Seed source impacts on whitebark pine regeneration dynamics post-fire

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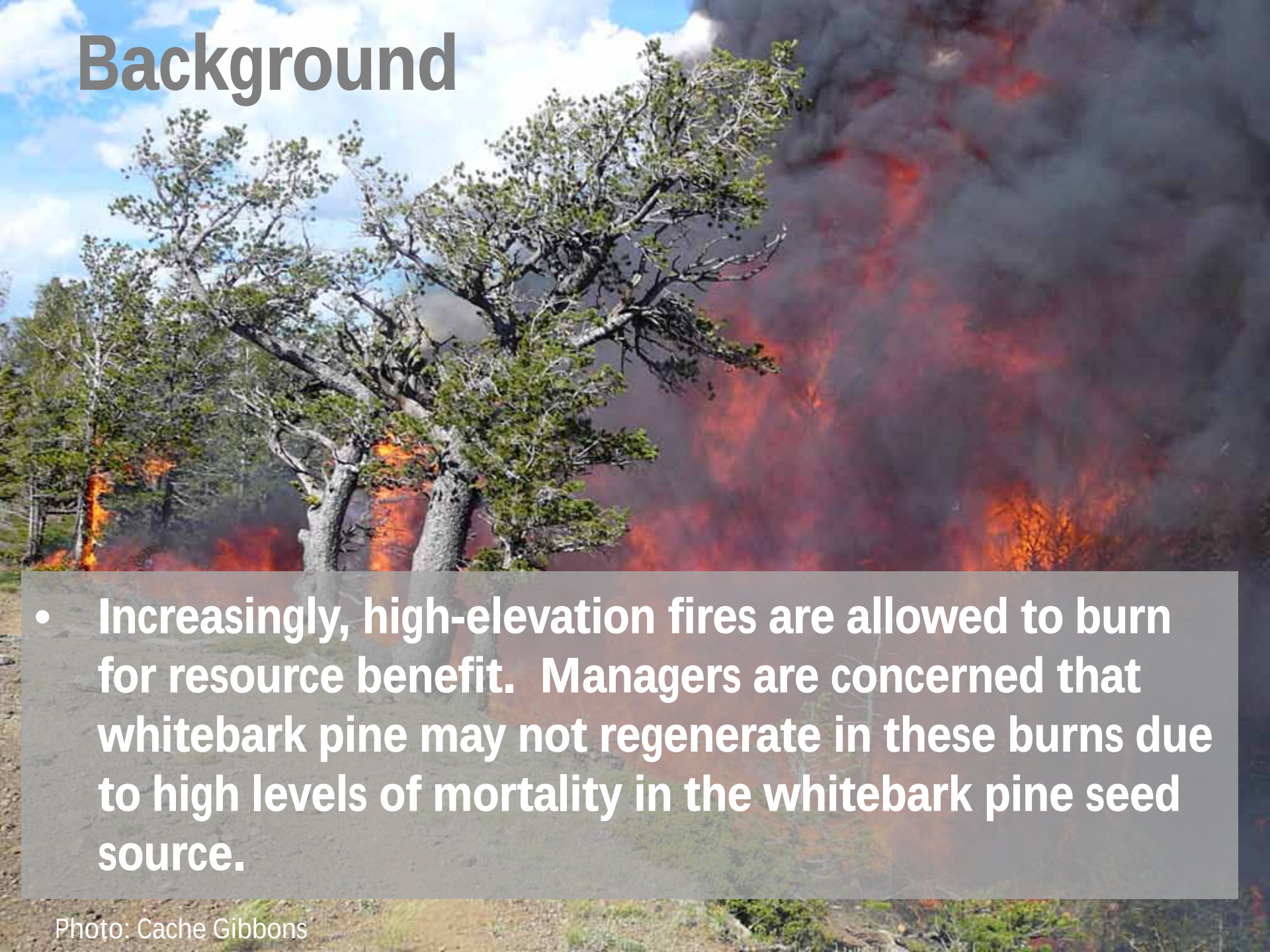
FireLab

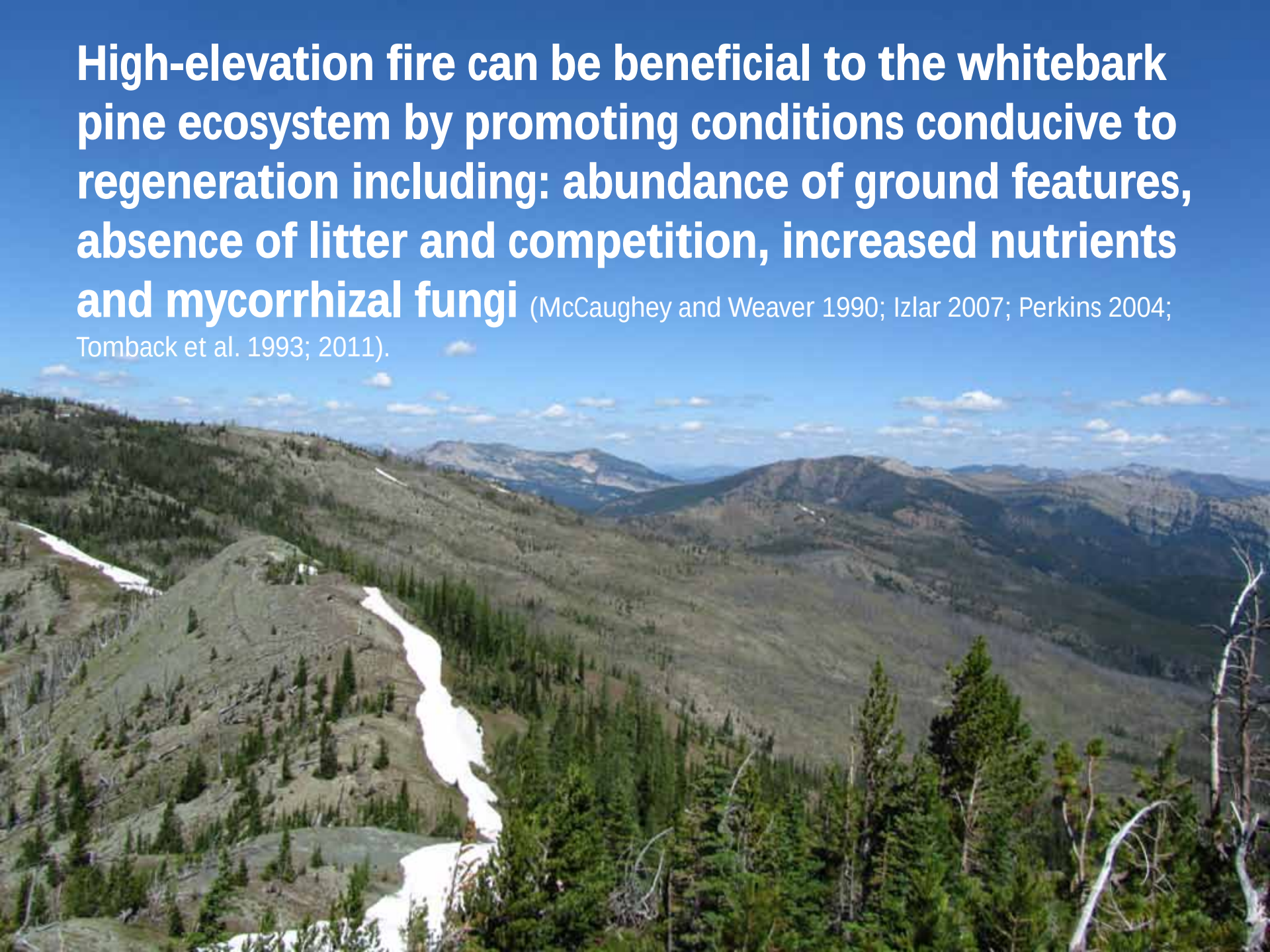
Background

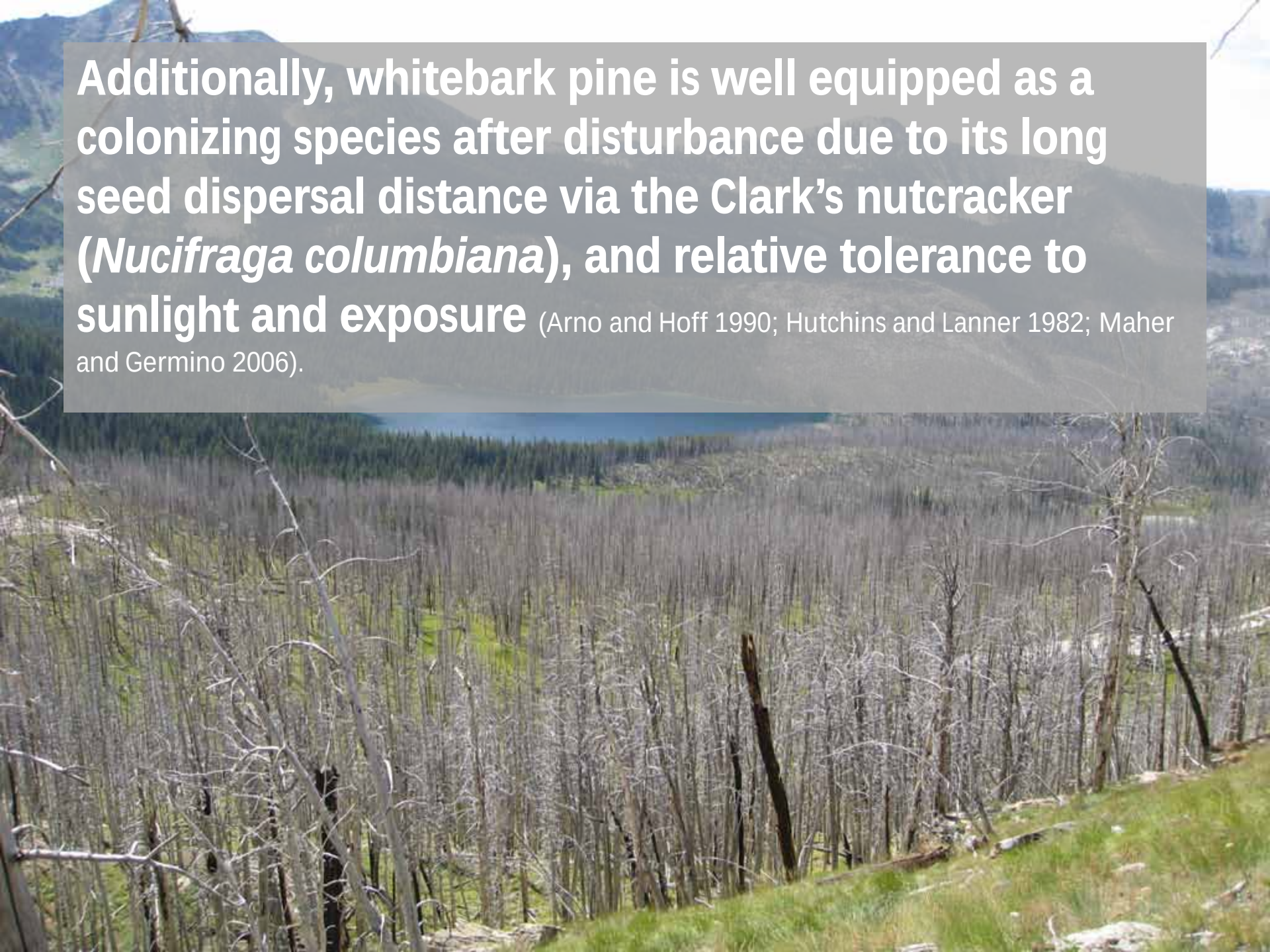


- **Increasingly, high-elevation fires are allowed to burn for resource benefit. Managers are concerned that whitebark pine may not regenerate in these burns due to high levels of mortality in the whitebark pine seed source.**

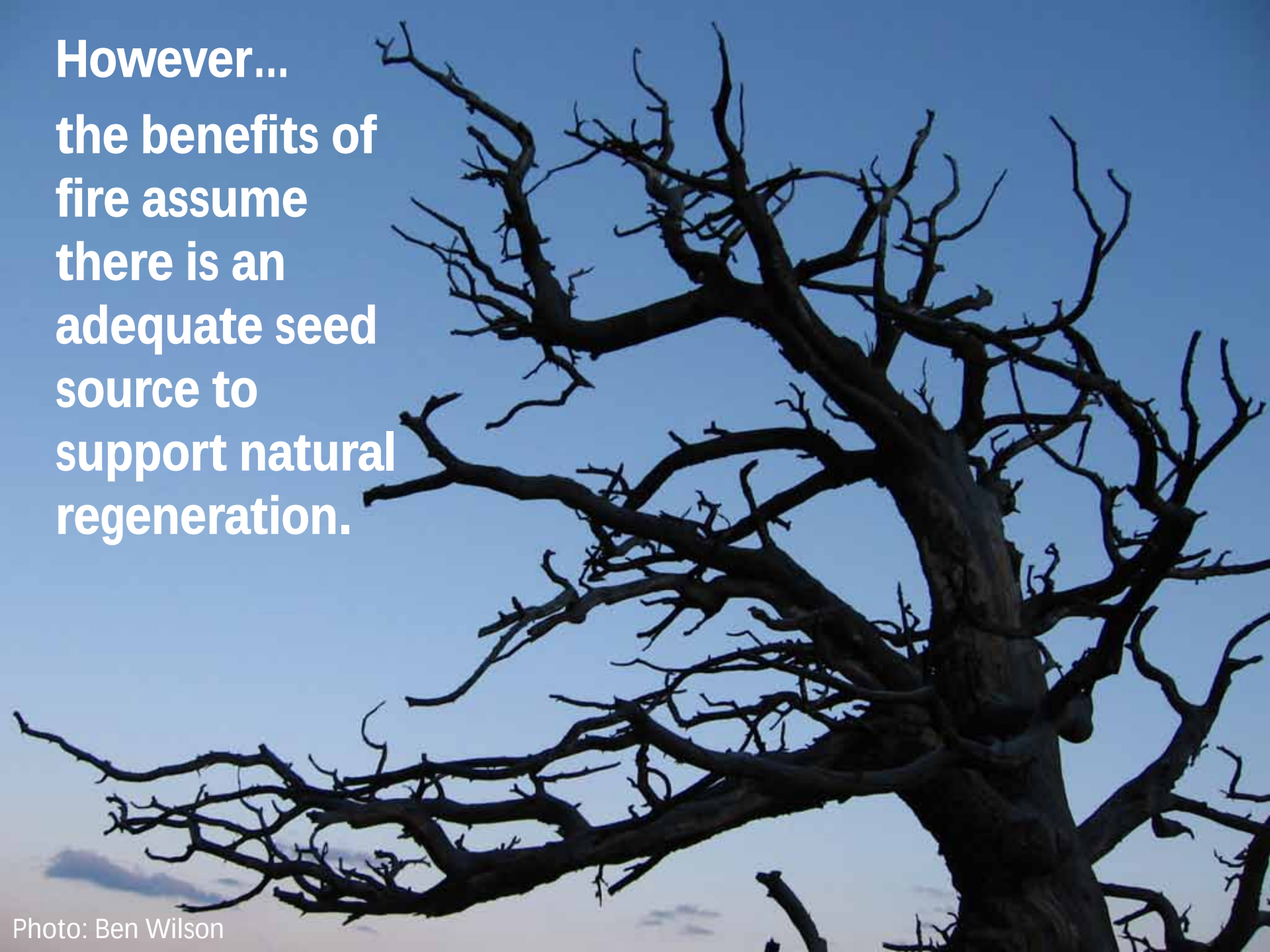
Photo: Cache Gibbons

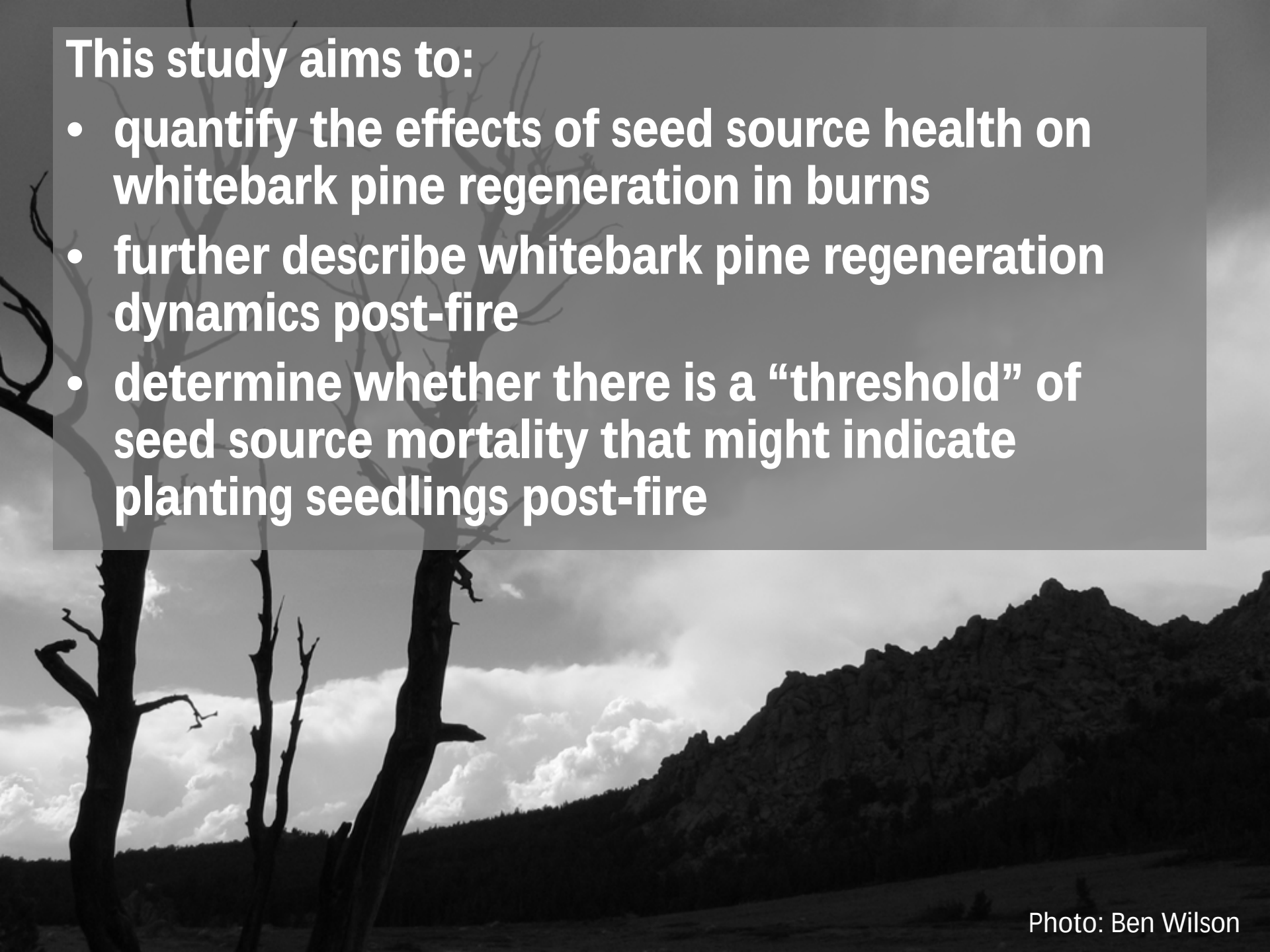
High-elevation fire can be beneficial to the whitebark pine ecosystem by promoting conditions conducive to regeneration including: abundance of ground features, absence of litter and competition, increased nutrients and mycorrhizal fungi (McCaughey and Weaver 1990; Izlar 2007; Perkins 2004; Tomback et al. 1993; 2011).





Additionally, whitebark pine is well equipped as a colonizing species after disturbance due to its long seed dispersal distance via the Clark's nutcracker (*Nucifraga columbiana*), and relative tolerance to sunlight and exposure (Arno and Hoff 1990; Hutchins and Lanner 1982; Maher and Germino 2006).


However...
the benefits of fire assume there is an adequate seed source to support natural regeneration.
Photo: Ben Wilson



This study aims to:

- quantify the effects of seed source health on whitebark pine regeneration in burns
- further describe whitebark pine regeneration dynamics post-fire
- determine whether there is a “threshold” of seed source mortality that might indicate planting seedlings post-fire

Photo: Ben Wilson

2004 – 2005:

Tomback et al. sampled 5 sites

Year Burned	Name of Burn	Size of Burn (ac/ha)	Study Area
1985	Charlotte Peak	5893/2385	Bob Marshall Wilderness Area
1994	Helen Creek	7032/2846	Bob Marshall Wilderness Area
1984	Red Owl	1460/591	Flathead National Forest
1998	Challenge Creek	9504/3846	Flathead National Forest
1987	Coal Creek	clearcut	Flathead National Forest

2010-2013:

Firelab crew sampled 11 additional burns

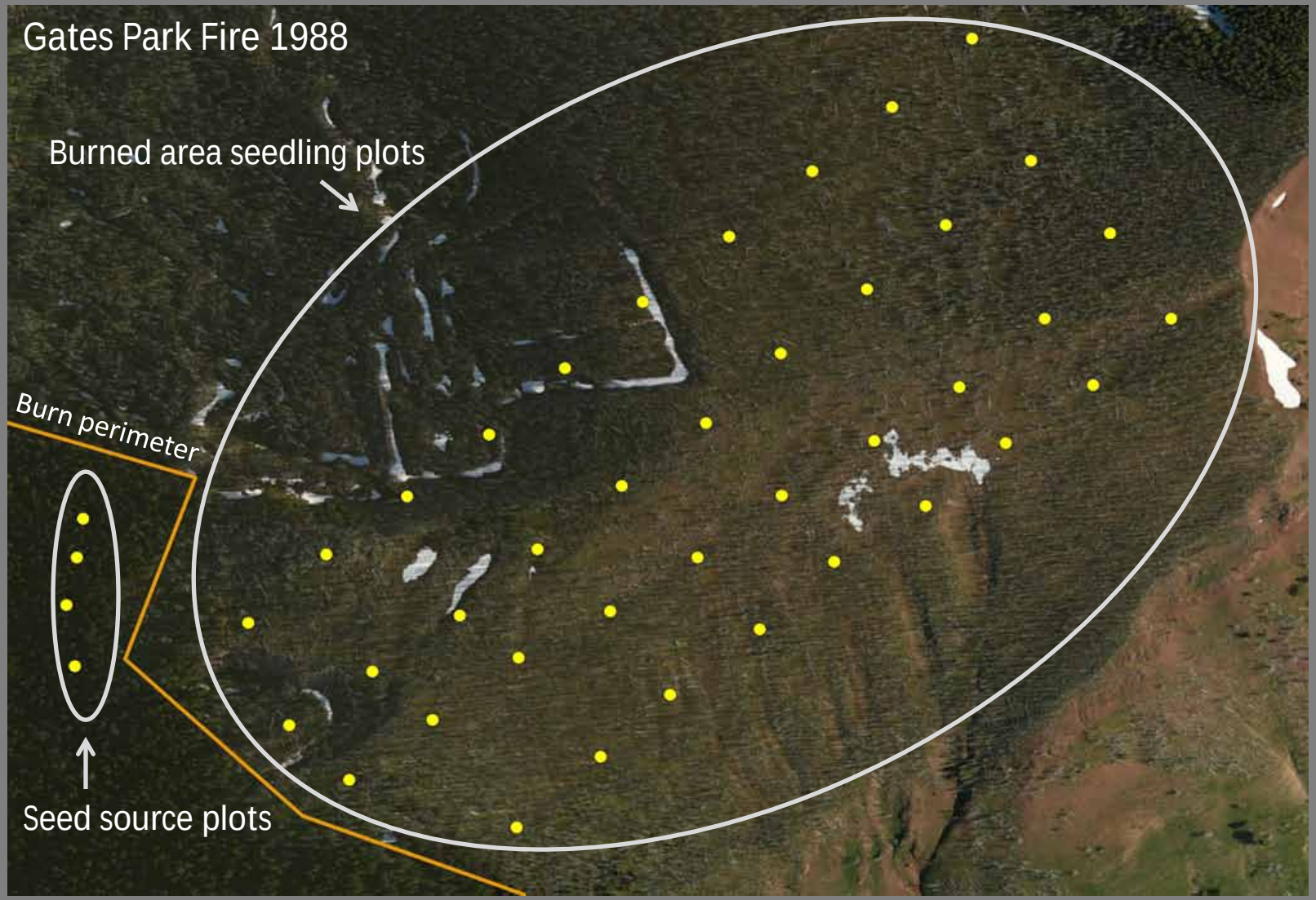
Year Burned	Name of Fire	Size of Burn (ac/ha)	Study Area
1988	Canyon Creek	200,060/80,961	Scapegoat Wilderness Area
1988	Canyon Creek	200,060/80,961	Scapegoat Wilderness Area
1988	Gates Park	54,592/22,093	Bob Marshall Wilderness Area
2000	Mussigbrod	27,622/11,178	Anaconda - Pintler Wilderness Area
2000	Monture	23,781/9,624	Bob Marshall Wilderness Area
2007	Wyman	35,520/14,374	Bitterroot /Beaverhead-Deerlodge National Forest
1994	Ann	3,125/1,265	Bitterroot /Beaverhead-Deerlodge National Forest
2000	Beaver	10,683/4,323	Gallatin National Forest
2000	Skalkaho	7,480/3,027	Bitterroot National Forest
2000	Fall Fork	2,100/850	Anaconda – Pintler Wilderness Area
2007	Pattengail (or Pettengill)	15,300/6,192	Beaverhead-Deerlodge National Forest

Methods

Photo: Ben Wilson

- Study areas were identified using GIS analysis and local knowledge
- Study sites consisted of a stand-replacing burn at least 100 ha in size adjacent to an unburned whitebark pine seed source
- Burns were between 5 and 30 years old
- 40-50 burned area plots (15m², circular) were measured on transects in a grid with 100m spacing
  - Assessed: age and health of individual whitebark pine seedlings and saplings, ground features, tally of other conifers by height class, vegetation and ground cover, slope, aspect and elevation
- 4-5 seed source plots (0.04ha, 0.1ac circular) were established adjacent to the burn, but at least 100m from the edge with 50m spacing
  - Assessed: mature trees, snags, seedlings and saplings, canopy characteristics, tree health, whitebark pine mortality agents (MPB and blister rust), ground cover, dominant vegetation and habitat type, slope, aspect, and elevation

Plot Layout


Gates Park Fire 1988
Burned area seedling plots
Burn perimeter
Seed source plots

Analysis consists of two parts:

- Describe the relationship between site-level factors and seedling densities BETWEEN burns

  Site factors include:

  -seed source health

  -seed source size

  -mean slope and aspect of burn

  -regional climate data

- Describe microsite factors that might influence seedling presence/absence or abundance WITHIN burns

  Microsite factors include:

  -distance to seed source

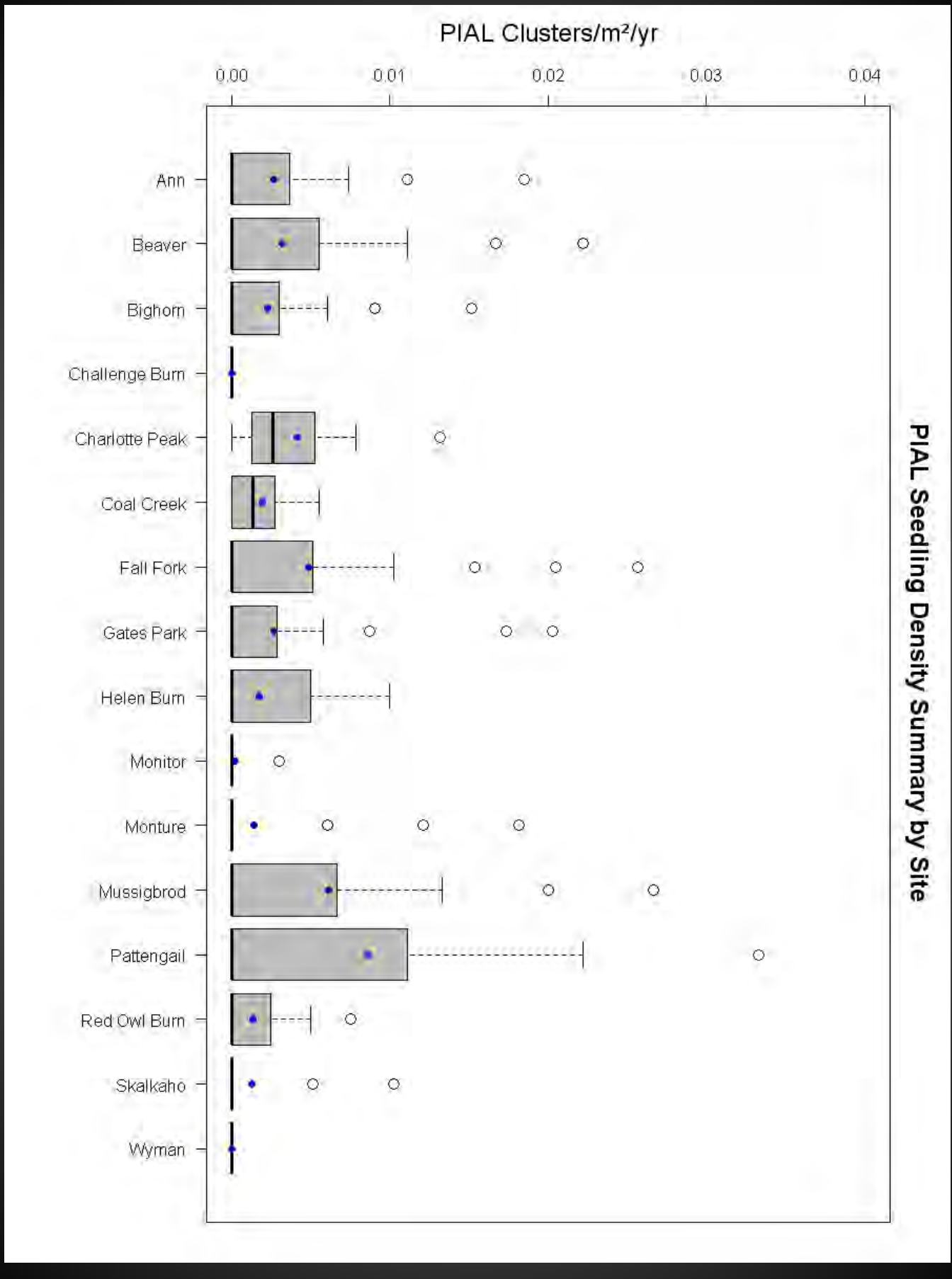
  -slope, aspect, elevation

  -ground/vegetation cover

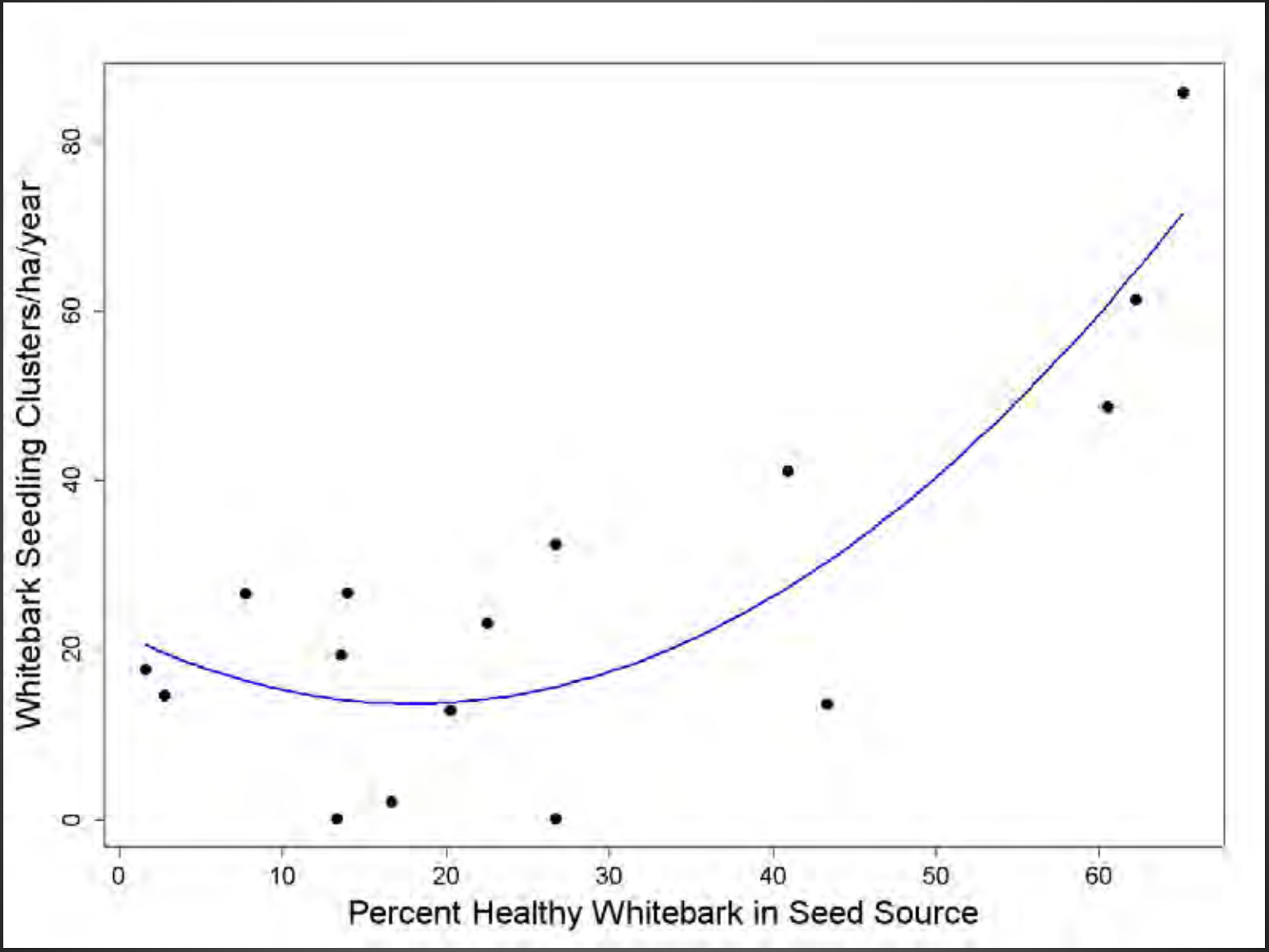
  -burn severity

  -relative moisture

Results


PIAL Clusters/m²/yr
0.00
0.01
0.02
0.03
0.04
Ann
Beaver
Bighorn
Challenge Burn
Charlotte Peak
Coal Creek
Fall Fork
Gates Park
Helen Burn
Monitor
Monture
Mussigbrod
Pattengail
Red Owl Burn
Skalkaho
Wyman
PIAL Seedling Density Summary by Site

Seed source health matters…



%healthy PIAL + (%healthy PIAL)^2, $p<0.01$, adjusted $R^2= 0.70$, 13 d.f.

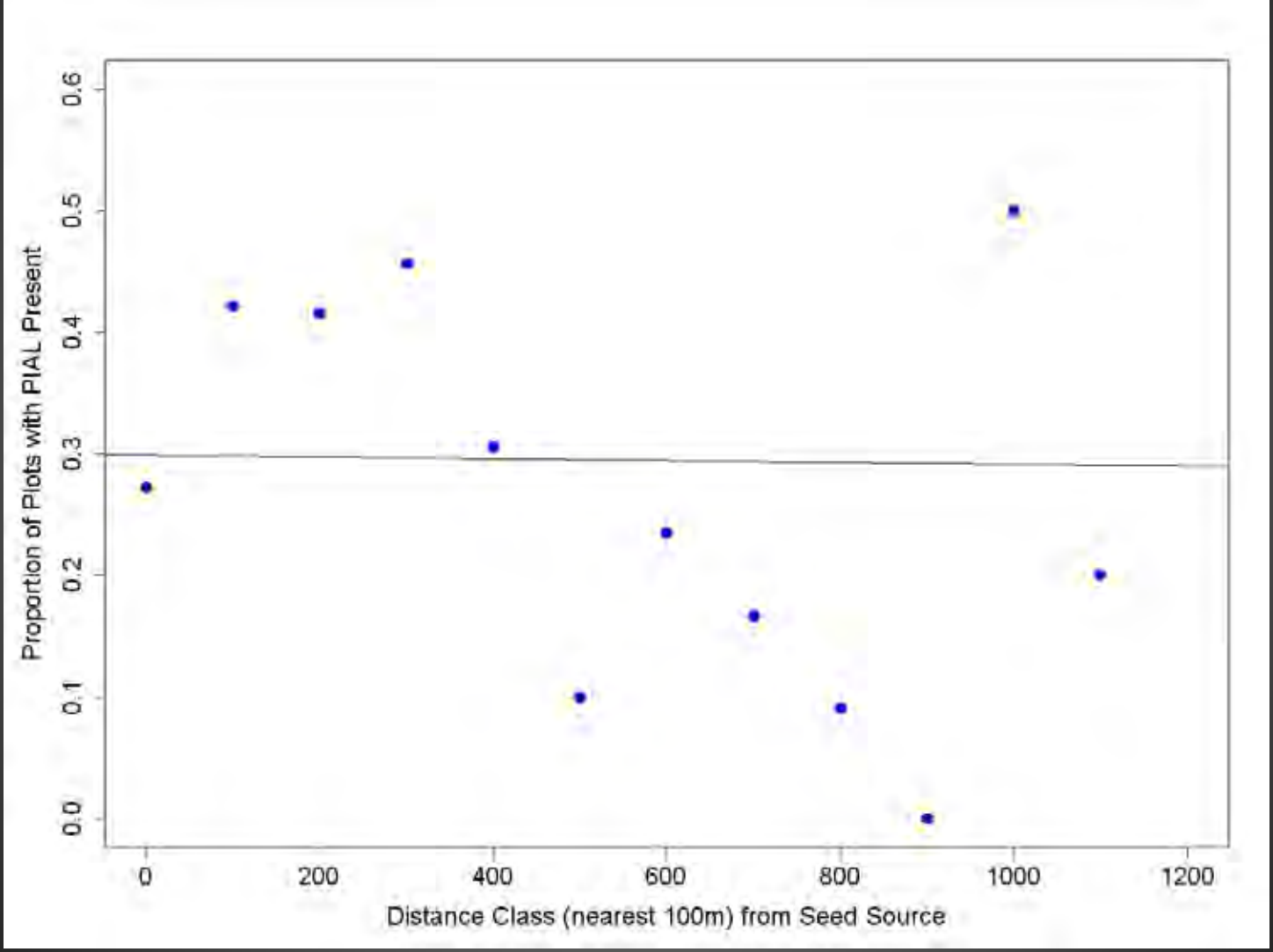
Insignificant predictors:

- Mature whitebark pine basal area (basal area and percent healthy are mildly correlated)
- Percent unhealthy + healthy
- Percent sick + dead
- Percent dead
- Interactions between basal area and health classes

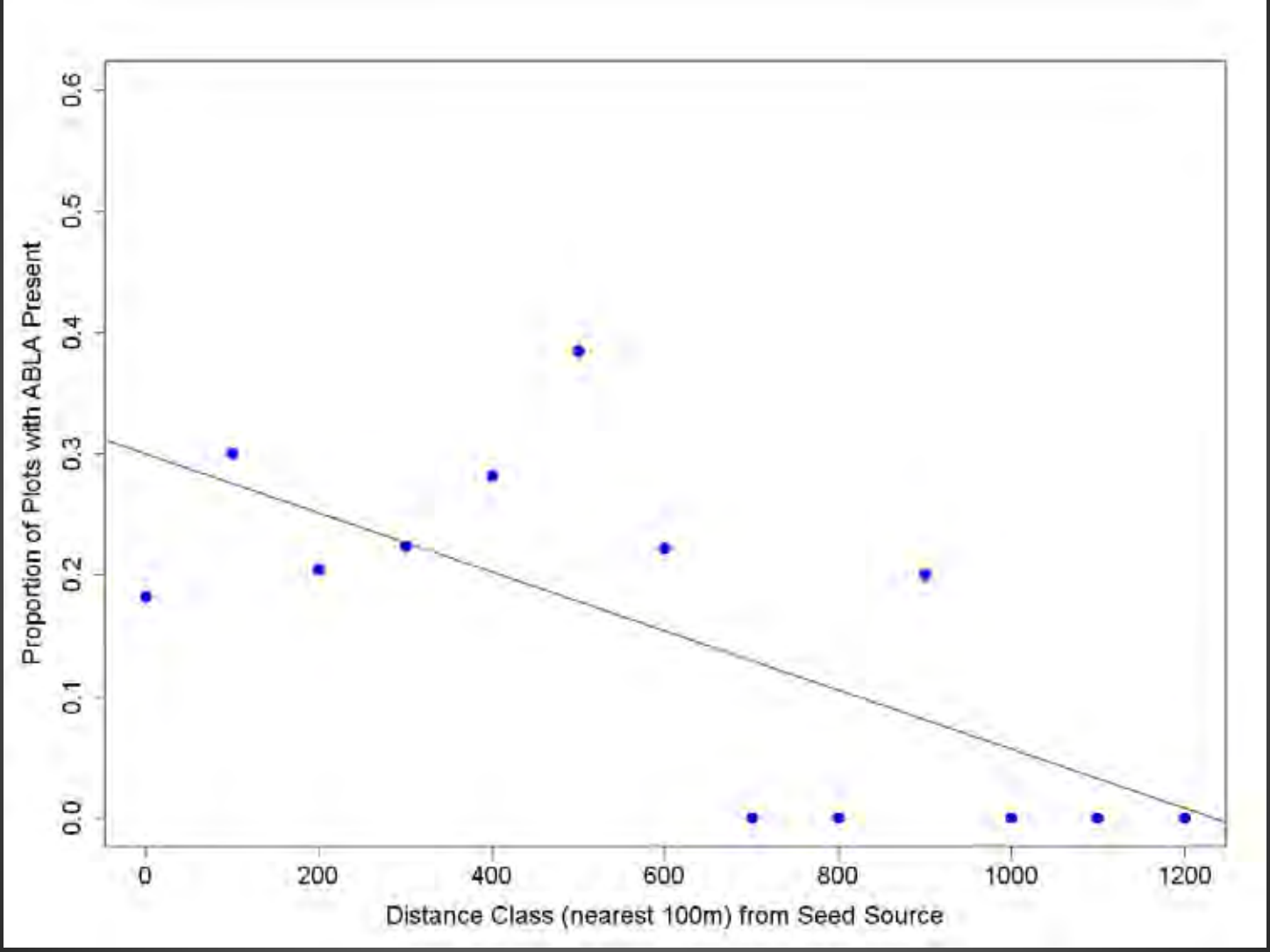
Distance to seed source analysis:

- Used ArcMap “distance from point to nearest polygon” feature
- Species specific seed source polygons were identified for each burn using burn severity data, imagery and field observations
- Large, unburned patches within the burn perimeters were included in the seed source polygons
- This analysis does not include any plots < 100m from the seed source, where there are likely fine scale relationships

Distance to seed source appears to be insignificant for whitebark pine…



Distance to seed source is significant for subalpine fir…



$P<0.01$, $R^2 = 0.43$

Implications of results – so what?

- Despite various factors that could potentially affect whitebark pine seedling recruitment and establishment, there is a strong relationship between seedling density and seed source health
- If at least 50 percent of the seed source trees are healthy, natural regeneration may be adequate and planting whitebark seedlings post-fire may be unnecessary
- This “50% threshold” may help managers justify or preclude planting seedlings post-fire (need to consider rust-resistance objectives)
- It appears that “distance to seed source” is an insignificant predictor of whitebark pine seedling presence at a coarse scale, therefore may not be a limiting factor in regeneration potential of the species

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