Upland Oak Silviculture

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Fei et al. 2008

Nearly 25% of all growing stock on timberland in the eastern US in oak (Smith et al. 2003)

Many regional studies have indicated significant declines in oak abundance (Johnson 1976, Abrams and Nowacki 1992, Lorimer 1993).

Declines are presumably related to new disturbance regimes, fire suppression, invasion of exotics, climate change, wildlife, and forest management practices

Oak-hickory is the single-most valuable forest type to wildlife

Moderate canopy shade encourages understory growth

"Acorns are a keystone to biological diversity"
– Dr. Cathryn Greenburg – U.S. Forest Service

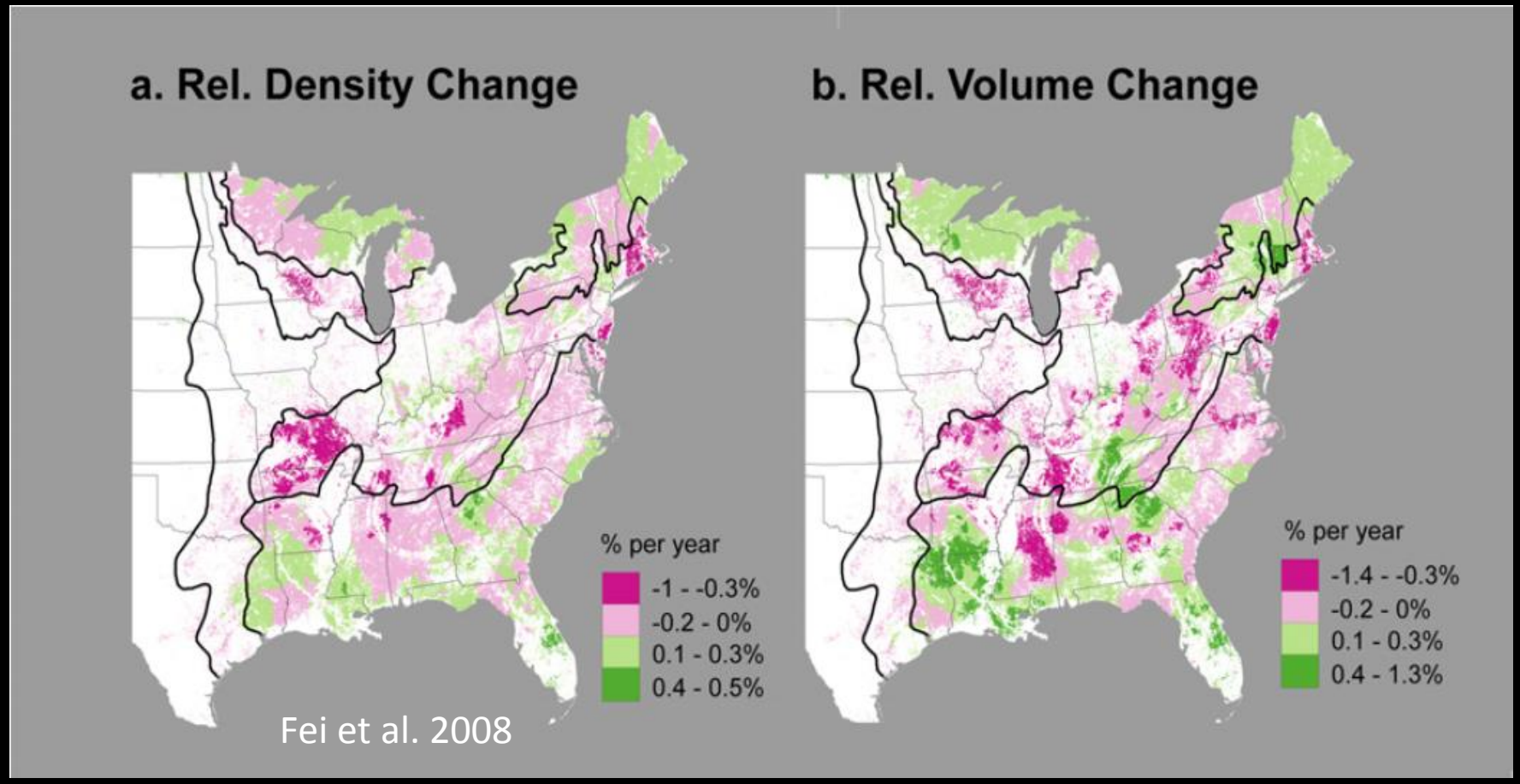
Many tree species produce hard or soft mast

Changes in Oak Cover from 1980 to 2008

Over 20 years, in the central hardwood region:

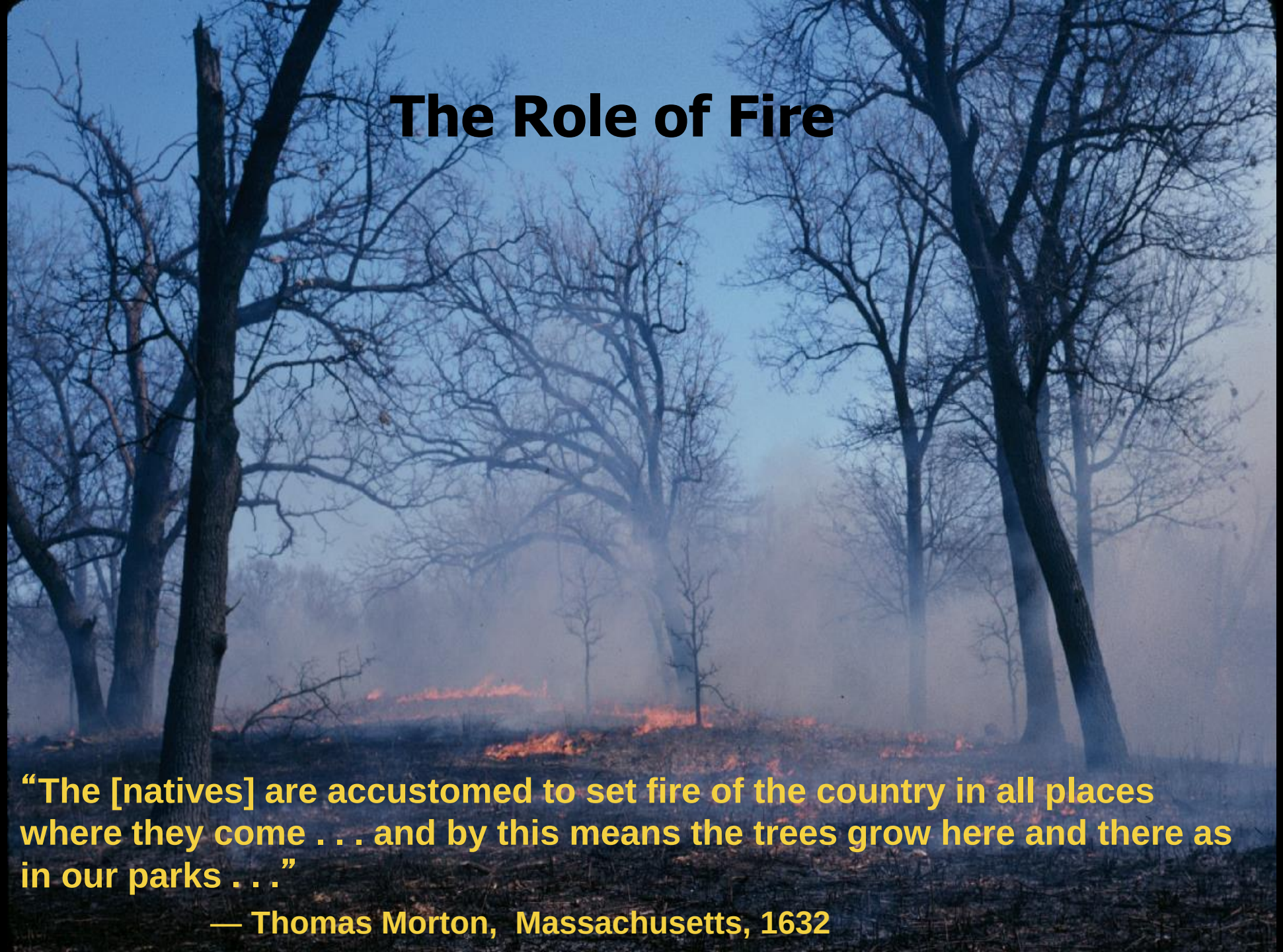
2.4% decrease in relative density

2.2% decrease in relative volume



Fei et al. 2008

The Role of Fire



“The [natives] are accustomed to set fire of the country in all places where they come . . . and by this means the trees grow here and there as in our parks . . .”

— Thomas Morton, Massachusetts, 1632

Possible explanatory hypothesis:

Natural habitat for oak species is mostly on dry, marginal sites, where it is easily capable of self-perpetuation.

It was only widespread burning by native Americans and early settlers that allowed oak to expand onto mesic sites

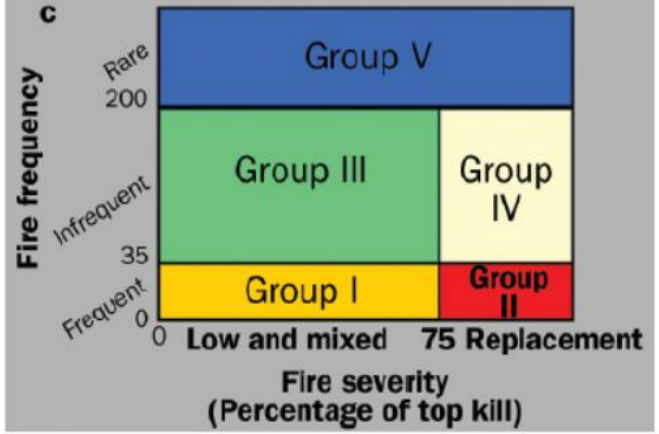
Oak: Fire-Adapted

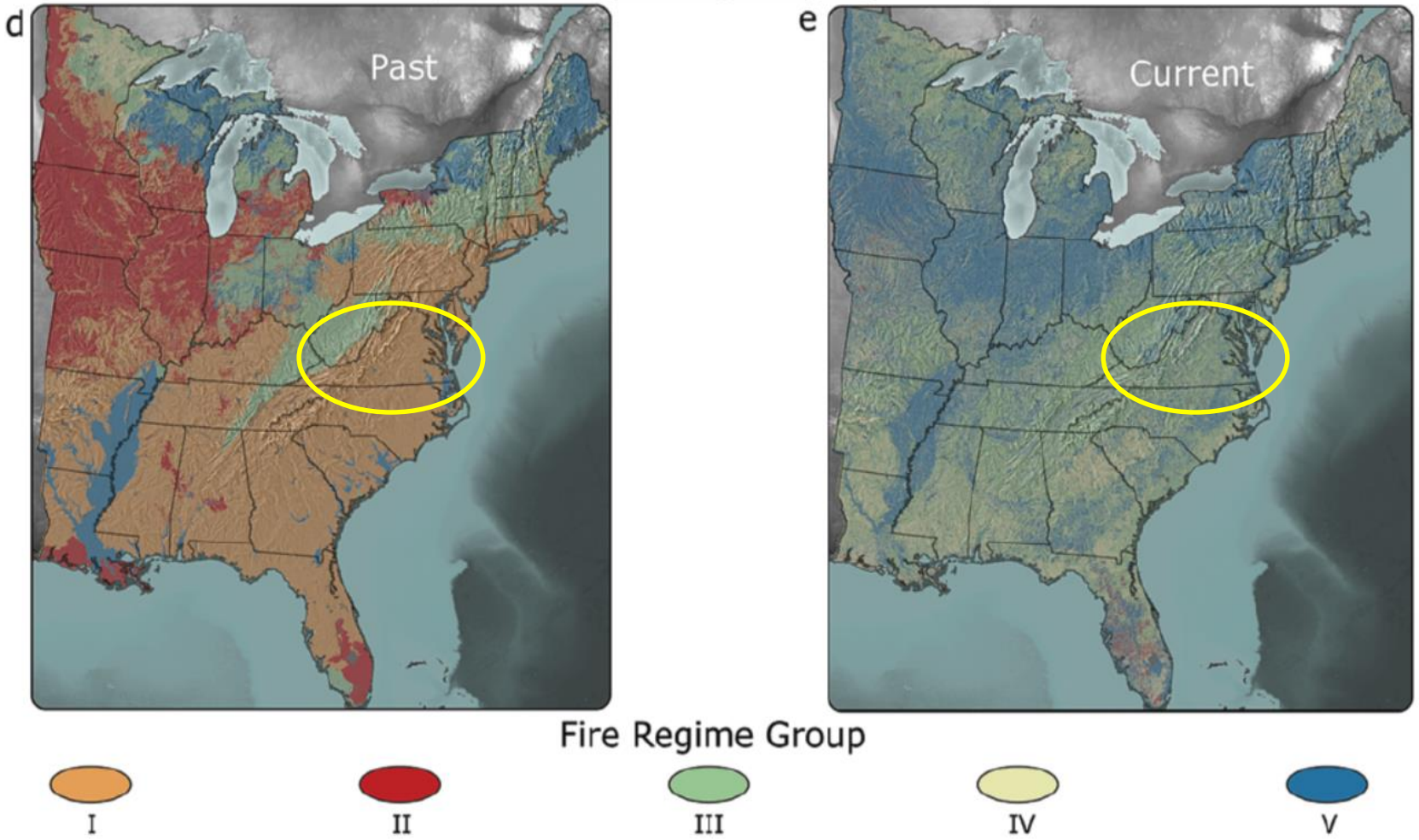
- Shoot growth of oak seedlings is slow because resources are preferentially allocated to roots
- Height growth cannot compete with other species
- Oak seedling *sprouts* post-fire, however, are more competitive than oak seedlings (Kruger and Reich 1993)

Photo: Smith et al. 2016
After bumper crop: 30,000 to 40,000 seedlings per acre; 3 years later: 100 per acre

Photo Credit: Jean Lorber

Nowacki and Abrams, 2008





Since the 1930s, fire suppression has nearly eliminated fire as a forest disturbance

Historically

Present Day

Mesophication

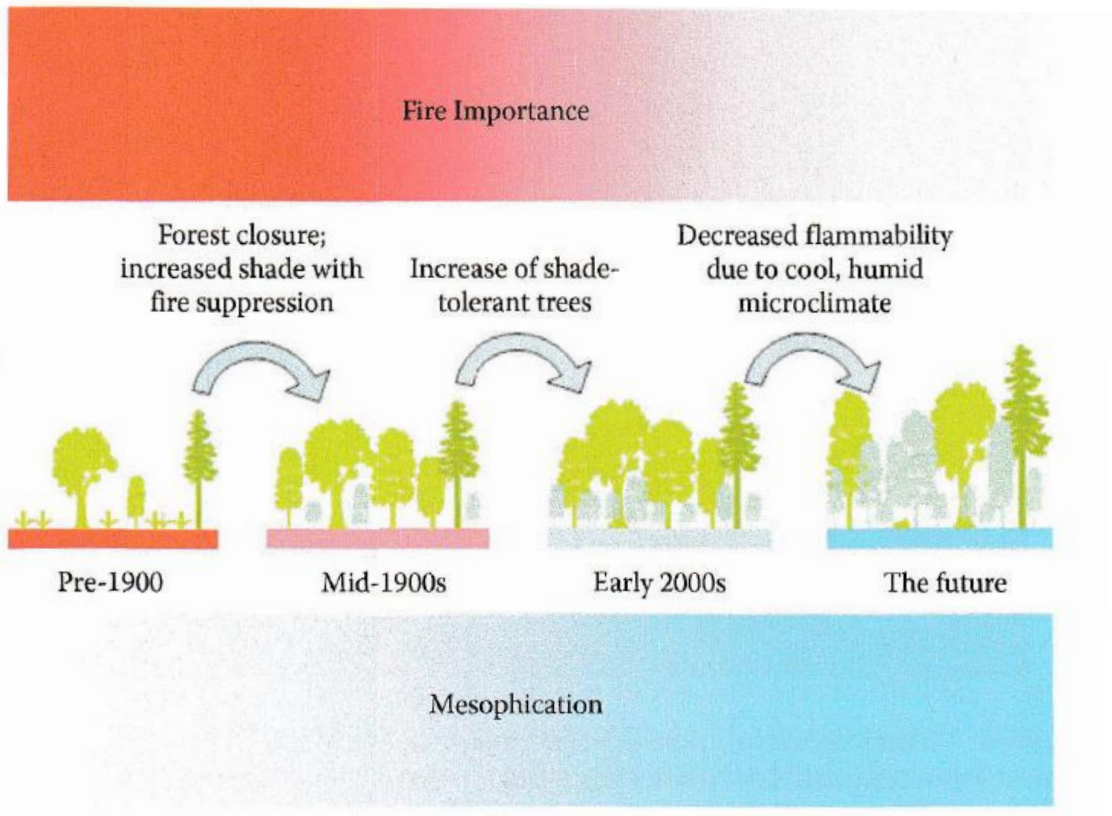
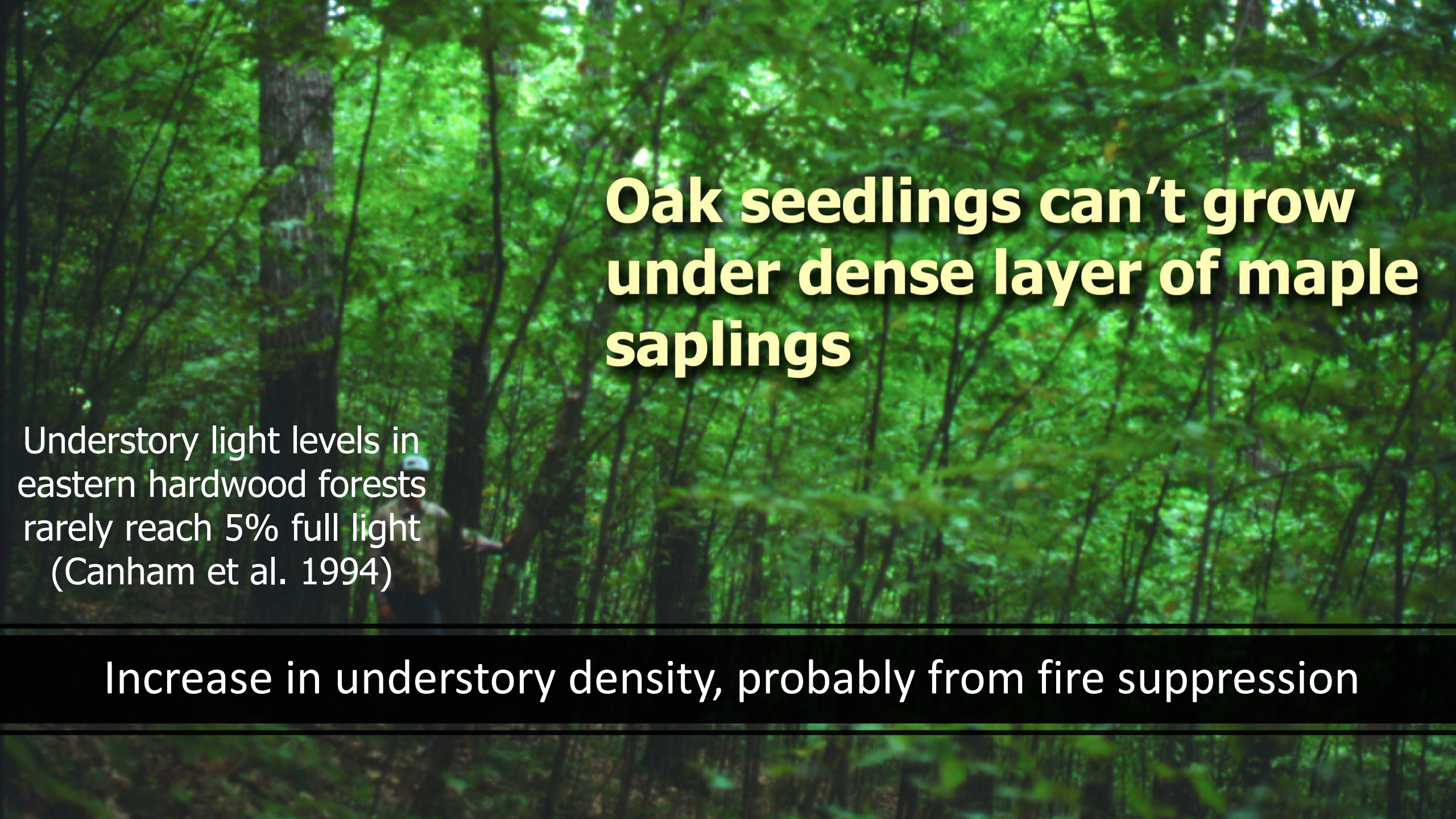


Figure 2.4 The mesophication of eastern oak forests as a result of fire suppression. (Adapted from Nowacki, G.J. and Abrams, M.D., *BioScience*, 58, 123, 2008.)

In the absence of fire:

- Mesophytic species – e.g. red maple, American beech, tulip poplar, and sugar maple – moved in to oak forests
- Canopies closed, inhibiting oak regeneration and promoting shade tolerant species
- Microclimates and fuels may challenge attempts to restore historic fire regime

Keyser et al. 2016


Oak seedlings can't grow under dense layer of maple saplings
Understory light levels in eastern hardwood forests rarely reach 5% full light (Canham et al. 1994)
Increase in understory density, probably from fire suppression

Fire Resistance

Table 18.1
Extent of damage to boles of trees >11 cm dbh one year after the last of the three winter burns and two years after the spring burn, by percentage of species

	Spring burns			*Winter burns*		
Species	*No damage*	*Bark scorched*	*Bark split*	*No damage*	*Bark scorched*	*Bark split*
Oak species	[illegible]	10	7	[illegible]	26	4
Yellow-poplar	33	33	33	8	42	50
Dogwood	56	—	44	16	8	76
Combined competition[a]	67	—	33	57	21	21

Source: Barnes and Van Lear 1998.

[a]Numerous species which occurred in relatively minor numbers and included red maple, American beech, black gum, sourwood, sassafras, and others.

Oak bark is resistant to fire

Growing season fires are more lethal

Dormant season fires (and cutting) allow for more vigorous sprouting in oaks (*and other hardwoods*)

Fire Suppression

- Stands with a long history of fire-suppression (>20 years) will require multiple burns

- A single fire, in this case, often worsens conditions for oaks

Native Insects and Diseases

- Many native diseases affect oak stands composition, structure, and acorn production *locally*
  - E.g. oak anthracnose, acorn weevils (22 species!), spring defoliators
- Oak Wilt (*Ceratocystis fagacearum*) and Oak Decline, however, do so on a *landscape-scale*

Gypsy Moth

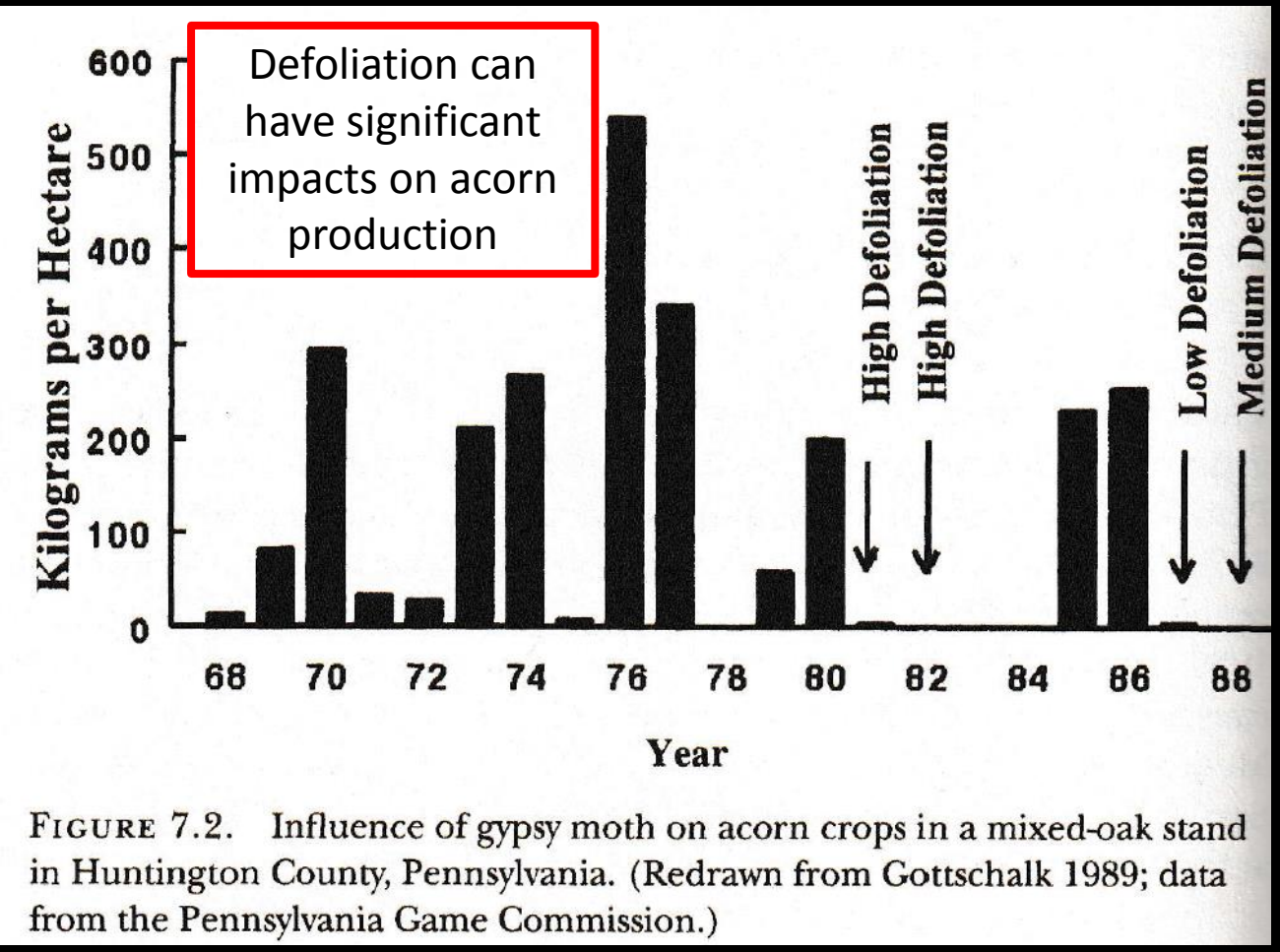


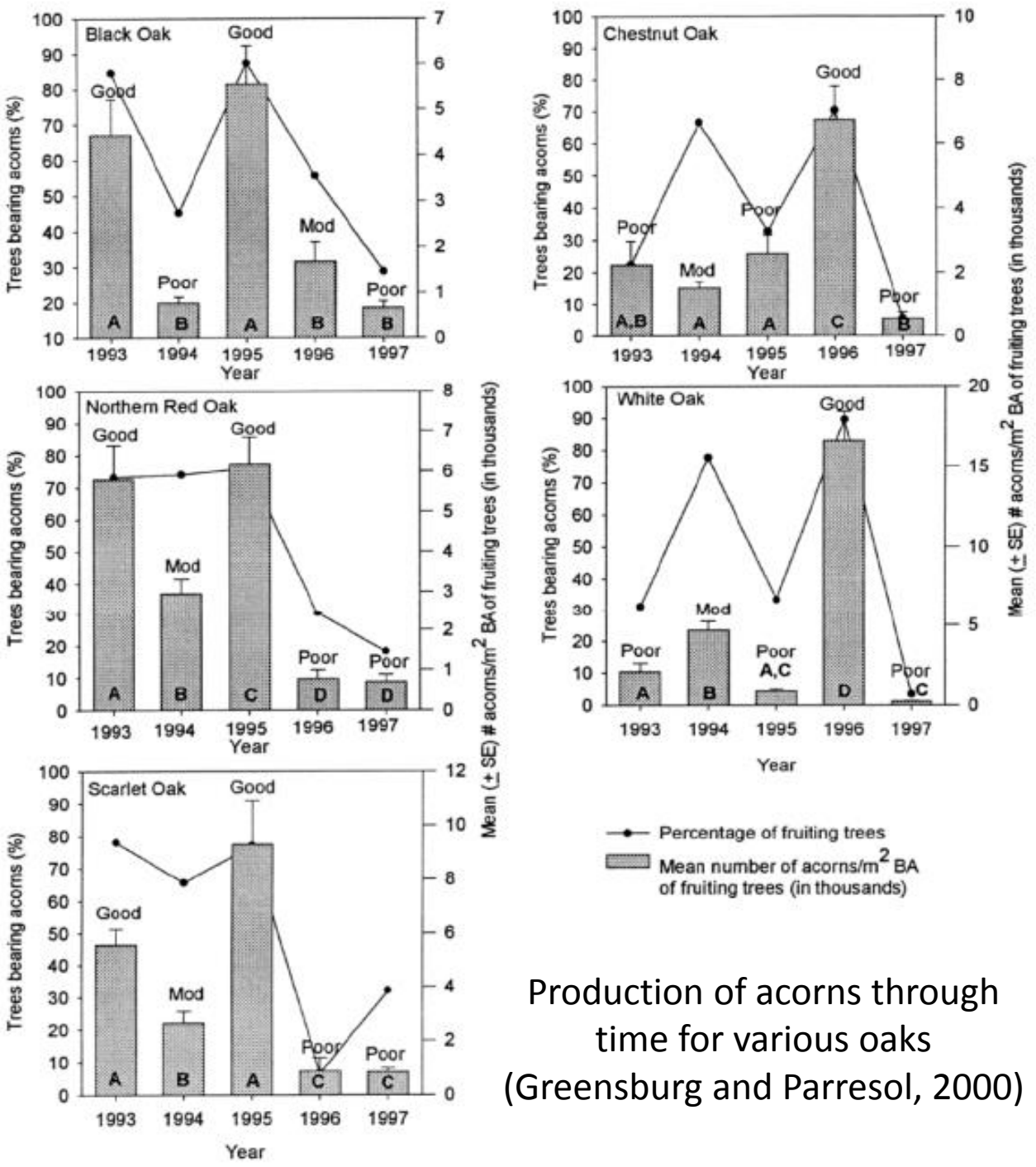
FIGURE 7.2. Influence of gypsy moth on acorn crops in a mixed-oak stand in Huntington County, Pennsylvania. (Redrawn from Gottschalk 1989; data from the Pennsylvania Game Commission.)

Oaks, a preferred host, can die from severe defoliation or multiple years of defoliation

- further reducing acorn production

Seed Periodicity in Oaks

- Good seed crops can occur every 2 to 10 years, very erratic
  - 50,000 to 100,000 seedlings per acre in a good year – can have virtually none other years
- Oak regeneration can persist in heavy shade understory for several years but will eventually die if not released
- Canopy density increases with site quality
  - Advance oak regeneration presence decreases, generally, as site quality (i.e. canopy closure) increases



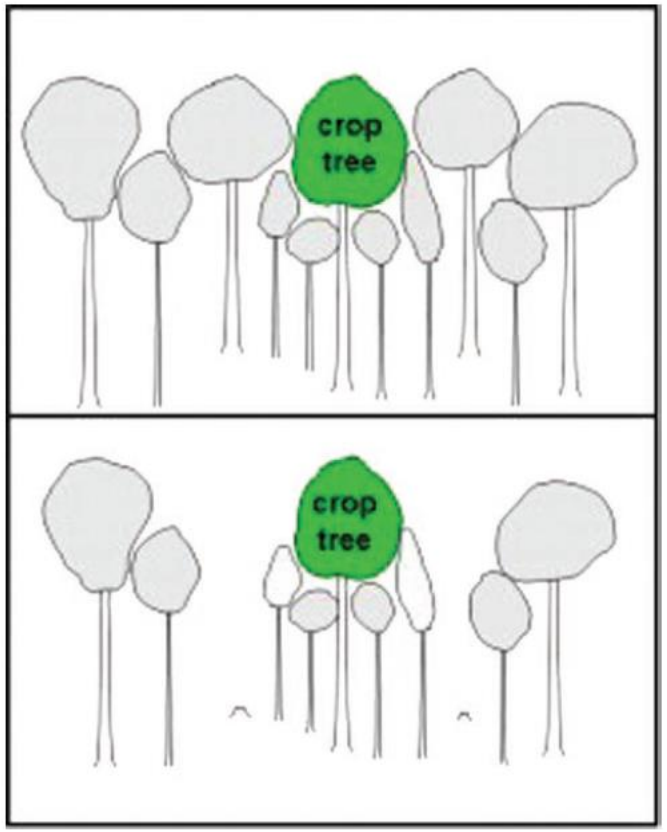
Production of acorns through time for various oaks (Greensburg and Parresol, 2000)

Managing for Acorn Production

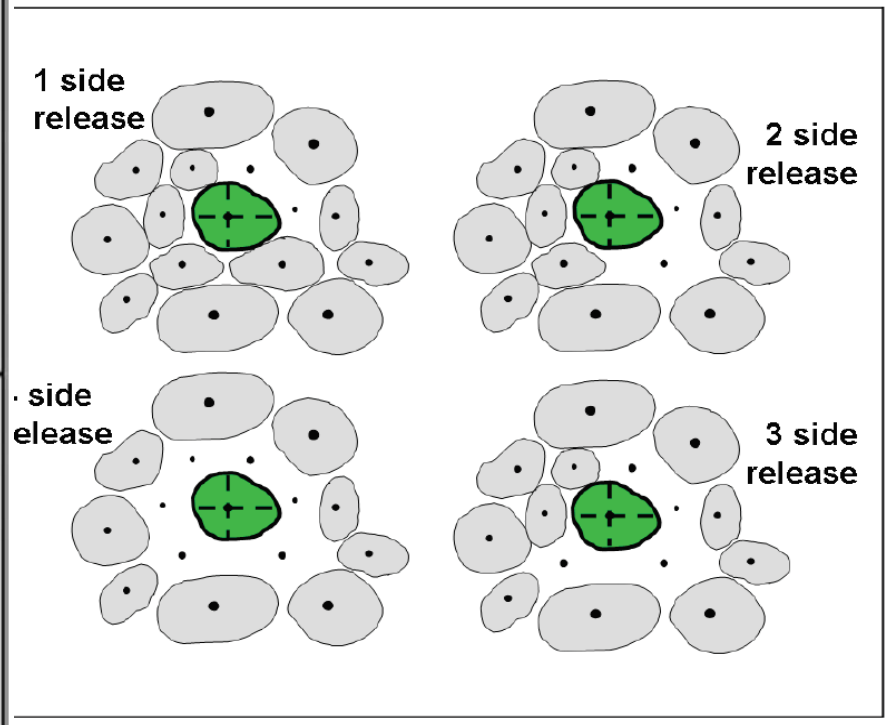
- Crown size, health and class

After a disturbance/harvest

- Crop tree release in the early late sapling-stage (60 TPA)



- Crop tree release can be used again in the pole-stage

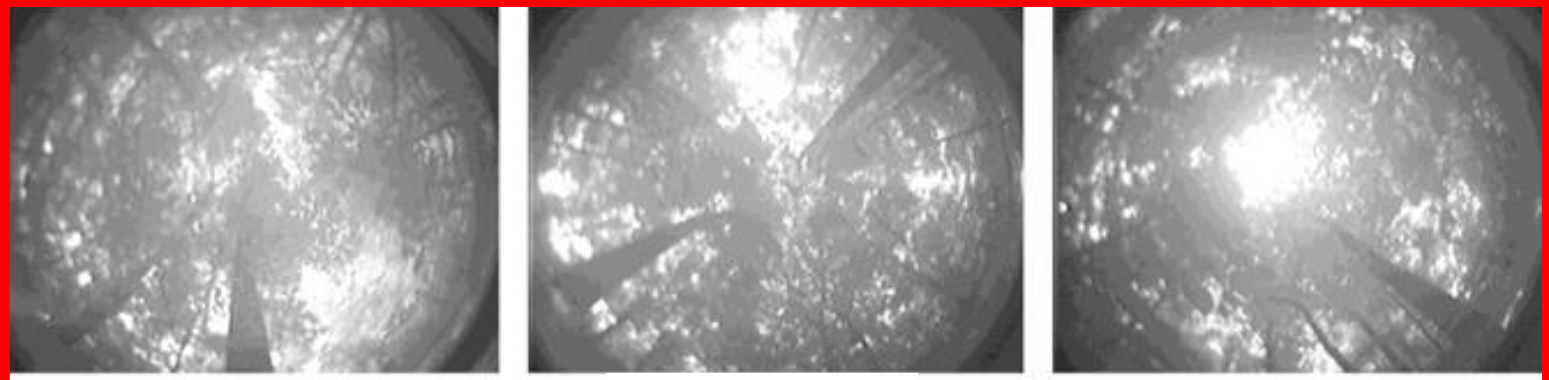


re 6.4.—A crop tree crown (green) is shown from above the forest canopy. The diagram vs a partial and full crown-touching release where one, two, three, or all four sides of the trees are released.

Red maple and beech show maximum net photosynthesis at 5 to 10% full sunlight

Light saturation of photosynthesis for oaks occurs at 30 to 50% full sunlight

Oaks' growth is maximized at 50% to 70% full sunlight (but so are competitors')



Closed Canopy (110 sq ft BA)

Light Thinning (85 sq ft BA)

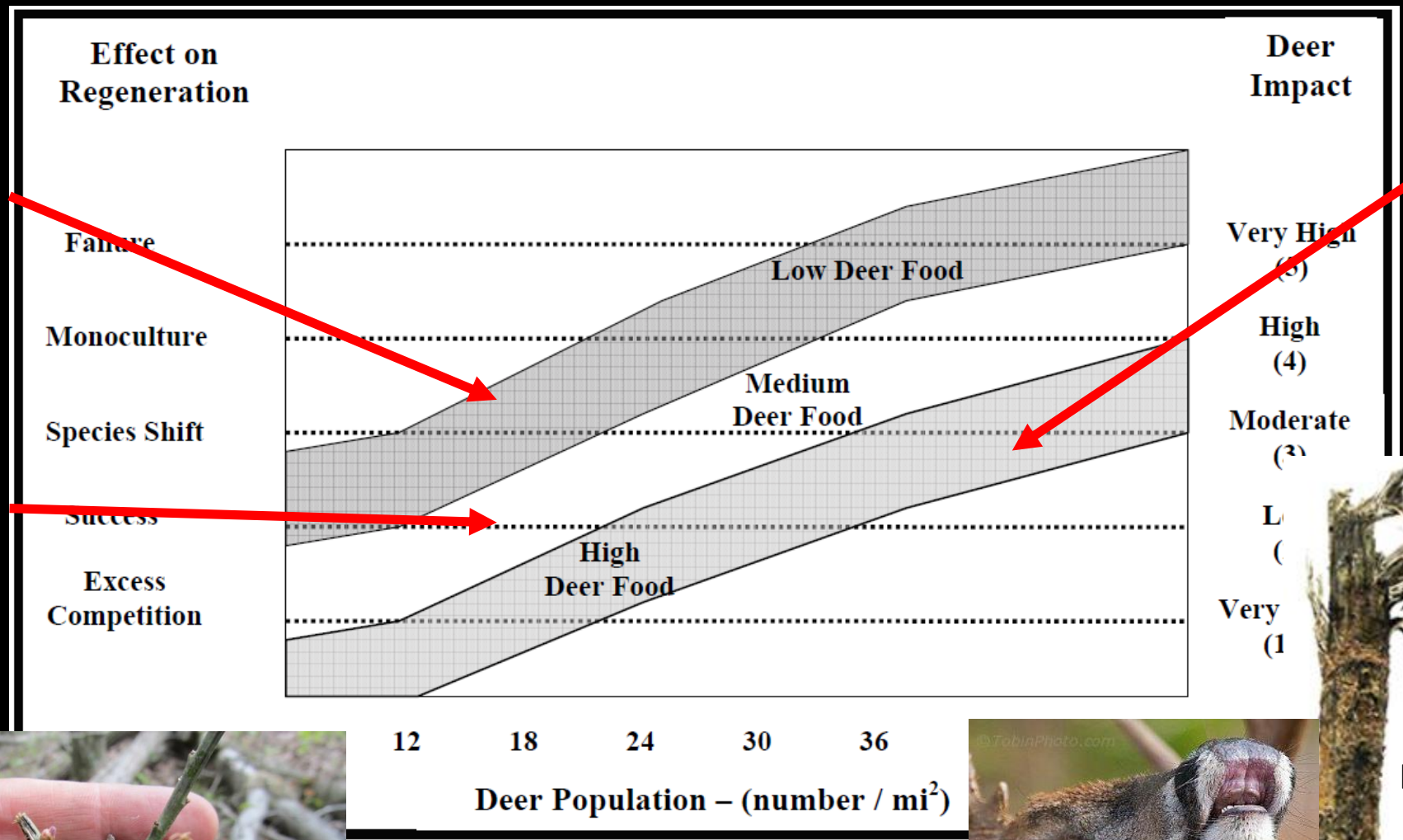
Shelterwood (65 sq ft BA)

Deer Browse

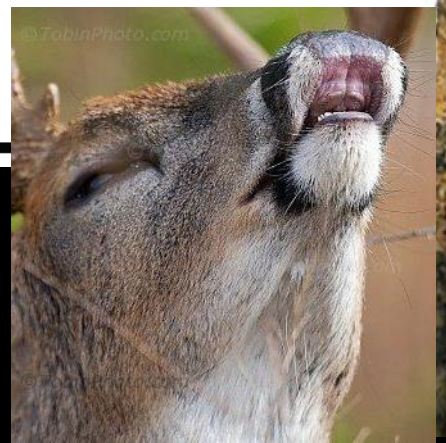
Low deer food= Uncut, mature forest

Med. deer food= Managed forest of many seral stages

High deer food= Forest interspersed with farmland



Marquis et al. 1992



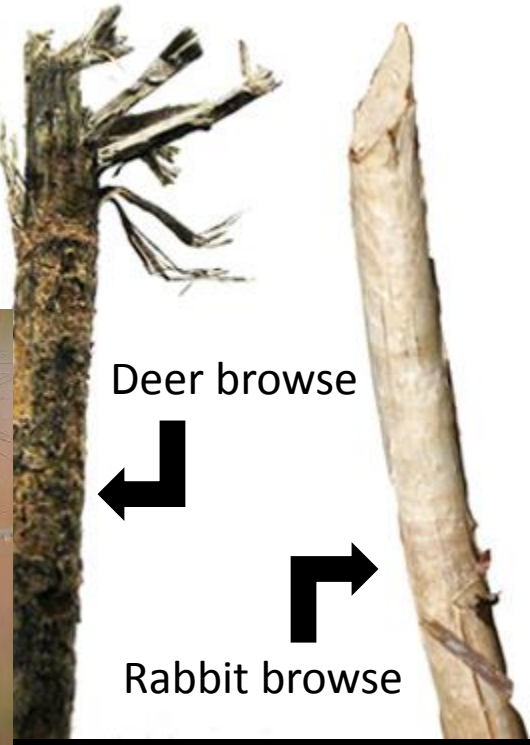
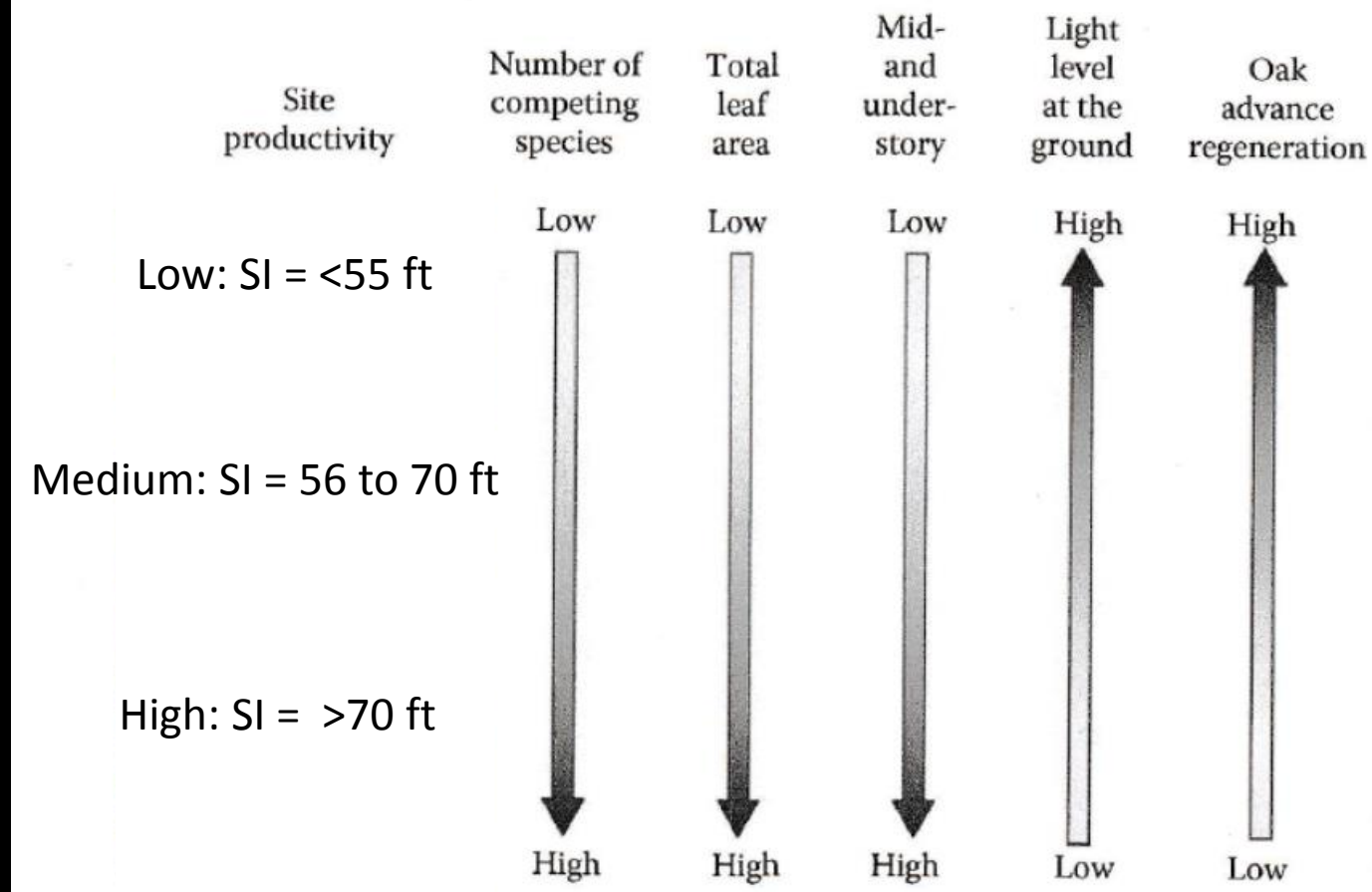


Table 5.1 Major hardwood forest types described by Smith (1994) in the Southern Appalachian Mountains, including the site index range, typical growth rate, and species commonly found in each type of forest

Scarlet oak–chestnut oak forest	White oak–black oak forest	Sugar maple–northern red oak forest	Yellow poplar–mixed hardwood forest
Site index range			
<55 feet base age 50	56–70 feet base age 50	70–85 feet base age 50	>85 feet base age 50
Growth rate in natively fully stocked stands			
150 board feet/acre/year	235 board feet/acre/year	320 board feet/acre/year	640 board feet/acre/year
Common trees			
Scarlet oak	White oak	Northern red oak	Yellow poplar
Chestnut oak	Black oak	Sugar maple	Northern red oak
Virginia pine	Scarlet oak	Yellow poplar	Sugar maple
Pitch pine	Chestnut oak	Black cherry	White ash
Table mountain	Pignut hickory	White ash	Basswood
Pine	Mockernut hickory	Basswood	American beech
Sassafras	Shagbark hickory	American beech	White oak
Bear oak	Red maple	White oak	Cucumbertree
Blackgum	Blackgum	Cucumbertree	Black cherry
	American beech	Red maple	Red maple
	Sweet birch	Frasier magnolia	Frasier magnolia
		Sweet birch	Sweet birch
		Yellow buckeye	Yellow buckeye
		American elm	American elm
		Black walnut	Black walnut
		Eastern white pine	Eastern white pine
		Eastern hemlock	Eastern hemlock

Keyser et al. 2016



Low: SI = <55 ft

Medium: SI = 56 to 70 ft

High: SI = >70 ft

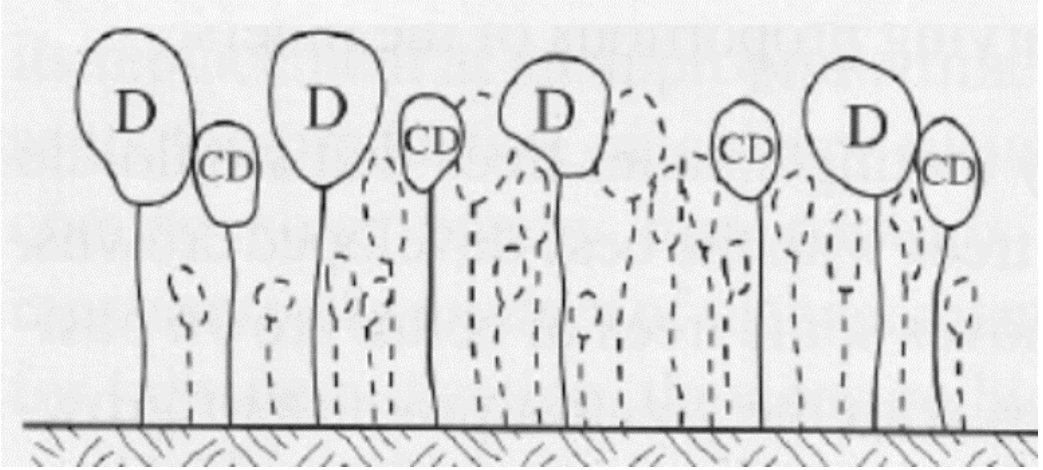
Figure 6.4 Characteristics associated with oak success relative to site quality.

Keyser et al. 2016

On moderate to high-quality sites: Oak seedlings not uncommon, but too small to be competitive

Thinning from Below

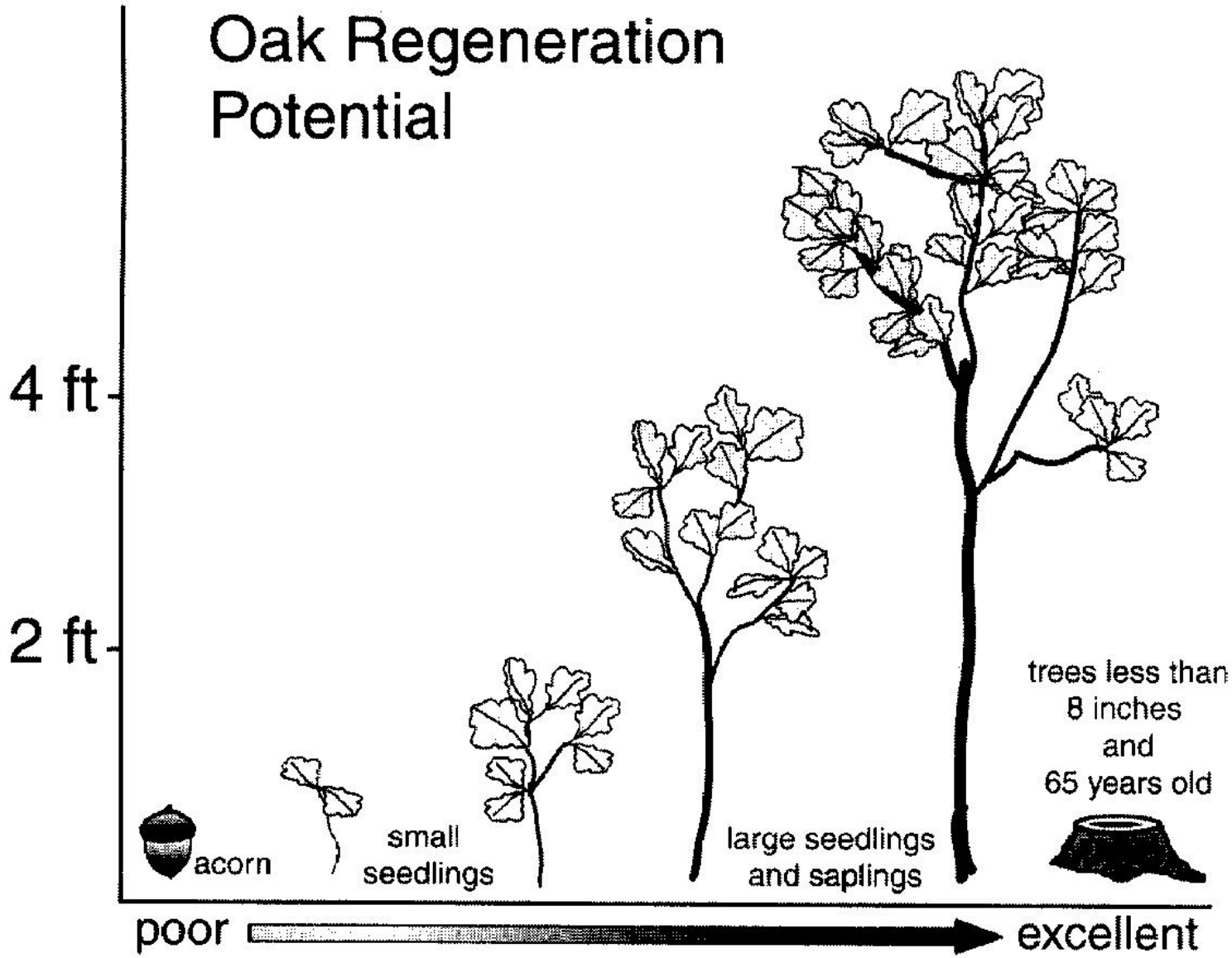
- Removing trees and shrubs below the main canopy can increase understory light 9% to 16%



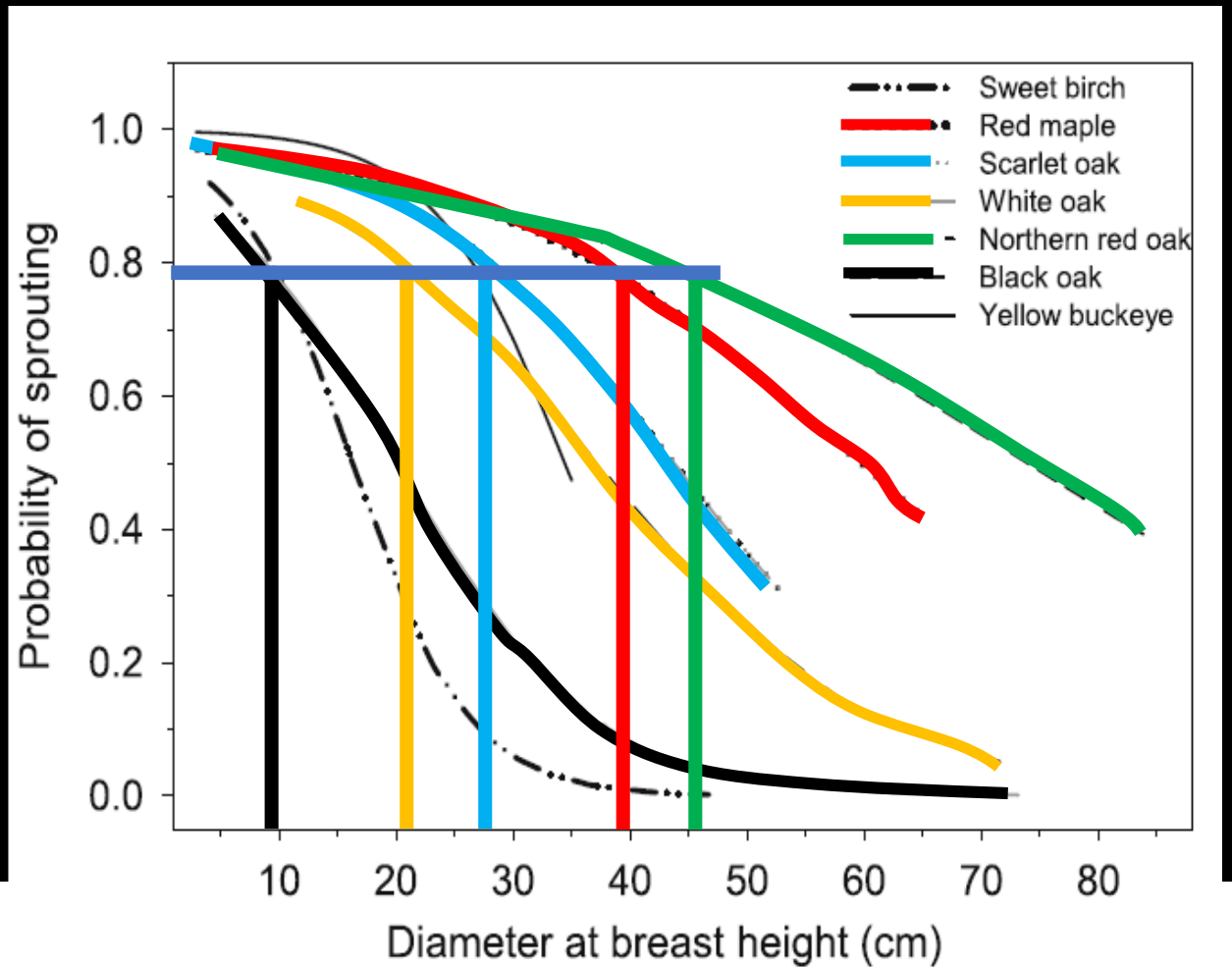
Midstory and Understory Control

- Herbicides are most effective
- Mechanical operations may be too indiscriminate and promote sprouting -- Costly
- Fire is cheap, promotes xeric soil conditions but patchy

Photos by Steve Horsley and Jim Kochenderfer, Northern Research Station


Oak Regeneration Potential
4 ft
2 ft
acorn
small seedlings
large seedlings and saplings
trees less than 8 inches and 65 years old
poor
excellent

Sprouting



80% or Greater Sprouting Probability

- < 45 cm (17 in) Northern Red Oak
- < 40 cm (16 in) Red Maple
- < 28 cm (11 in) Scarlet Oak
- < 21 cm (8 in) White Oak
- < 9 cm (4 in) Black Oak

Northern red oak likely not abundant on most upland oak sites but upland site will likely have chestnut oak – a prolific sprouter

Fig. 1 Relationships between parent tree diameter at breast height (dbh) and probability of sprouting one growing season post-harvest for white oak, scarlet oak, northern red oak, black oak, sweet birch, yellow buckeye, and red maple based on model coefficients presented in Table 4

Sprouting Potential of Chestnut Oak

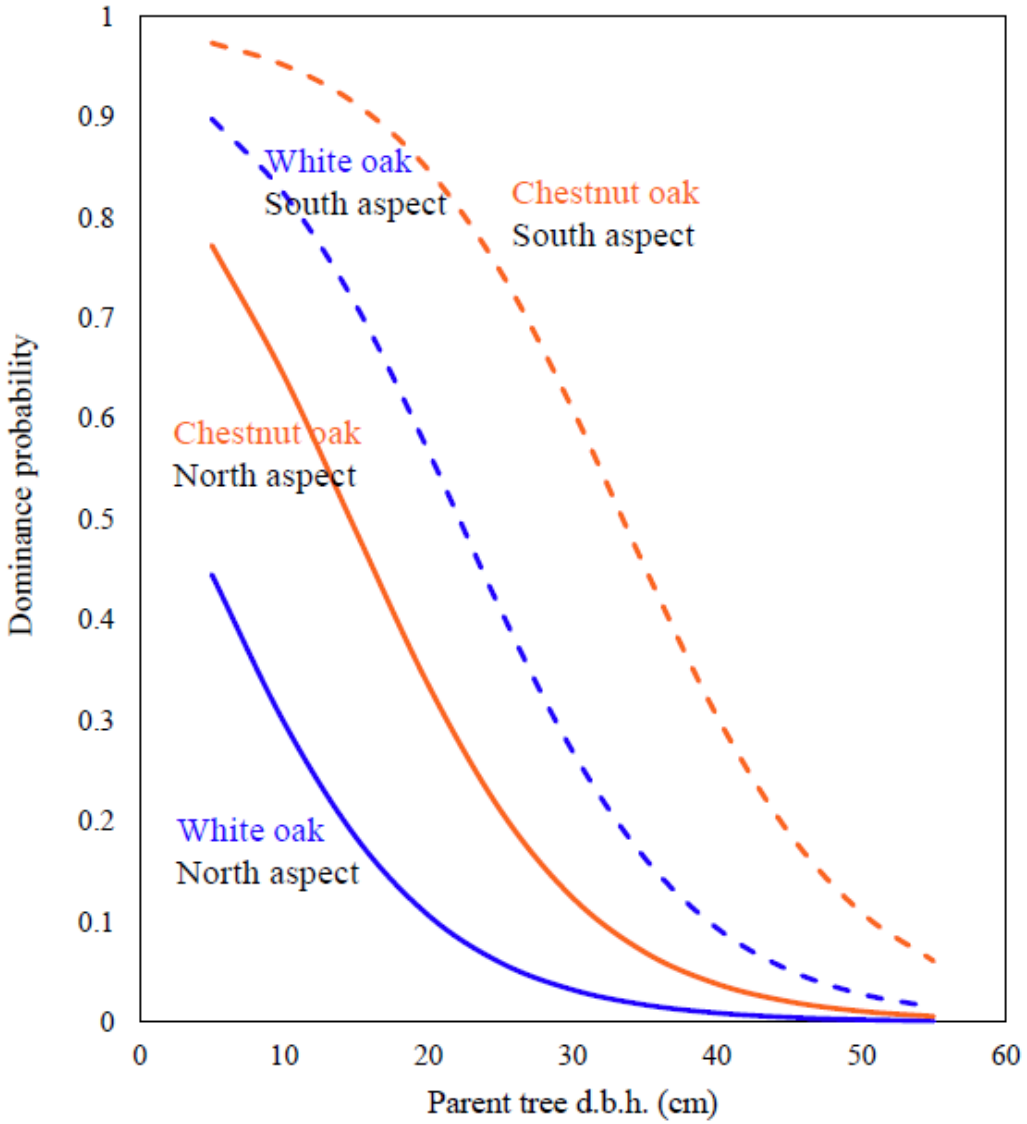


Figure 1.—Estimated probability (Table 1) that a white oak or chestnut oak stump will produce a sprout that is either dominant or codominant 25 years after the parent tree is cut in a clearcut regeneration harvest based on preharvest d.b.h. and aspect.

Chestnut oak sprouts likely to form dominant or codominant stem 25 years after harvest

… increasingly so on south-facing slopes

Sprouting Potential of Scarlet Oak

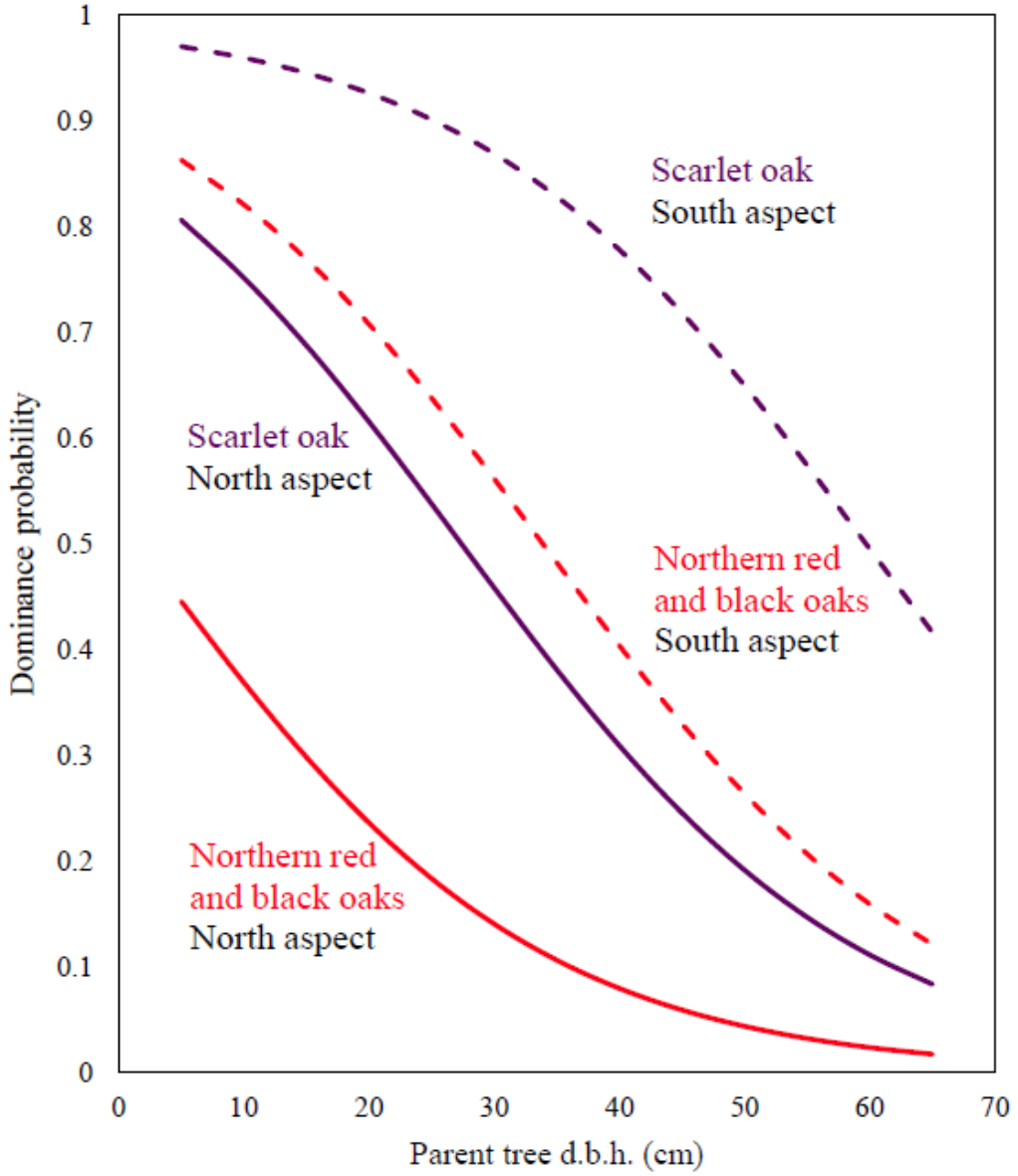


Figure 2.—Estimated probability (Table 1) that a black and northern red oak or scarlet oak stump will produce a sprout that is either dominant or codominant 25 years after the parent tree is cut in a clearcut regeneration harvest based on preharvest d.b.h. and aspect.

Scarlet oak sprouts also likely to be a dominant or codominant stem 25 years after harvest

… increasingly so on south-facing slopes

Clearcut

- Sound method on low-quality sites
  - Competitors too aggressive on more productive sites

- There must be adequate regeneration, sprouting parents
  - Oaks are “advance growth dependent” meaning newly germinated acorns on a clearcut will not compete successfully

  (i.e. seed tree method **will not** work)

- Limited red maple (seedlings) and tulip poplar (seed bank)

- Clearcut must be “clean”

White oak stand with red maple understory in the piedmont

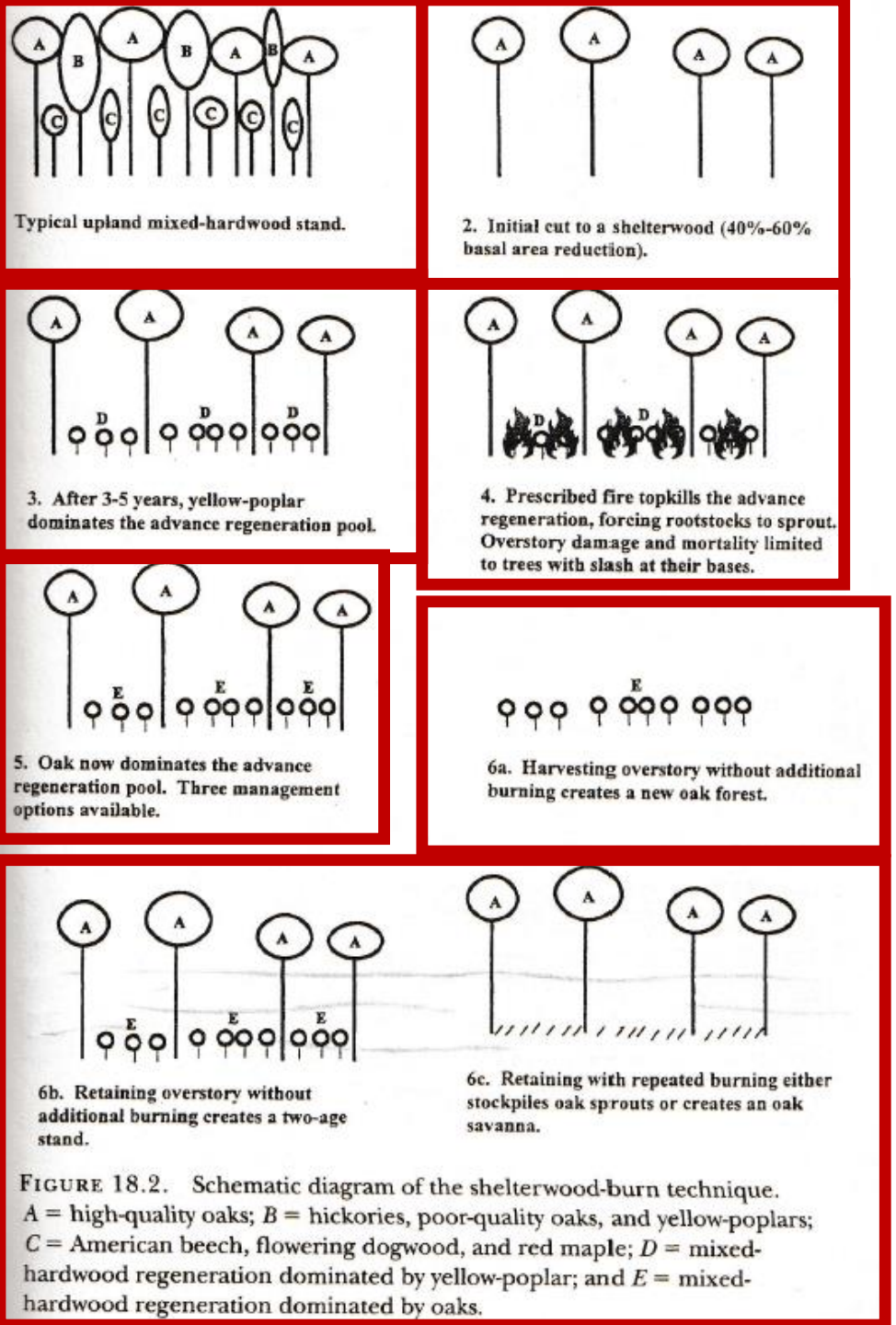


FIGURE 18.2. Schematic diagram of the shelterwood-burn technique. *A* = high-quality oaks; *B* = hickories, poor-quality oaks, and yellow-poplars; *C* = American beech, flowering dogwood, and red maple; *D* = mixed-hardwood regeneration dominated by yellow-poplar; and *E* = mixed-hardwood regeneration dominated by oaks.

Shelterwood Method (In the Piedmont)

- Shelterwood cut
  - Reduce stand to 40-60% stocking
    - Residual stocking and competition control importance increase as site quality increases
      - > 70% crown cover inhibits growth and survival, however
- Understory Prescribed burn
  - 3 to 5 years after the shelterwood cut
  - Burn benefits oak over competitors
  - May need to control competitors post-fire (sweetgum, pin cherry, poplar, and raspberry)
- Remove (even-aged) or retain overwood (two-aged)
  - Advance reproduction should be ≥ 4.5 feet, ~300 TPA

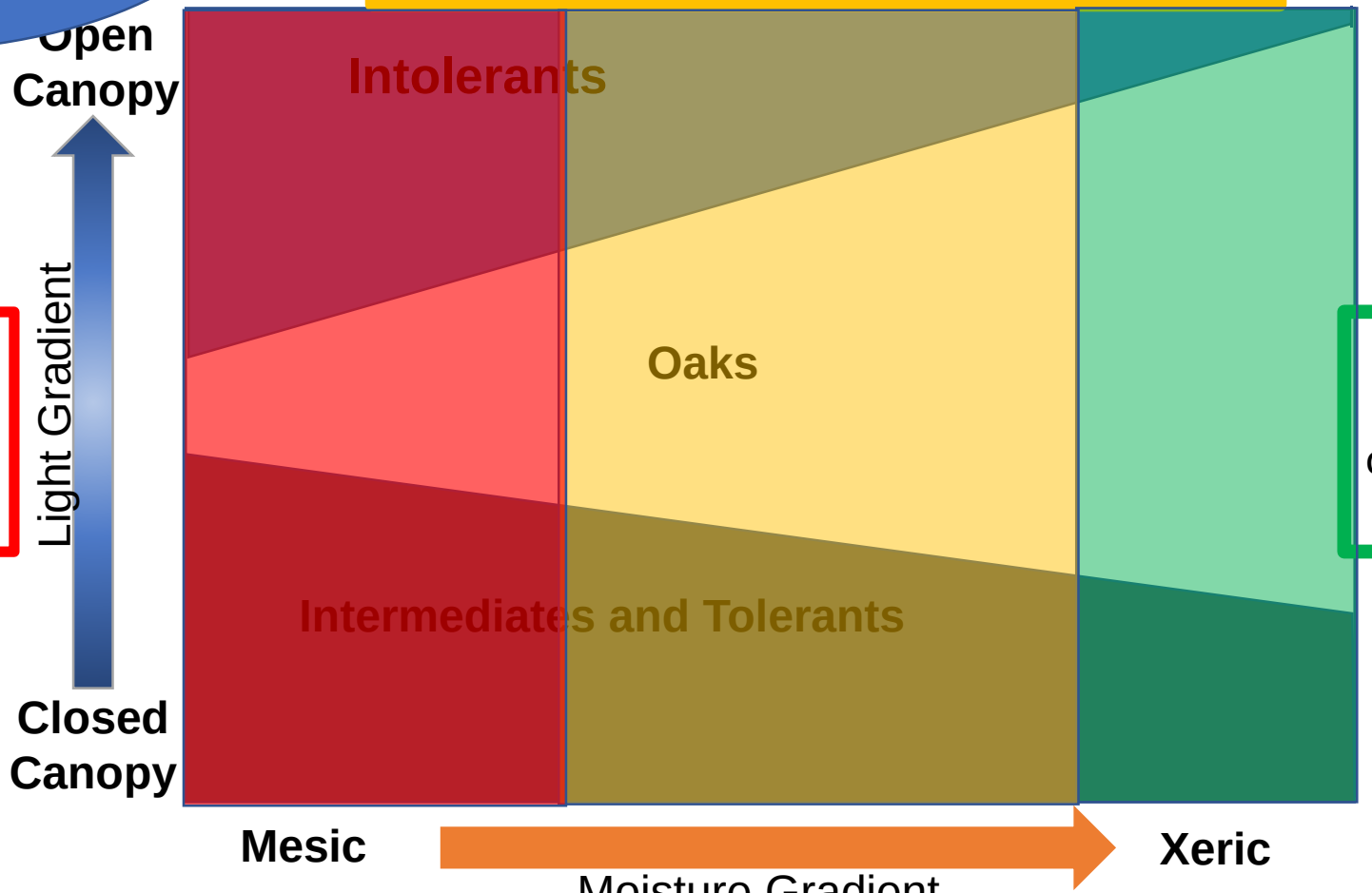
Managing Oak

Achieving pre-harvest oak levels with the shelterwood can be an elusive goal

Intermediate-quality sites will likely require a shelterwood (40% stocking) with veg control

High-quality sites will likely require a 3+ stage shelterwood with **plenty** of vegetation control!

VERY clean clearcuts (remove all stems >2" DBH) on low-quality sites will likely maintain oak (SI < 60 ft)



Graphic adapted from Hodges and Gardiner, 1993 as cited in Johnson et al. 2009 with some local customization


Thanks