Charting assisted migration as a climate change adaptation strategy

Mary I. Williams and R. Kasten Dumroese

Michigan Technological University and
USDA FS, RMRS, Grassland, Shrubland, and Desert Ecosystem Research Program
Moscow, ID

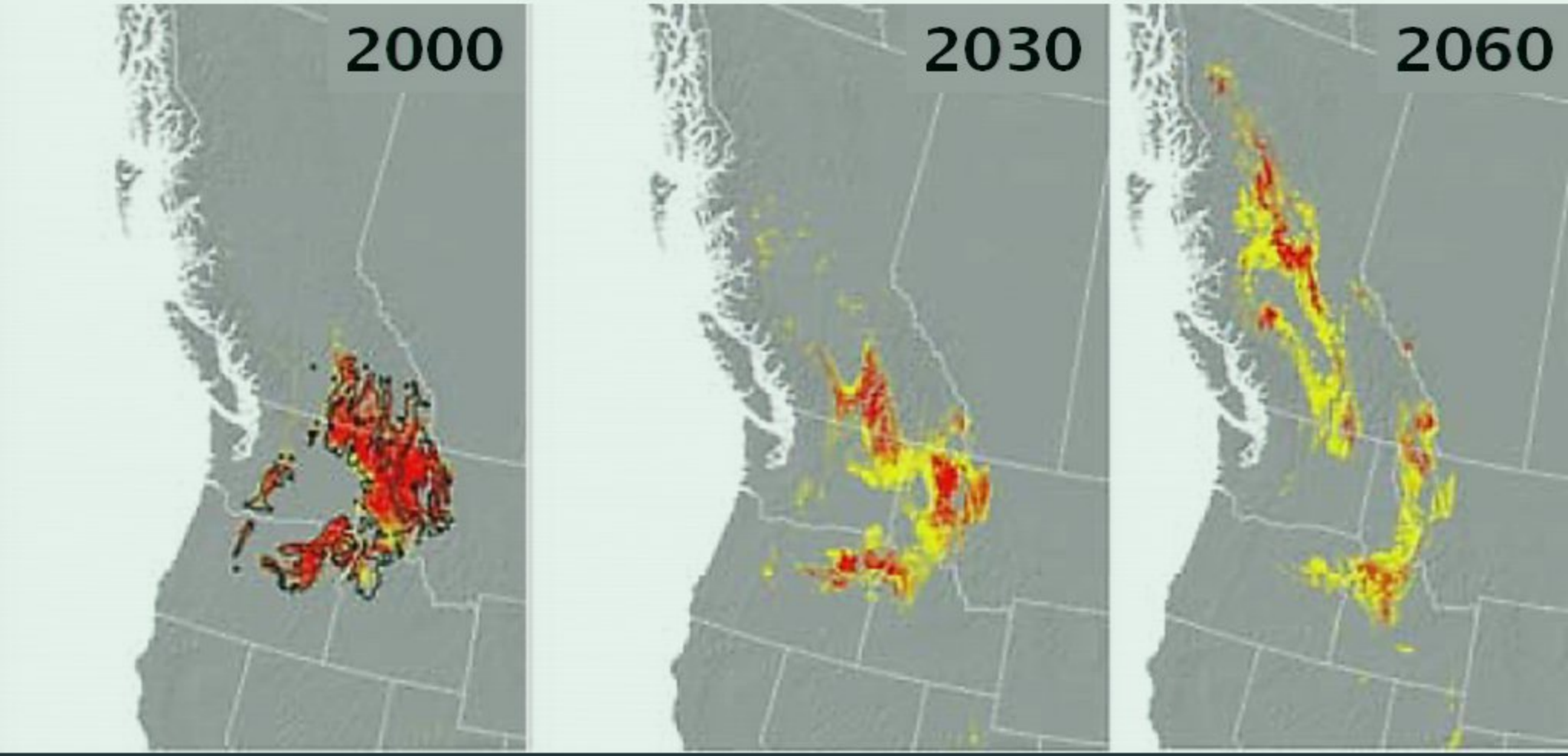
Concept to Implementation

1. Adaptation and Climate Change
2. Assisted Migration
3. Decision Making
4. Implementation
5. Limitations
6. Research Needs
7. Summary

Adaptation and Climate Change

If predictions are correct, plants will need to adapt or move to avoid maladaptation

Western Larch Current and Projected Distribution



Rehfeldt, G. E. and B. C. Jaquish. 2010. Ecological impacts and management strategies for western larch in the face of climate change. Mitig Adapt Strateg Glob Change 15: 283-306.

Climate change effects on forests may not be gradual:
Mountain Pine Beetle Outbreaks

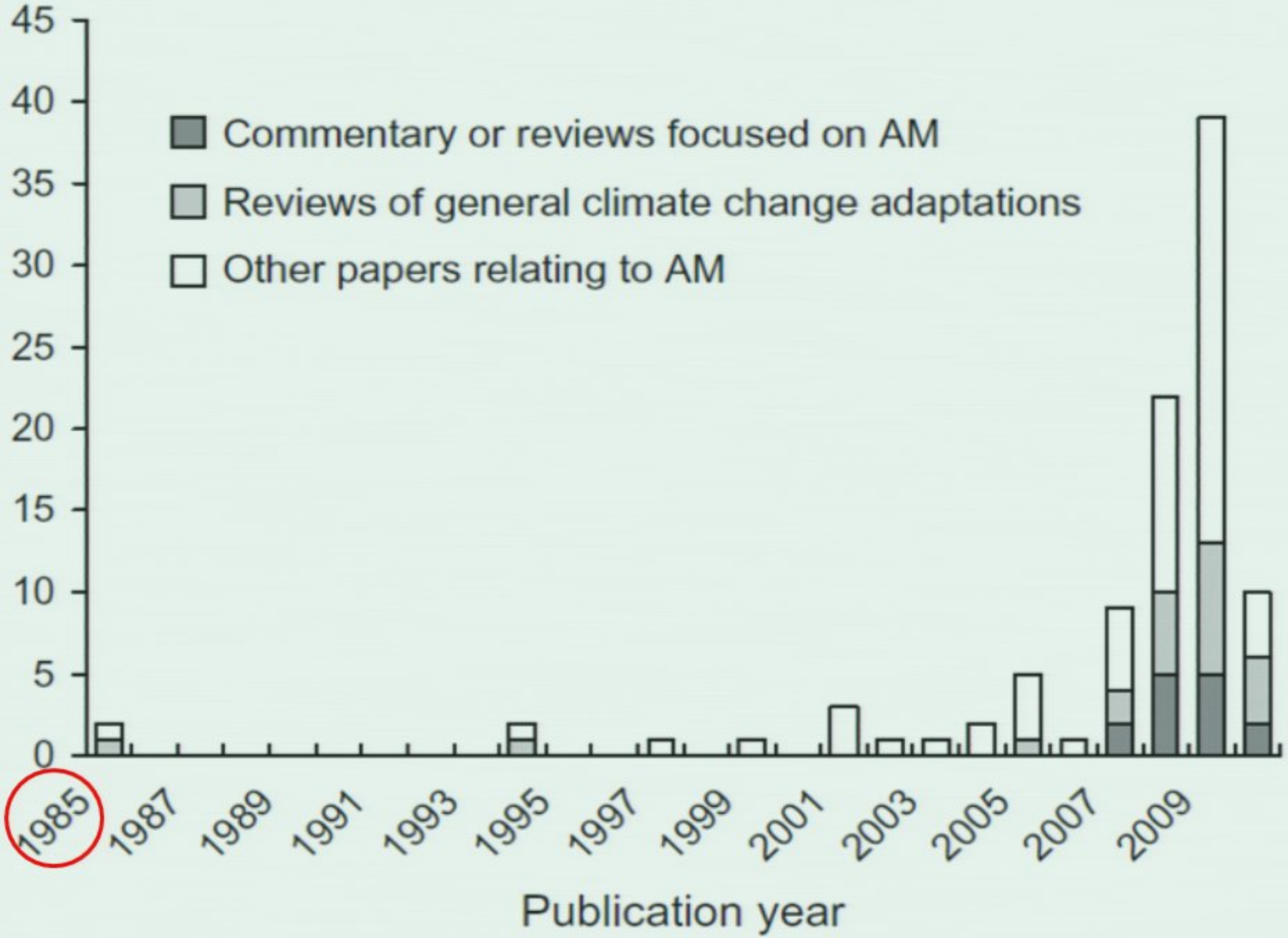
Many plants will not be able to move fast enough without human assistance

Assisted Migration

Human-assisted movement of species in response to climate change

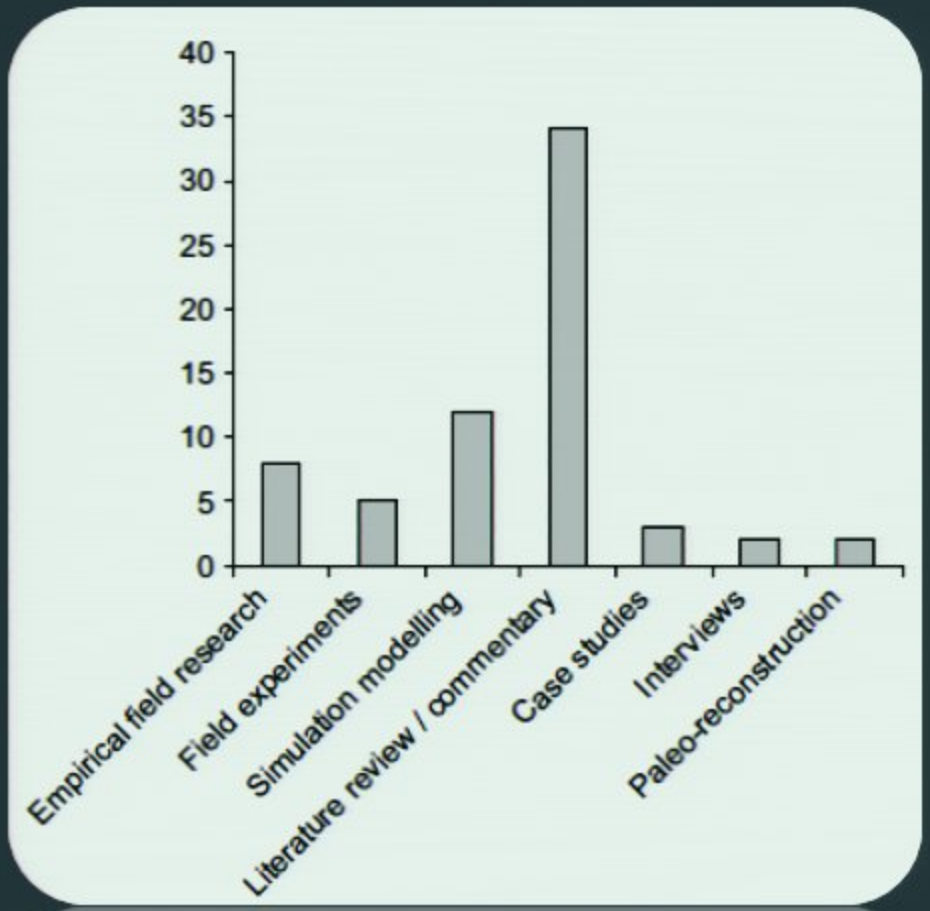
(Ste-Marie et al. 2011)

- Assisted colonization –
  - purposeful movement and establishment of a species in response to climate change (Hunter 2007)
- Managed relocation –
  - intentional movement of biological units to locations outside their historical distribution for the purpose of maintaining ecosystem services as an adaptation strategy for climate change (Richardson et al. 2009)

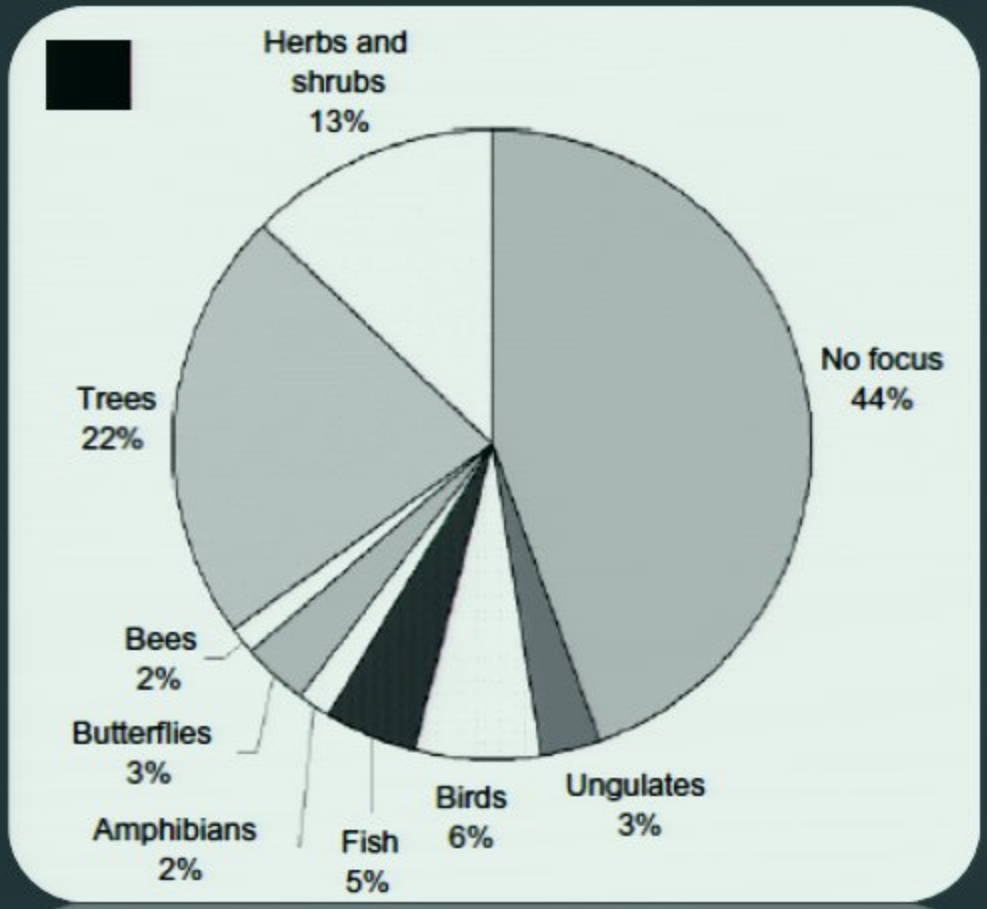


Hewitt et al. 2011. Taking stock of the assisted migration debate. Biological Conservation 144: 2560-2572

Study Methods



Groups



Hewitt et al. 2011. Taking stock of the assisted migration debate. Biological Conservation 144: 2560-2572

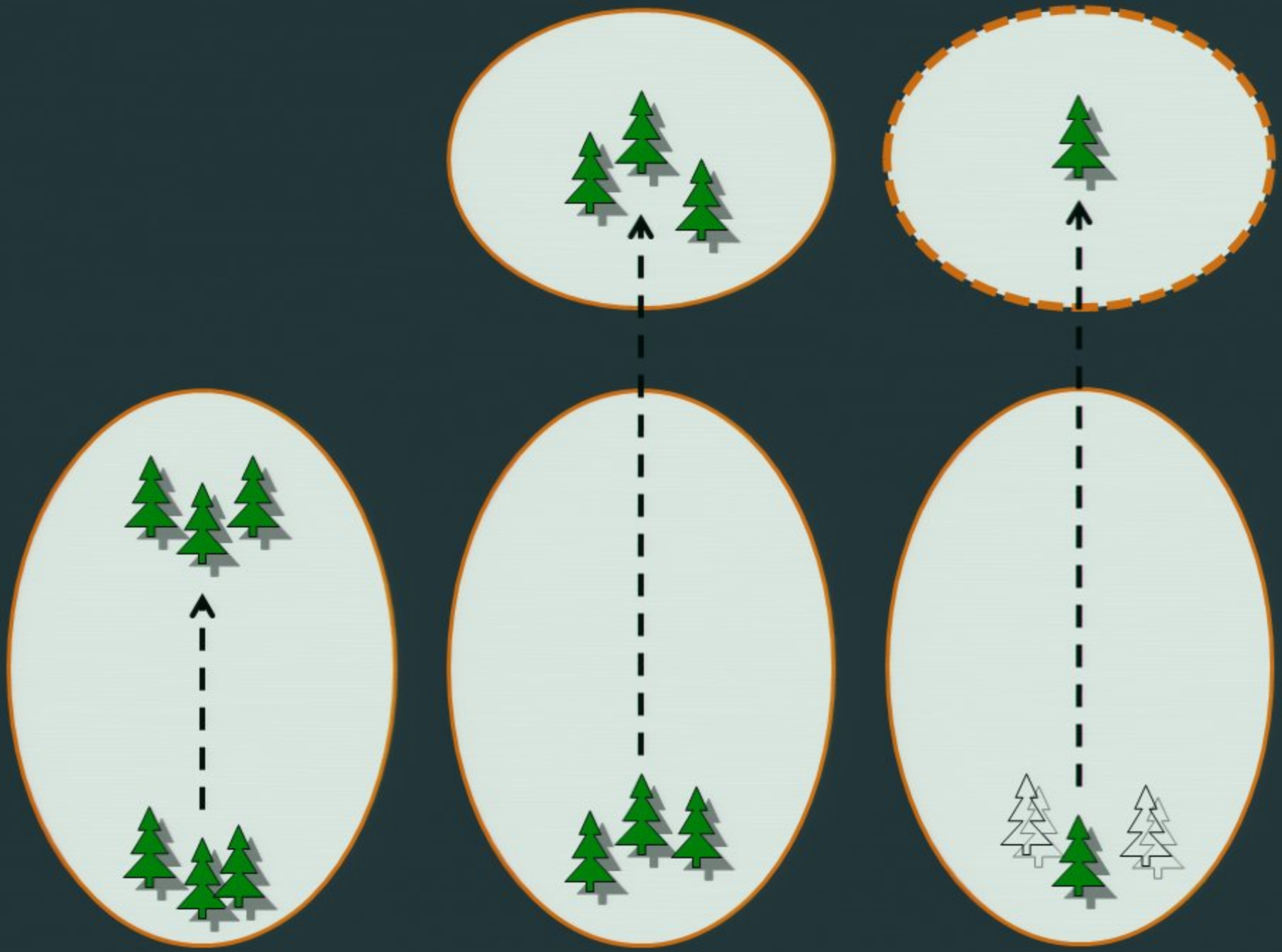
Prevent Species Extinction

Torreya taxifolia

Economic Goods

Ecosystem Services

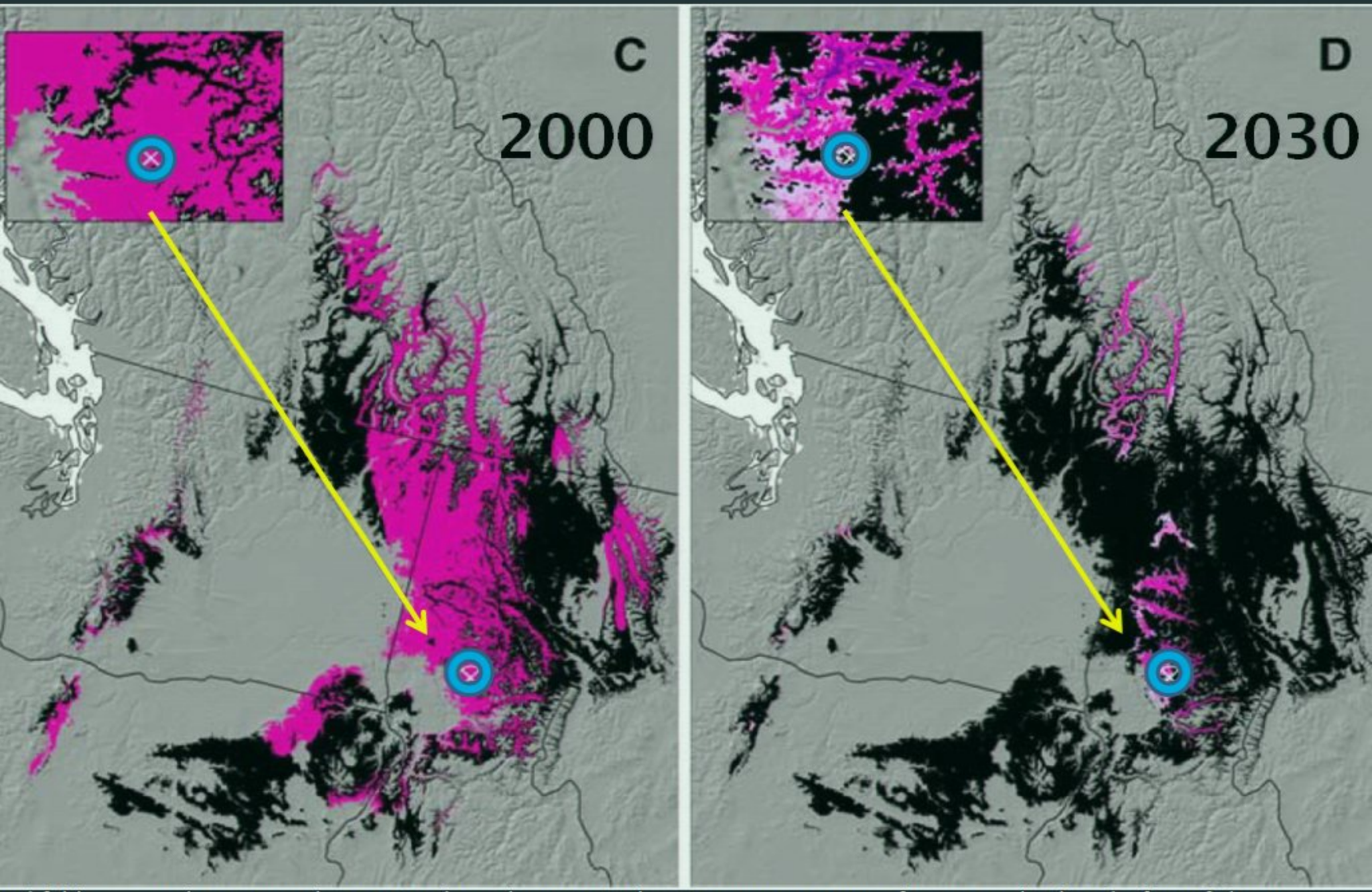
Foundation		
Soil & Site Stability	Hydrologic Function	Biotic Integrity


Assisted Population Migration
Assisted Range Expansion
Assisted Species Migration

Ecological and Economic Risks

- Costs increase with migration distance
- Establishment failure
- Effect on donor ecosystem
  - Removal of genetic resources
  - Loss of function or structure
- Effect on receiving ecosystem
  - Invasiveness
  - Genetics

Western Larch Seed Sources



Rehfeldt, G. E. and B. C. Jaquish. 2010. Ecological impacts and management strategies for western larch in the face of climate change. Mitig Adapt Strateg Glob Change 15: 283-306.

"Conservation plans should reflect knowledge of climatic effects as soon as it becomes available."

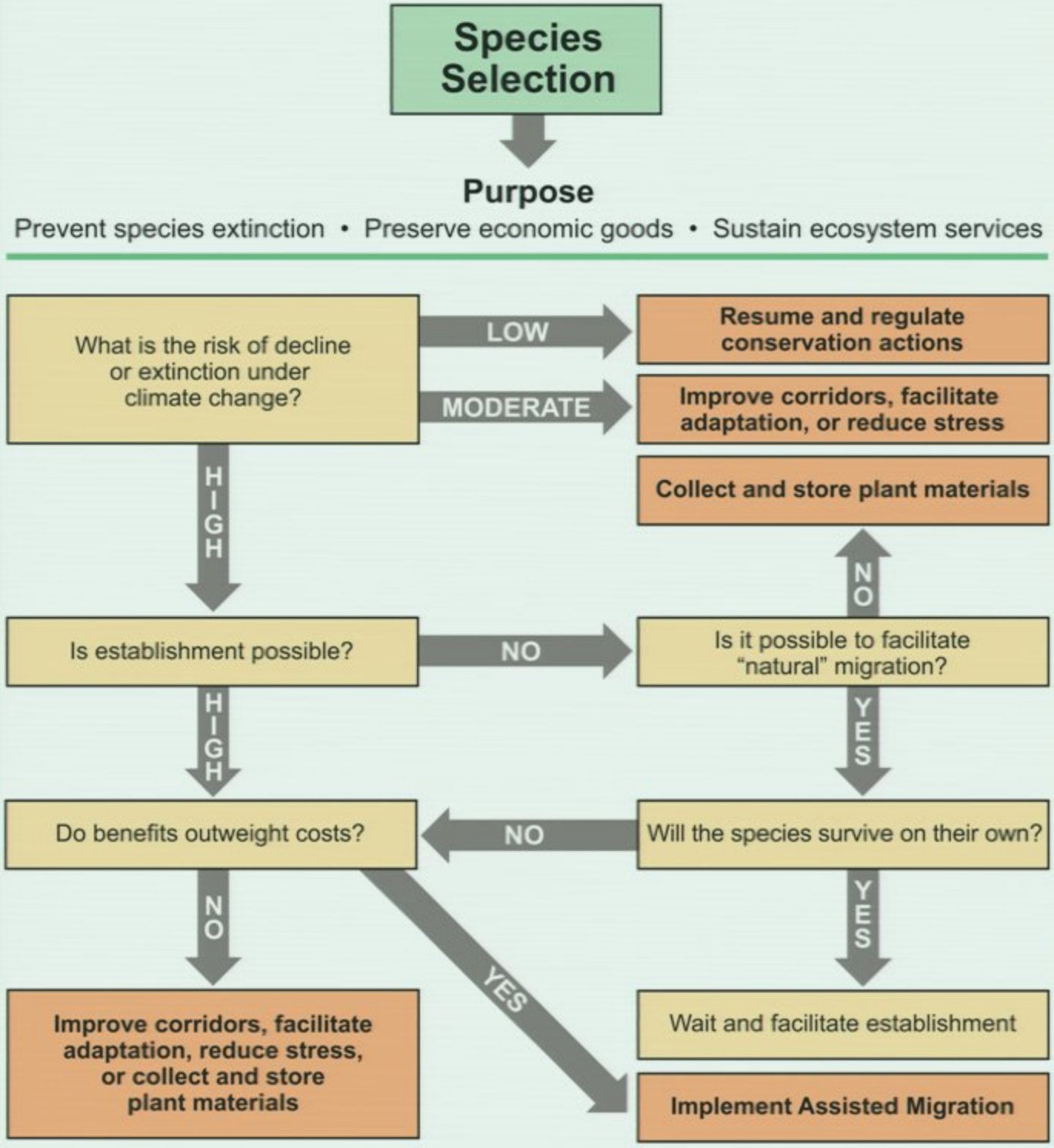
Peters and Darling 1985

Awareness of climate change and assisted migration has been around for more than 30 years

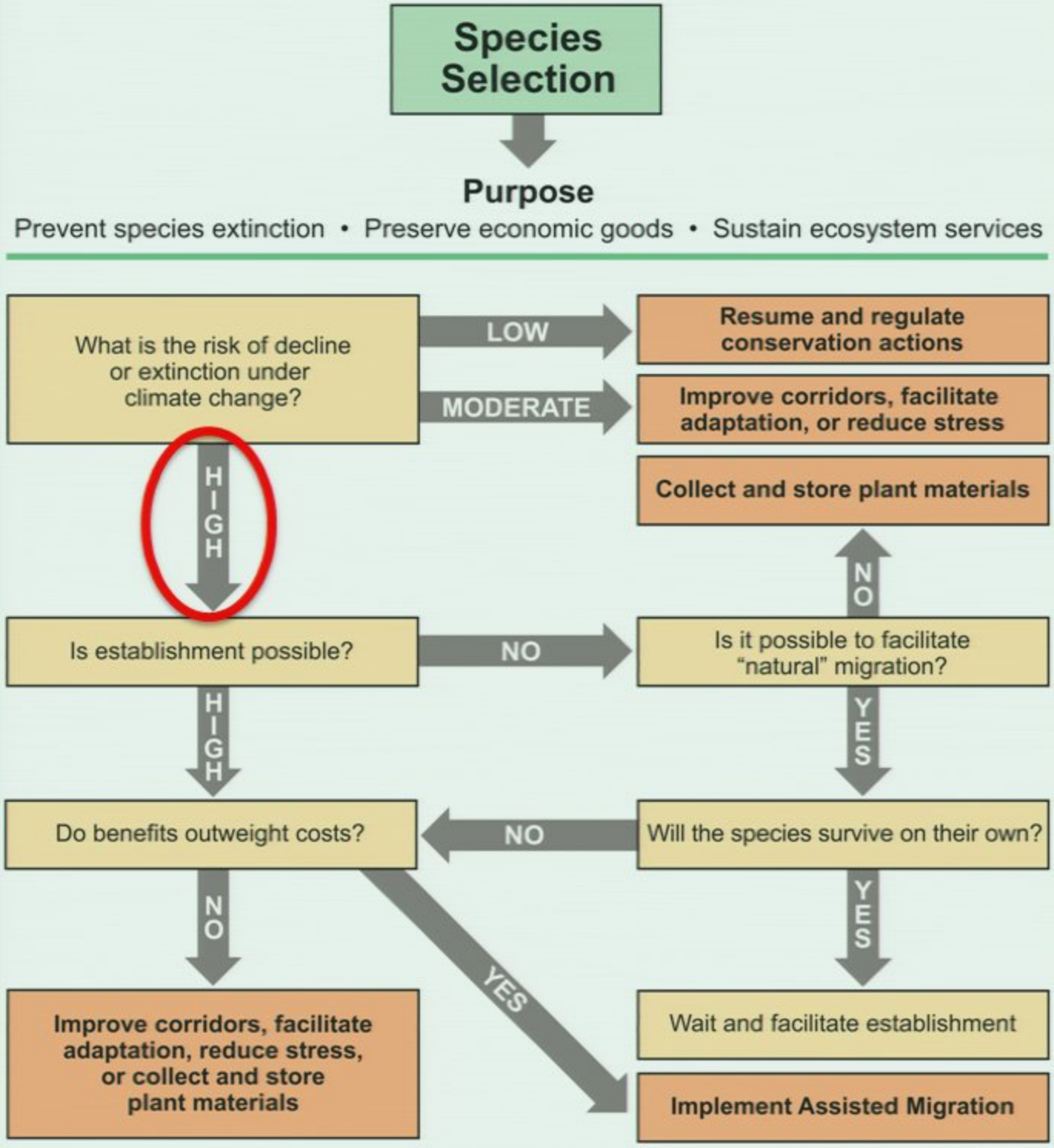
Decision Making

- Forecast climate change impacts
- Use previous reintroductions
- Implement experiments
- Use historical records

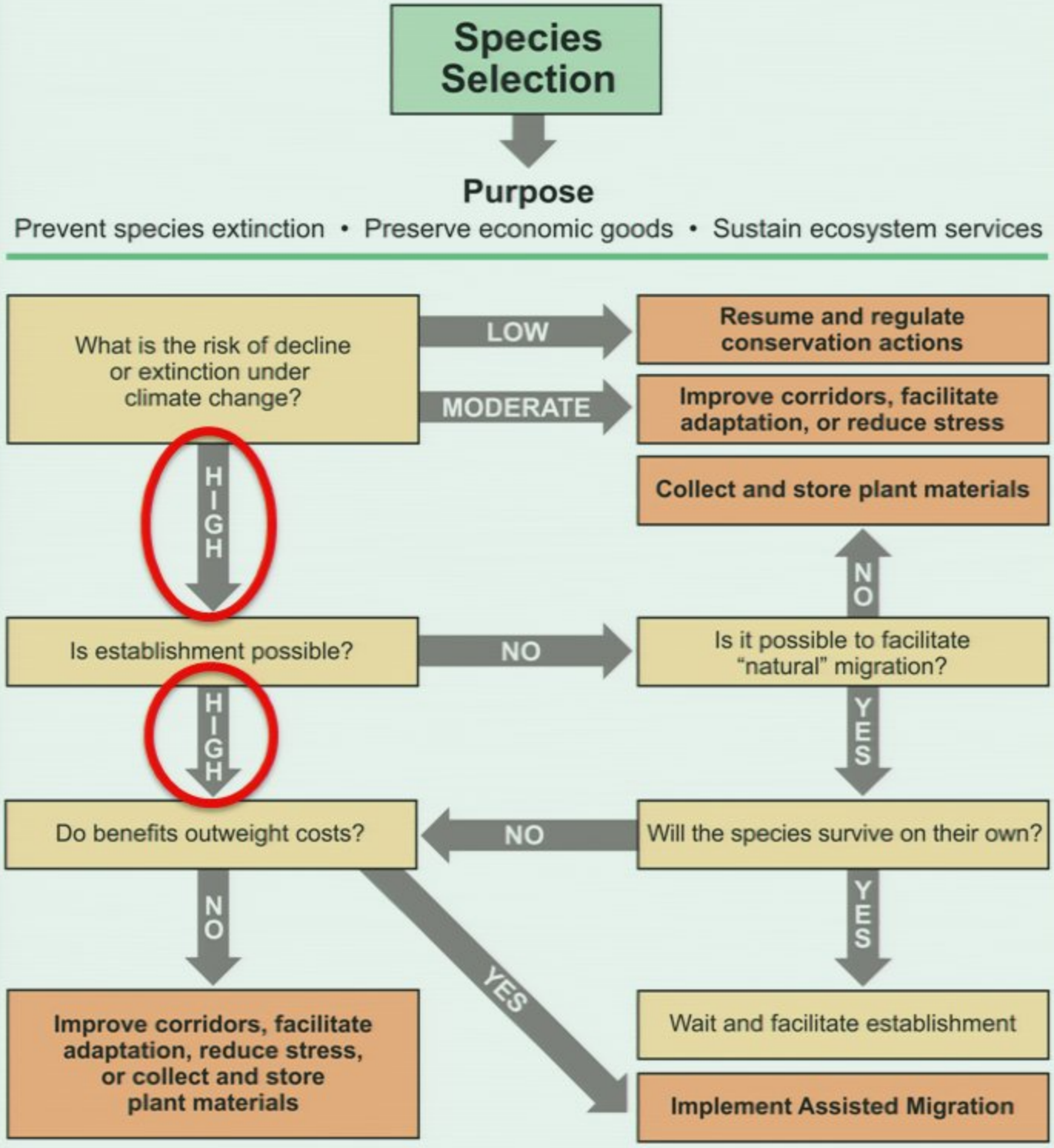
Lawler, J. J. and J. D. Olden. 2011. Reframing the debate over assisted colonization. Frontiers in Ecology and Environment 9: 569-574.



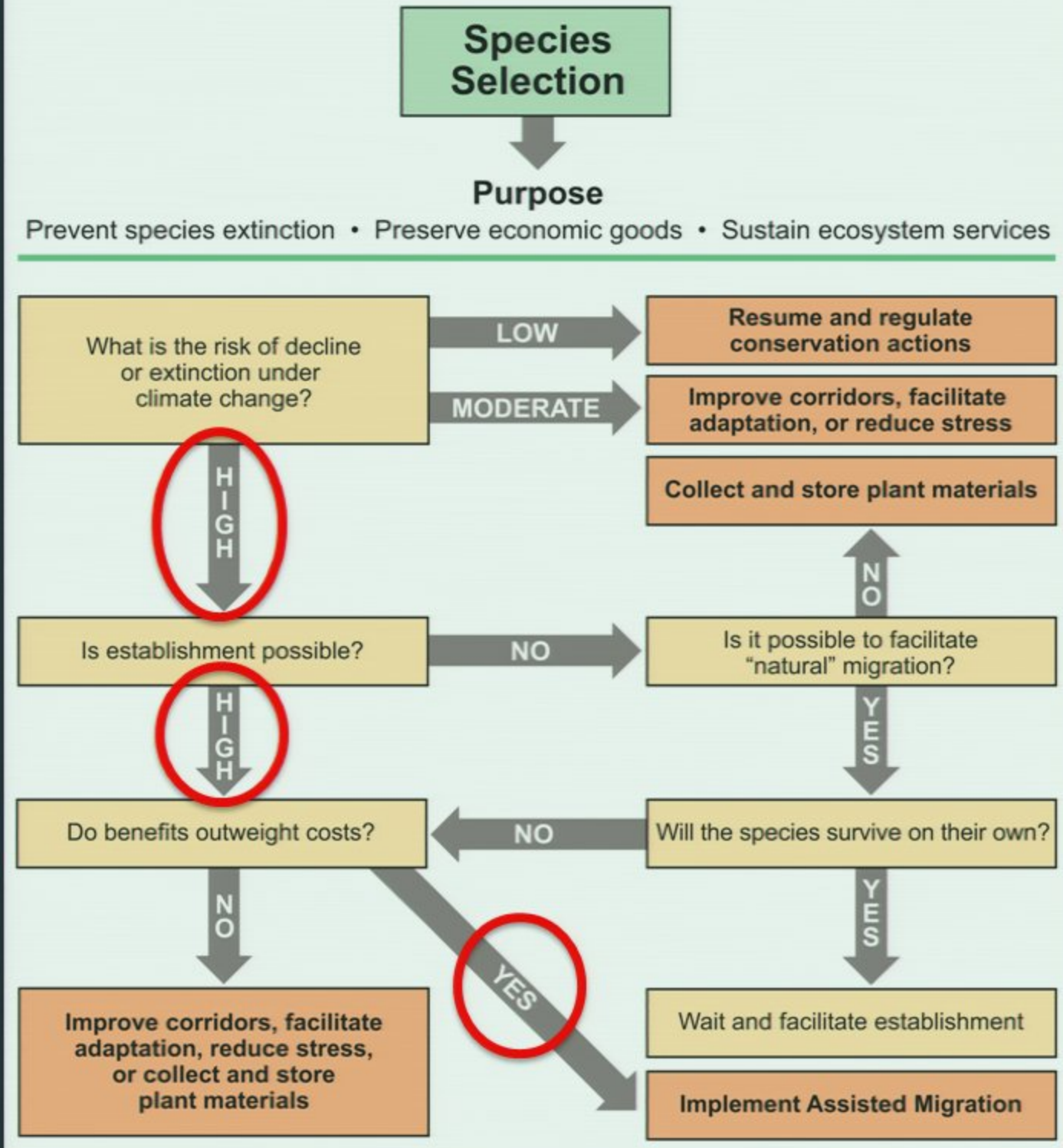
Adapted from Hoegh-Guldberg et al. 2008



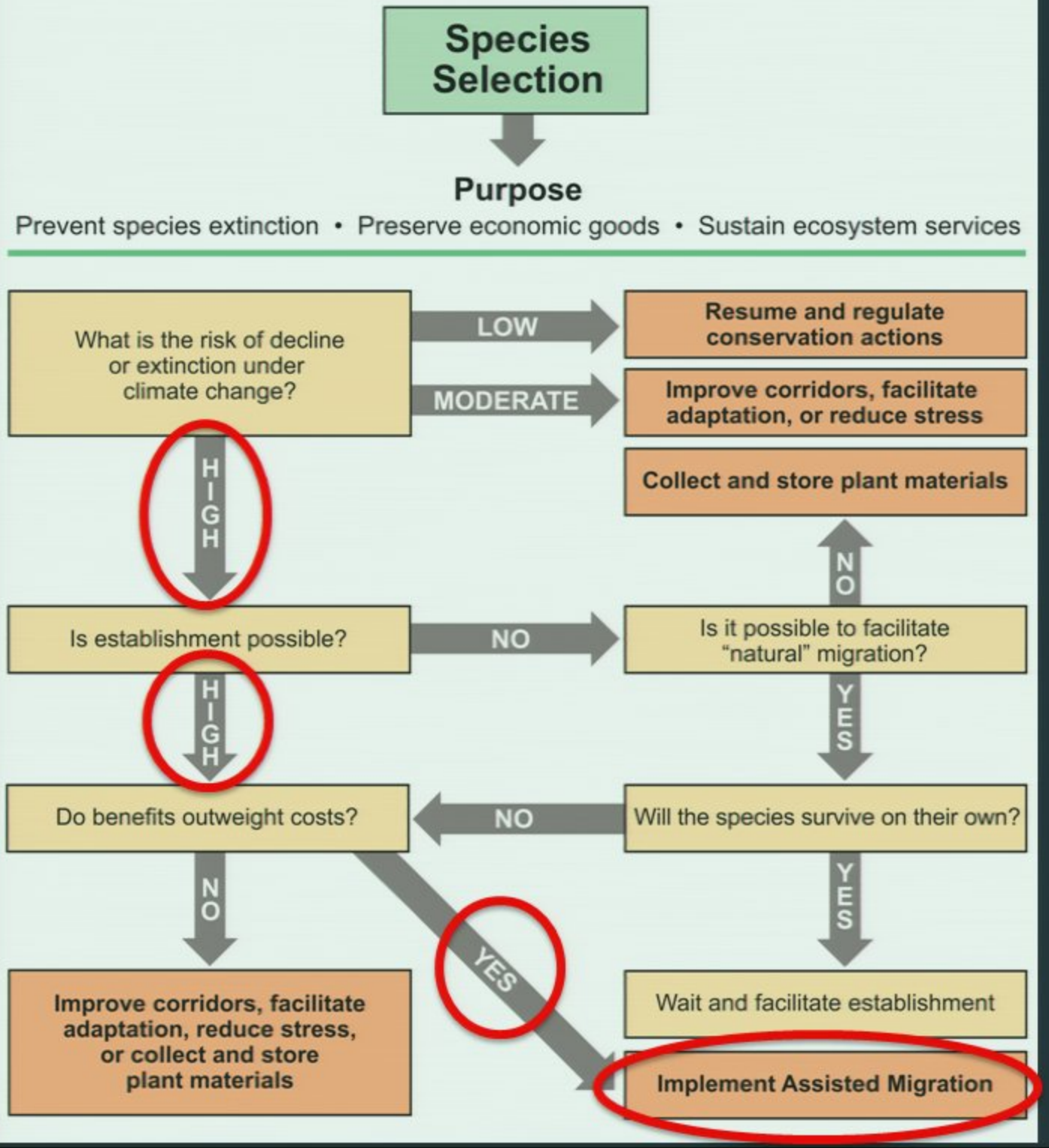
Adapted from Hoegh-Guldberg et al. 2008



Adapted from Hoegh-Guldberg et al. 2008



Adapted from Hoegh-Guldberg et al. 2008



Adapted from Hoegh-Guldberg et al. 2008


Migration Distance
Seed Collection
Propagation
Site Selection
Outplanting
Maintenance and Monitoring
Species or Population

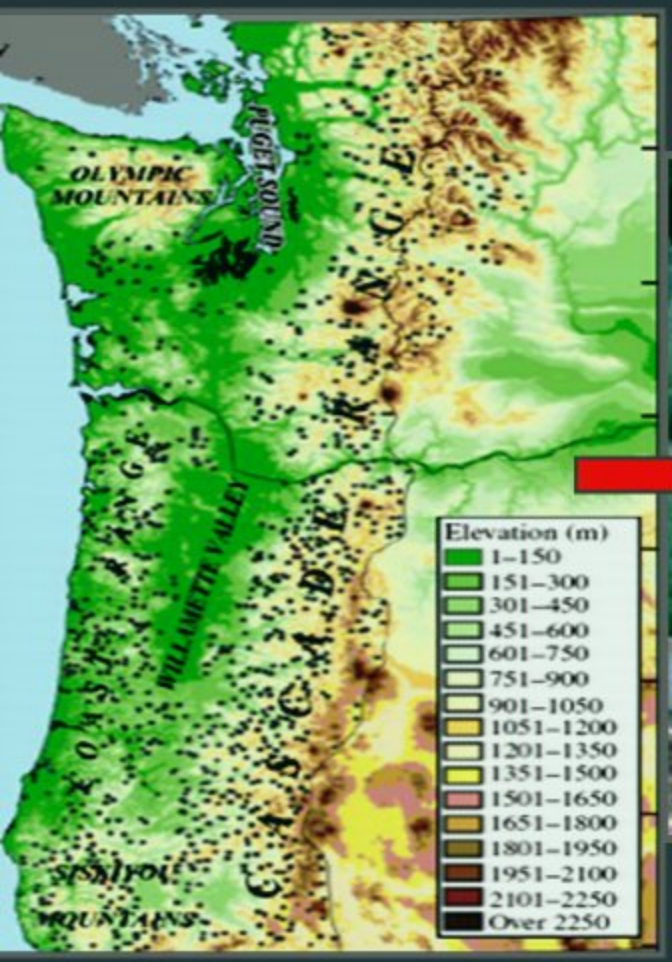
Implementation

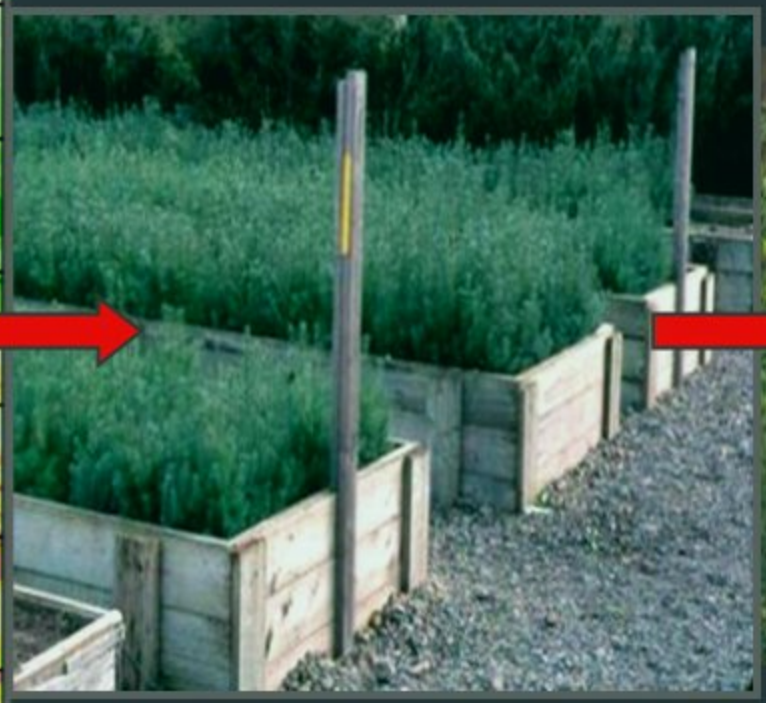
1. Select species
   - Commercial or noncommercial
2. Determine suitable distance
   - Seed transfer guidelines
   - Seed transfer zones
   - Climate models and predicted range

Implementation - Determine Suitable Distance

- Seed transfer guidelines:
  - Guidelines to restrict movement to avoid maladaptation
- Seed transfer zone:
  - Area where a species can be transferred with little risk of maladaptation

Guideline and Zone Development



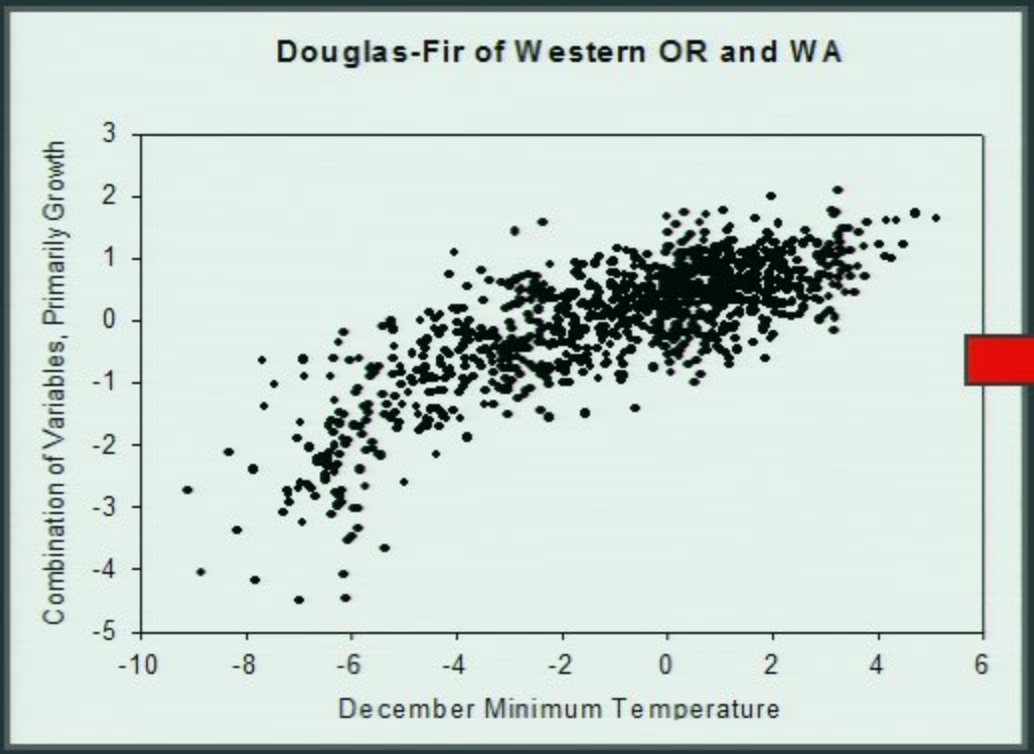


1. Collect seeds

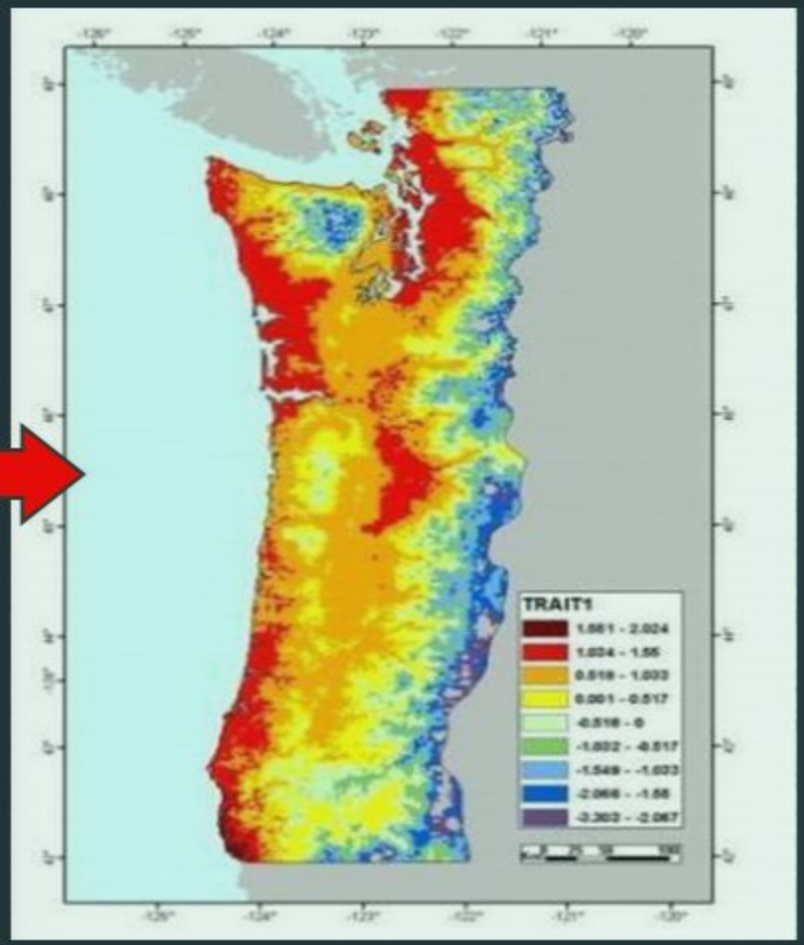
2. Grow in a common garden

3. Measure adaptive traits

Guideline and Zone Development



4. Model traits and source environment

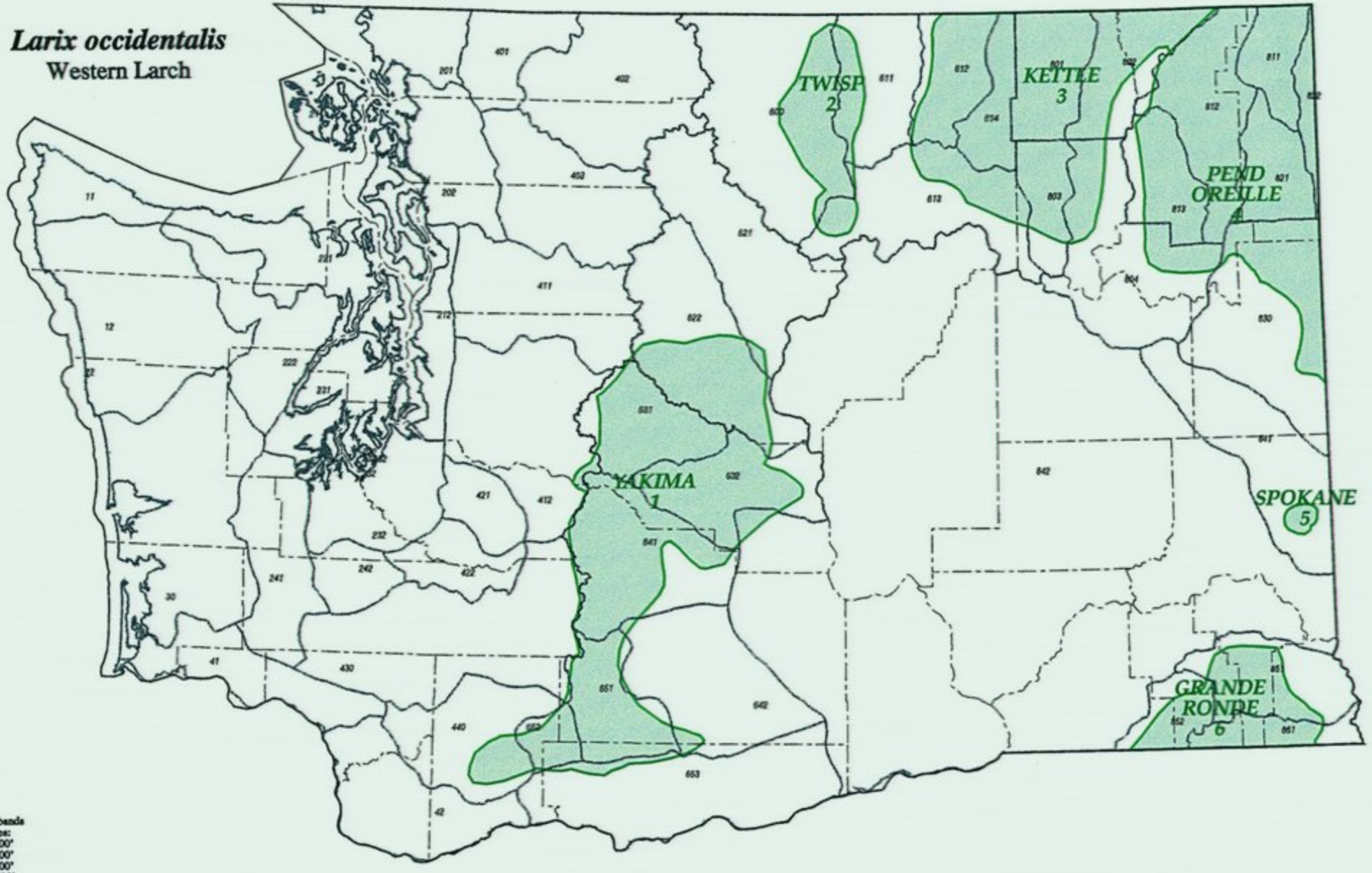


5. Map transfer zones in GIS

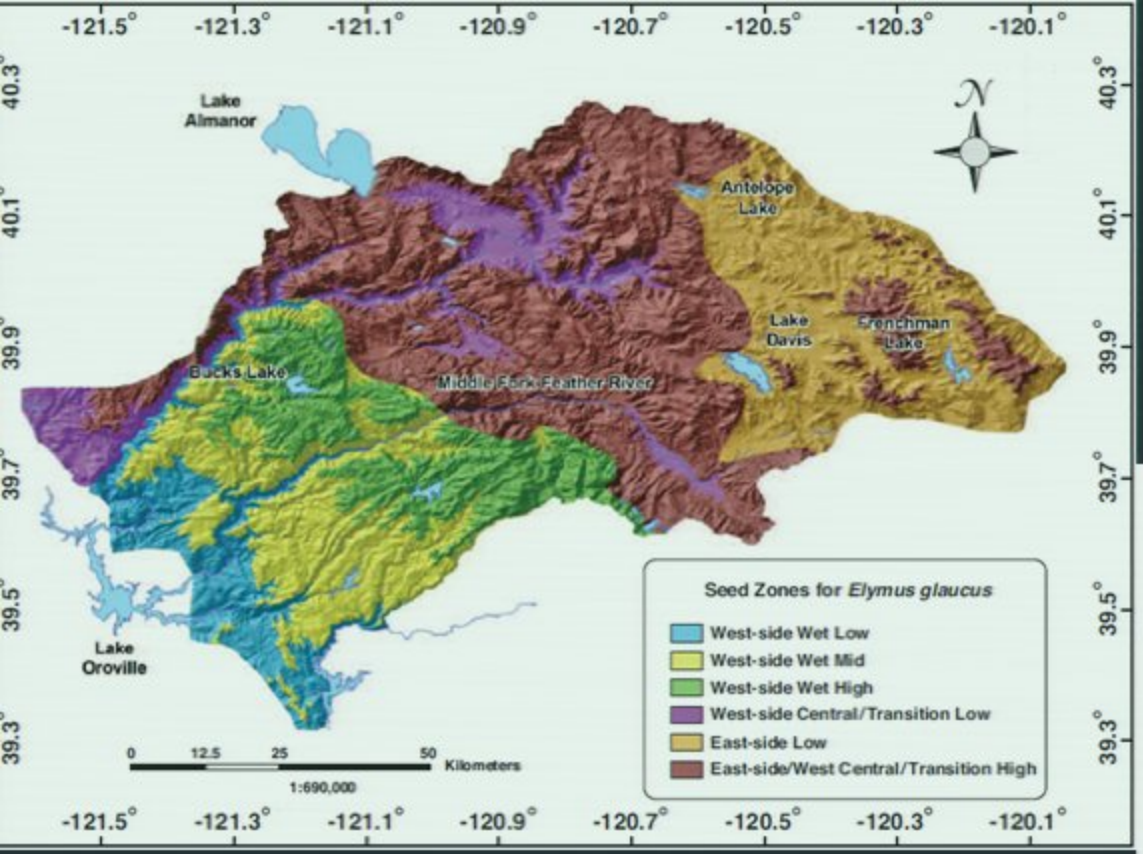
From Kilkenny et al. 2012

Three Situations

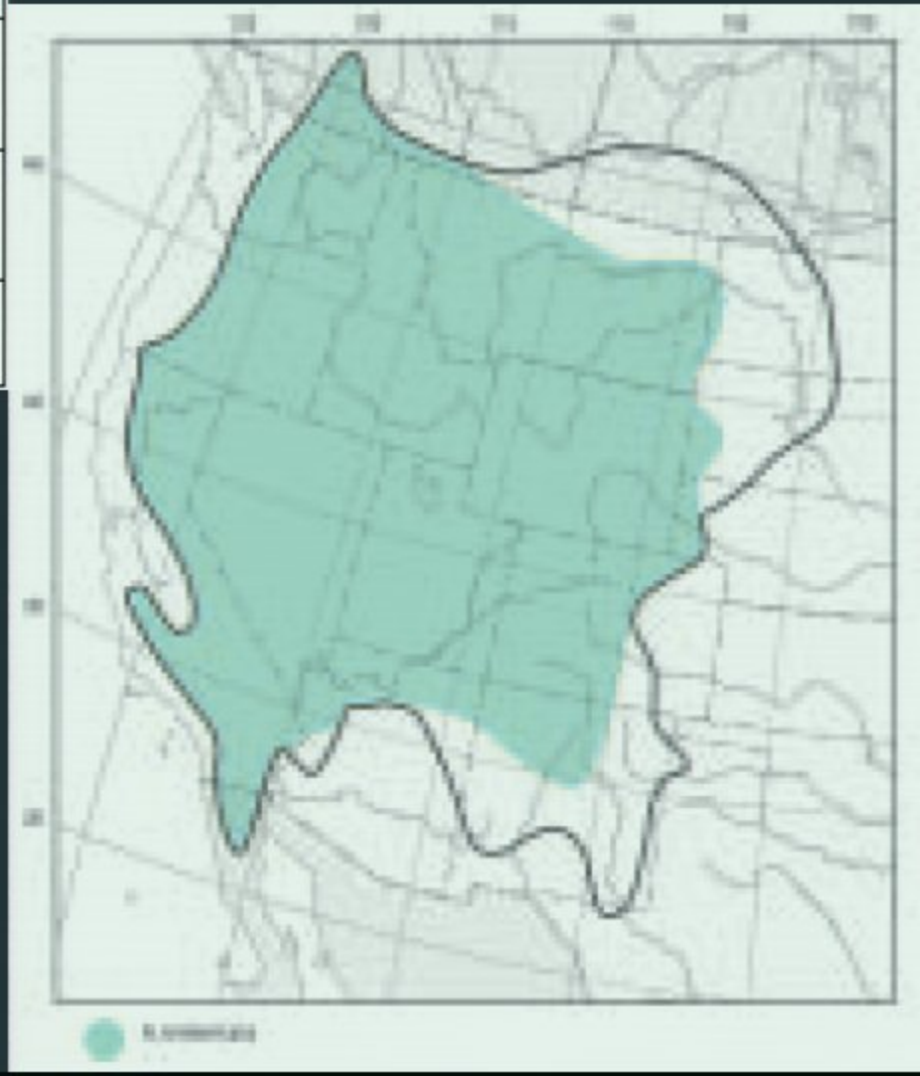
1. Commercial species
   - Known transfer guidelines
2. Conservation species
   - Known transfer guidelines
3. Conservation species
   - *Unknown* transfer guidelines


Larix occidentalis
Western Larch
TWISP
2
KETTLE
3
PEND
OREILLE
YAKIMA
1
SPOKANE
5
GRANDE
RONDE
6
Elevation bands
for all zones:
2000' - 3200'
3200' - 4400'
4400' - 5600'
>5600'

Provisional Seed Transfer Zones

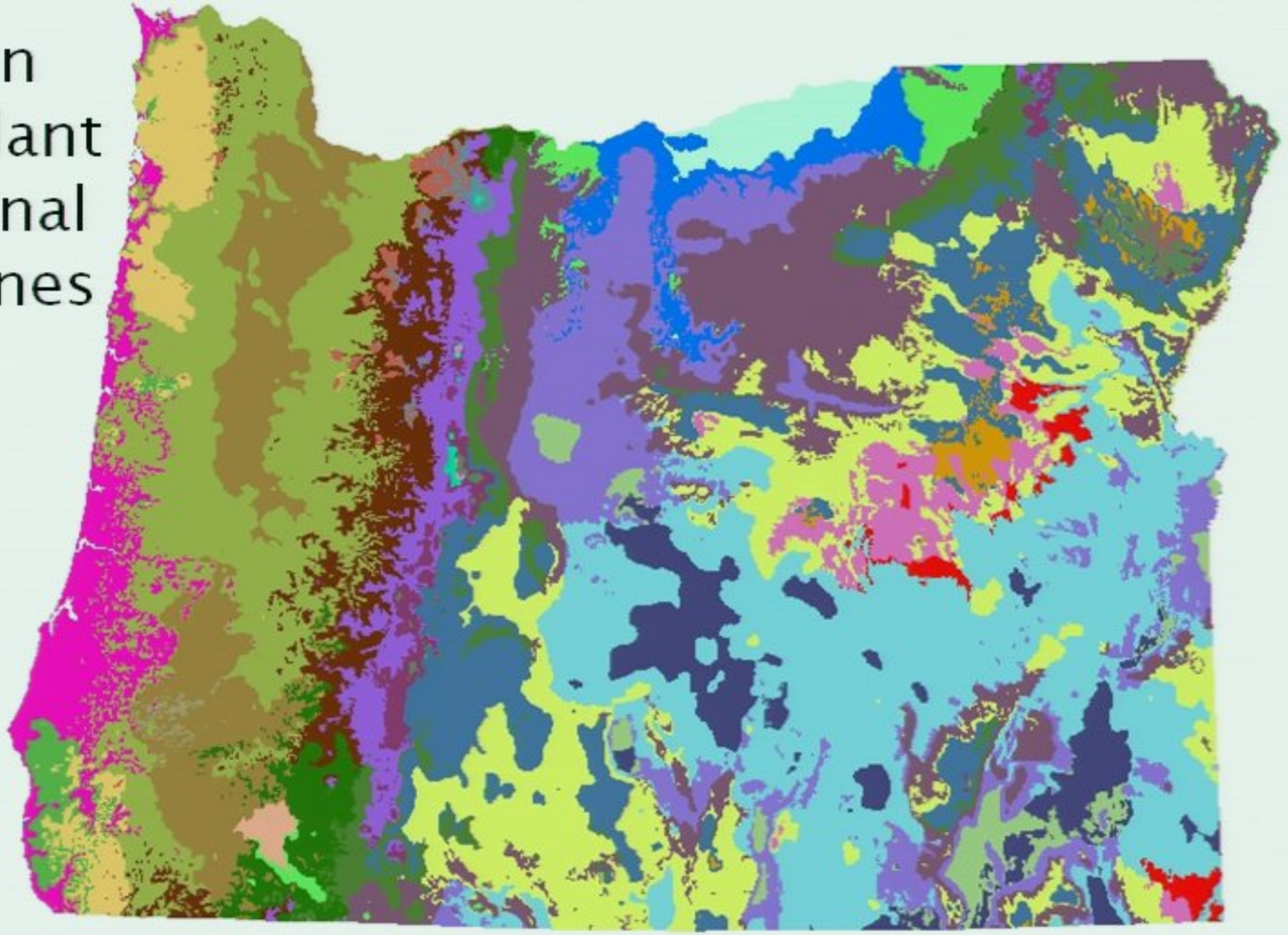


Blue wildrye (Kitzmiller and Hanson 2011)



Sagebrush (Mahalovich and McArthur 2004)

Oregon Native Plant Provisional Seed Zones



Legend

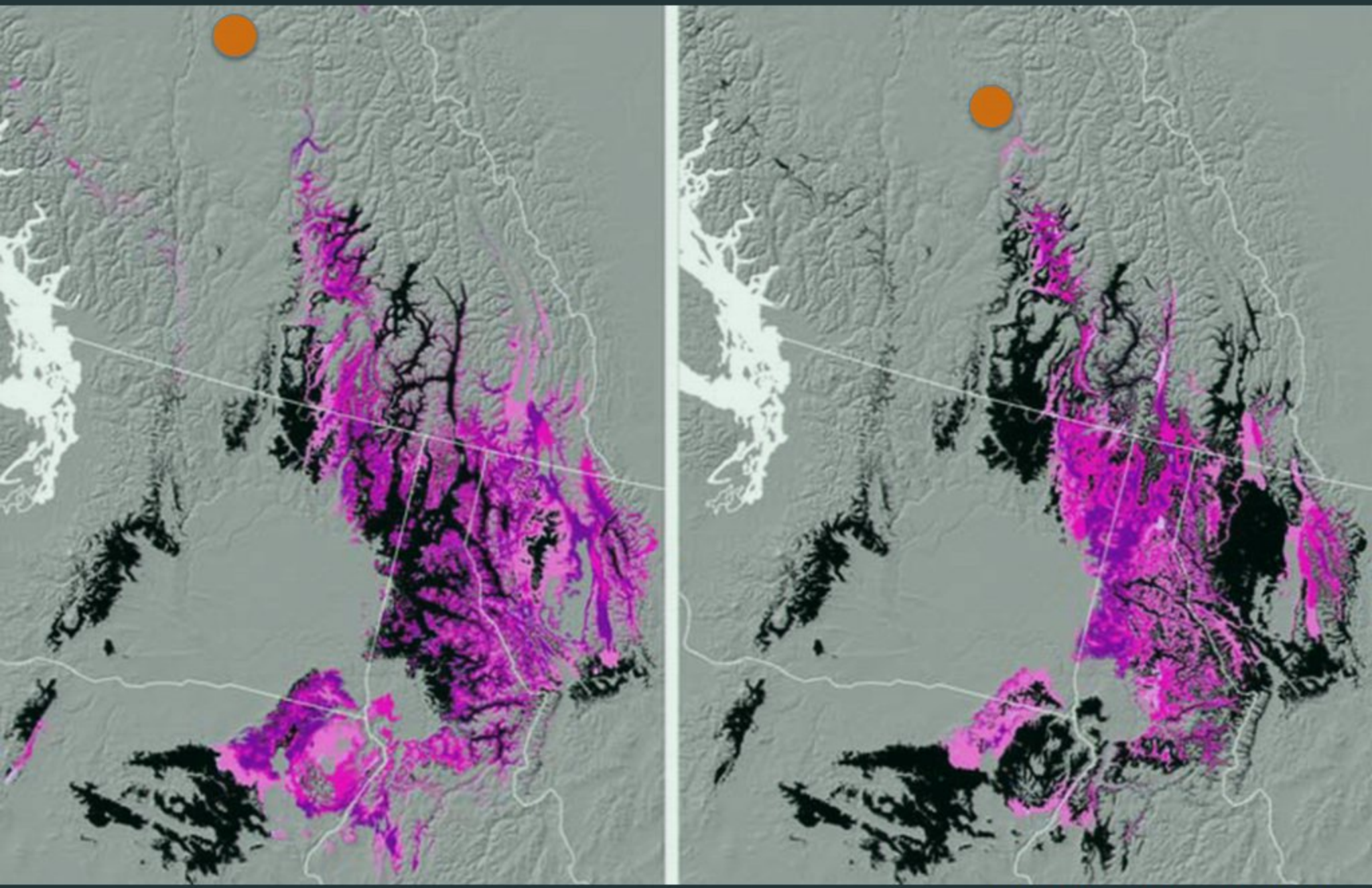
Min Temp Seed Zone

- 10 to 15 / 10 - 14 in.
- 10 to 15 / 14 - 24 in.
- 10 to 15 / 24 - 48 in.
- 10 to 15 / 48 - 100 in.
- 10 to 15 / < 10 in.
- 10 to 15 / > 100 in.
- 15 to 20 / 10 - 14 in.
- 15 to 20 / 14 - 24 in.
- 15 to 20 / 24 - 48 in.
- 15 to 20 / 48 - 100 in.
- 15 to 20 / < 10 in.
- 15 to 20 / > 100 in.
- 20 to 25 / 10 - 14 in.
- 20 to 25 / 14 - 24 in.
- 20 to 25 / 24 - 48 in.
- 20 to 25 / 48 - 100 in.
- 20 to 25 / < 10 in.
- 20 to 25 / > 100 in.
- 25 to 30 / 10 - 14 in.
- 25 to 30 / 14 - 24 in.
- 25 to 30 / 24 - 48 in.
- 25 to 30 / 48 - 100 in.
- 25 to 30 / < 10 in.
- 25 to 30 / > 100 in.
- 30 to 35 / 14 - 24 in.
- 30 to 35 / 24 - 48 in.
- 30 to 35 / 48 - 100 in.
- 30 to 35 / > 100 in.
- 35 to 40 / 24 - 48 in.
- 35 to 40 / 48 - 100 in.
- 35 to 40 / > 100 in.
- 40 to 45 / 48 - 100 in
- 5 to 10 / 24 - 48 in.
- 5 to 10 / 48 - 100 in.
- 5 to 10 / > 100 in.

Internet Resources

- Climate Change Resource Center – geared to land managers
  - http://www.fs.fed.us/ccrc/
- Center for Forest Provenance Data – online database
  - http://cenforgen.forestry.oregonstate.edu/index.php
- Native Seed Network – ecoregions and plant materials
  - http://www.nativeseednetwork.org/
- Seedlot Selection Tool – match seed lots with planting sites
  - http://sst.forestry.oregonstate.edu/index.html
- Seed Zone Mapper – empirical and provisional zones
  - http://www.fs.fed.us/wwetac/threat_map/SeedZones_Intro.html

Western Larch Seed Sources for 2030



Rehfeldt and Jaquish 2010

Limitations

- Uncertainty
  - Future climate conditions
  - Establishment effects
- Species' biology and behavior
- Human element
- Current policies constrain decisions

Research Needs

- Seed zones and guidelines –
  - Current and projected, data warehouse
- Risk assessments –
  - Species, populations, ecosystems
- Adaptation studies
  - Assisted migration, landscape connectivity, ecosystem engineering
- Management actions –
  - Incorporation of climate change information
- Collaboration

Summary Charting

- Climate change and adaptation
- Limitations and research needs
- Management actions

Acknowledgements

- Marty Jurgensen (MTU)
- Tom Landis (Nursery Consultant)
- Jim Marin (Marin Graphic Services)
- Matt Horning, Randy Johnson, Francis Kilkenny, Jerry Rehfeldt, Nancy Shaw, Brad St. Clair, and Jeremy Pinto (USFS)

Mary Williams, PhD
Postdoc Research Ecologist
Michigan Tech/USFS
miwillia@mtu.edu

Kas Dumroese, PhD
Research Plant Physiologist
USFS RMRS, GSD
kdumroese@fs.fed.us

For more information, please visit the US Forest Service Reforestation, Nurseries & Genetics Resources website at **http://rngr.net**