Court Jester is chasing the Red Queen: Adaptation as a key feature of future forest management

Klaus J. Puettmann

Oregon State University

Oregon State University

Drivers of Evolution(Adaptation)

Modified from Benton 2009

Adapation is a never ending, continually accelerating process.

Adaptation versus Resilience

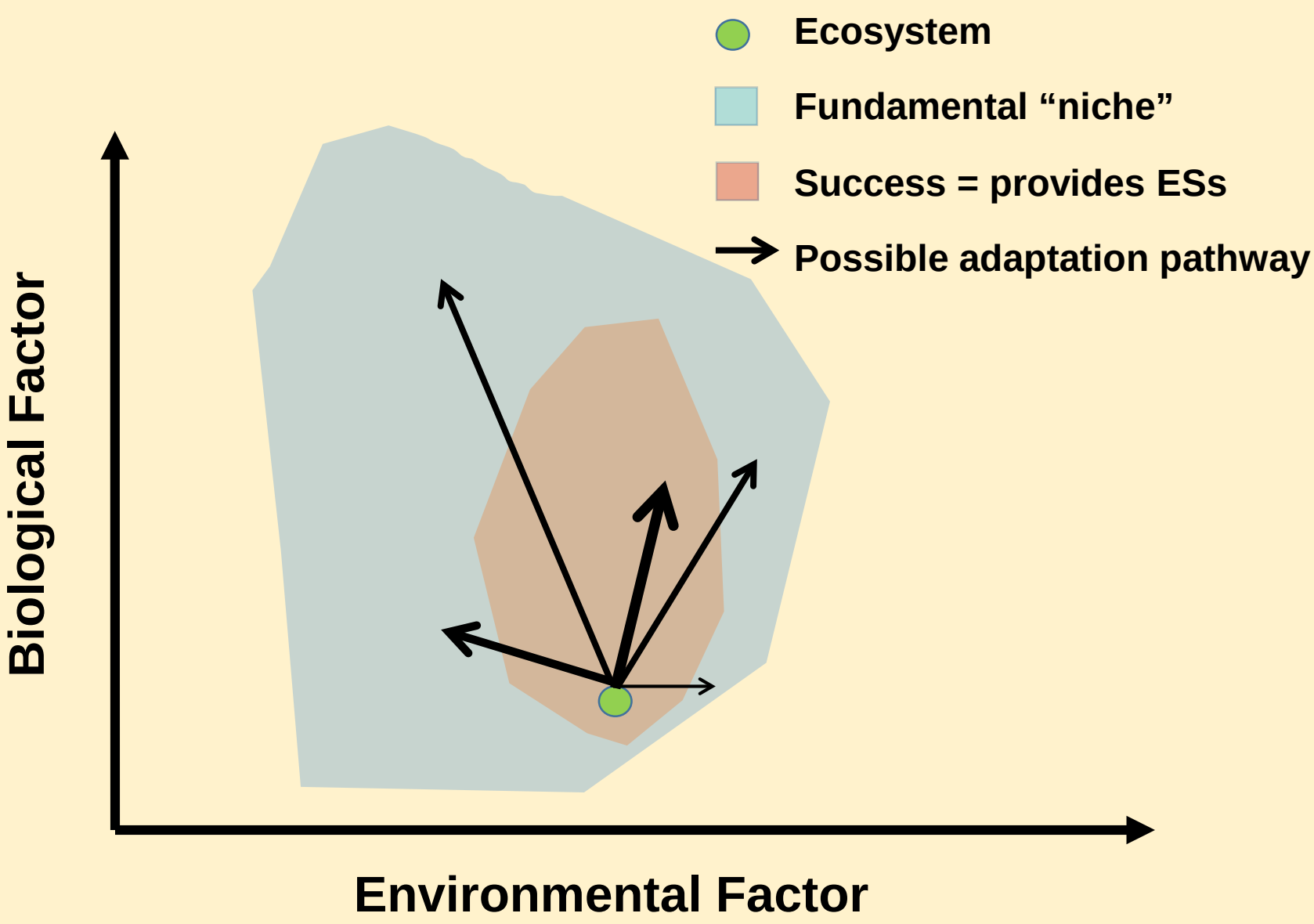
Adaptative capacity = strategies of a system to respond to environmental (and socioeconomic) changes

- by new ways of operating, interactions, and reorganization.

Success = Provision of desired ecosystem services

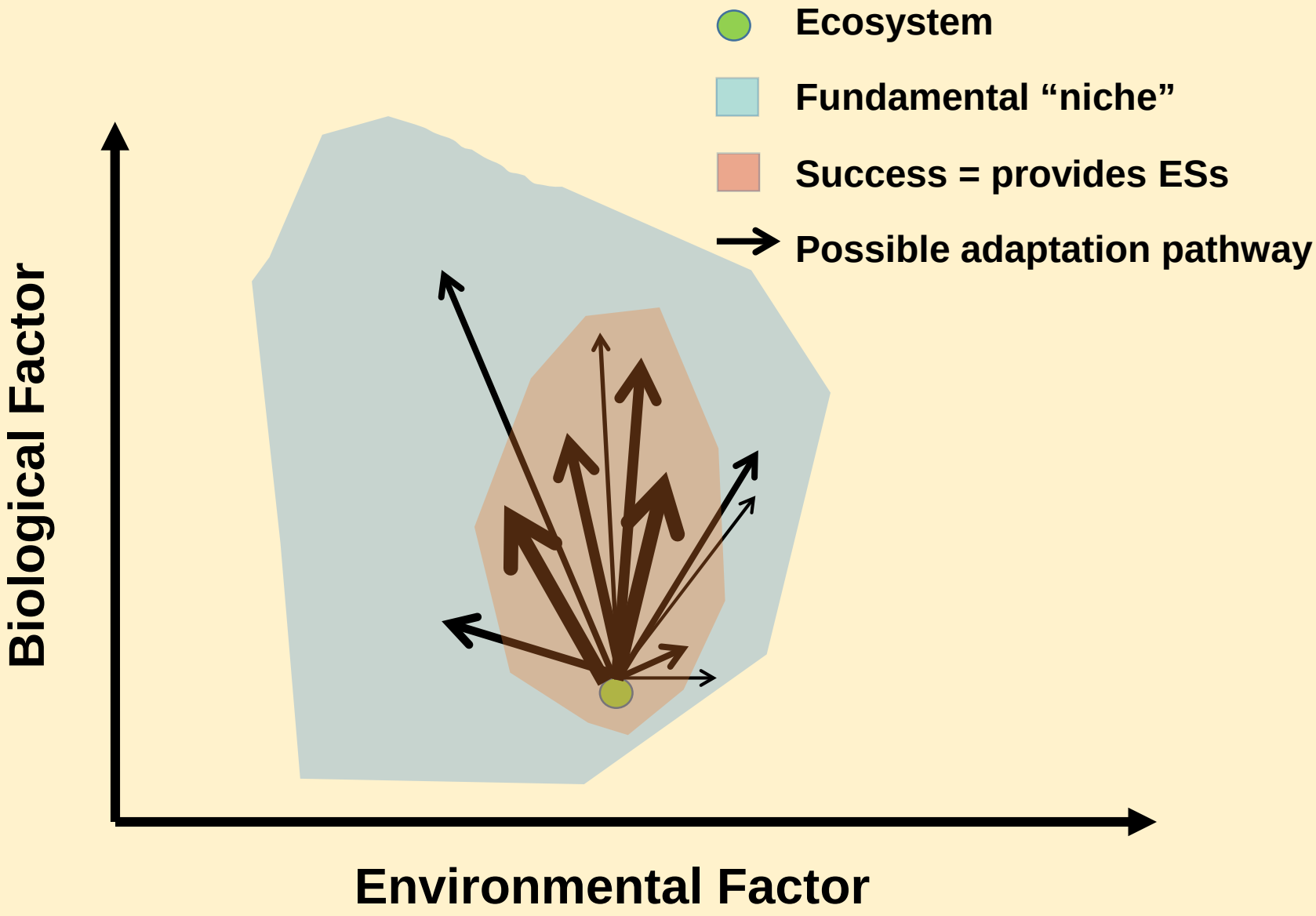
Resilience = adaptation + success

Adaptability



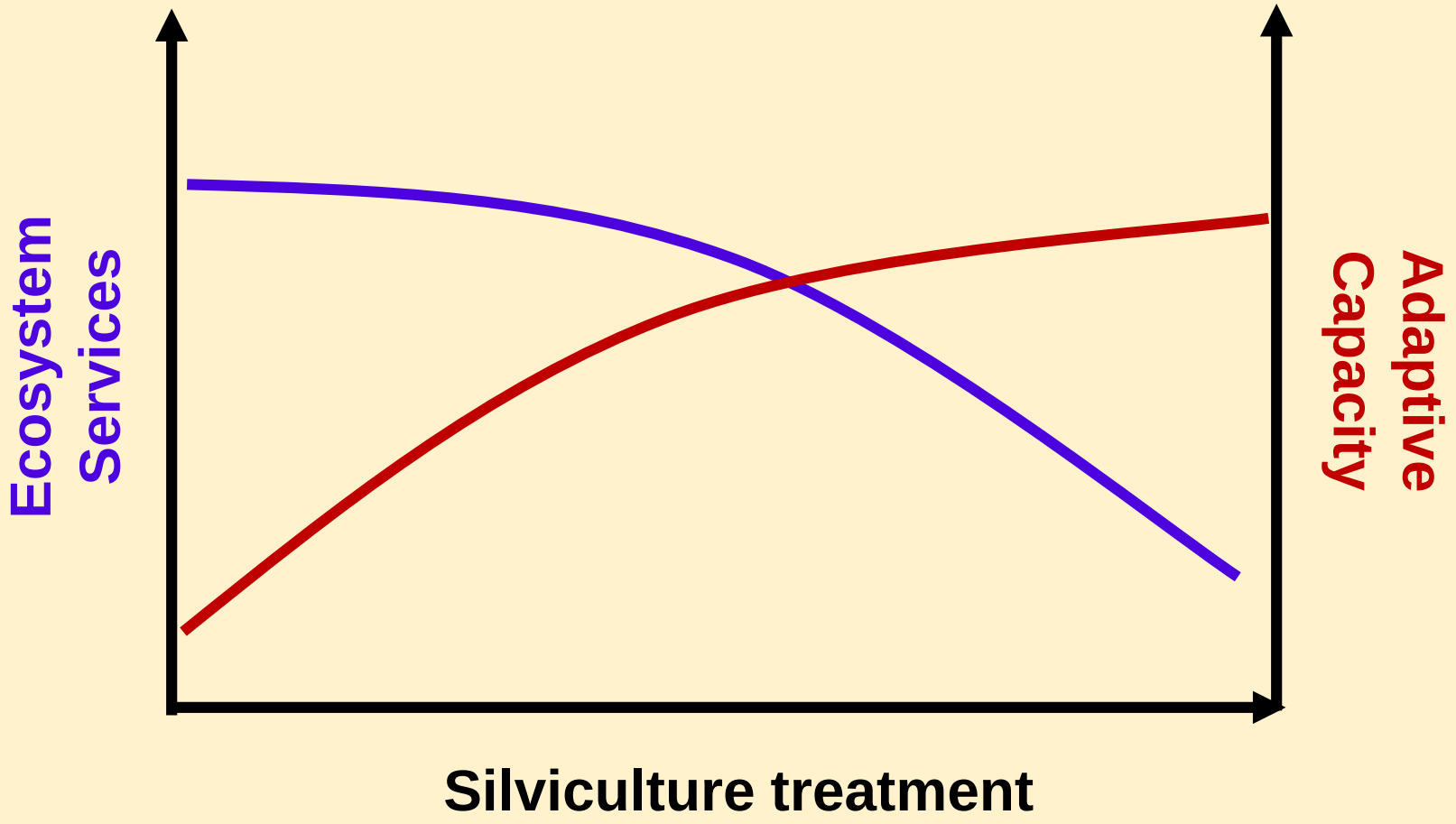
Modified from Puettmann 2014

Adaptability



Modified from Puettmann 2014

Adaptation = Ecosystem Service

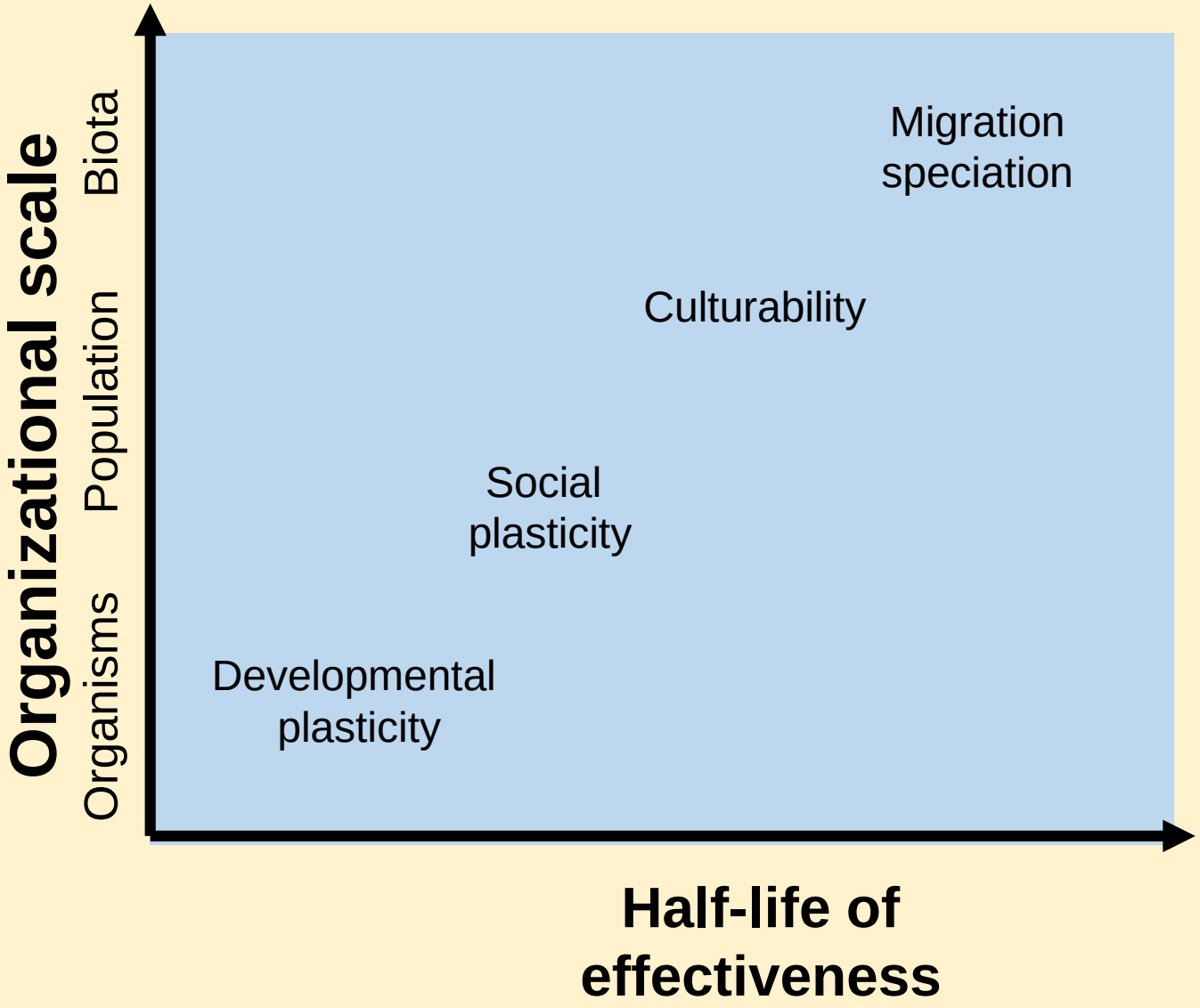


Adaptation mechanisms

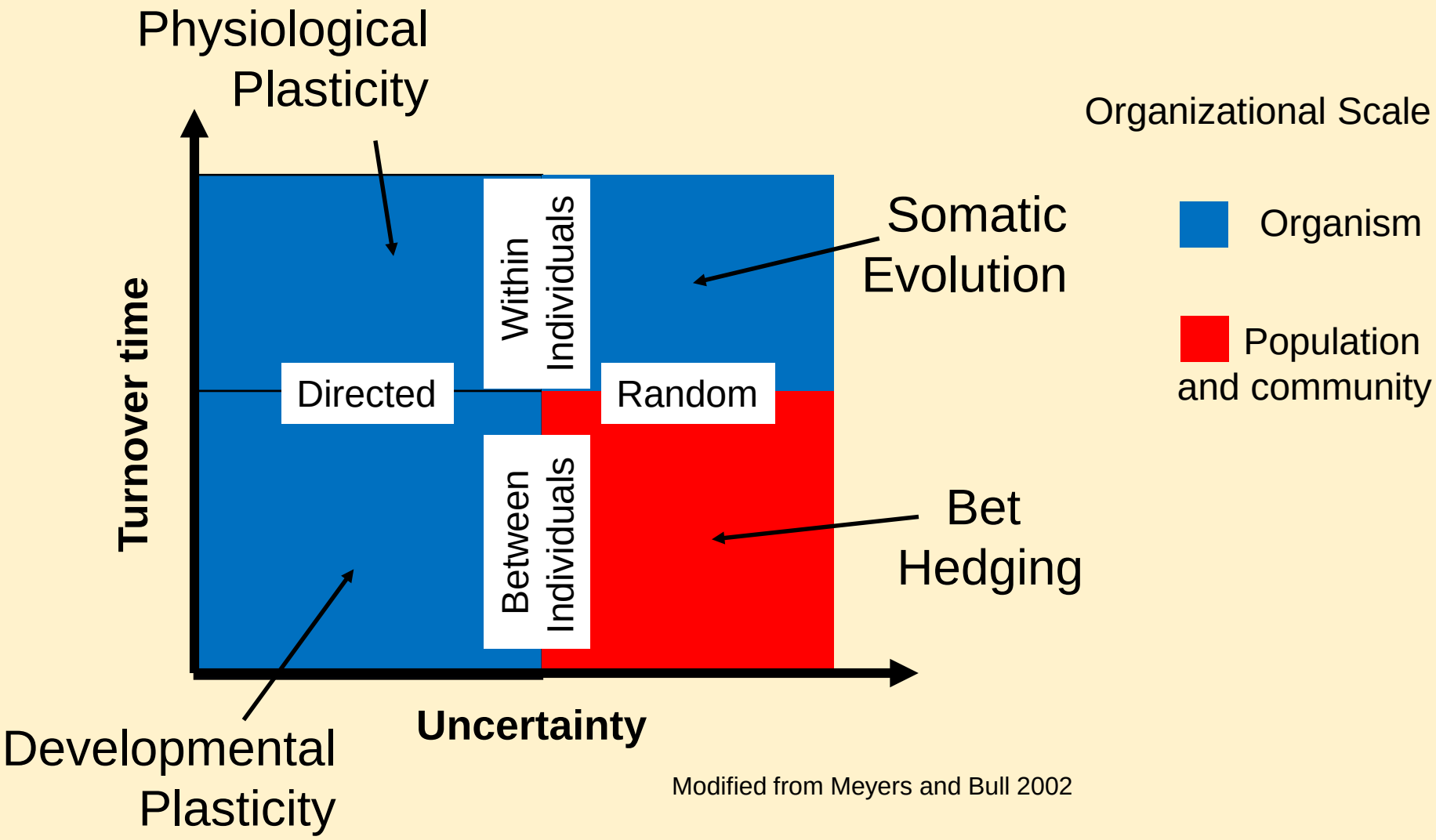
Organiza-tional level	Measurable property	Adaptation mechanisms
Communities	Species composition	Migration, extinction, speciation
	Food web structure	Different routes and rates of energy movement (matter?)
Population	Number of organisms	Culturability, e.g., flexibility in reproduction rates, social structures, and relationships
	Spatial location of organisms	Social plasticity, movement
Organism	Number of organs, relative position of organisms, behavior	Developmental plasticity (e.g., muscle, leaf area, size), epigenetics
		Physiological and behavioral plasticity

Modified from Conrad 1983

Adaptation mechanisms



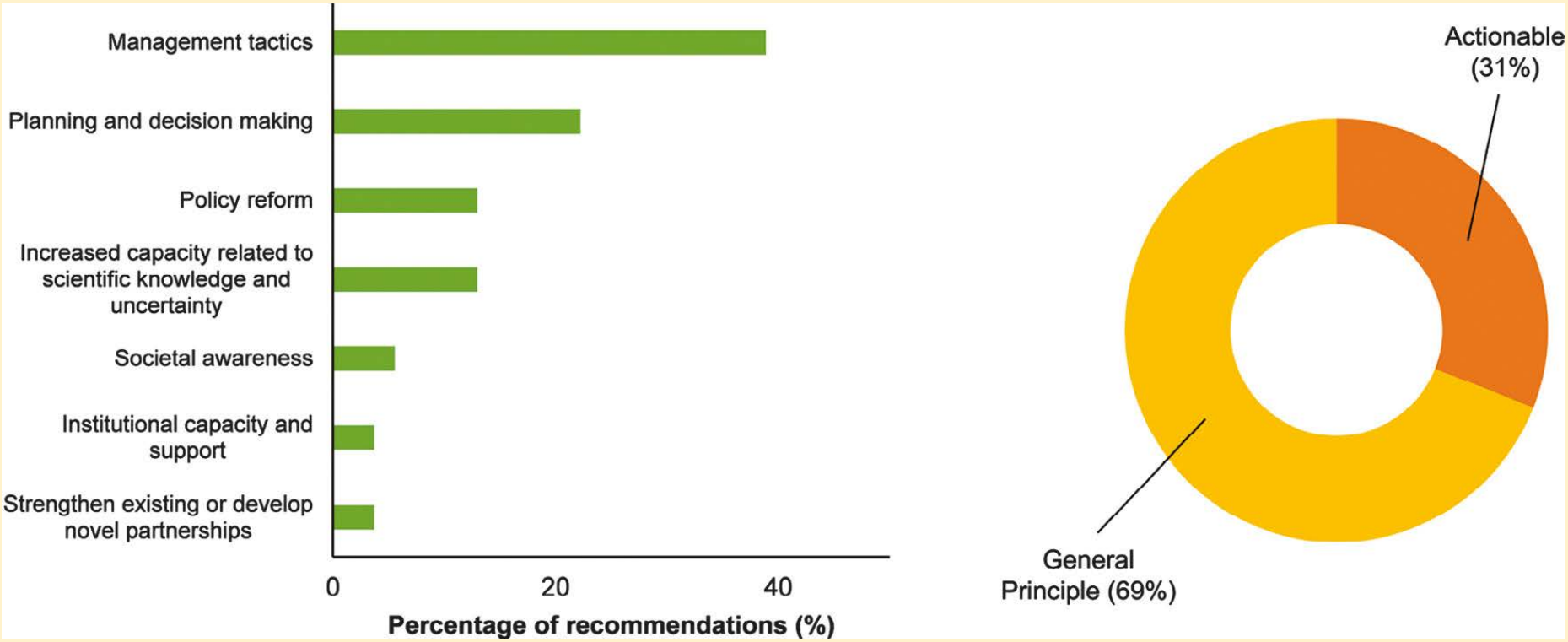
Adaptation mechanisms



Modified from Meyers and Bull 2002

Adaptation: management recommentations

Climate change



From Hagerman and Pelai 2018 FrontEcolEvol

Adaptation: management recommendations

Journal of Forestry, 2020, 86–101
doi:10.1093/jofore/fvz062
Practice of Forestry - biomass, carbon & bioenergy
Received March 5, 2019; Accepted October 8, 2019
Advance Access publication November 30, 2019

OXFORD

Practice of Forestry - biomass, carbon & bioenergy

Forest Management for Carbon Sequestration and Climate Adaptation

Todd A. Ontl, Maria K. Janowiak, Christopher W. Swanston, Jad Daley, Stephen Handler, Meredith Cornett, Steve Hagenbuch, Cathy Handrick, Liza McCarthy, and Nancy Patch

Todd A. Ontl (todd.ontl@usda.gov;taontl@gmail.com), Maria K. Janowiak (maria.janowiak@usda.gov), Christopher W. Swanston (christopher.swanston@usda.gov), Stephen Handler (
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Implementing Climate Change Adaptation in Forested Regions of the United States

Jessica E. Halofsky
Research Ecologist, University of Washington, College of the Environment, School of Environmental and Forest Resources

David L. Peterson
Research Biological Scientist, USDA Forest Service, Pacific Northwest Research Station, Pacific Wildland Science Fire Laboratory

Linda A. Joyce
Research Ecologist, Human Dimensions Research Program, USDA Forest Service, Rocky Mountain Research Station

Constance I. Millar
Research Paleoecologist, USDA Forest Service, Pacific Southwest Research Station

Janine M. Rice
Research Associate, University of Colorado, Western Water Assessment and the USDA Forest Service, Rocky Mountain Research Station

Christopher W. Swanston
Director, Northern Institute of Applied Climate Science, USDA Forest Service, Northern Research Station

Abstract: Natural resource managers need concrete ways to adapt to the effects of climate change. Science-management partnerships have proven to be an effective means of facilitating climate change adaptation for natural resource management agencies. Here we describe the process and results of several science-management partnerships in different forested regions of the United States (U.S.), including the Pacific Northwest, interior West, Pacific Southwest, and Upper Midwest and Northeast. Led by U.S. Forest Service scientists, these partnerships were developed to adapt resource management in National Forests, national parks, and land managed by other federal and state agencies to climate change and typically involved vulnerability assessments and science-management workshops to develop adaptation strategies and tactics. We discuss commonalities among these efforts, specific outcomes, and applicability to other regions and adaptation efforts.

INTRODUCTION

Federal land management agencies in the United States are beginning to incorporate climate change into their management planning and operations. Department- and agency-level strategic plans and directives are increasingly recognizing the importance of incorporating climate change in agency activities. For example, Secretary of the Interior Order 3289, signed in 2009 and amended in 2010, suggests that potential climate change impacts necessitate changes in how the U.S. Department of the Interior (USDOI) manages natural resources and requires its agencies to incorporate climate change in planning, prioritization, and decision-making (USDOI 2009). Similarly, in the U.S. Department of Agriculture (USDA) strategic plan for fiscal years 2010–2015 (USDA 2010), one of four strategic goals is to ensure that National Forests and private working lands are conserved, restored, and made more resilient to climate change, and a 2011 Departmental Regulation (DR-1070-

USDA
United States Department of Agriculture

Forest Adaptation Resources:
Climate Change Tools and Approaches for Land Managers, 2nd edition

Forest Service
Northern Research Station
General Technical Report NRS-87-2
Major Revision
September 2016

Annals of Forest Science (2019) 76: 48
https://doi.org/10.1007/s13595-019-0827-x

OPINION PAPER

Forest adaptation to climate change—is non-management an option?

Robert Jandl [1] · Peter Spathelf [2] · Andreas Bolte [3] · Cindy E. Prescott [4]

USDA

United States Department of Agriculture
Forest Service
Pacific Northwest Research Station
General Technical Report PNW-GTR-855
November 2011

Responding to Climate Change in National Forests: A Guidebook for Developing Adaptation Options

David L. Peterson, Constance I. Millar, Linda A. Joyce, Michael J. Furniss, Jessica E. Halofsky, Ronald P. Neilson, and Toni Lyn Morelli

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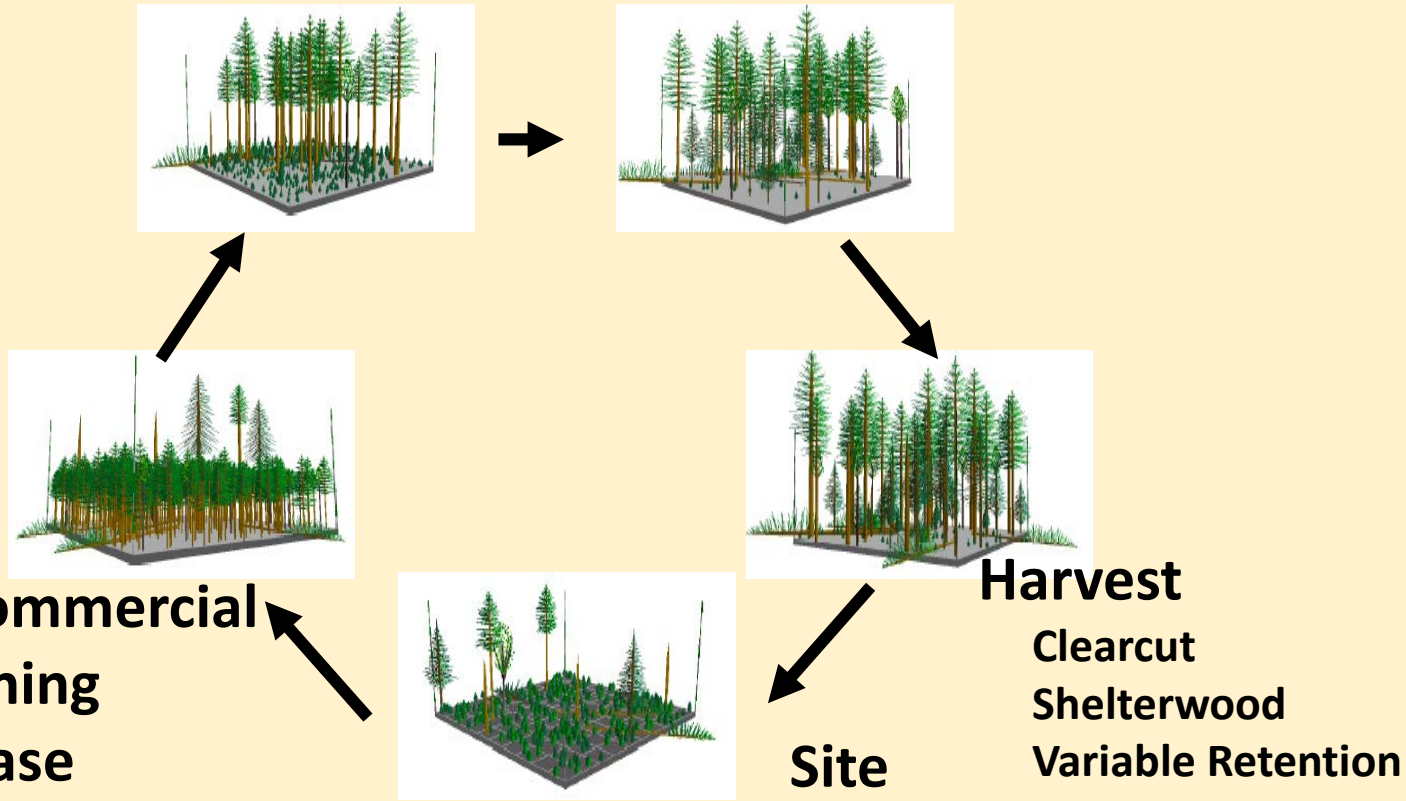
Silviculture tools

Silviculture practices



The dog and the Frisbee

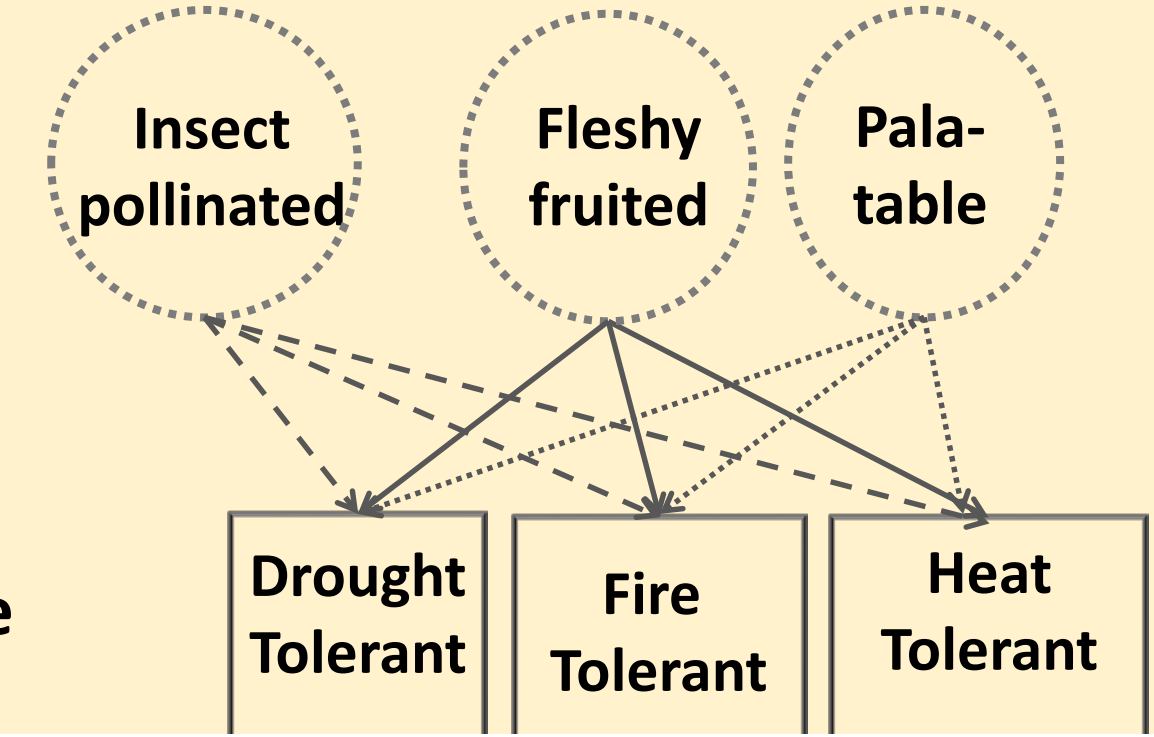
Sensu A. Haldane

Complex problems = simple rules

Conceptual basis for management

- **Insurance hypothesis: functional diversity of species, provenances, traits**
  - mixed species, multiple canopy layers

Conceptual basis for management



428

NRC Research Press

ARTICLE

Managing for adaptive capacity: thinning improves food availability for wildlife and insect pollinators under climate change conditions

Andrew R. Neill and Klaus J. Puettmann

Neill and Puettmann 2013

Conceptual basis for management

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- **Cross-scale interactions**
  - variable density stands, different stand sizes, rotation age, retention

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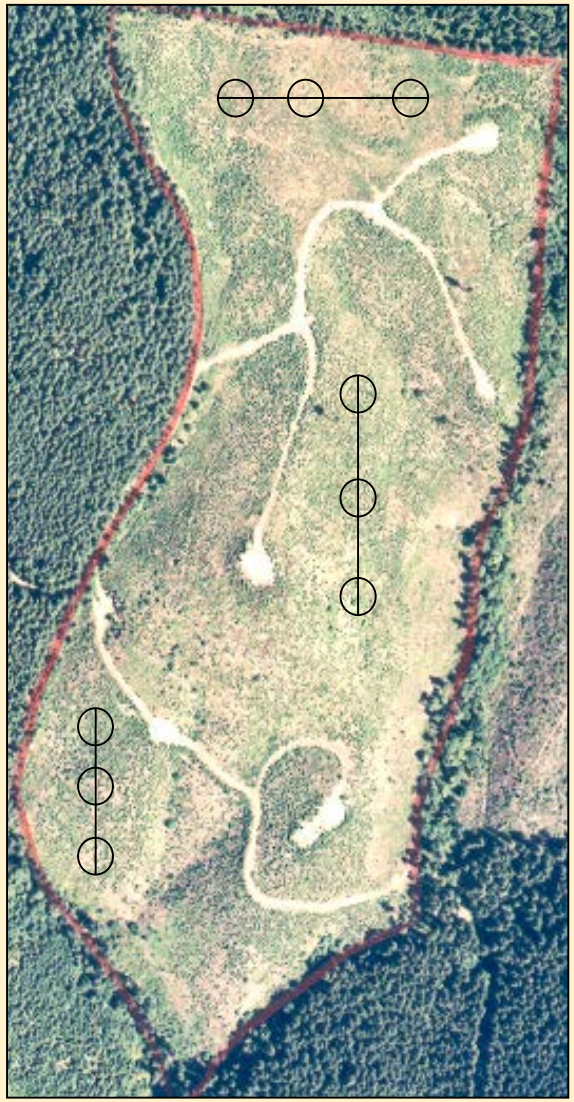
  - understocked areas, let natural processes play out

Conceptual basis for management



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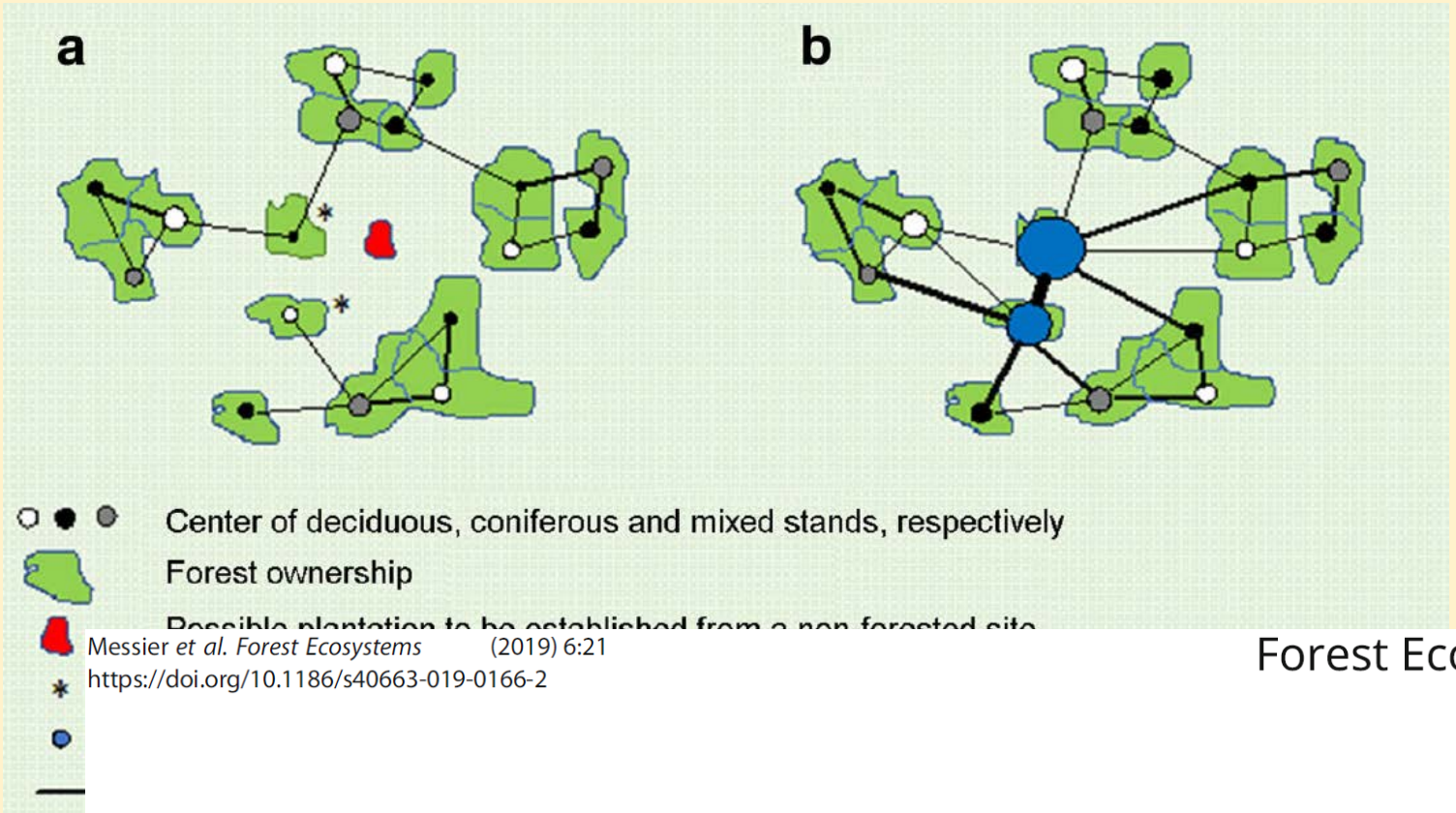
- **Spatial configuration, modularity:**
  - connectivity, fragmentations, “inoculation”



Messier *et al. Forest Ecosystems* (2019) 6:21
https://doi.org/10.1186/s40663-019-0166-2

Forest Ecosystems

DISCUSSION Open Access

The functional complex network approach to foster forest resilience to global changes

Christian Messier[1,2*], Jürgen Bauhus[3], Frederik Doyon[1], Fanny Maure[2], Rita Sousa-Silva[1], Philippe Nolet[1], Marco Mina[2,4], Núria Aquilué[2], Marie-Josée Fortin[5] and Klaus Puettmann[6]

Conceptual basis for management:

- Insurance hypothesis: functional diversity of species, provenances, traits
  - mixed species, multiple canopy layers
- Cross-scale interactions
  - variable density stands, different stand sizes, rotation age, retention
- Self-organization, bottom-up control w/ feedback loops
  - understocked areas, let natural processes play out
- Spatial configuration, modularity:
  - connectivity, fragmentations, “inoculation”
- **Disturbances: manage/reduce severity**
  - density management, rotation age, fuel management, let-burn policy, species choice, connectivity

Conceptual basis for management

https://www.nrfirescience.org/event/fuel-treatment-effects-ponderosa-pine-and-mixed-conifer-forests

	Funct. Div.	Cross -scale interact.	Self- organ.	Spatial config.	Reduce dist. sever.
Group selection					
Shelterwood					
Thinning					
Natural regeneration					
Artificial regen. (species mixtures)					
Assisted migration species;provenances)					
Variable rotation age					
Variable retention (green tree; snag)					
Corridor creation					
Expanded reserves					
Prescribed fire					

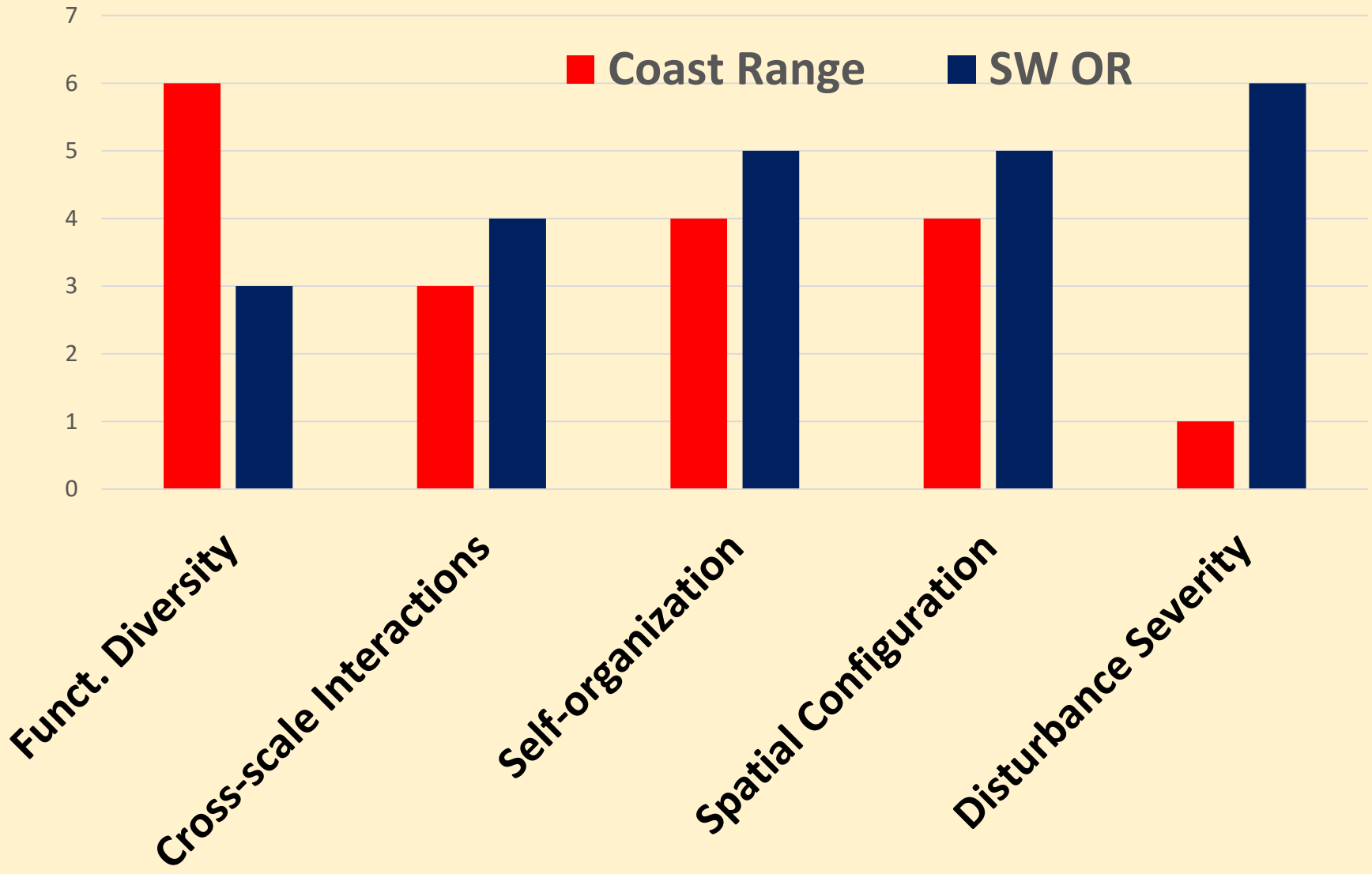
Modified from Scheller et al. NSF proposal

	Funct. Div.	Cross -scale interact.	Self-organ.	Spatial config.	Reduce dist. sever.
Group selection	CR	SW		SW	SW
Shelterwood				CR, SW	SW
Thinning					CR, SW
Natural regeneration	CR, SW	CR, SW	CR, SW	CR, SW	
Artificial regen. (species mixtures)	CR				
Assisted migration species;provenances)	CR, SW				SW
Variable rotation age	CR	CR	CR, SW		SW
Variable retention (green tree; snag)	CR,SW	CR, SW	CR, SW	CR,SW	
Corridor creation				CR	
Expanded reserves		SW	CR, SW	SW	
Prescribed fire			SW		SW

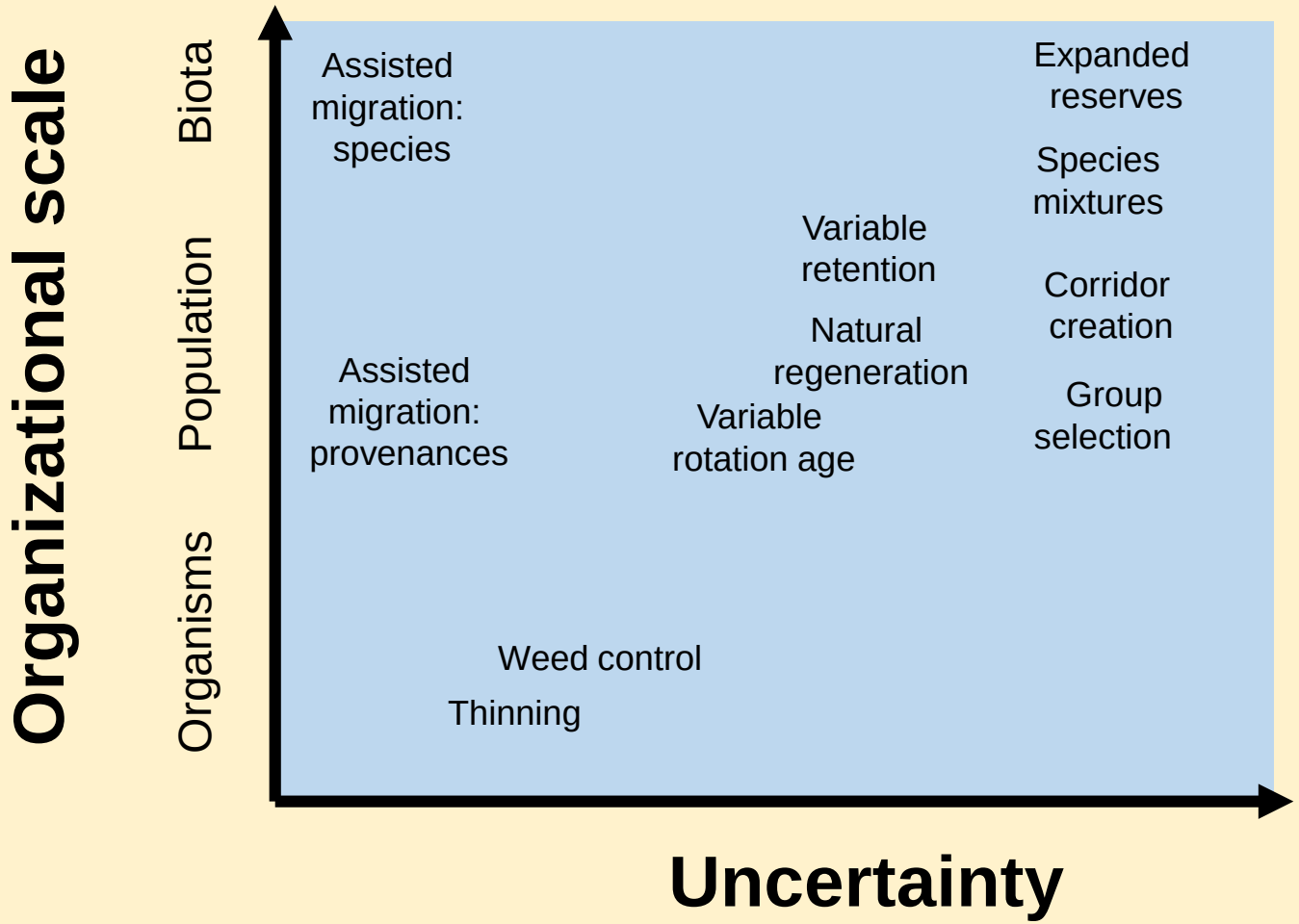
CR = Coast Range SW = SouthWest Oregon

Modified from Scheller et al. NSF proposal

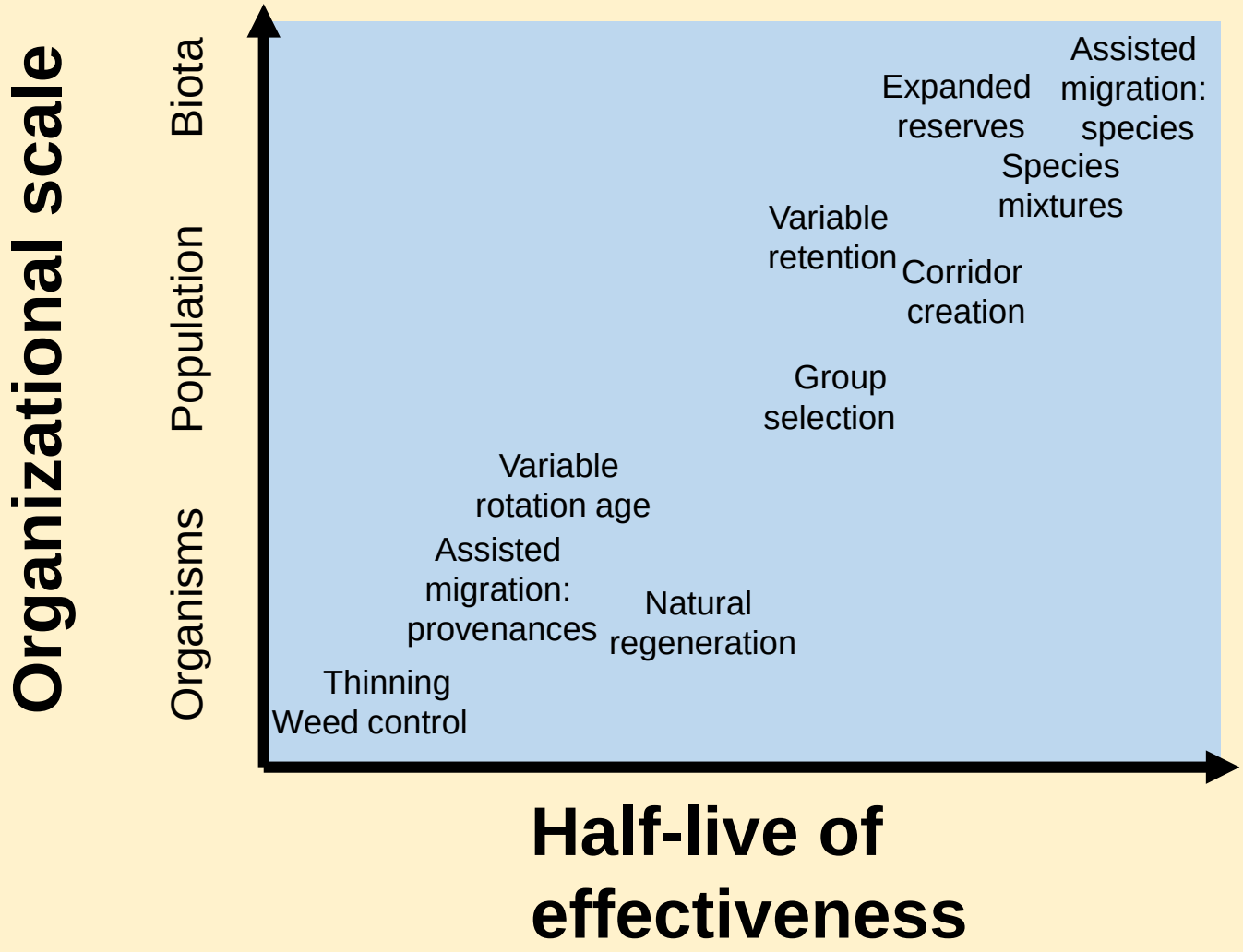
Management examples



Management examples

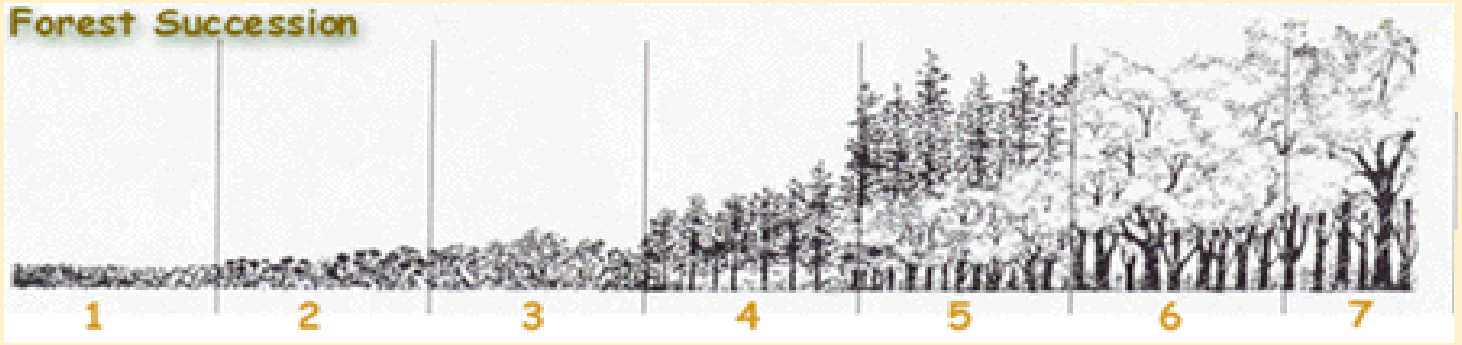


Management examples

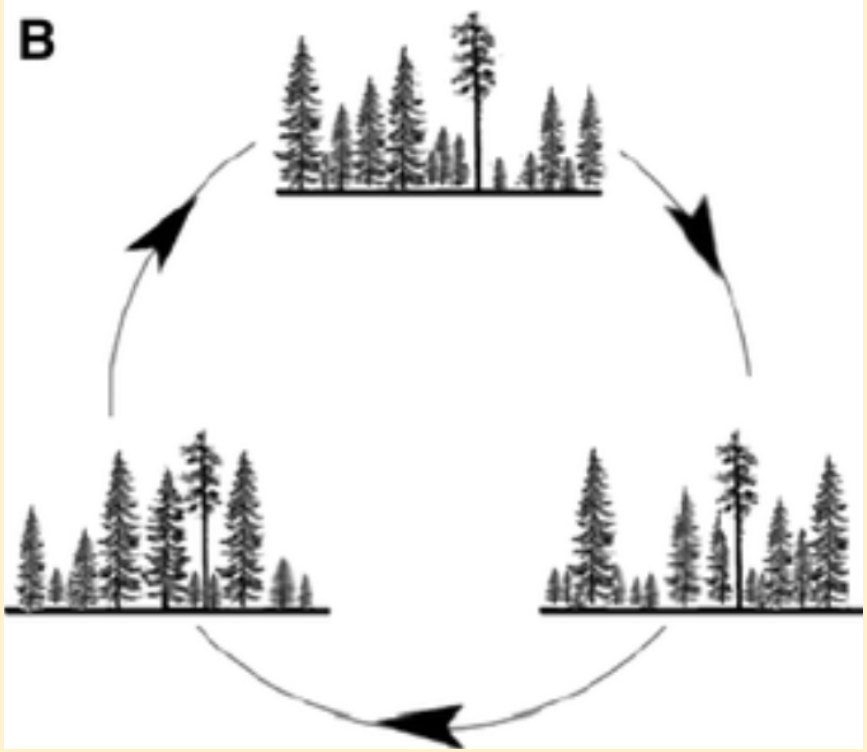


Treatment timing: Even-aged forest

Traditional forest Management



Treatment timing: Uneven-aged forest



Possible pathways
Adaptive capacity

Drawing from Kuuluvainen et al. 2012 AMBIO

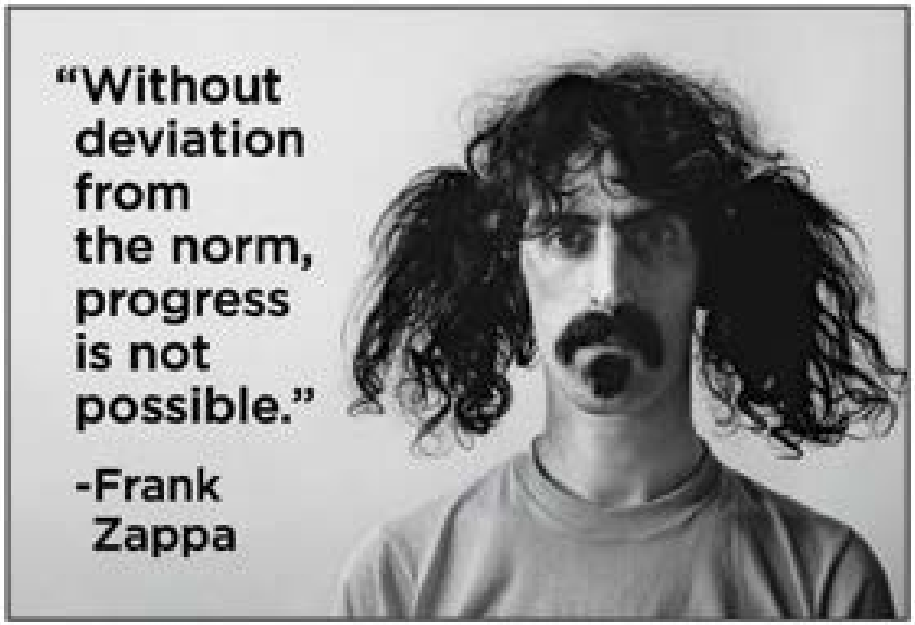
Adaption of treatment timing

Assisted migration: species

Thinning Thinning Thinning Thinning Thinning

Danke !!

Questions and Comments?



Acknowledgement: Colleagues and students for inspirational readings, discussions, and feedback.