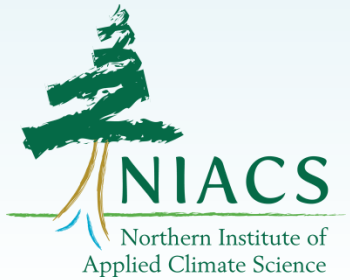
An Approach to Assessing Vulnerability of Forest Communities to Climate Change

Using Impact Models and Expert Elicitation

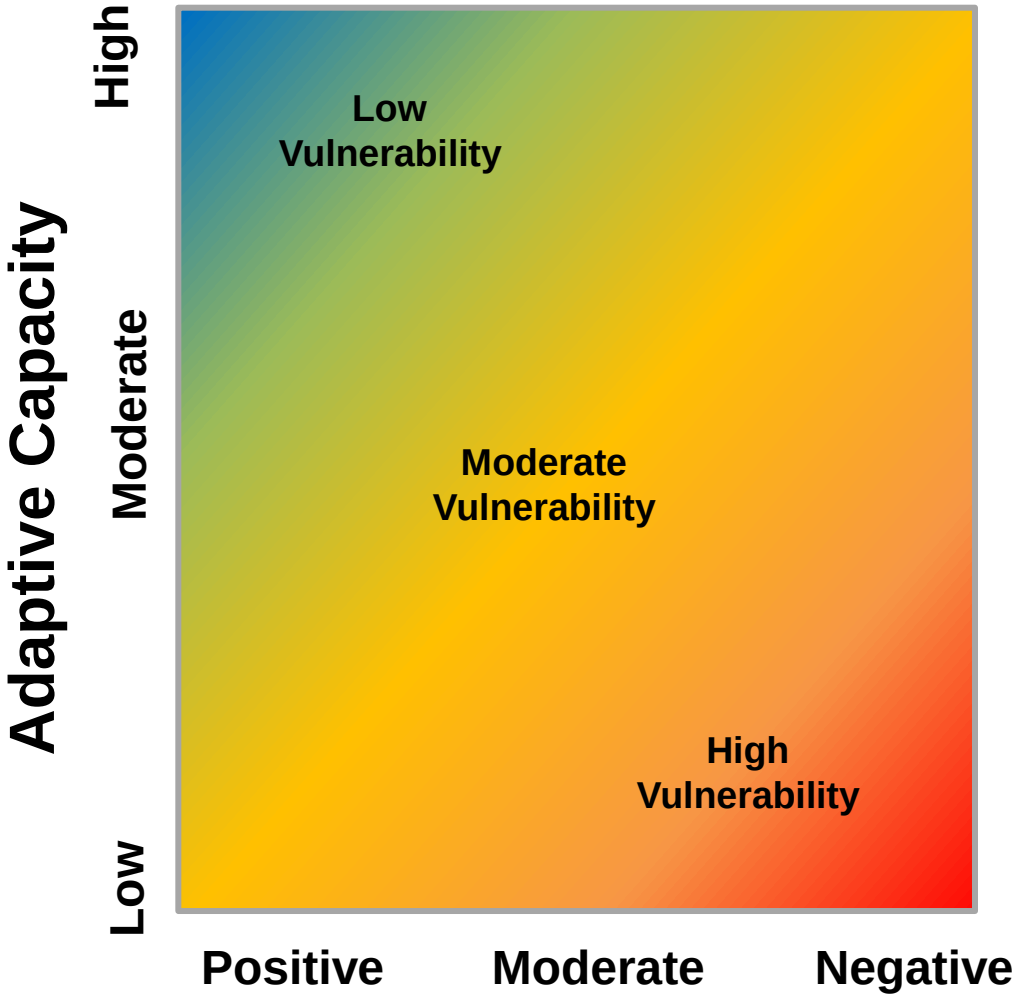
Leslie Brandt, Chris Swanston, Patricia Butler, Stephen Handler, Maria Janowiak



Michigan Tech

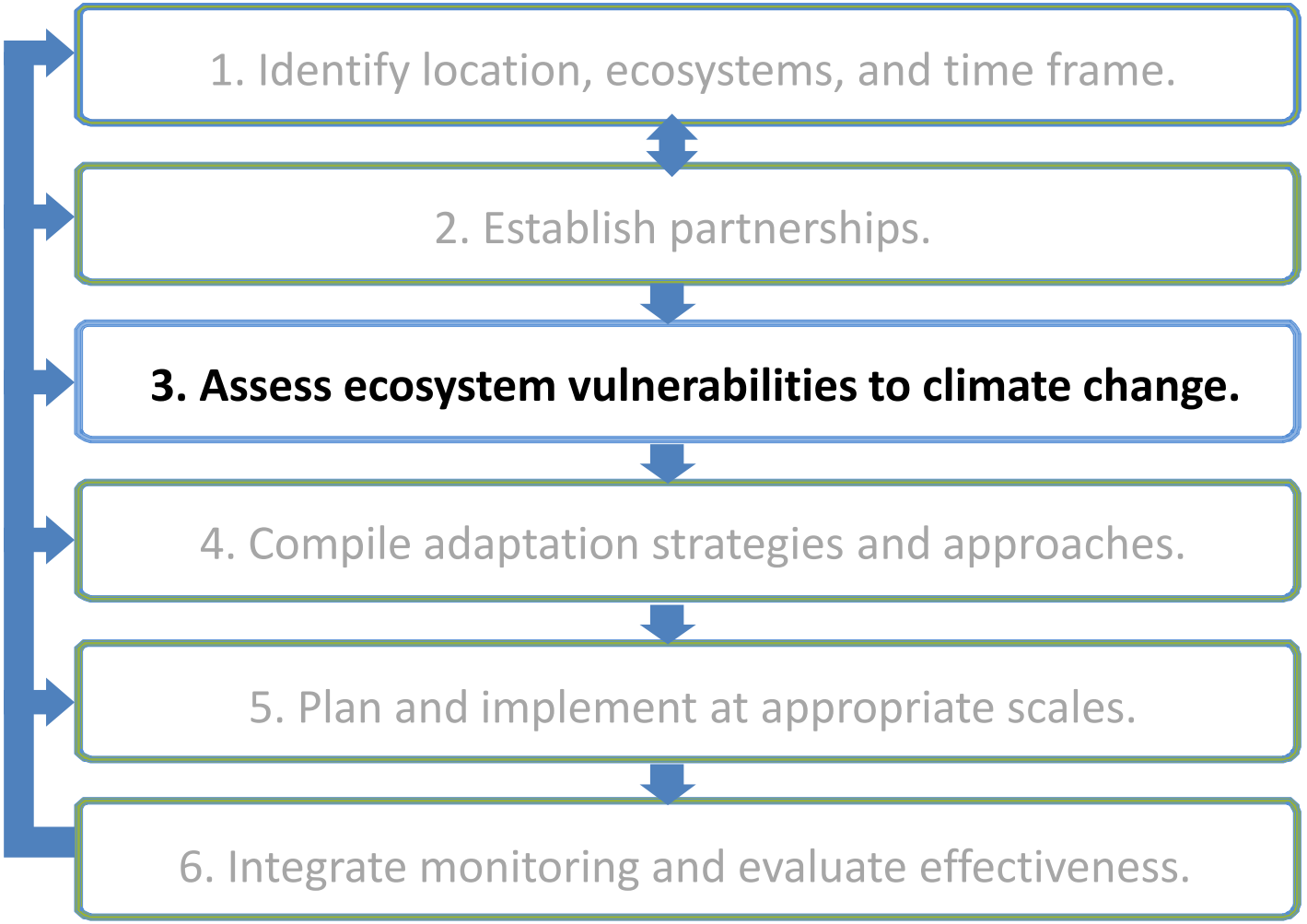
Climate change vulnerability?

Vulnerability: Conceptual Framework



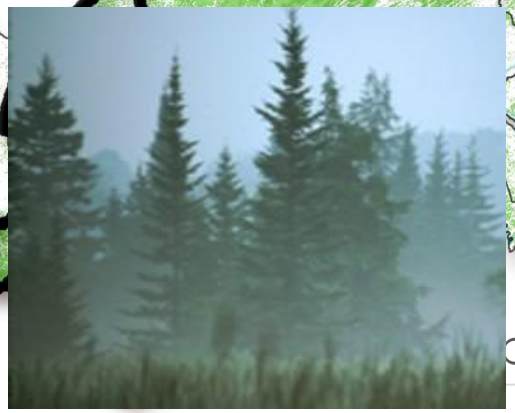
modified from *Swanston and Janowiak 2012*

Climate Change Response Framework



Assessment Areas

Northwoods



Central Hardwoods

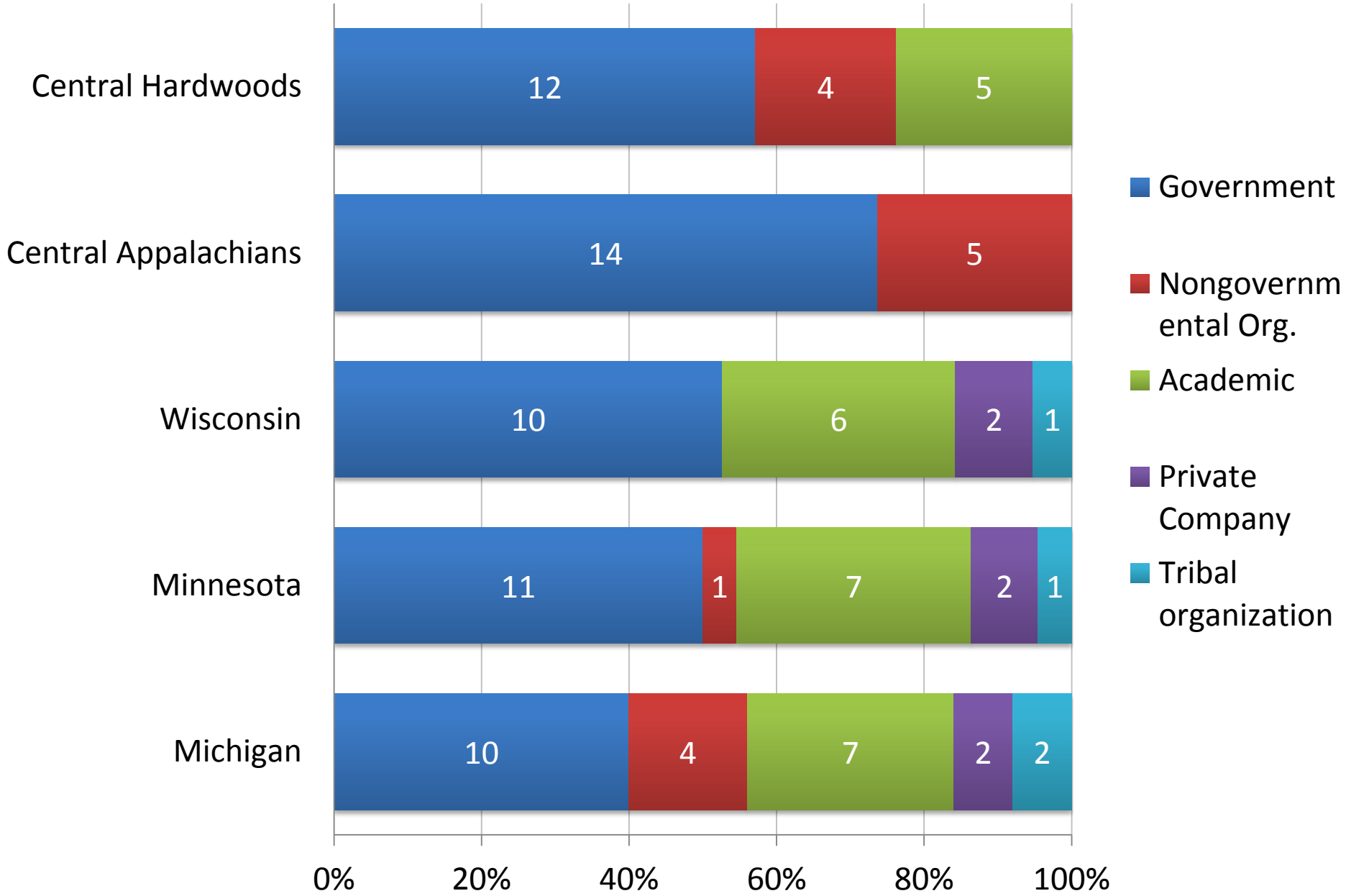
ppalachians

Questions

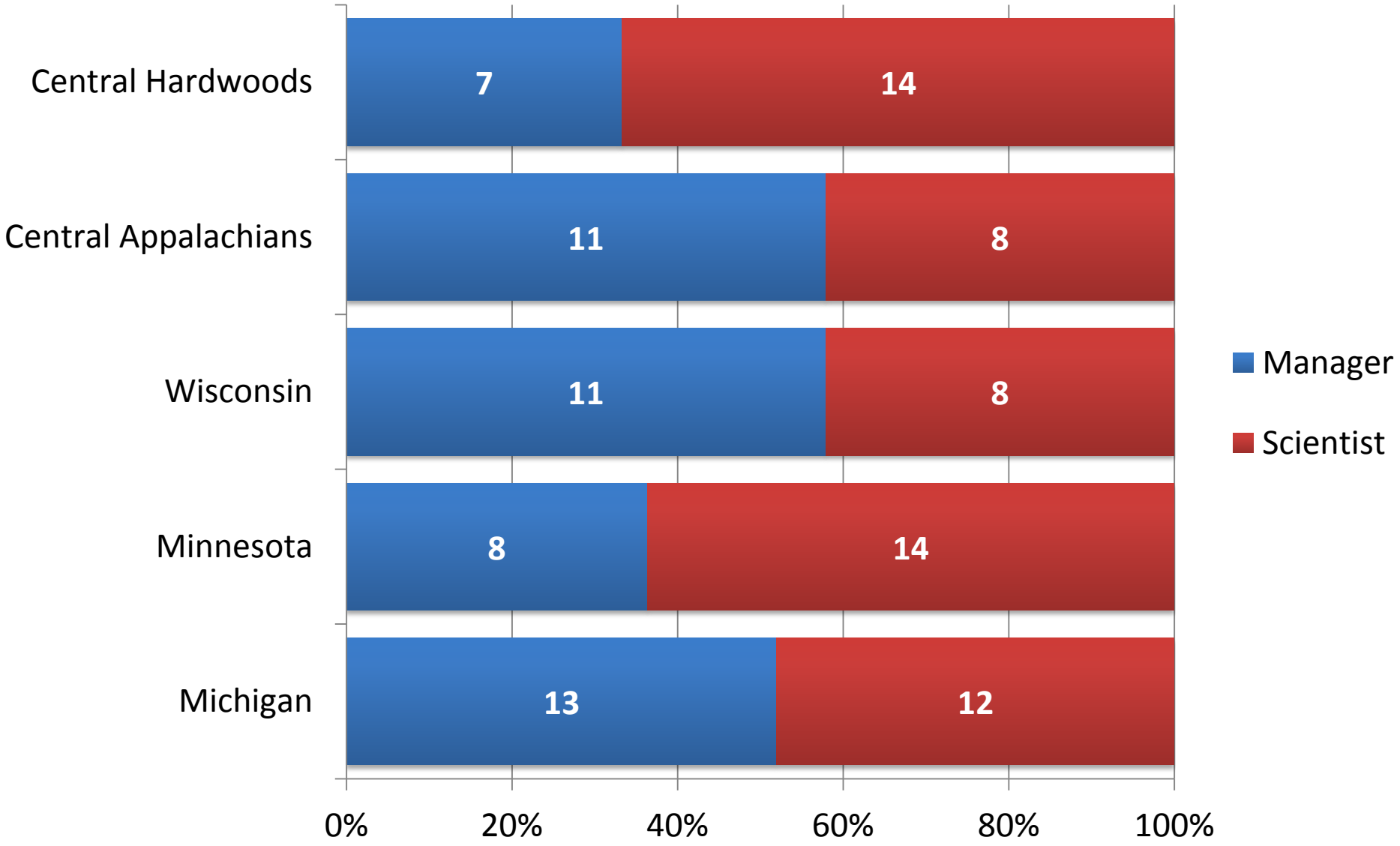
1. What are the main factors that contribute to vulnerability ratings in these systems?
2. Which forest/community types tend to be rated as most or least vulnerable?
3. How certain are we about the vulnerability of these systems?

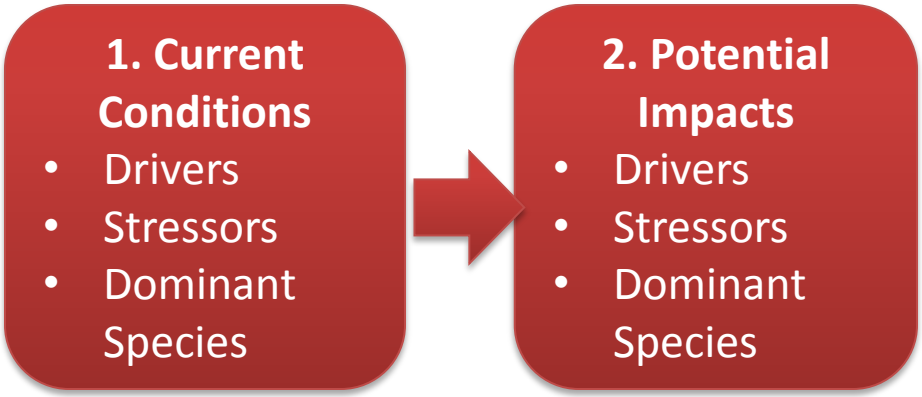
Expert Panel

Panel Representation



Scientist/Manager Distribution



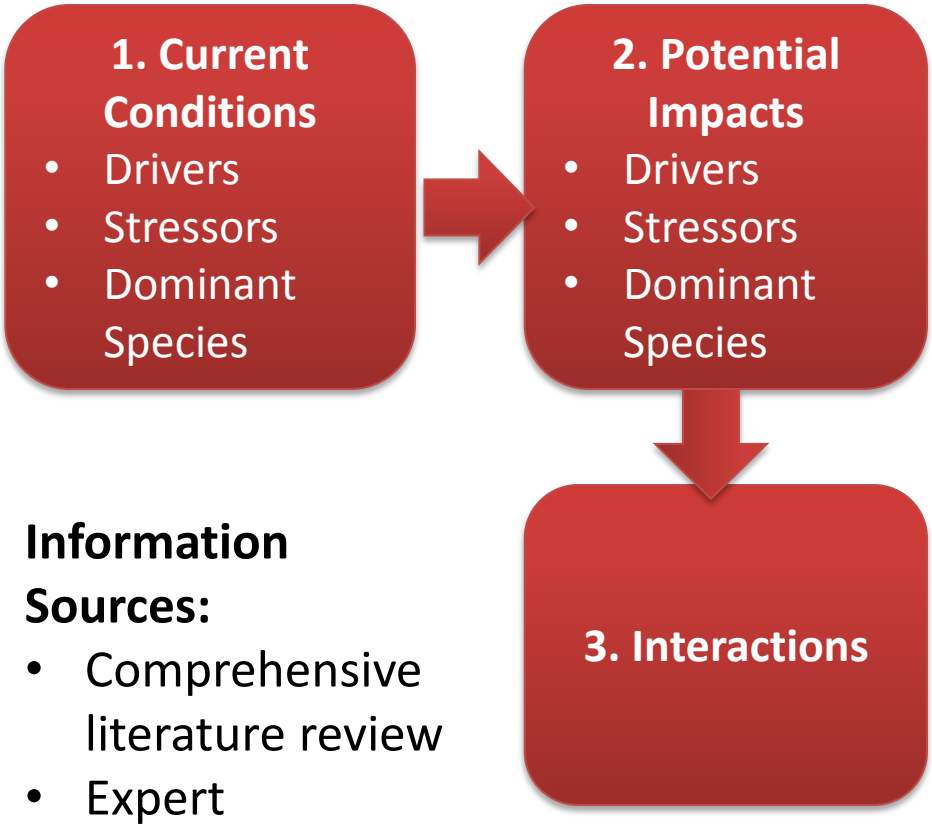


Vulnerability Assessment Process

Information Sources:

- Statistically-downscaled climate model projections (1/8)
- Two model-scenario combinations (PCM B1, GFDL A1FI)
- Several independent forest impact models selected from (varies by region):
  - DISTRIB
  - PnET
  - LINKAGES v2.2
  - LANDIS-II
  - LANDIS PRO
- Comprehensive literature review
- Expert knowledge

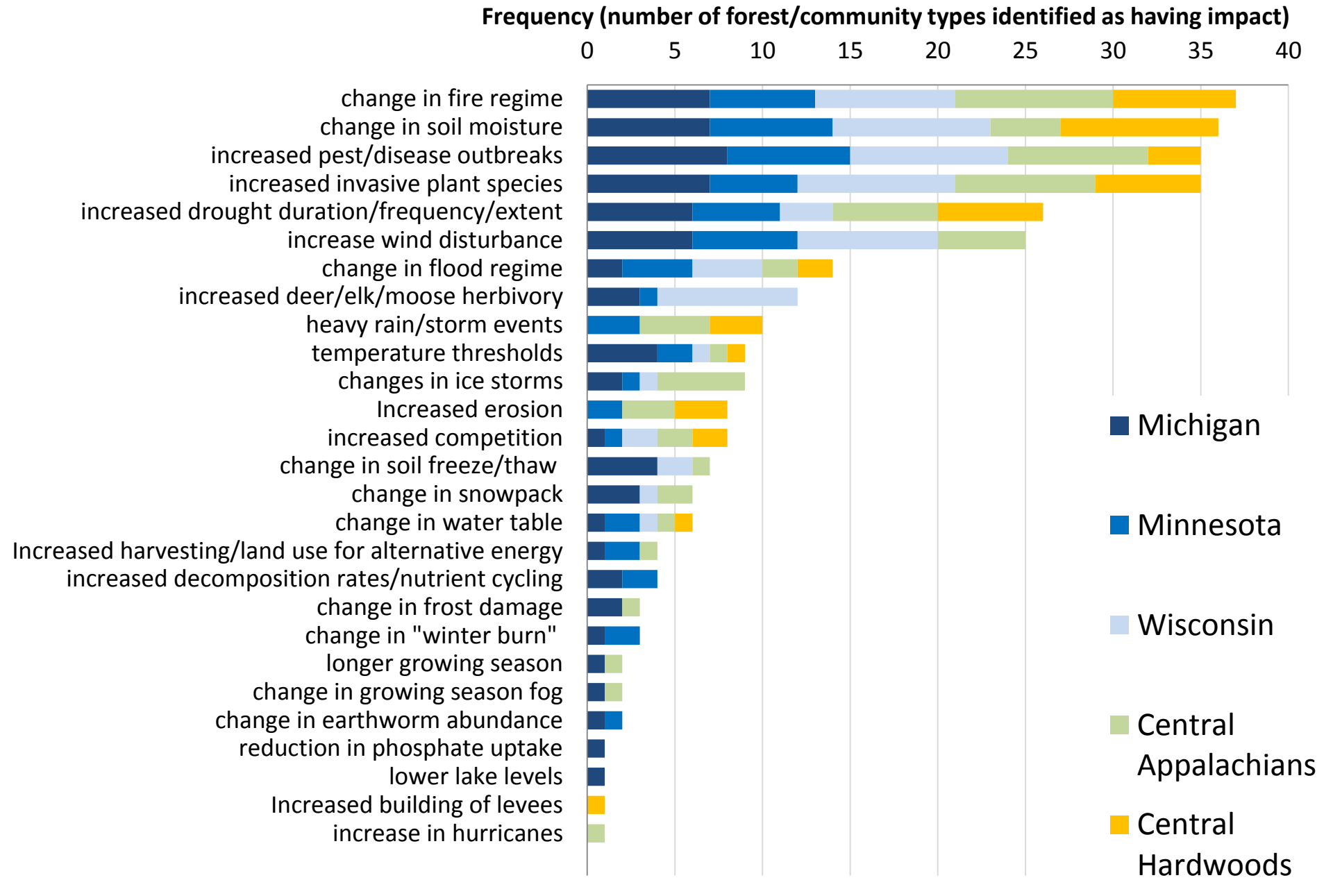
Vulnerability Assessment Process



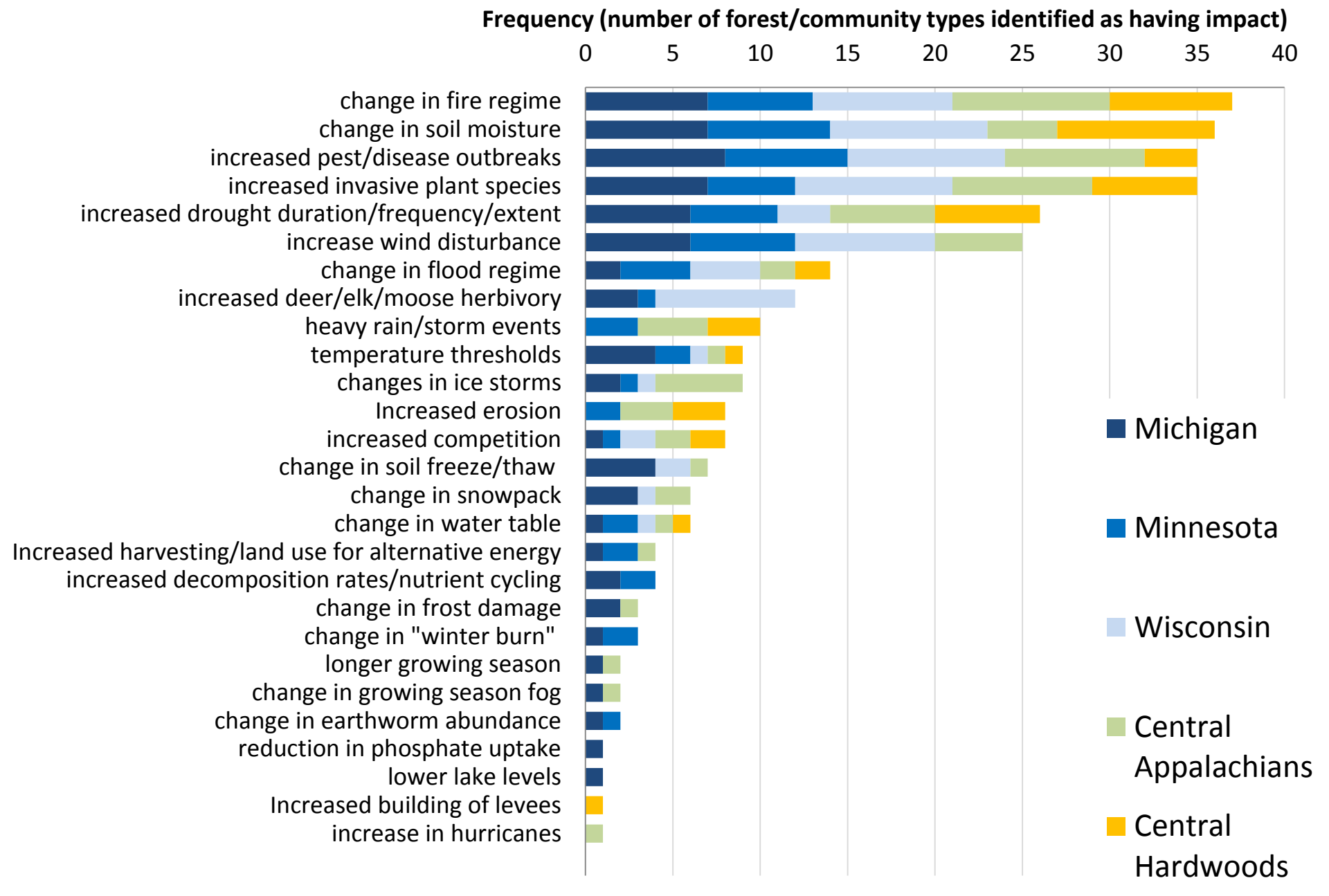
Information Sources:

- Comprehensive literature review
- Expert knowledge

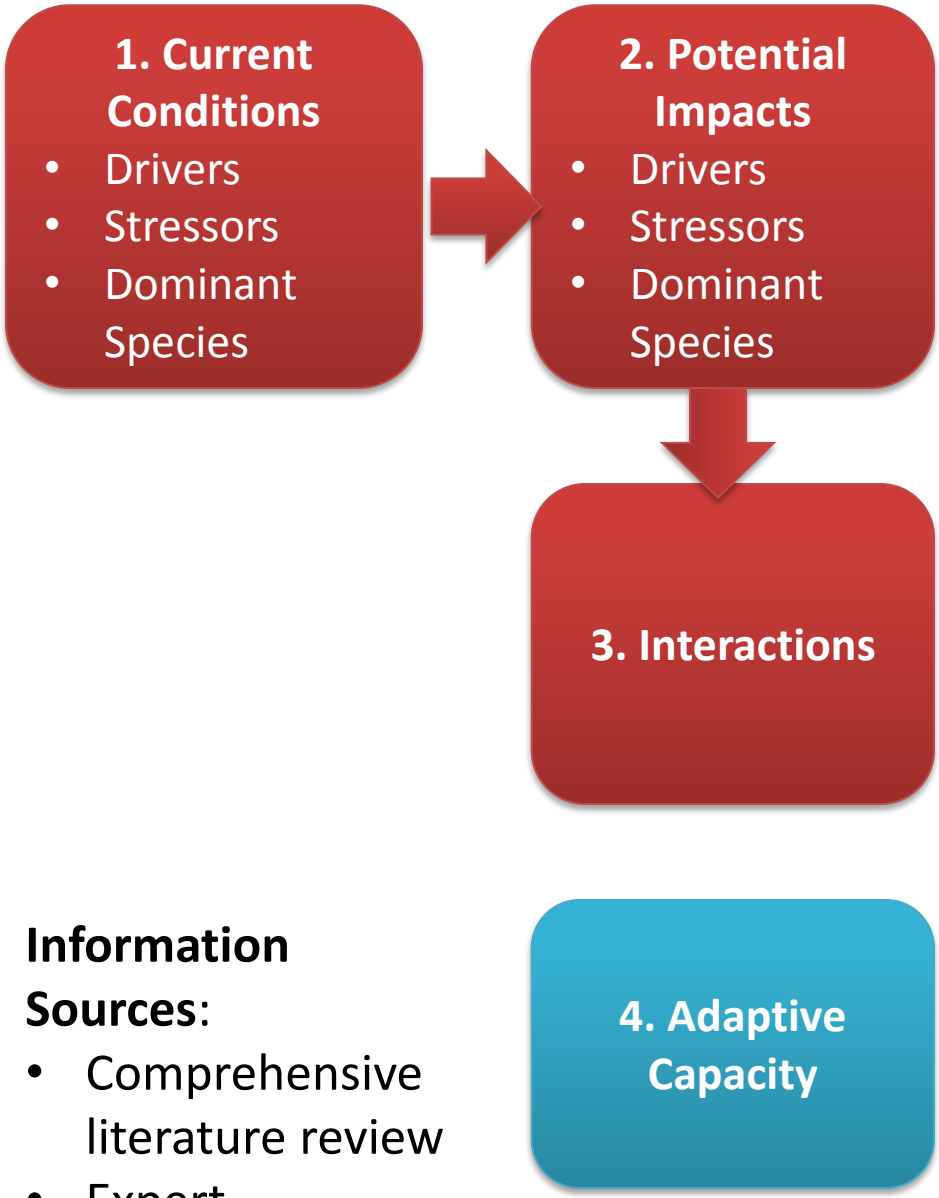
Impacts Identified



Impacts Identified



Vulnerability Assessment Process



Information Sources:

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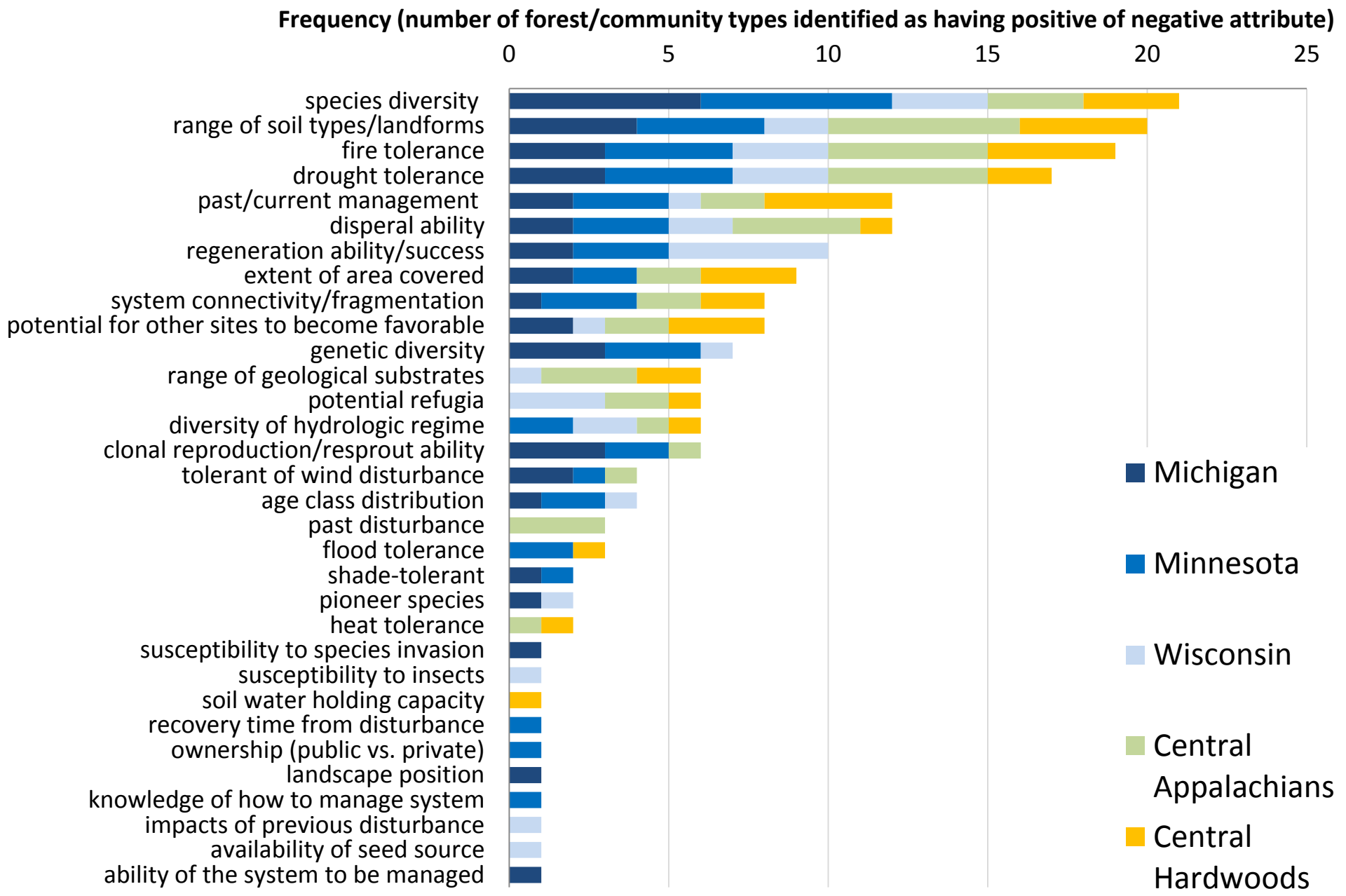
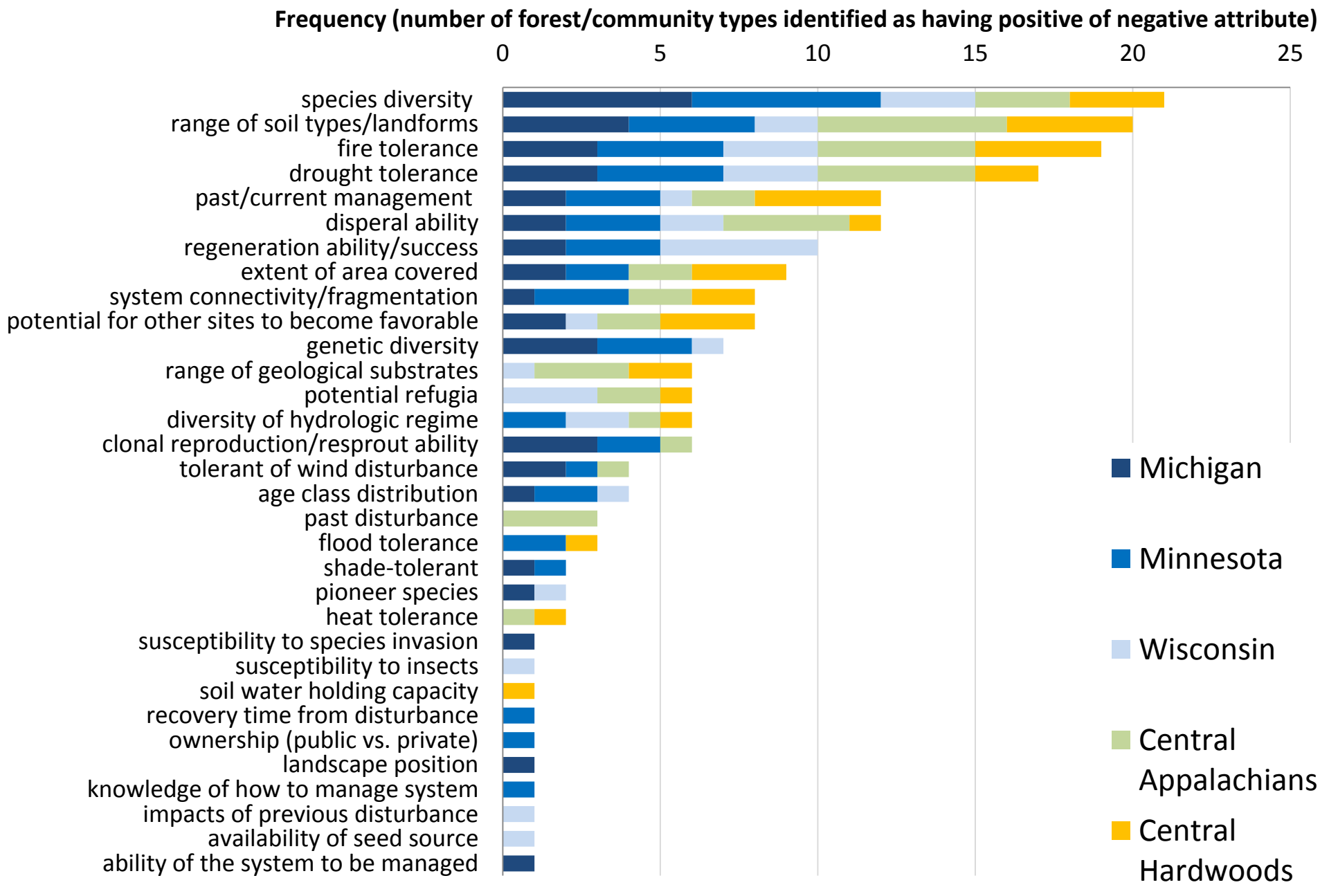
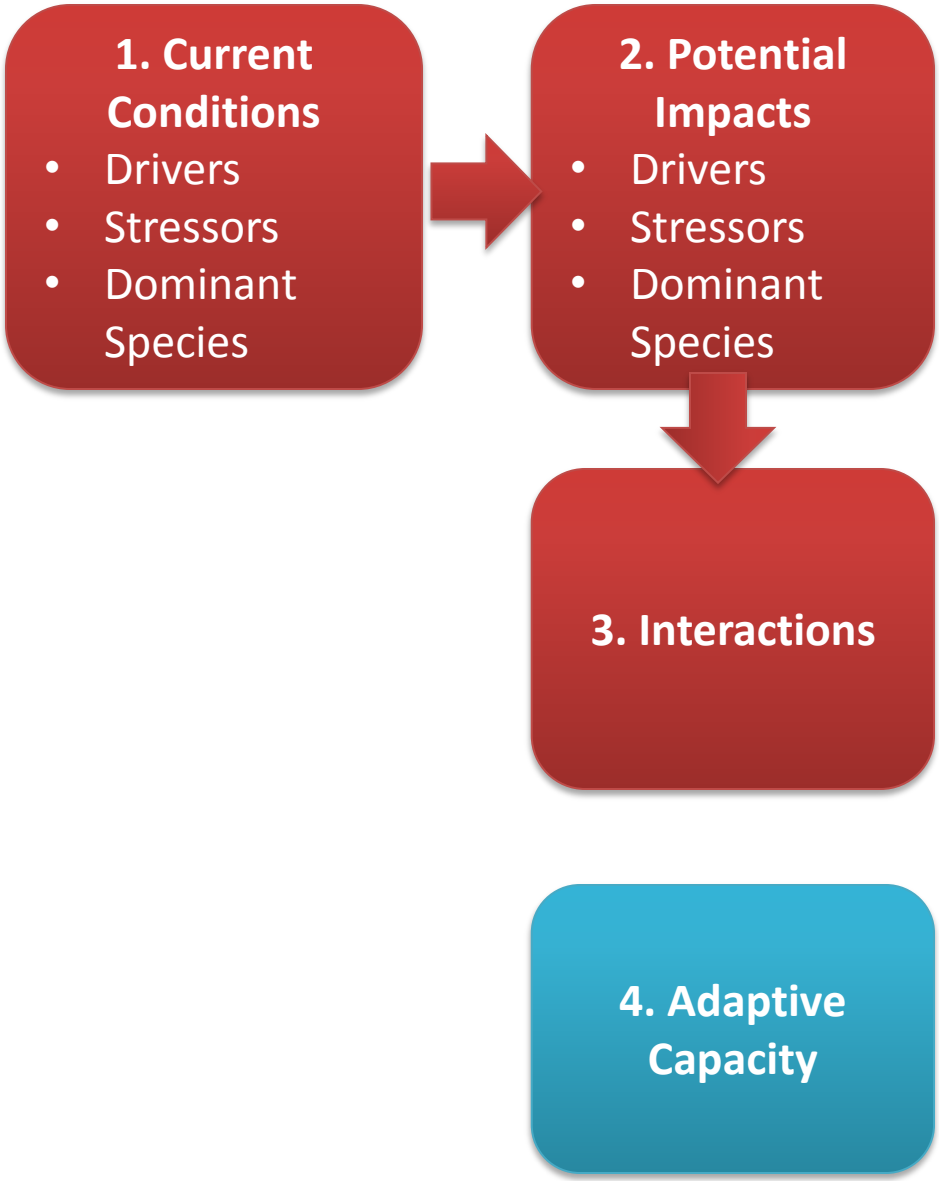
Adaptive Capacity Factors Identified



Adaptive Capacity Factors Identified



Vulnerability Assessment Process



1. Current Conditions		2. Potential Impacts	
Drivers	dunes, glacial lake plains, thin soil over bedrock	(0) no change	
	sand, loamy sand, sandy loam - acidic soils, alkaline soils on limestone	(?) increased precipitation in winter/spring, reduced soil moisture late in growing season	
	limited by high summer temps	(-) Increased Temperature	
	frequent windthrow	(-) increased severe events, including storms	
	infrequent catastrophic wildfire linked to ~50 year cycle spruce budworm	(?) increased fire frequency or severity	
Dominant Species	balsam fir	(-) Decrease (most models)	
	white spruce	(-) Decrease (all models)	
	eastern white pine	(?) Mixed model results	
	red maple	(?) Mixed model results	
	northern white-cedar	(-) Decrease (all models)	(+) 'Increased productivity under GFDL (High), small increases with PCM B1 (Low) -- with increased CO2
	paper birch	(-) Decrease (all models)	
	quaking aspen	(-) decrease (most models)	
	eastern hemlock	(+) Increase (most models)	
	balsam poplar	(?) Mixed model results	
	bigtooth aspen	(?) Mixed model results	
Stressors	Suppression or exclusion of natural fire regimes	(?) Fire season may change	
	Drought	(?) Unclear whether drought will increase or decrease	
	Root damage	(0) No clear climate impacts	
	Deer herbivory	(-) may increase if deer increase from milder winters	
	Pests and Diseases: *Armillaria* root disease, balsam fir bark beetle, Spruce budworm, Spruce decline, Sudden Needle Drop	(-) increase. Warmer temperatures may increase susceptability to mountain pine beetle (if established)	
	Invasives: Spotted Knapweed, Oriental Bittersweet, Japanese Barberry, Asiatic Honeysuckles, Buckthorn	(-) Increased disturbance, CO_2, or stress on forests may increase susceptability	
3. Potential Interactions	(-) Spruce has current range edge effects, expected to be exacerbated by climate change (-) could convert to aspen		
4. Adaptive Capacity	(-) white spruce and balsam fir susceptible to fire topkill (+) balsam fir is a prolific seed producer, occurs everywhere, responsive to management, not preferred deer browse (-) Balsam fir will do worse than projected by models due to lower adaptive capacity factors, especially drought (-) area already lost a large amount of white spruce due to drought, logging, insects, other stressors		

Vulnerability Assessment Process

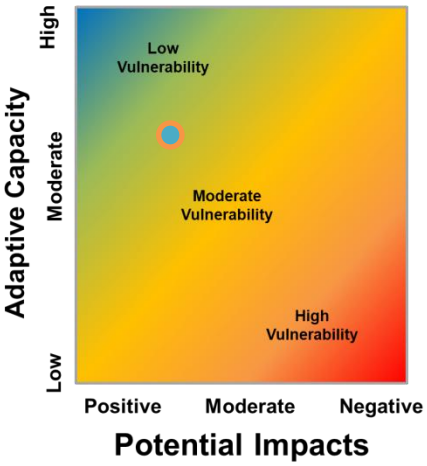
1. Current Conditions
- Drivers
- Stressors
- Dominant Species

2. Potential Impacts
- Drivers
- Stressors
- Dominant Species

3. Interactions

4. Adaptive Capacity

5. Individual Vulnerability Determination



Vulnerability Assessment Process

1. Current Conditions
- Drivers
- Stressors
- Dominant Species

2. Potential Impacts
- Drivers
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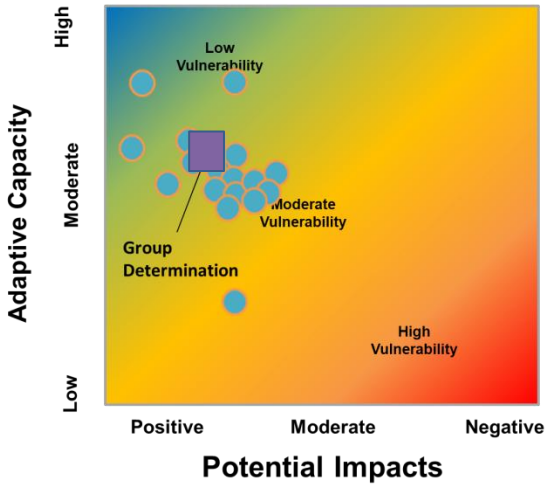
- Dominant Species

3. Interactions

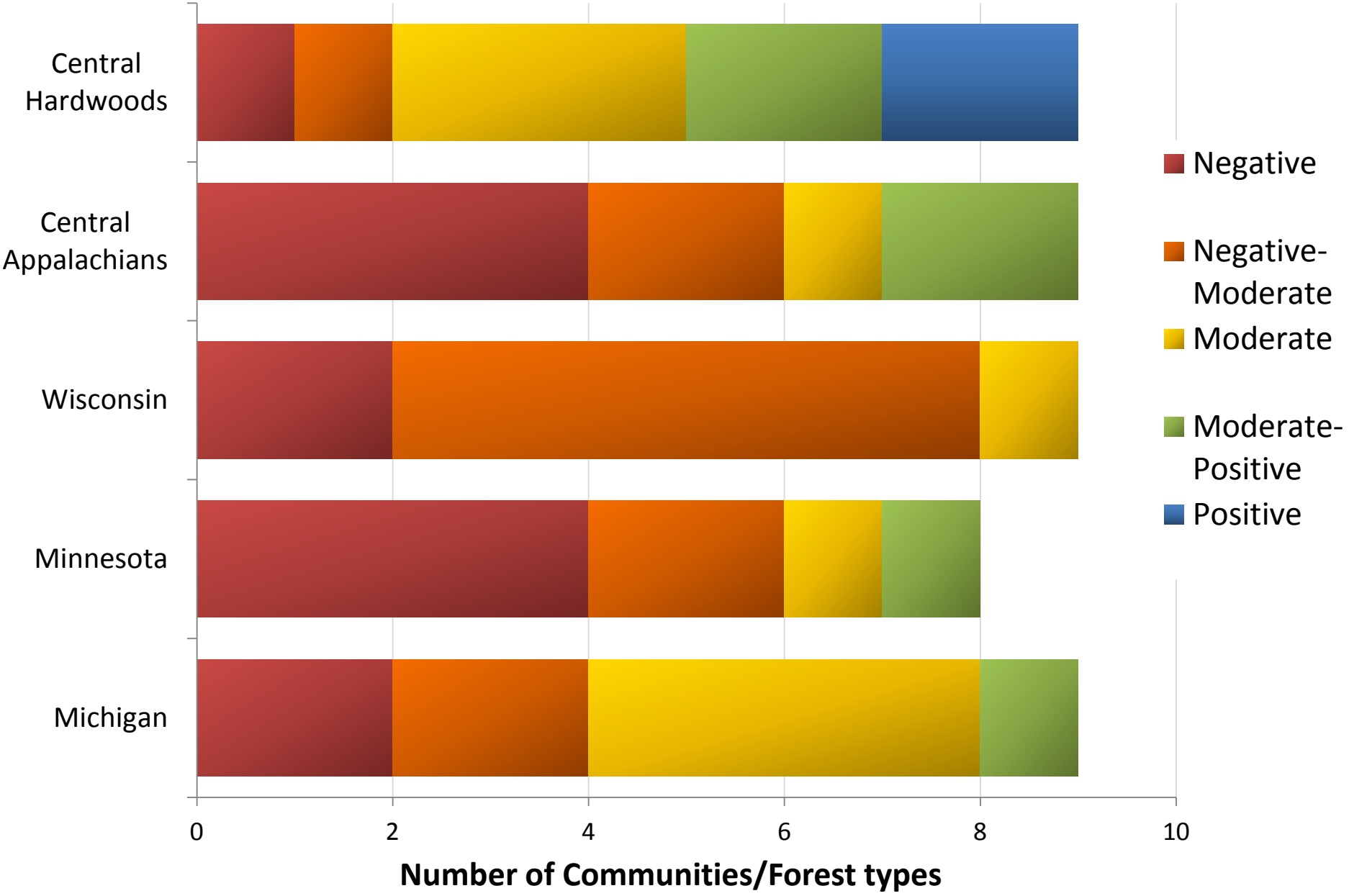
4. Adaptive Capacity

5. Individual Vulnerability Determination

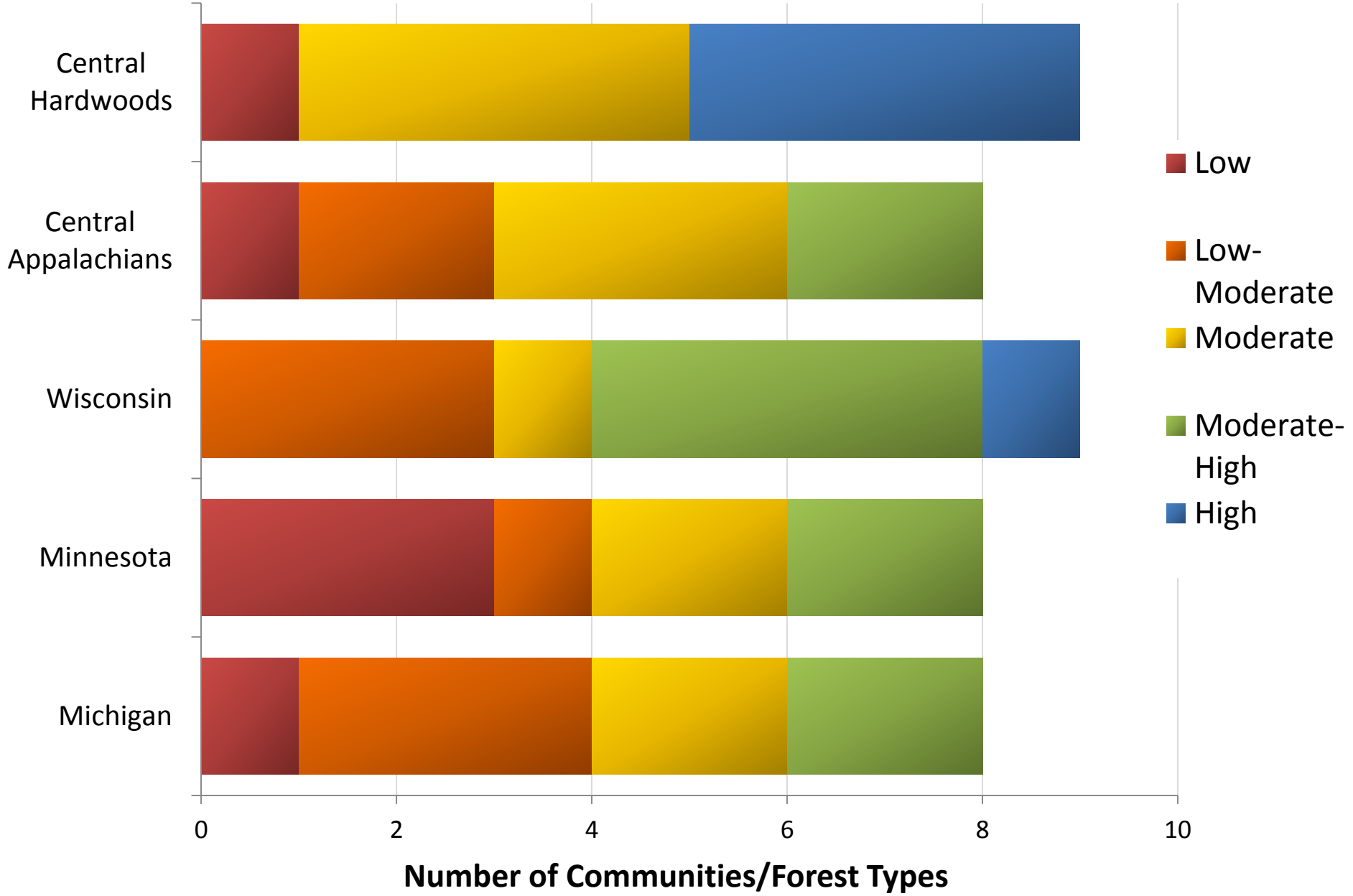
6. Group Vulnerability Determination



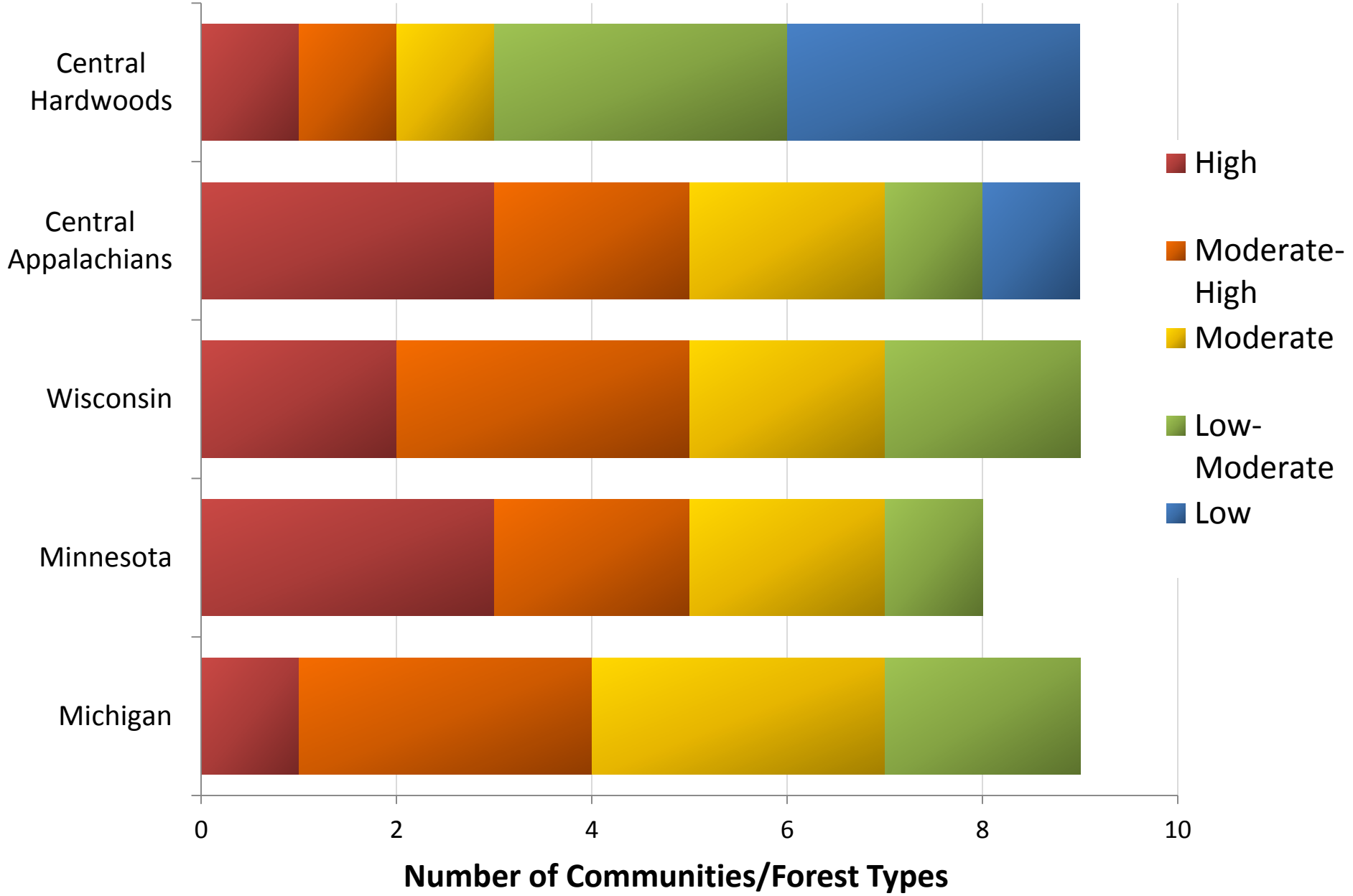
Impacts


Central Hardwoods
Central Appalachians
Wisconsin
Minnesota
Michigan
0
2
4
6
8
10
Number of Communities/Forest types
Negative
Negative-Moderate
Moderate
Moderate-Positive
Positive

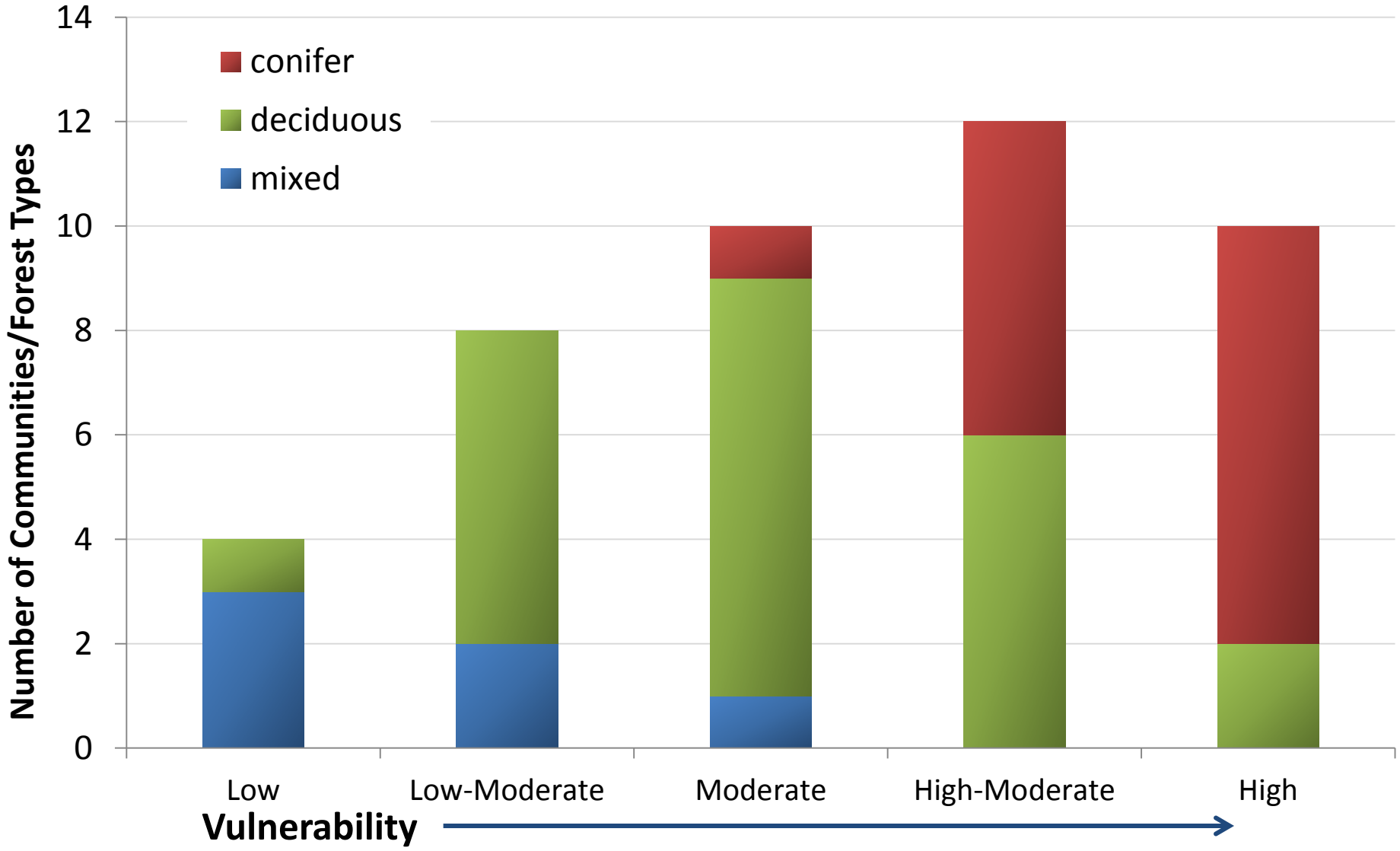
Adaptive Capacity



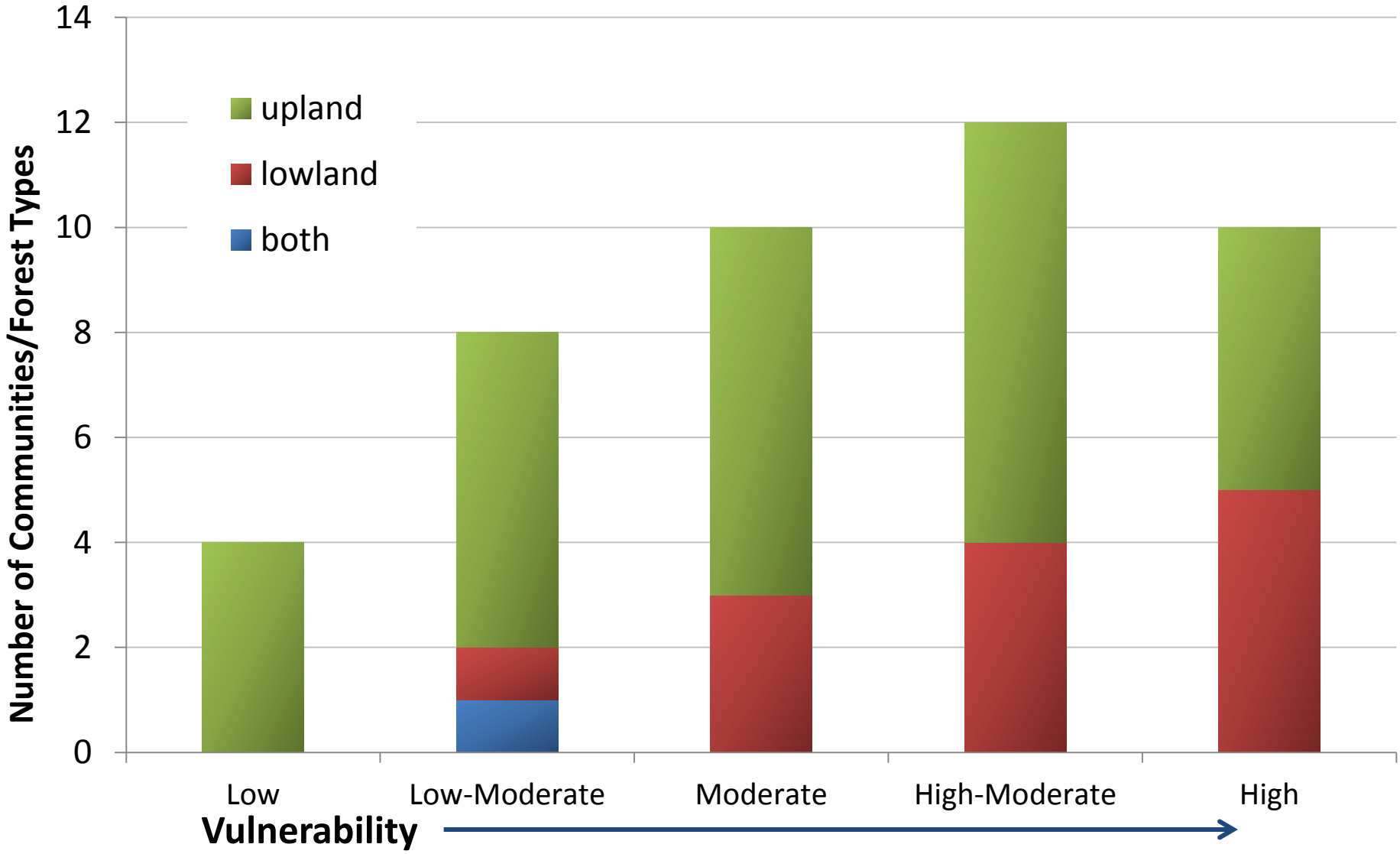
Vulnerability



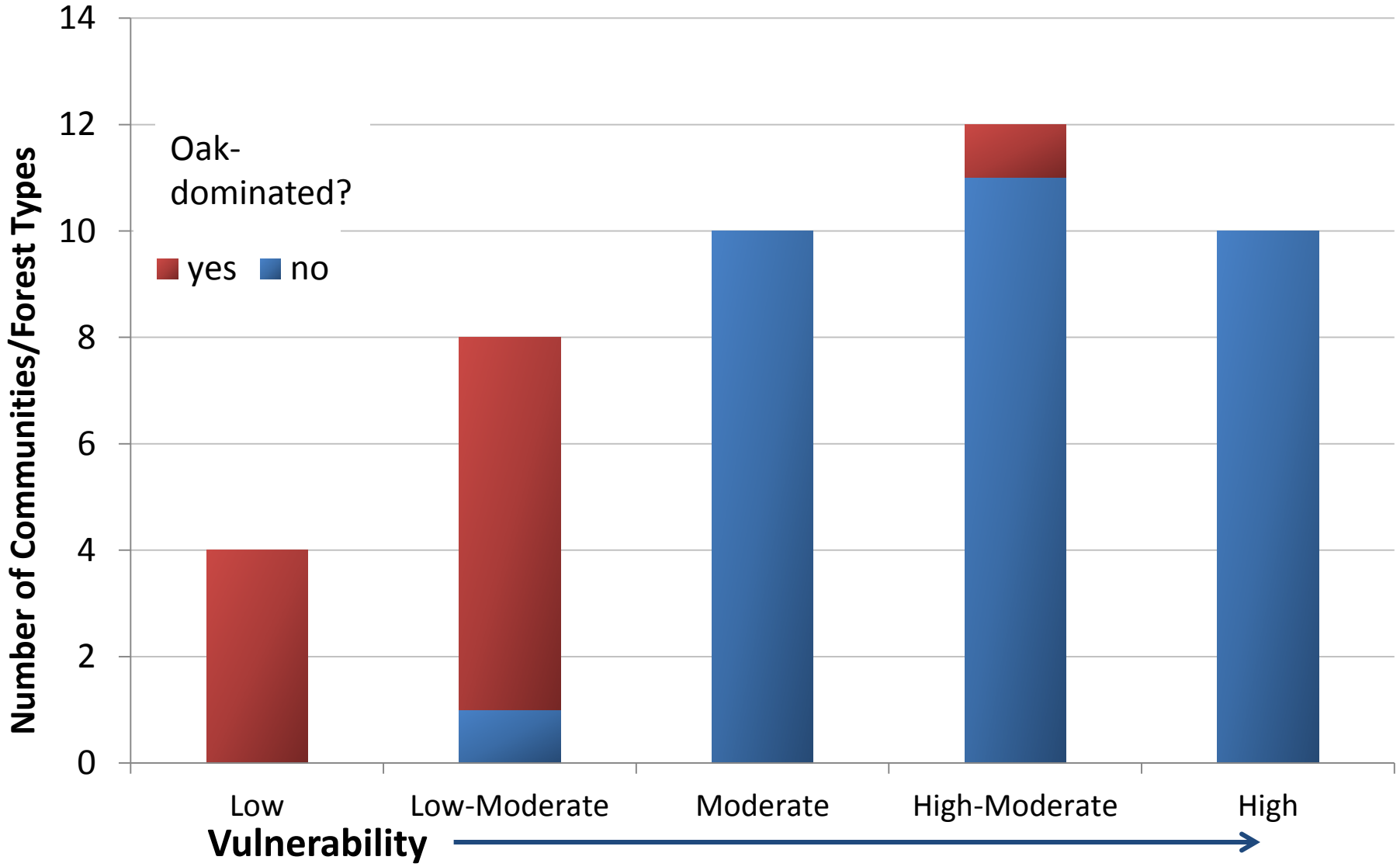
Conifer-dominated systems receive higher vulnerability ratings



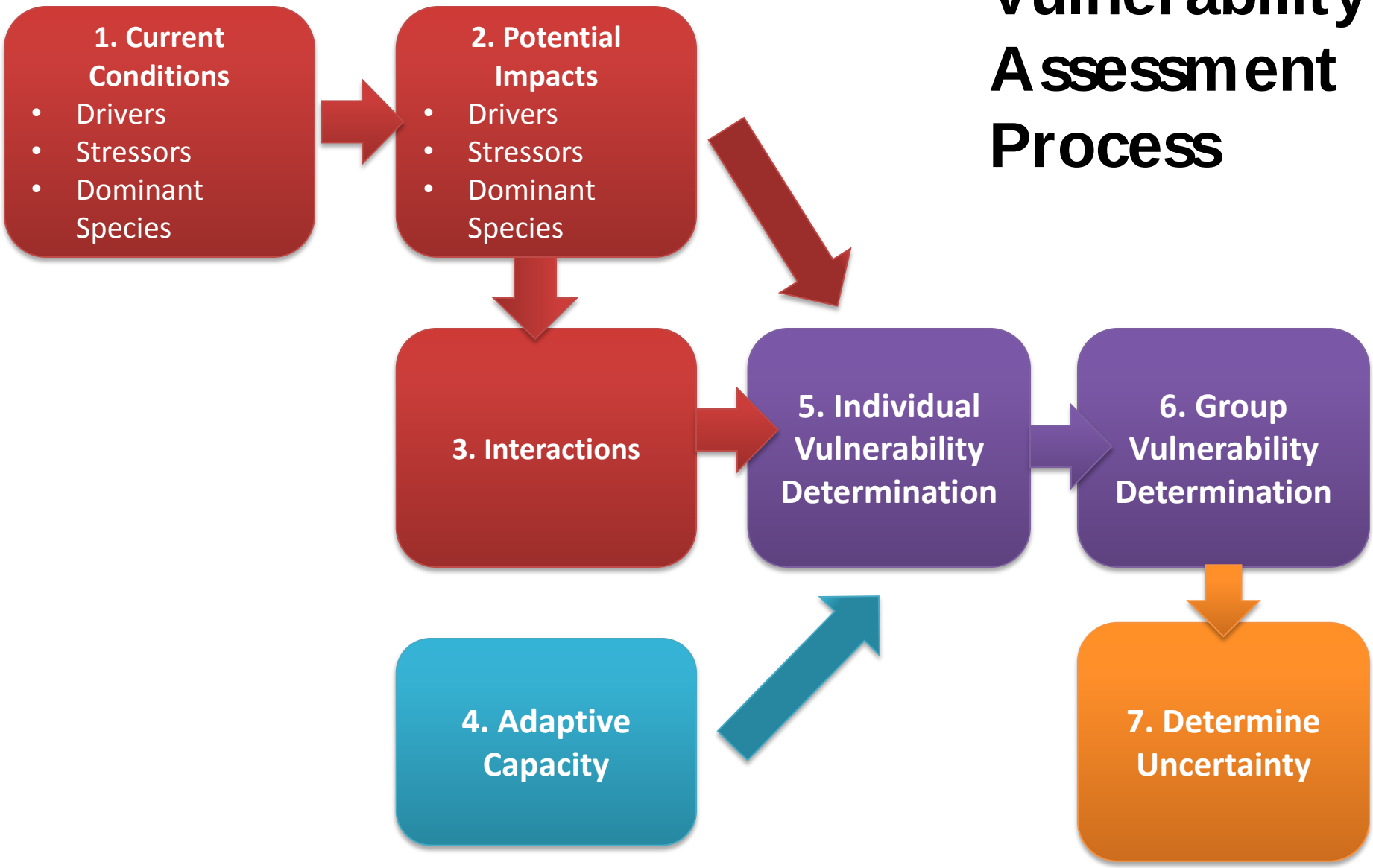
Lowland systems
receive higher vulnerability ratings

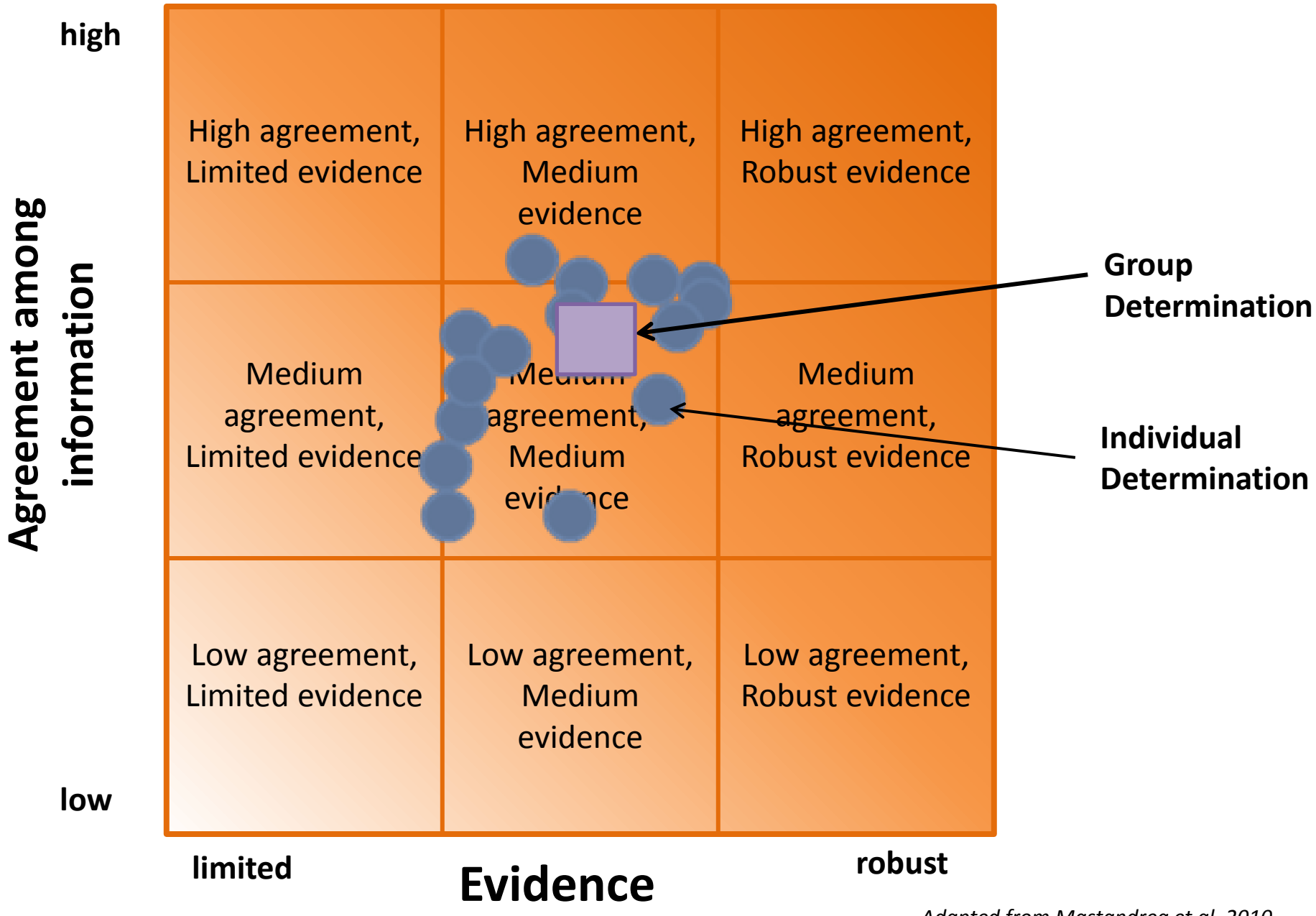


Oak-dominated systems receive lower vulnerability ratings

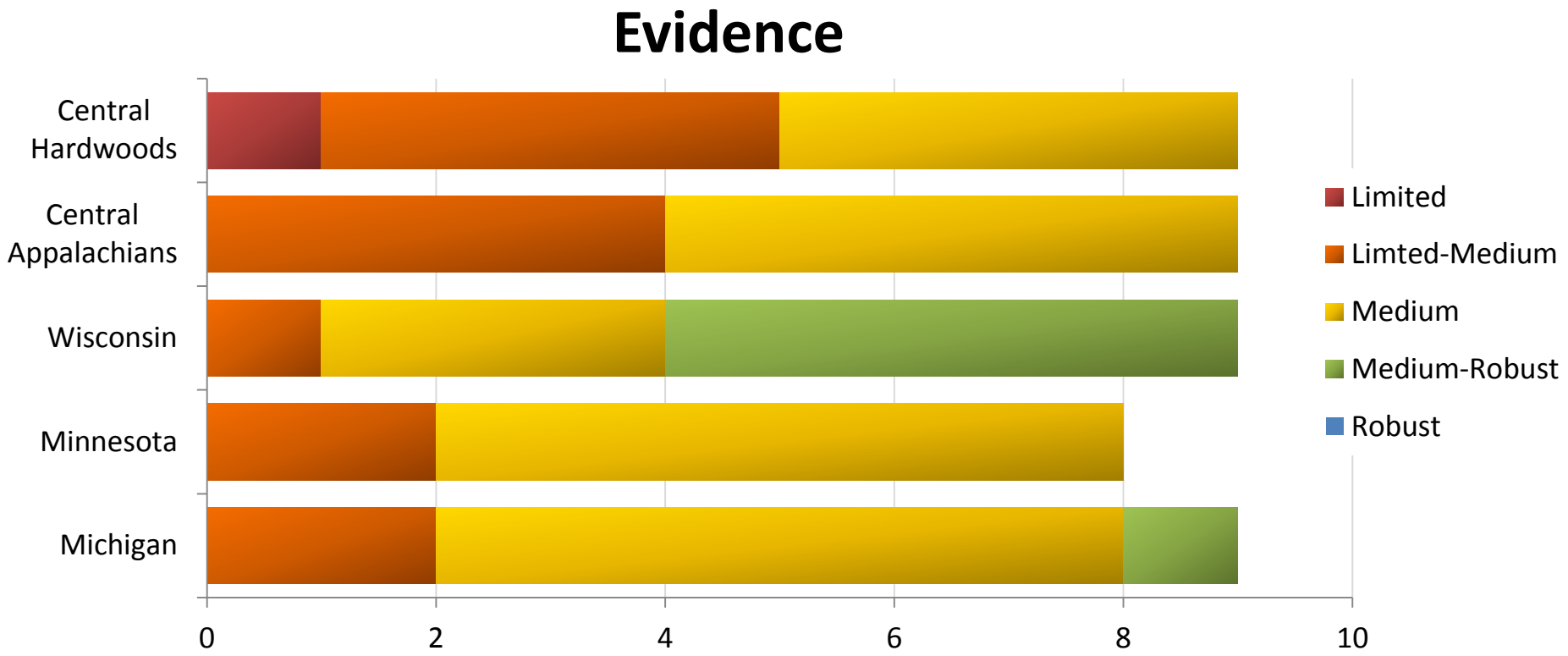


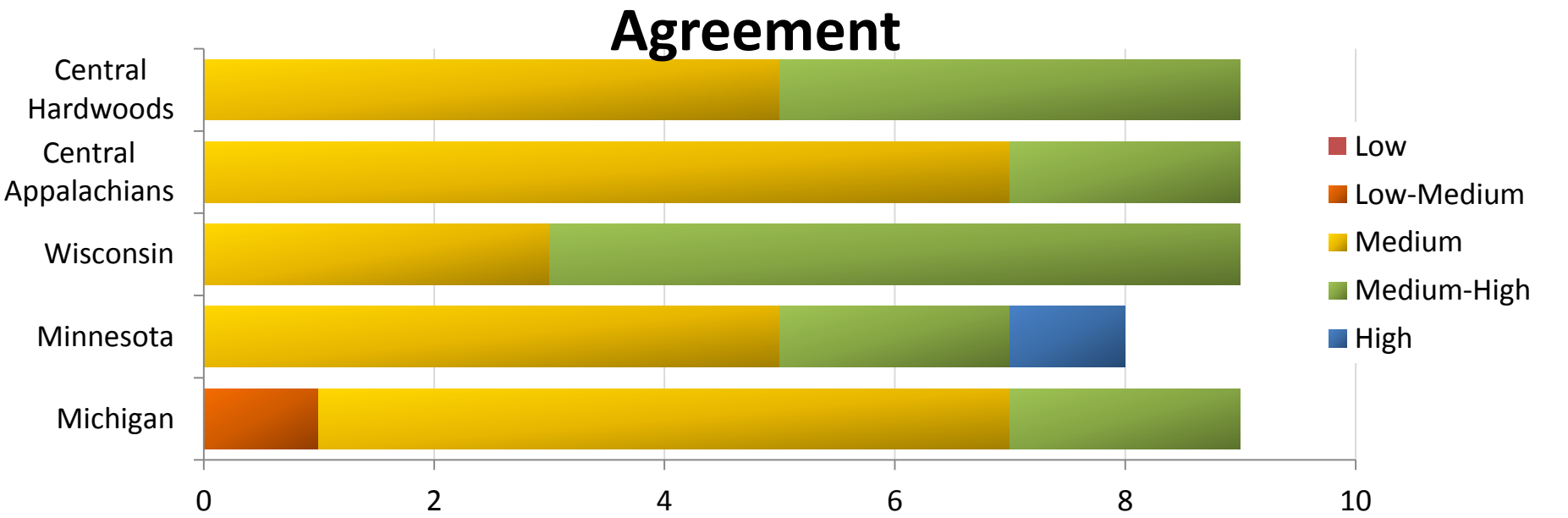
Vulnerability Assessment Process





Adapted from Mastandrea et al. 2010


Evidence
Central Hardwoods
Central Appalachians
Wisconsin
Minnesota
Michigan
0
2
4
6
8
10
Limited
Limted-Medium
Medium
Medium-Robust
Robust


Agreement
Central Hardwoods
Central Appalachians
Wisconsin
Minnesota
Michigan
0
2
4
6
8
10
Low
Low-Medium
Medium
Medium-High
High

Summary

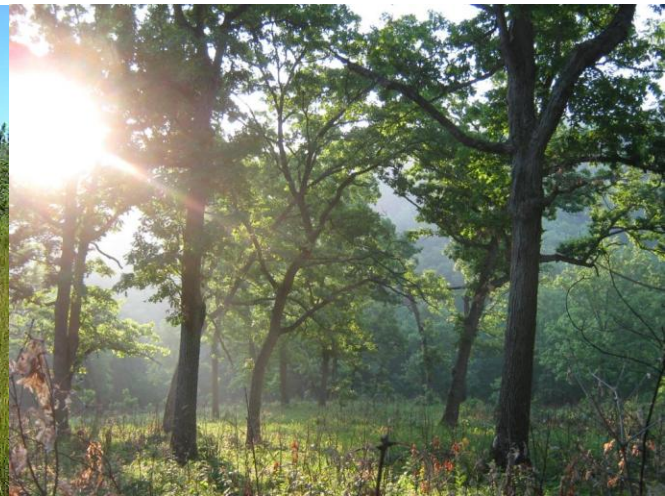
1. What are the main factors that contribute to vulnerability ratings in these systems?
   - Impacts:
     - fire, soil moisture, pests, disease, invasive species
   - Adaptive capacity:
     - species/landform diversity, disturbance tolerance, past/current management




Summary

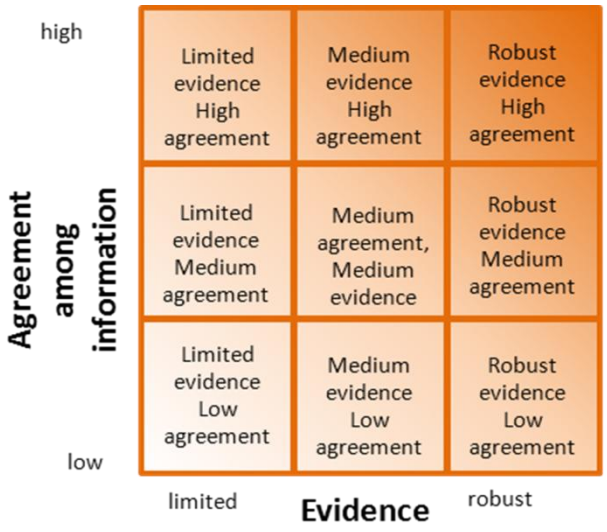
2. Which forest/community types tend to be rated as most or least vulnerable?
   - Conifer-dominated
   - Lowlands
   - Oak-dominated systems perceived as least vulnerable





Summary

3. How certain are we about the vulnerability of these systems?
   - Moderate amount of supporting evidence
   - Available evidence tends to agree on direction of change



More Information

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