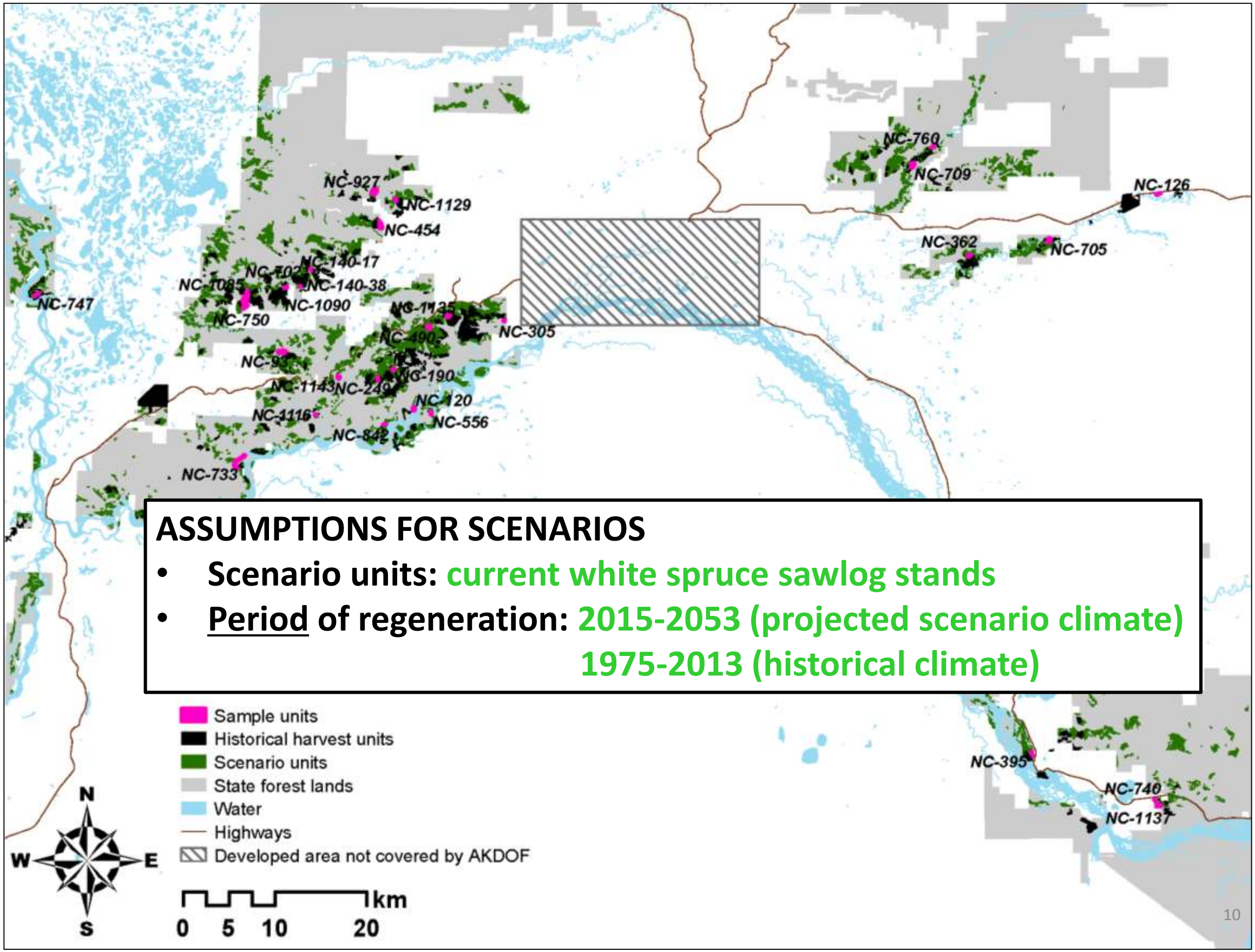
Is it feasible under climate change?

The effects of climate change on post-harvest regeneration

Study Area in Interior Alaska and Tanana Valley



Distribution of sampled units and scenario units



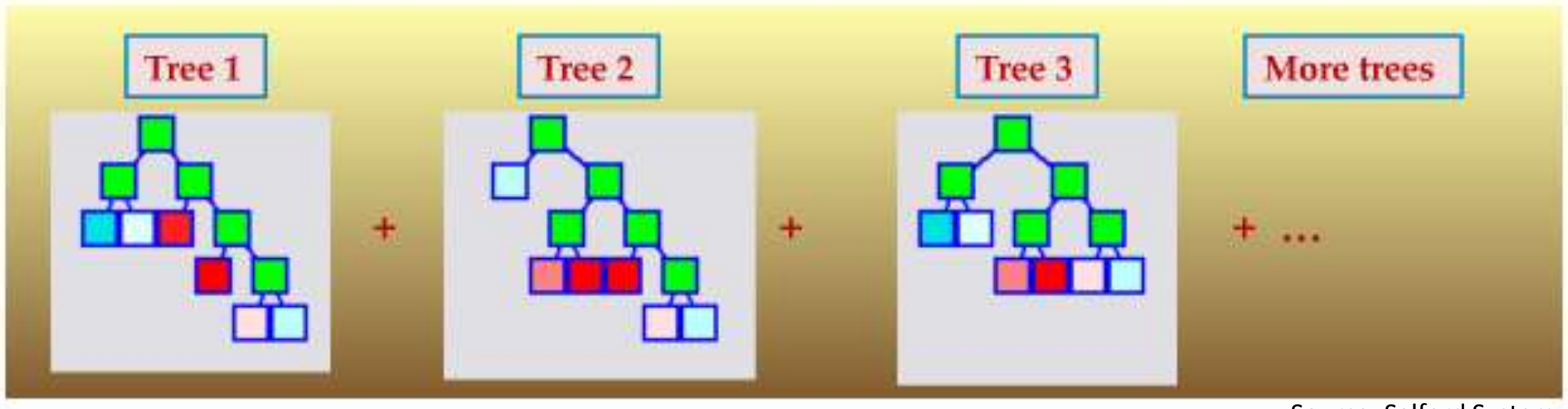
ASSUMPTIONS FOR SCENARIOS

- **Scenario units:** current white spruce sawlog stands
- **Period of regeneration:** 2015-2053 (projected scenario climate)
  1975-2013 (historical climate)

Methods: Statistical Analysis

TreeNet algorithm (machine learning)

- Stochastic Gradient Boosting
- Many ”weak learners” to create a ”strong learner”



Source: Salford System

- Robust
- Able to analyze large dataset quickly
- No assumptions (e.g. normality, independece etc,)

Methods

Response variables (Binary class)

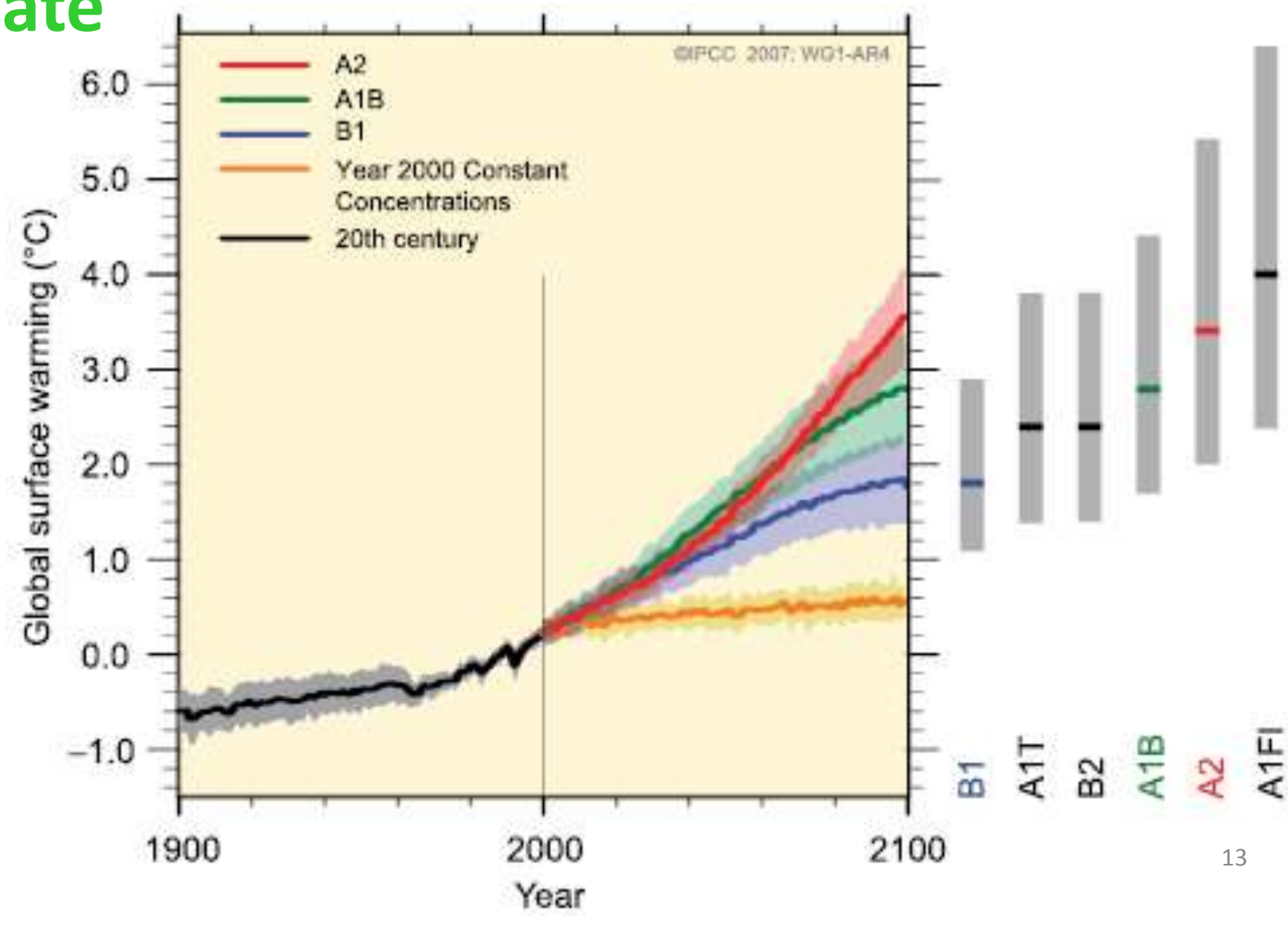
- Presence/absence of *white spruce, birch* and *aspen*

Predictor variables

- Management practices
  - Harvest type
  - Site preparation method
  - Reforestation technique
- Year of harvest
- Size of harvest
- Topography
  - Elevation
  - Slope
  - Aspect
  - Topographic position index
- Soil subgroup
- Distance to landscape features
  - Edge of harvest unit
  - White spruce forest
  - Birch forest
  - Aspen forest
  - Water
  - Highway
  - Forest road
  - Urban area
  - Developed area
- Climate of growing season (May-August)
  - Mean average monthly temperatures
  - Total monthly precipitation

Methods

- IPCC Climate projections
  - **B1** (*lowest emissions/warming*)
  - **A1B** (*mid-range*)
  - **A2** (high emissions/strong warming)
  - **Historical climate**



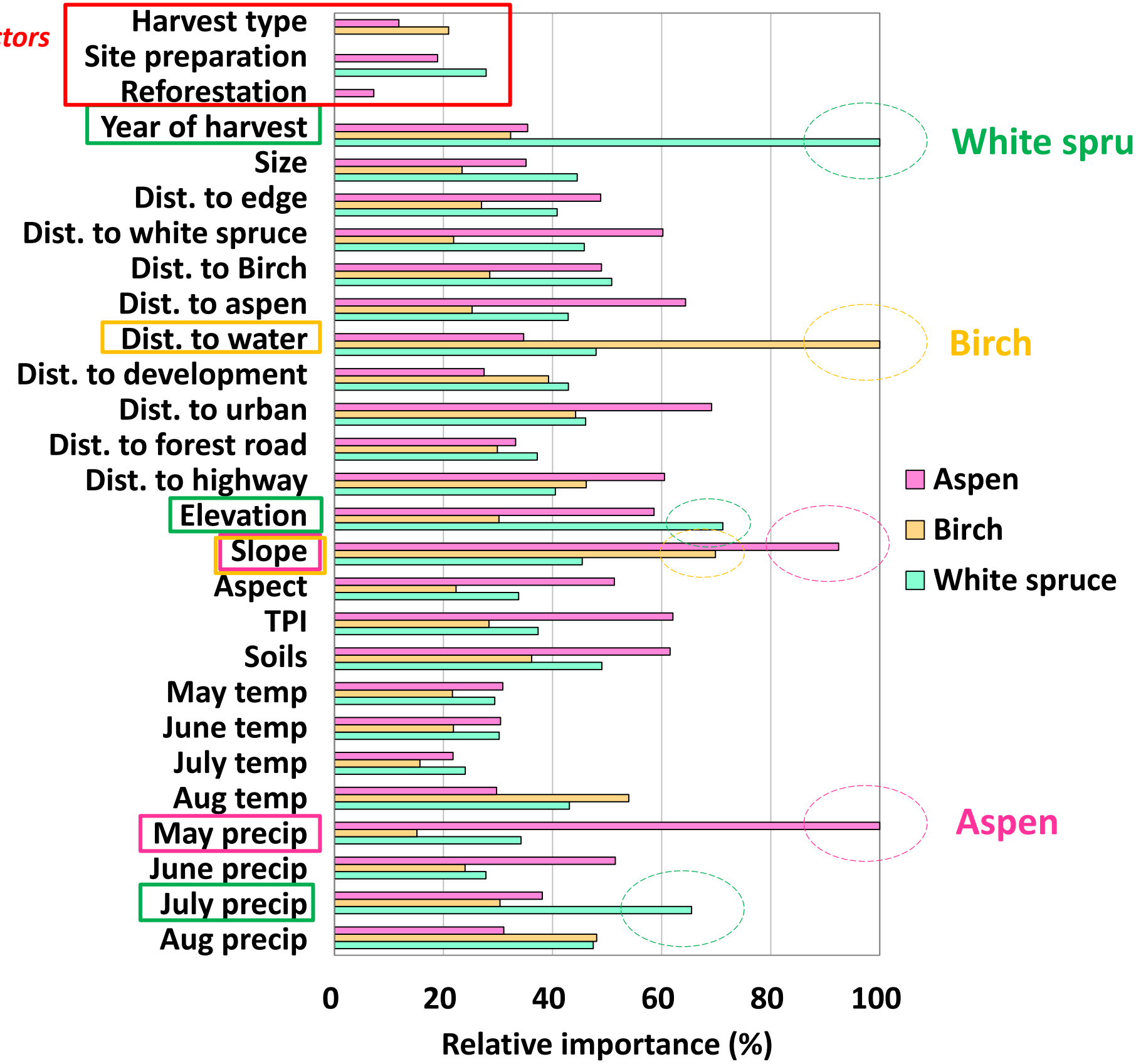
Results: predictive accuracies of presence/absence developed from actual regeneration outcomes

Correct prediction
Incorrect prediction

		Predicted presence/absence		Specificity Sensitivity	Mean accuracy	AUC
		Absent	Present			
Aspen	Absent	**491**	**92**	84.22%	0.84	0.92
	Present	**22**	**121**	84.62%		
Birch	Absent	**176**	**91**	65.92%	0.68	0.74
	Present	**138**	**321**	69.93%		
White spruce	Absent	**239**	**93**	71.99%	0.72	0.79
	Present	**108**	**286**	72.59%		

Results: relative importance of predictors to presence

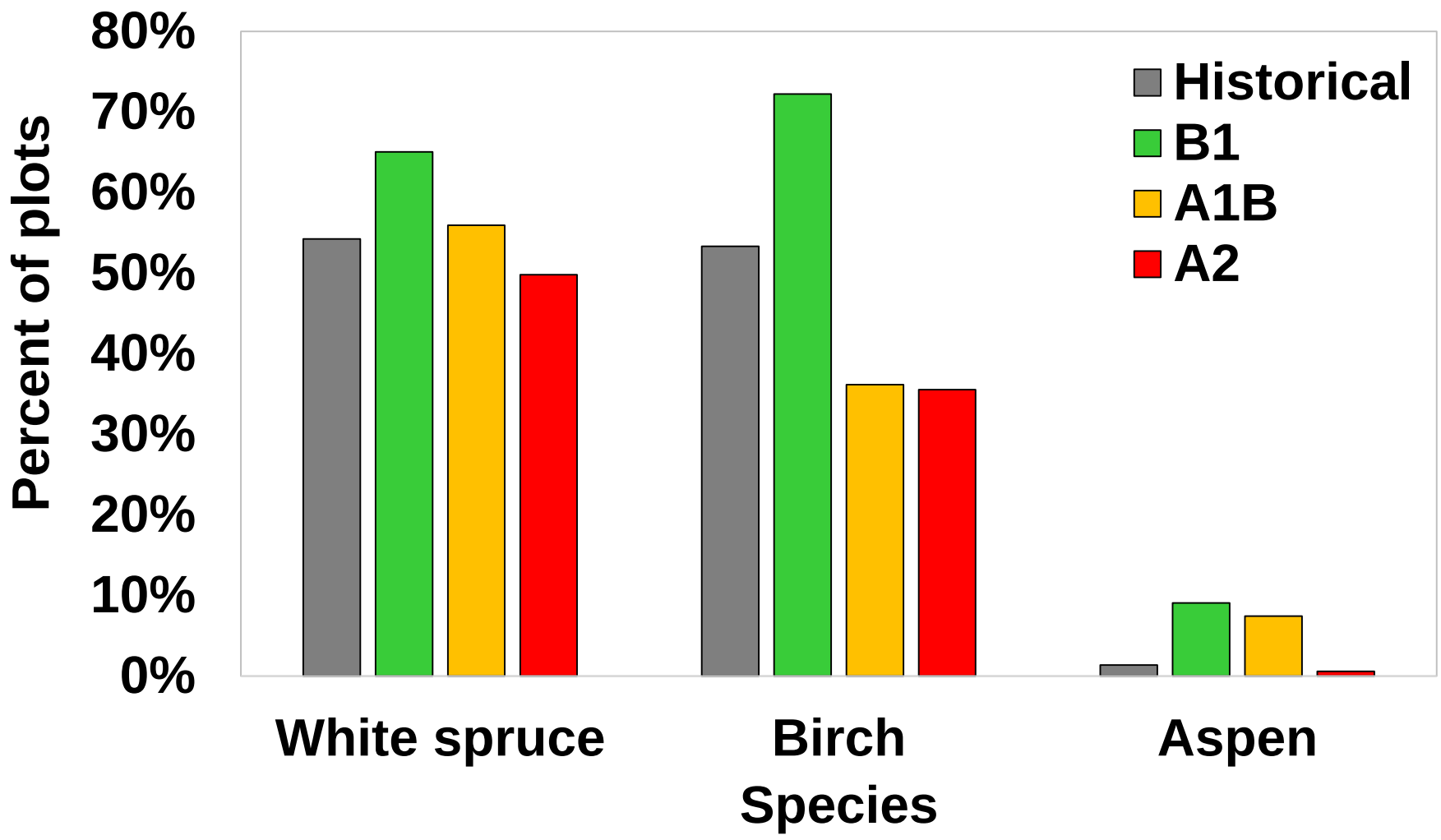
Management factors of interest



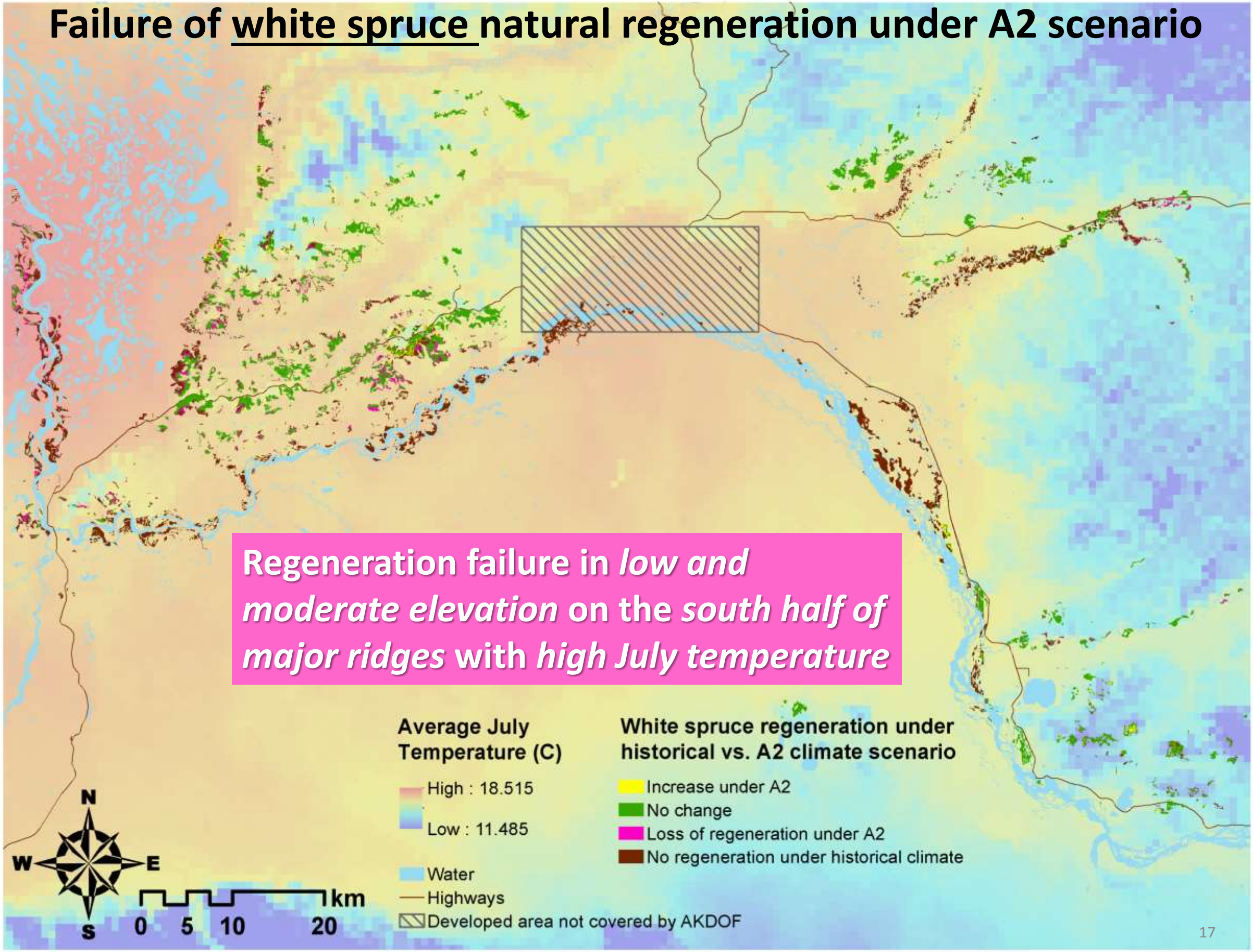
Percentage of occurrence of natural regeneration under climate change scenario

PROJECTIONS:

- Increase in regeneration under modest warming (B1, A1B)
- Substantial reduction of regeneration under A2



Failure of white spruce natural regeneration under A2 scenario



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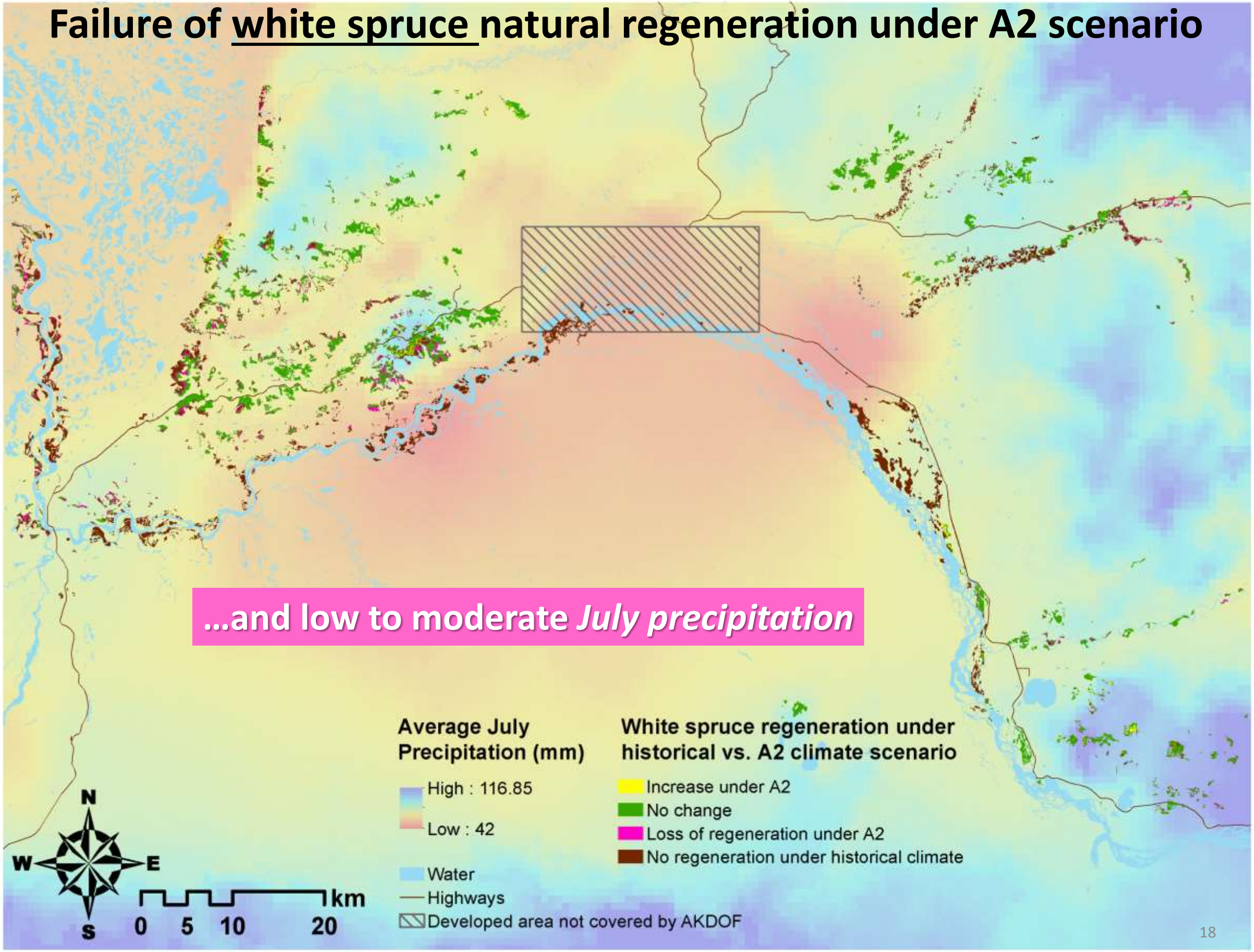


Failure of <u>birch</u> natural regeneration under A2 scenario

Widespread **regeneration failure across** ***low elevation valleys and ridges*** **with** ***high July temperatures***

Average July Temperature (C)

High : 18.515

Low : 11.485

Water

Highways

Developed area not covered by AKDOF

Birch regeneration under historical vs. A2 climate scenario

Increase under A2

No change

Loss of regeneration under A2

No regeneration under historical cliamte

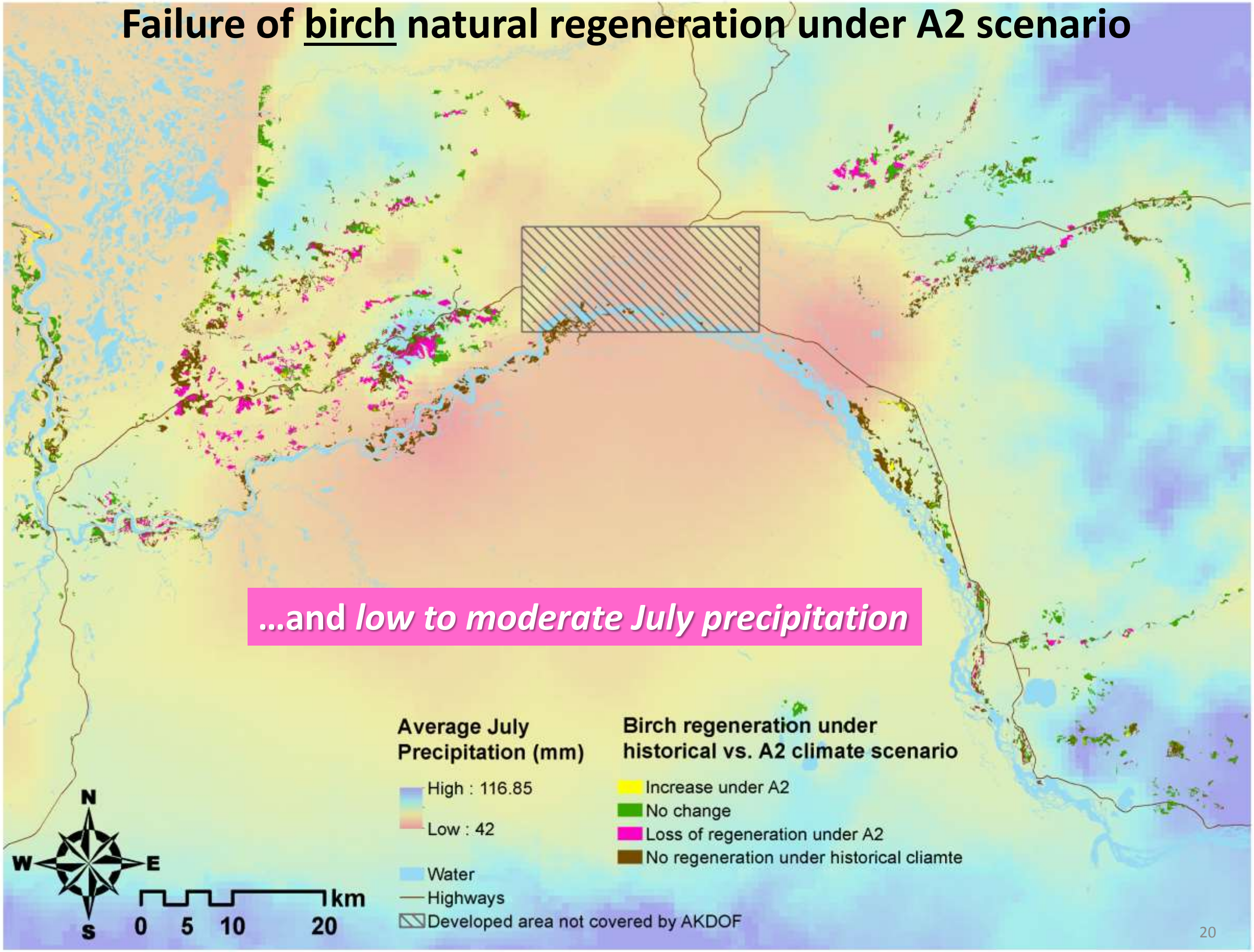
N

W E

S

0 5 10 20 km

Failure of <u>birch</u> natural regeneration under A2 scenario



Evaluate

Adjust

Compiled findings from this study

- **Forest harvest management has been small scale and in a sustainable manner**
- **Trees are experiencing reduced growth/mortality due to drought stress**
- **Wildfire is becoming more intense, frequent and severe, resulting in reduction of fire prone species (i.e. white spruce)**

Plan

Identify vulnerability of sites to climate change

Low ***(e.g. higher elevation; northerly aspects)*** ***High*** ***(e.g. low elevation; southerly aspects)***

Maintain current species

- ***Assisted migration to non-forest sites (diverse genes)***
- ***No human assistance***
- ***Assisted migration of current species***

Maintain forest landscape

- ***Assisted migration of new species***

Supervise biome conversion

- ***No human assistance (e.g. wildfire)***
- ***Facilitate conversion to shrub/grass land***

Act

- **- Identify suitable genes**
  - ***Plant genetically suitable seedling in non-forest sites***
- **- Follow figure**
- **- Identify adaptive genotypes not native to the area**
  - ***Plant suitable seedlings from other forest regions***
- **- Identify adaptive species**
  - Assess flammability and habitat suitability
  - ***Plant suitable species***
- **- Identify new products (e.g. biomass, wildlife species)**
  - ***Harvest, site preparation and/or prescribed fire***

Monitor

Monitor…..

- ***Survival***
- ***Growth***
- ***Productivity***
- ***Adaptability***
- ***Invasiveness***
- ***Climate***
- ***Fire behavior***


Thank you