Natural Disturbance-Based Silviculture: Adaptation and Wildlife Outcomes

THE UNIVERSITY OF VERMONT FORESTRY

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Northeast Climate Adaptation Science Center

What we'll cover

- General natural disturbance archetypes and their influence on wildlife habitat conditions
- Natural disturbance-based silviculture systems and linkages with adaptation and wildlife outcomes

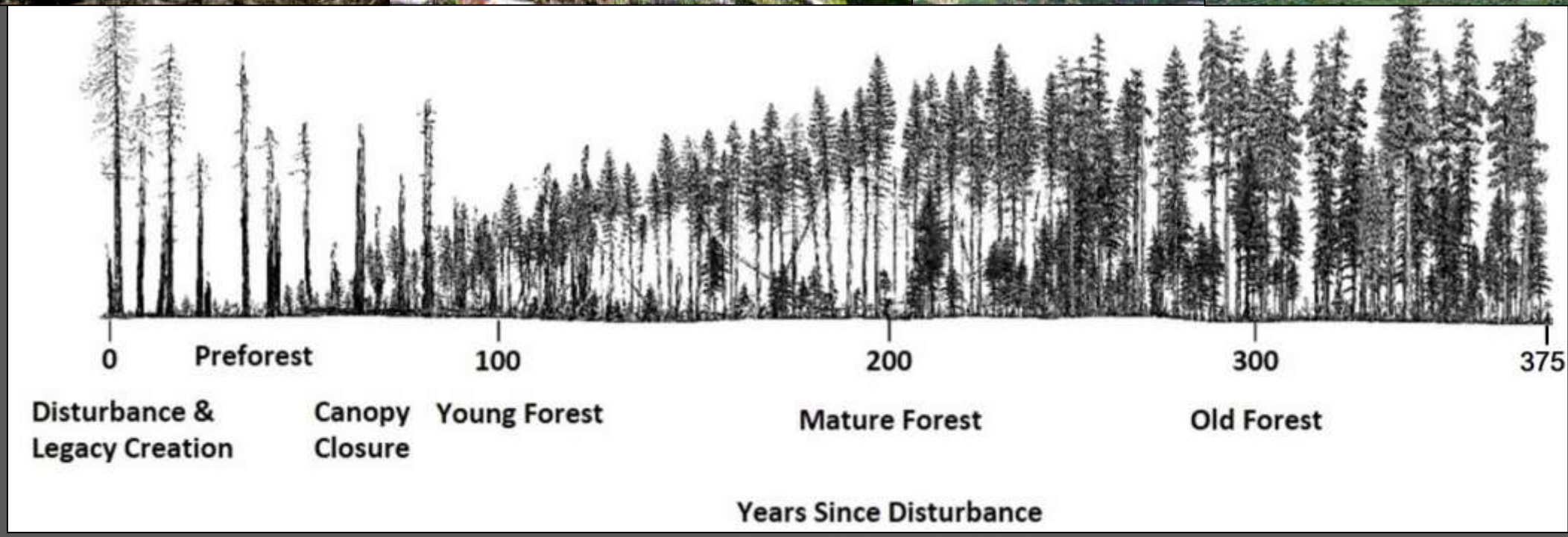
Disturbance archetypes

Disturbance archetypes

Four predominant forest archetypes based on disturbance regime

1. Forests initiated by infrequent severe disturbance
2. Forests characterized by frequent low-severity disturbance, primarily fire
3. Forests characterized by gap disturbance, notably from wind
4. Forests characterized by mixed-severity disturbance regimes

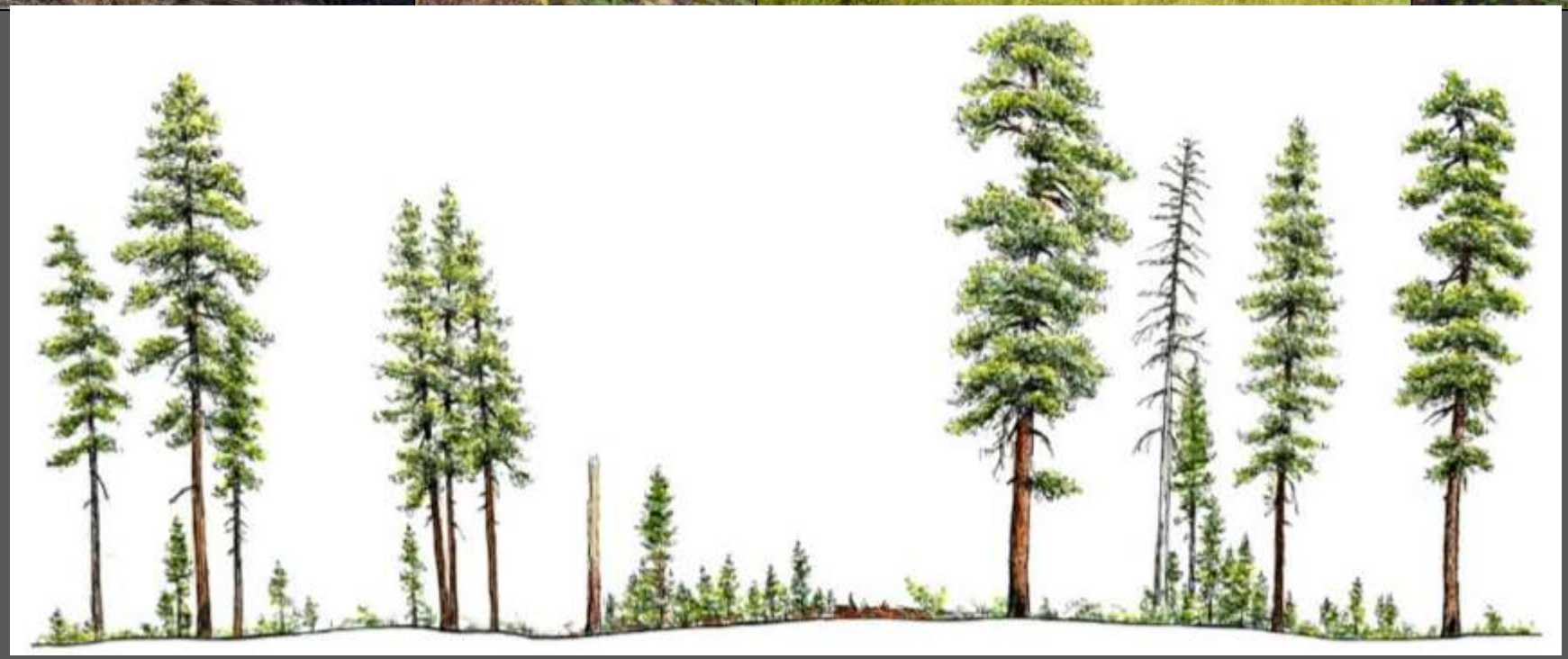
Infrequent severe disturbance



Frequent low-severity fire

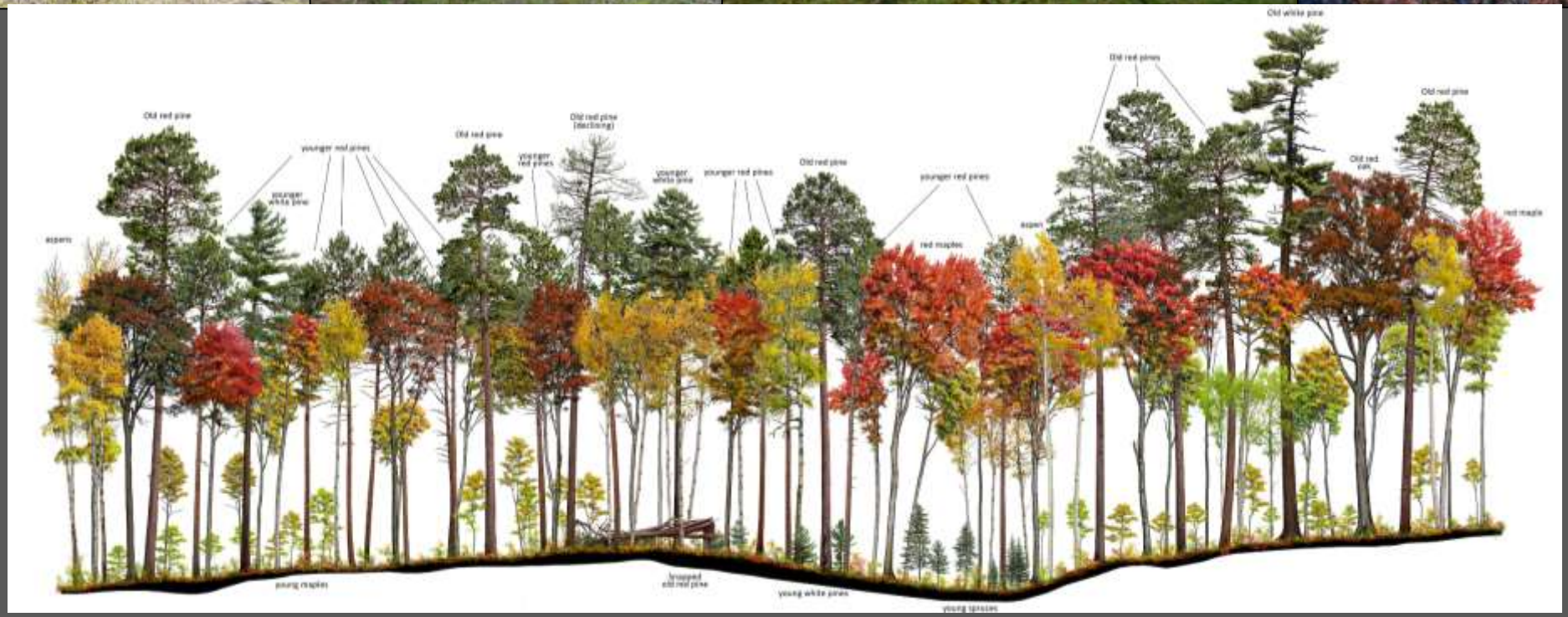






Gap-scale, wind disturbance

Mixed severity (heavy partial) disturbance



Disturbance and forest-dependent wildlife

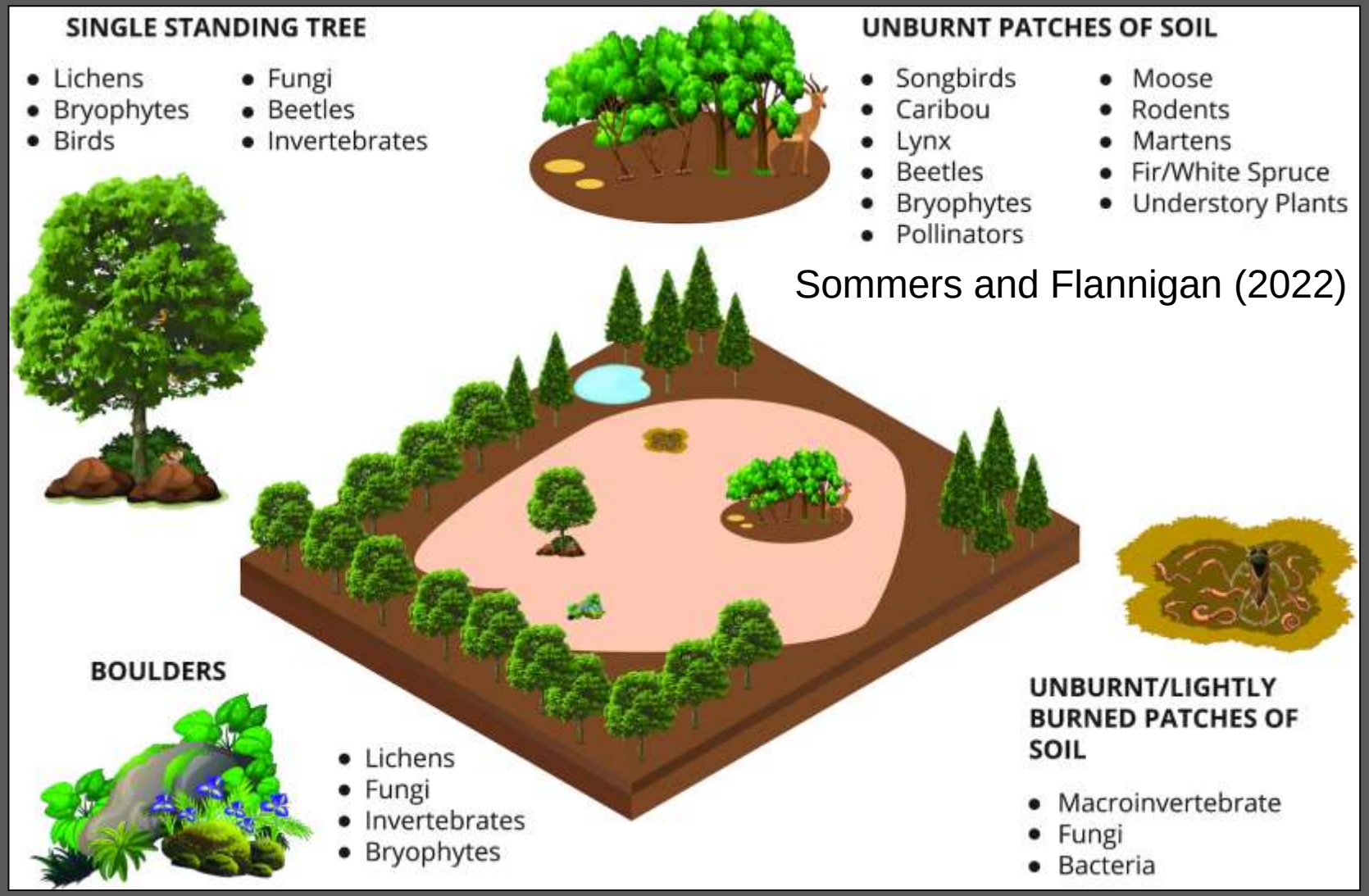
What does disturbance leave behind?

- Biological legacies (living and dead trees; unimpacted areas) representing unique habitat features

What does disturbance create?

- Structural complexity and floristic diversity at multiple spatial scales through differences in disturbance severity and frequency

Disturbance and forest-dependent wildlife

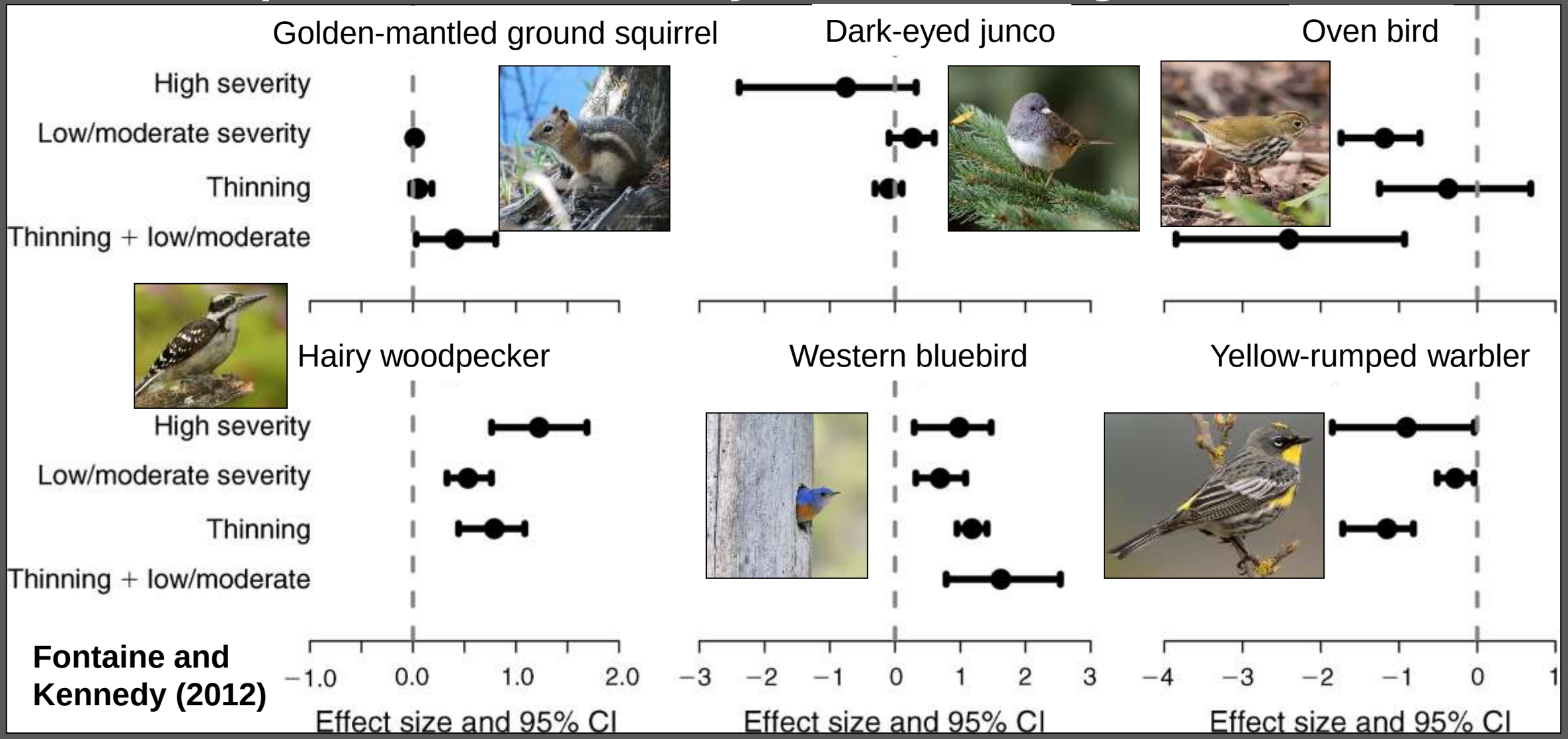


Sommers and Flannigan (2022)

Photo: B. de Groot

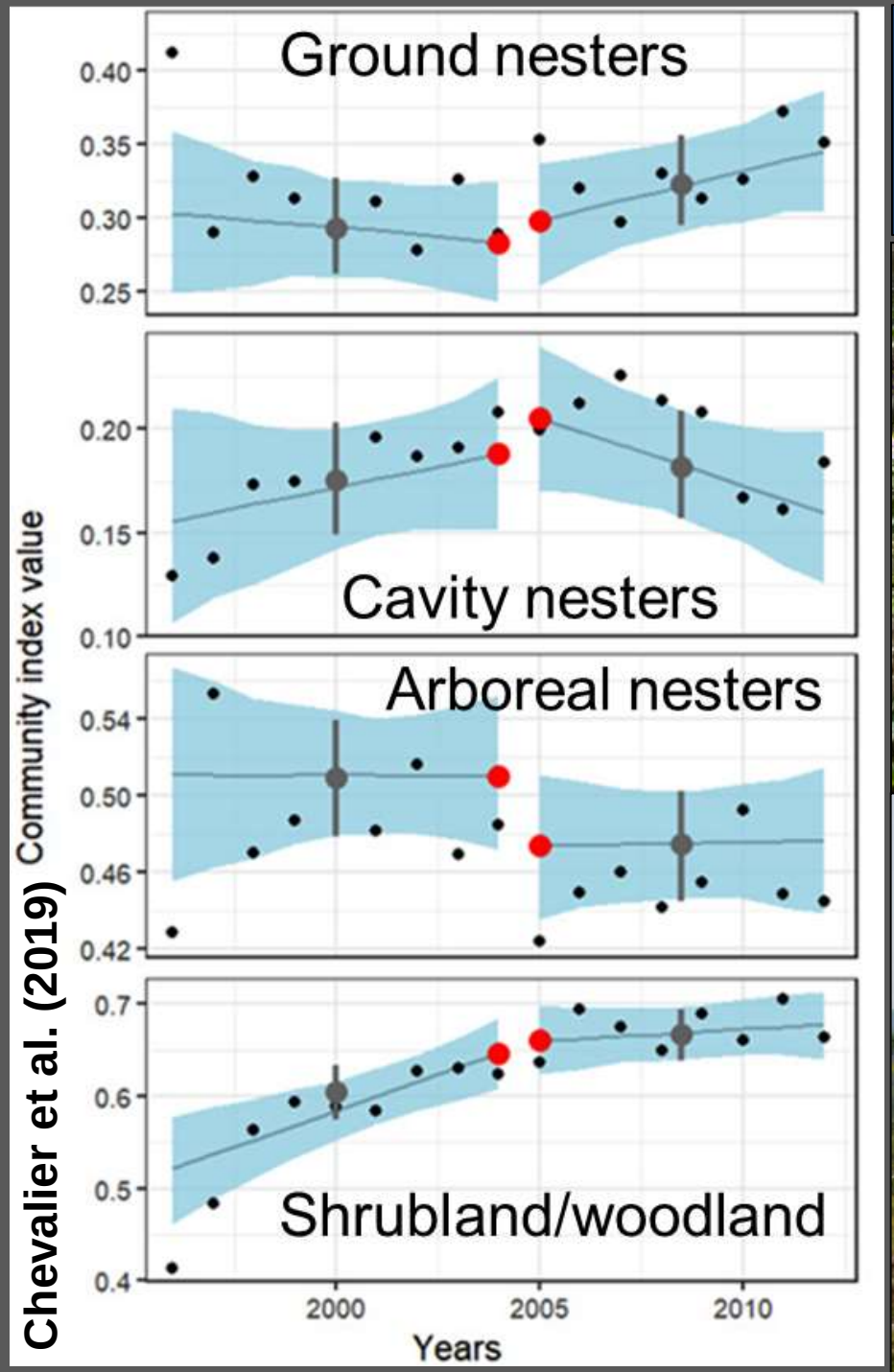
Disturbance and forest-dependent wildlife

Wildlife response to fire severity and fire surrogate treatments



Fontaine and Kennedy (2012)

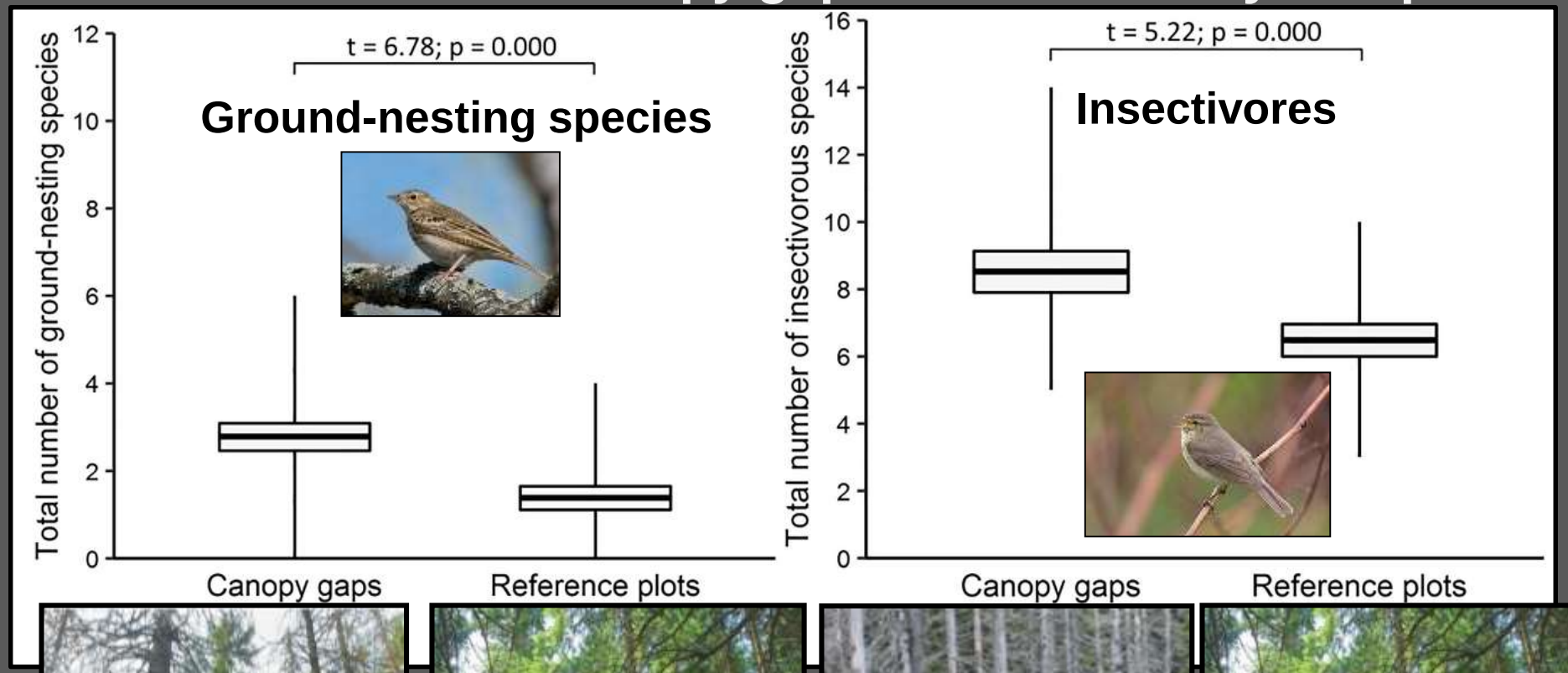
Bird community response to hurricane disturbance



Chevalier et al. (2019)

Disturbance and forest-dependent wildlife

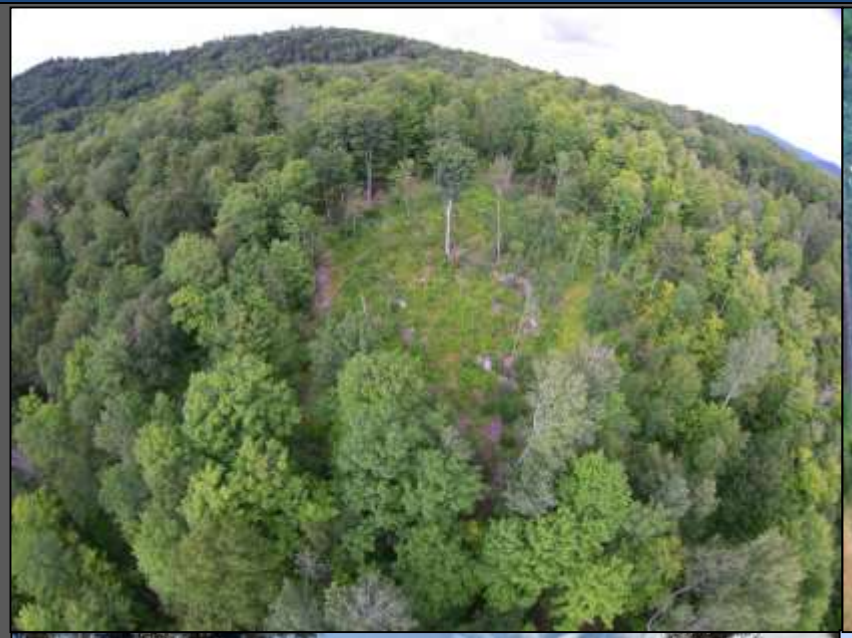
Bark beetle-induced canopy gaps as biodiversity hotspots



Przepióra et al (2020)

Question break

Natural disturbance-based silviculture



Natural disturbance-based silviculture

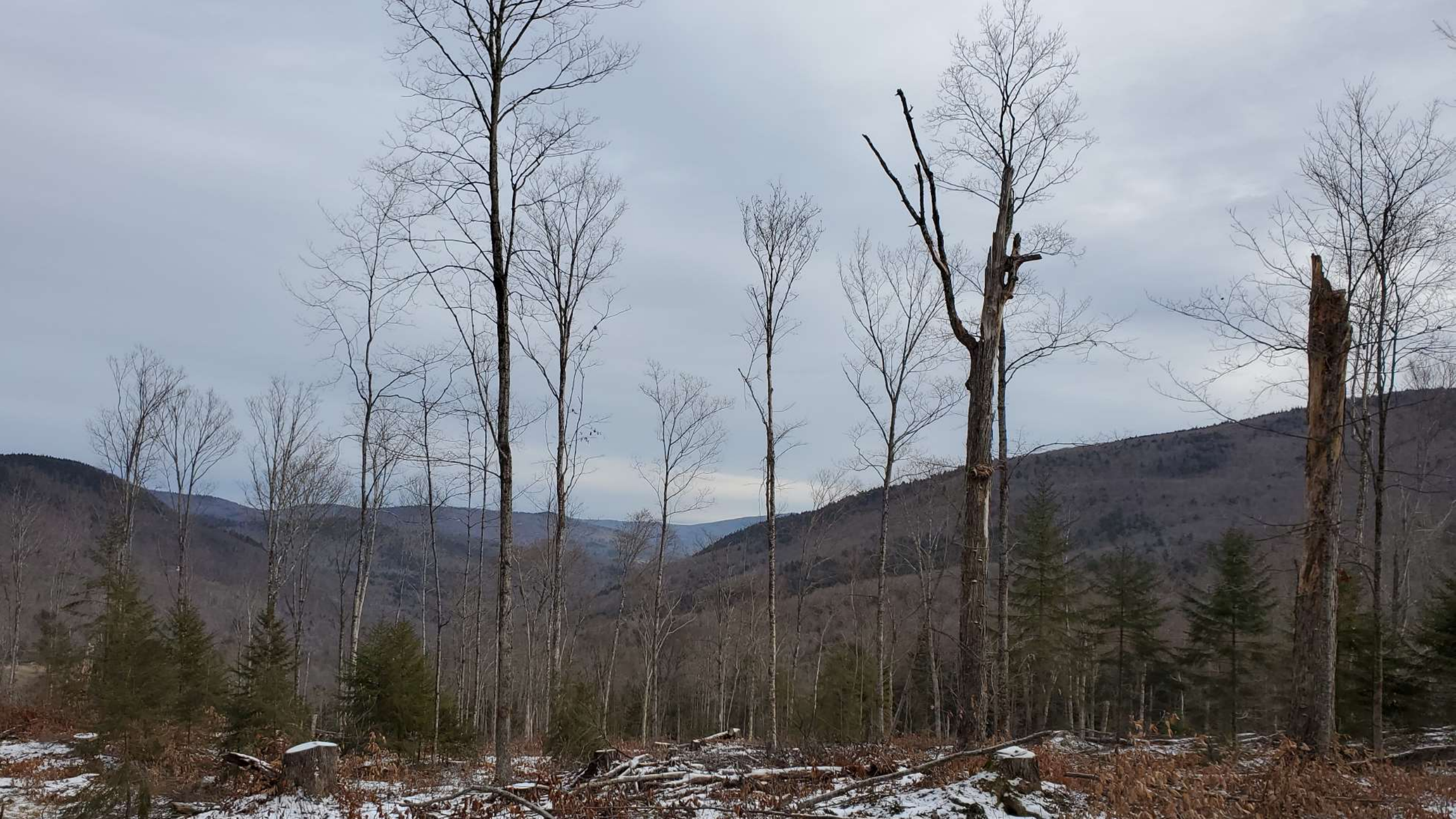
Silviculture based on emulation of natural disturbance regimes to create representative range of structural and compositional conditions at multiple spatial scales

- **Assumption**: creates habitat conditions for vast majority of native species ("coarse-filter" approach)

Natural disturbance-based silviculture

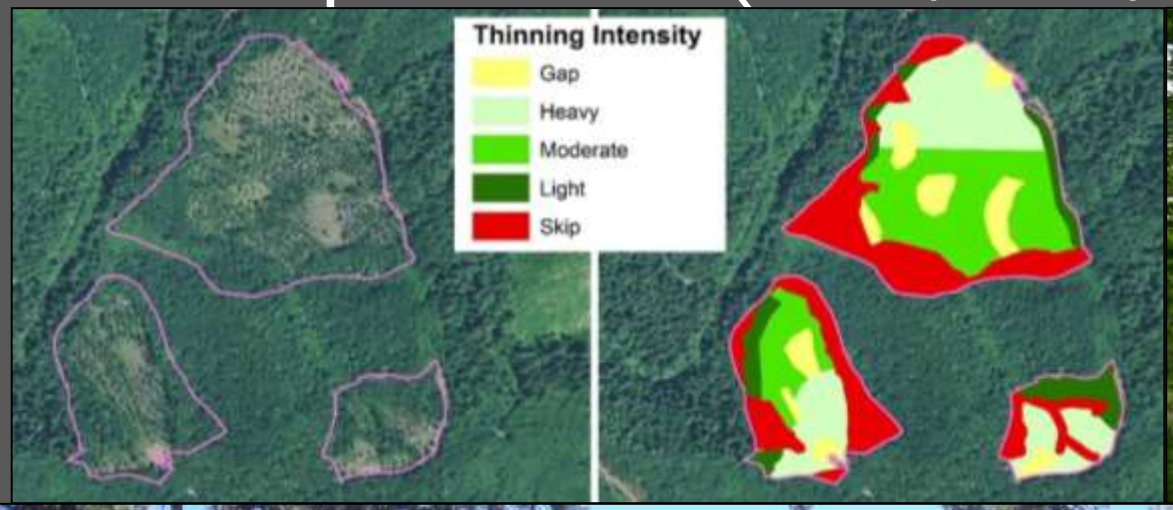
- What is being emulated?
  - Structures left behind by disturbance (living and dead legacies)

Gap-level retention of legacy trees



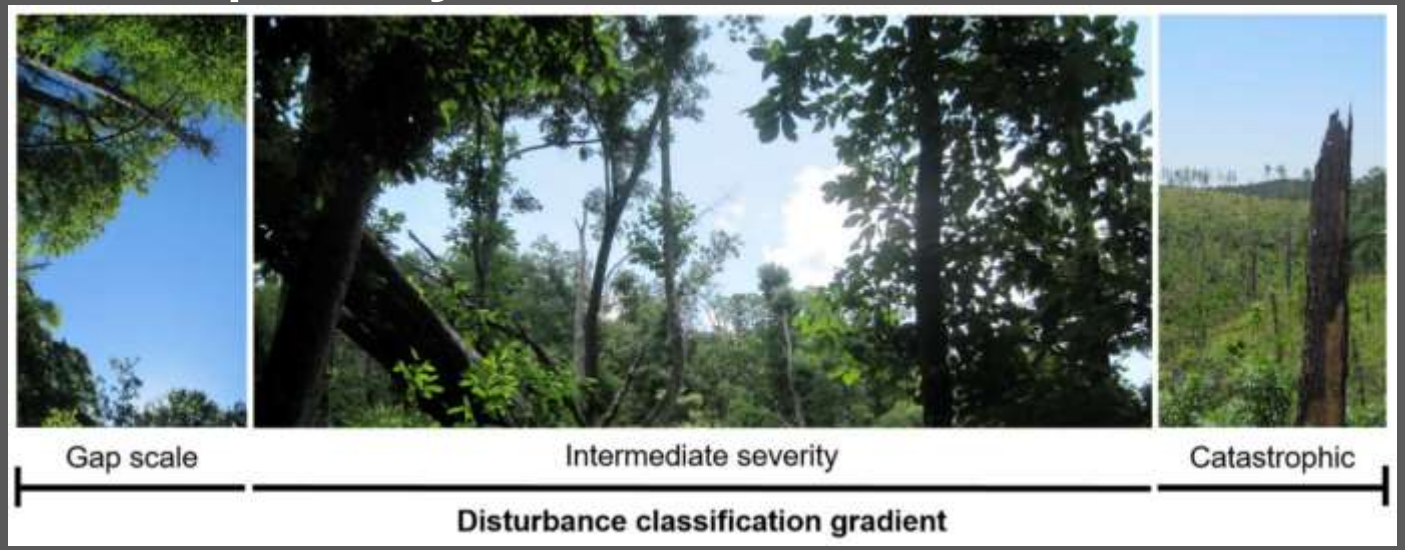
Natural disturbance-based silviculture

- What is being emulated?
  - Accumulated complexity in structure and composition at multiple scales (VDT, ICO, selection and irregular SW methods)



Natural disturbance-based silviculture

- What is being emulated?
  - Severity and frequency of disturbance



Hart and Kleinman (2019)

Single-tree and group selection

Irregular shelterwoods

Seed-tree and clearcut with reserves

Frequent, low severity archetype

Gap disturbance archetype

Mixed severity archetype

Infrequent, severe archetype


Simply retaining trees at harvest is not ecological silviculture!

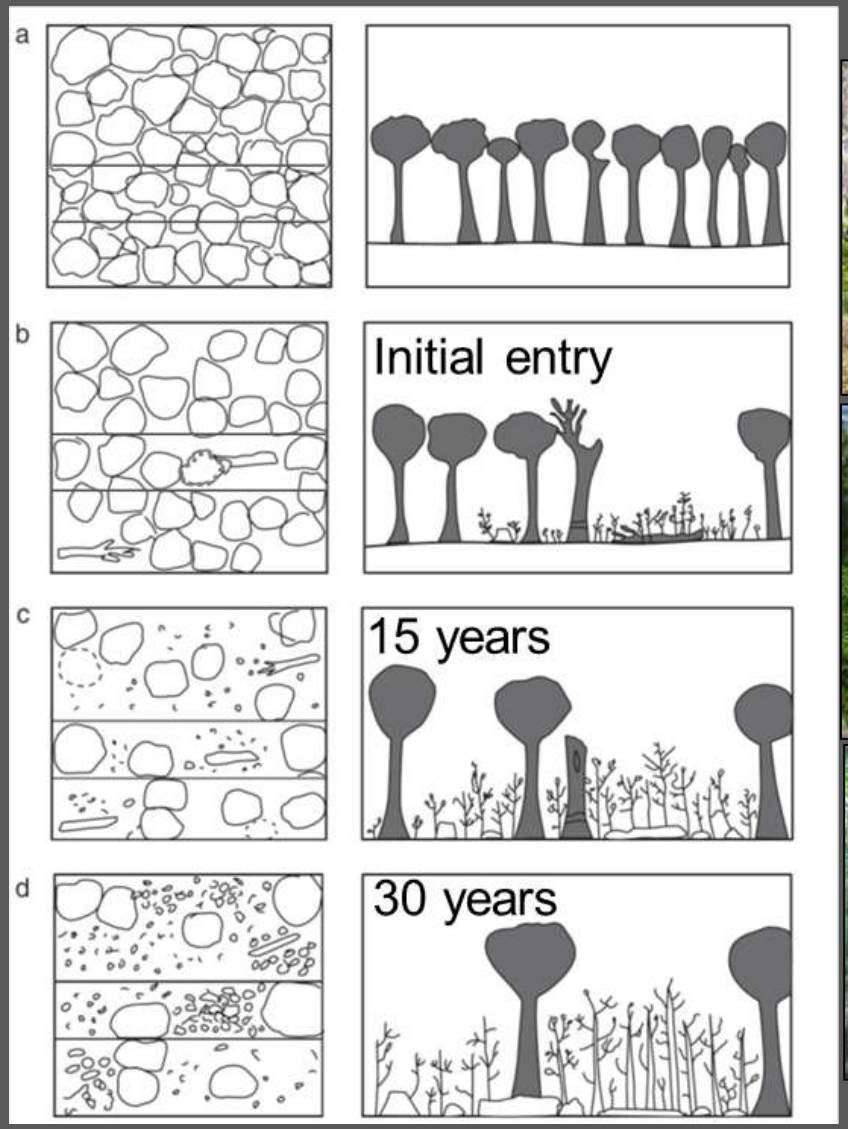
Ecological silvicultural systems

<u>Ecological silvicultural system</u>-long-term sequence of treatments for restoring, maintaining, and enhancing compositional diversity, ecological complexity, and heterogeneity

- Informed by understanding of natural disturbance dynamics and processes for a given community

Ecological silvicultural systems

Gap disturbance ecological system for northern hardwood forests



Initial: canopy gaps (0.1-0.5 ac) across 10-20% of stand to initiate cohort with placement where possible focused on cull and advance regeneration; in-gap retention and deadwood creation; crown thinning across remainder (60-70ft^2/ac stand wide)

Years 15 and 30: continued creation of canopy gaps and deadwood legacies in areas previously receiving crown thinning treatments (continuous cover irregular shelterwood) or expansion of initial gaps using expanding gap irregular shelterwood (10-20% of area in each entry)

Creates mosaic of structural and compositional conditions generated by natural disturbance with opportunity for adaptive decisions

Ecological silvicultural systems

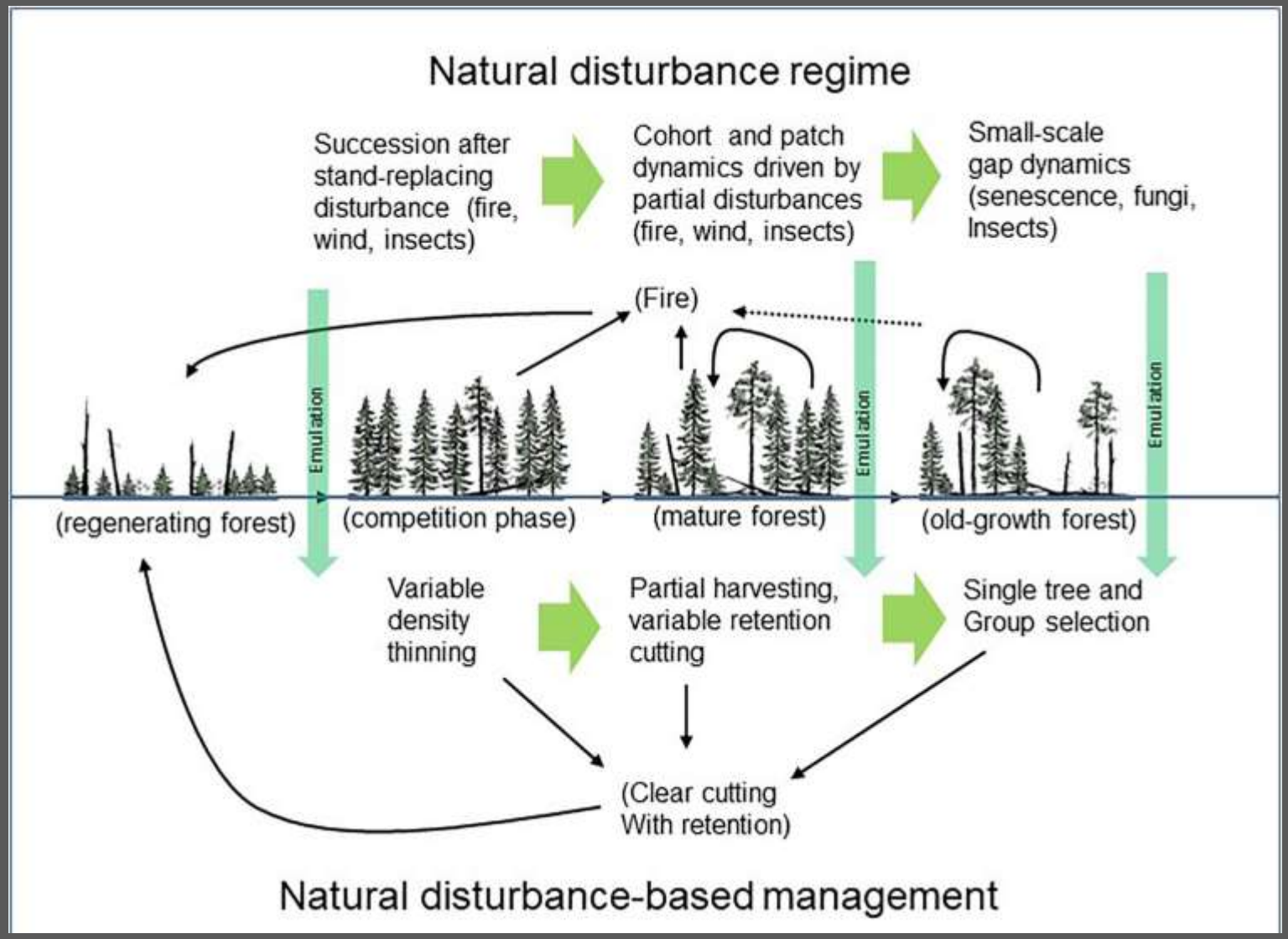
Mixed severity ecological system for Great Lakes mixed pine forests

Ecological Silvicultural System: Great Lakes Mixed-Pine Ecosystem		
Developmental Stage/Event	**Timing (yrs)**	**Example Activities**
Disturbance and Legacy Creation	0	Variable retention harvest (VRH)
Preforest	1 to 5+ (20+)	Site preparation; Competition control; regeneration
Young Forest (early)	5 to 30	Regeneration; browse control; release
Young Forest (later)	30 to 70	Variable density thinning (VDT))
Mature Forest	70 to 150	VDT; regeneration in VDT gaps; deadwood creation; competition control
		VRH
Old Forest	+150	Decadence/deadwood creation; VDT; regeneration in openings; competition control ; VRH?

Palik et al. (2020)

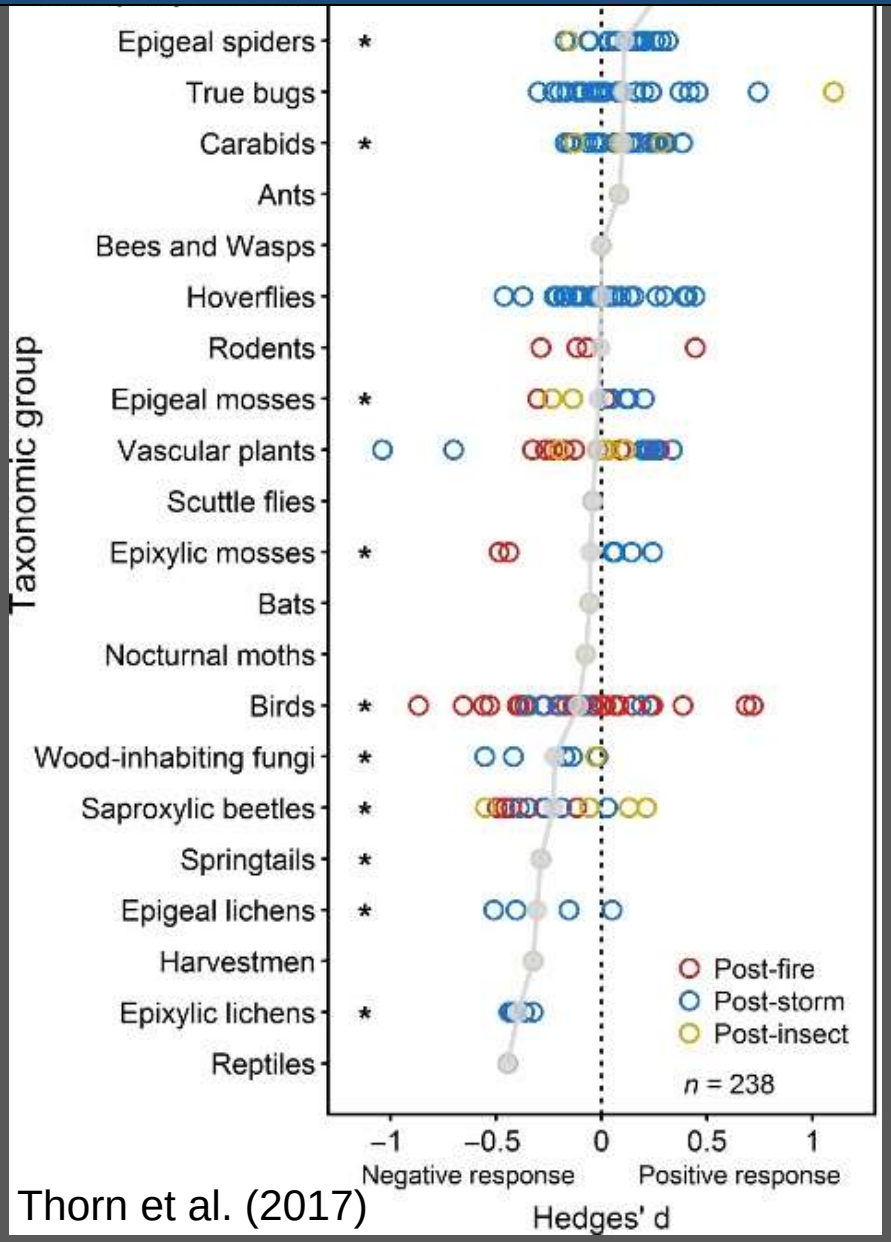
Ecological silvicultural systems

Kuulivainen et al. (2021)



Salvage logging considerations

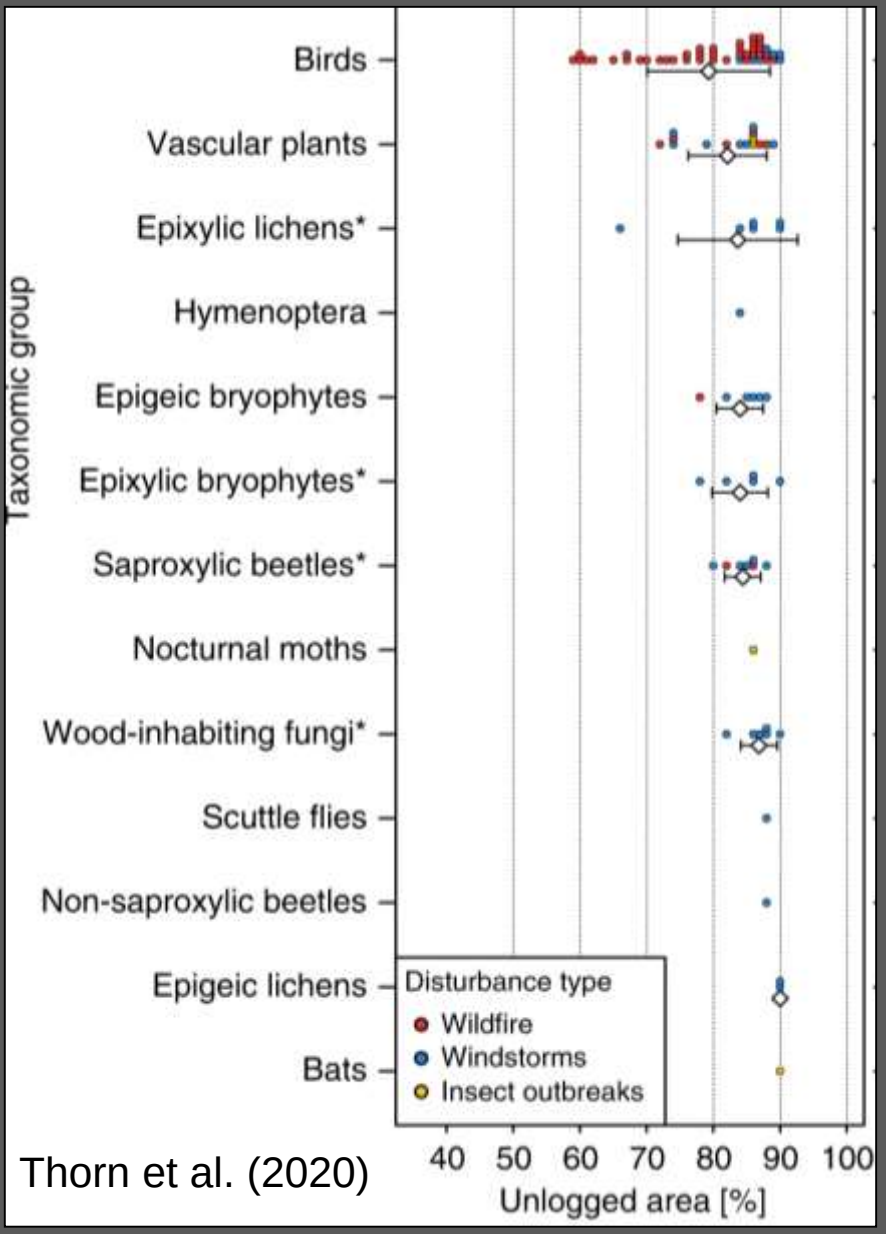
Salvage logging considerations



Thorn et al. (2017)

Loss of biodiversity following salvage logging tied to reduction in: **1)** abundance and diversity of legacies and **2)** heterogeneity in forest conditions at stand and landscape

Salvage logging considerations

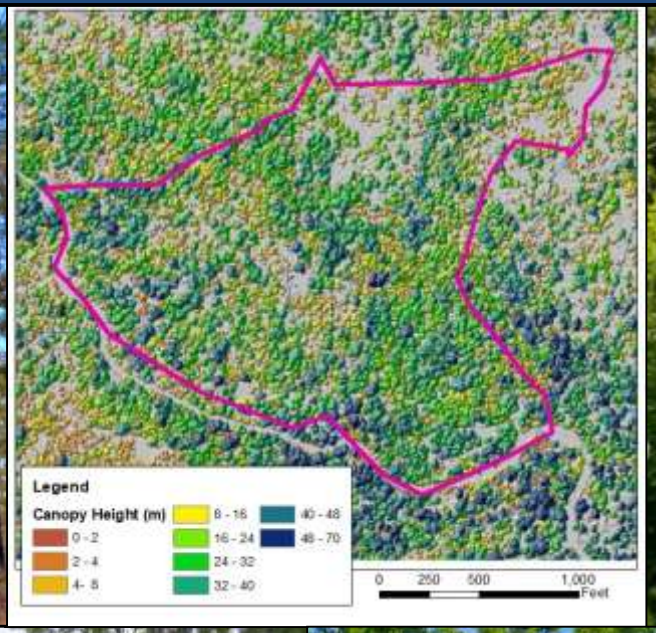


Thorn et al. (2020)

Salvage logging can follow same principles used for managing living trees (leave future options; retain key structures; restore and maintain complexity)

- ~50-90% retention necessary to sustain species unique to naturally-disturbed areas

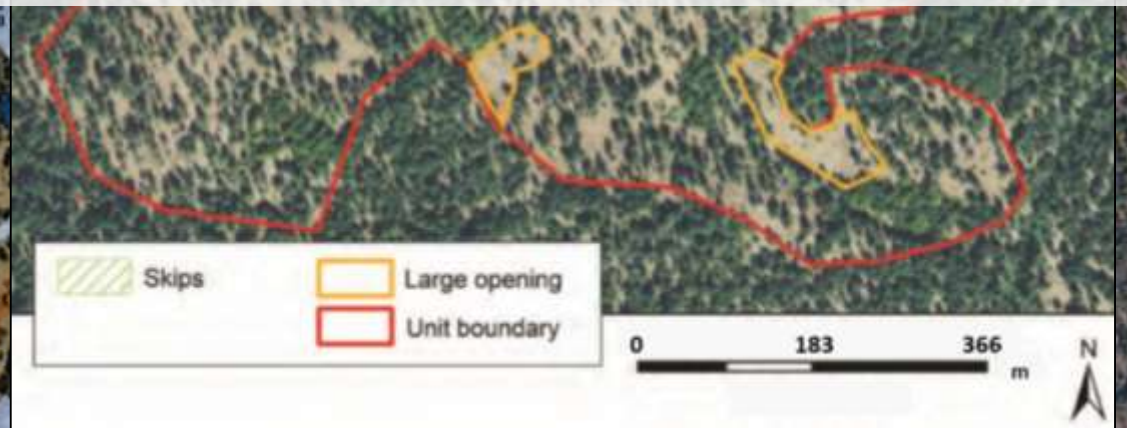
Adaptation outcomes

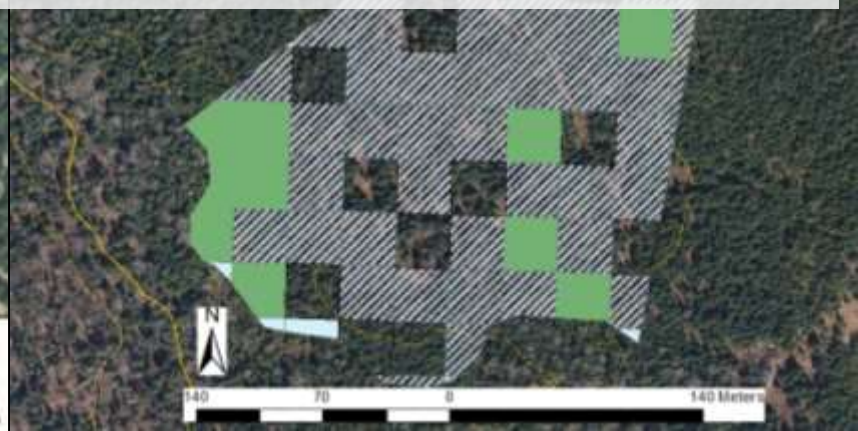




Natural disturbance-based silviculture confers adaptation by:

- Creating conditions that express range of sensitivities to future climate change and disturbance impacts at multiple scales
- Generating multiple opportunities and pathways for persistence, recovery, and reassembly

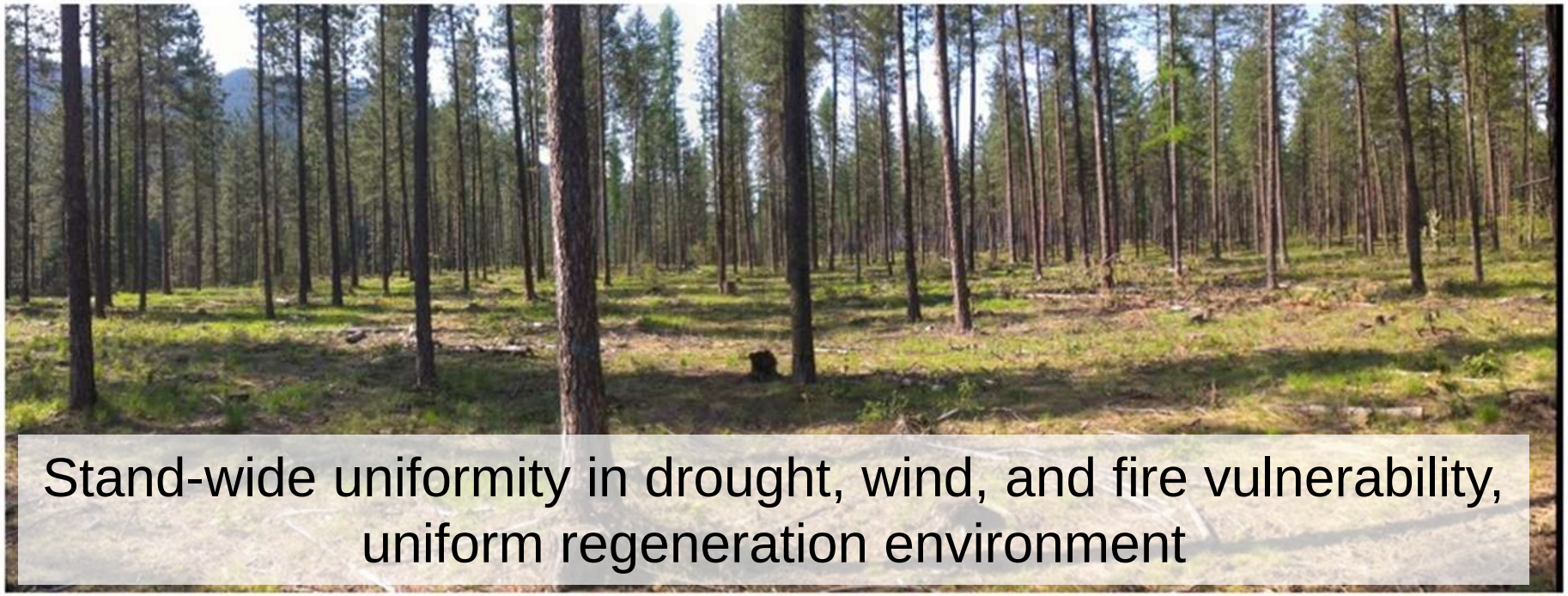


51 m^2 ha^{-1}
- Fall temp
+ August precip

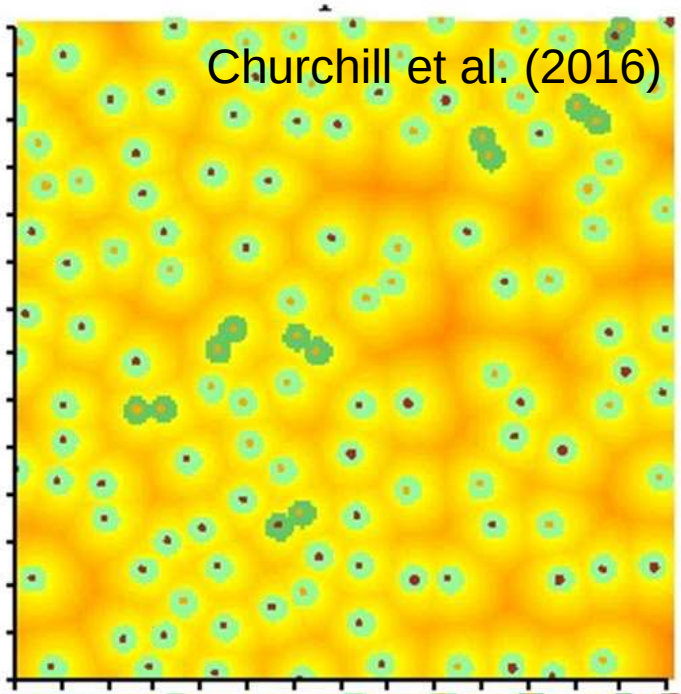
21 m^2 ha^{-1}
- Summer temp

7 m^2 ha^{-1}
- Fall temp

Within-stand heterogeneity in size and density = Complexity in climate and disturbance response

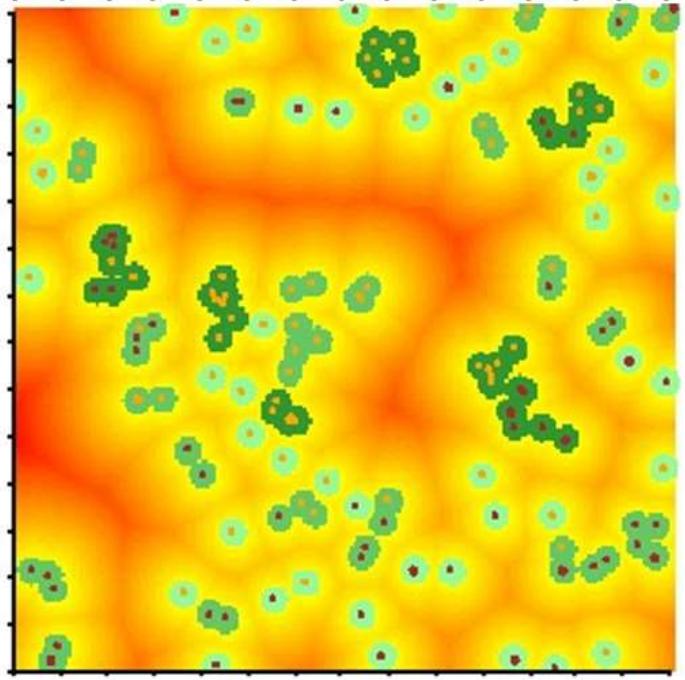


Stand-wide uniformity in drought, wind, and fire vulnerability, uniform regeneration environment



Churchill et al. (2016)

Within-stand variability in drought, wind, and fire vulnerability; multiple regeneration environments



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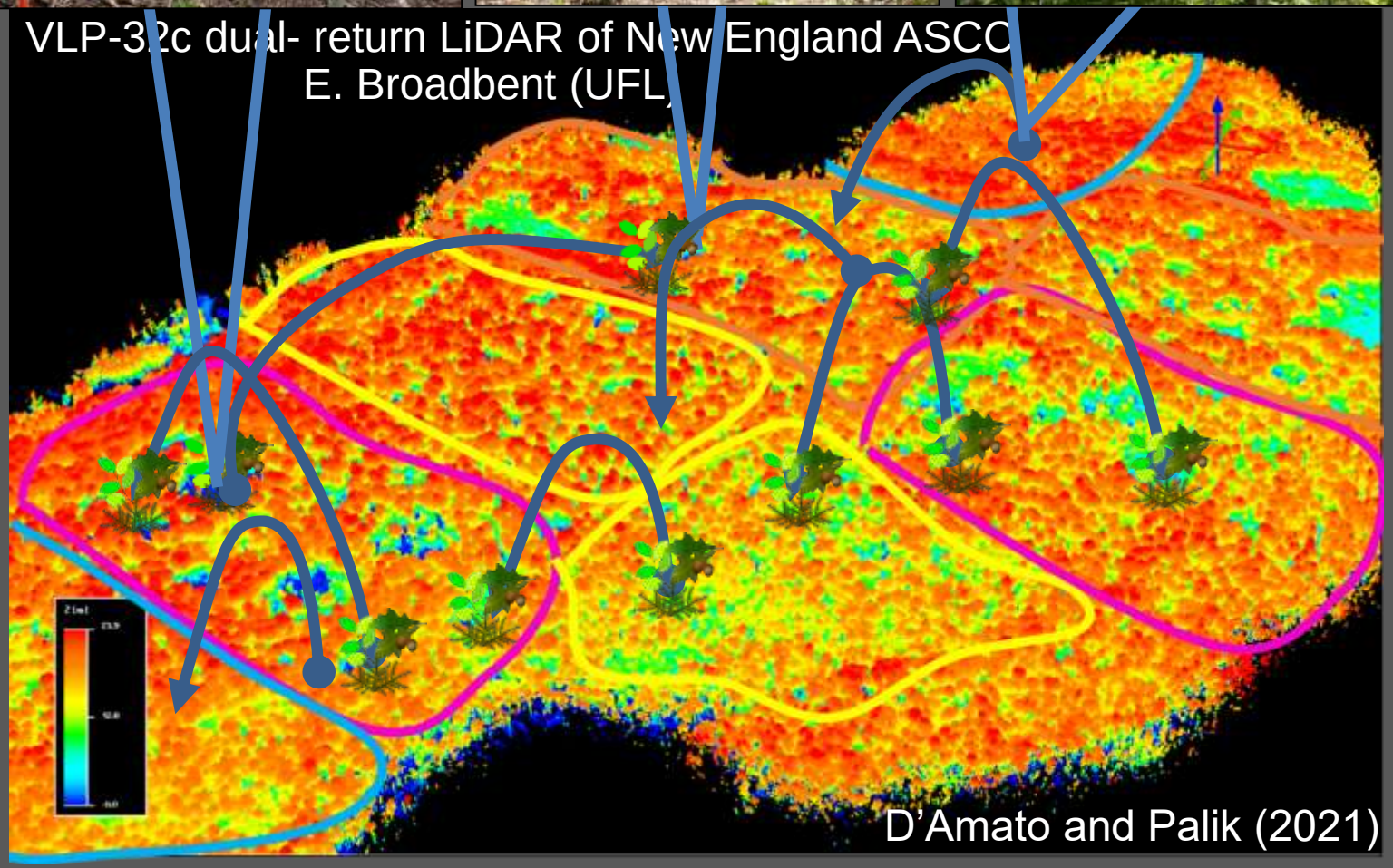
VLP-32c dual- return LiDAR of New England ASCC
E. Broadbent (UFL)



D'Amato and Palik (2021)

evant scales (micro stand)

Stand-level and landscape heterogeneity in resources, microsites, propagule pressure, and interaction strength provide useful template for more deliberate adaptation strategies (planting of future-adapted genotypes and species)

- "Micro stands" represent unique nodes in broader complex, adaptive network of conditions (cf. Messier et al. 2019)

Conclusions

- Natural disturbance-based silviculture provides opportunity to generate patch, stand, and landscape conditions consistent with habitat needs for wide range of forest-dependent wildlife species
- Increasing frequency and severity of disturbance requires greater emphasis on thoughtful, proactive (versus reactive) ecological silviculture strategies
- Although based on “natural” systems, principles and outcomes of ecological silviculture provide useful building blocks for prescriptions that address novel challenges and objectives





Thanks!