

Interactive Effects of Plant Invasions and Fire in the Hot Deserts of North America

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Presentation Outline

- Explain what a fire regime is and how invasive plants can alter it.
- Describe how fire regimes are altered in major desert vegetation types.
- Present recommendations on how best to manage altered fire regimes.

Fire Regimes

It is relatively simple to comprehend the characteristics and effects of an individual fire. However, it is much more difficult to do the same for fire regimes, which are defined as patterns of burning across time, space, and magnitude.

- Time (seasonality, return interval)
- Space (size, complexity)
- Magnitude (intensity, severity, type)

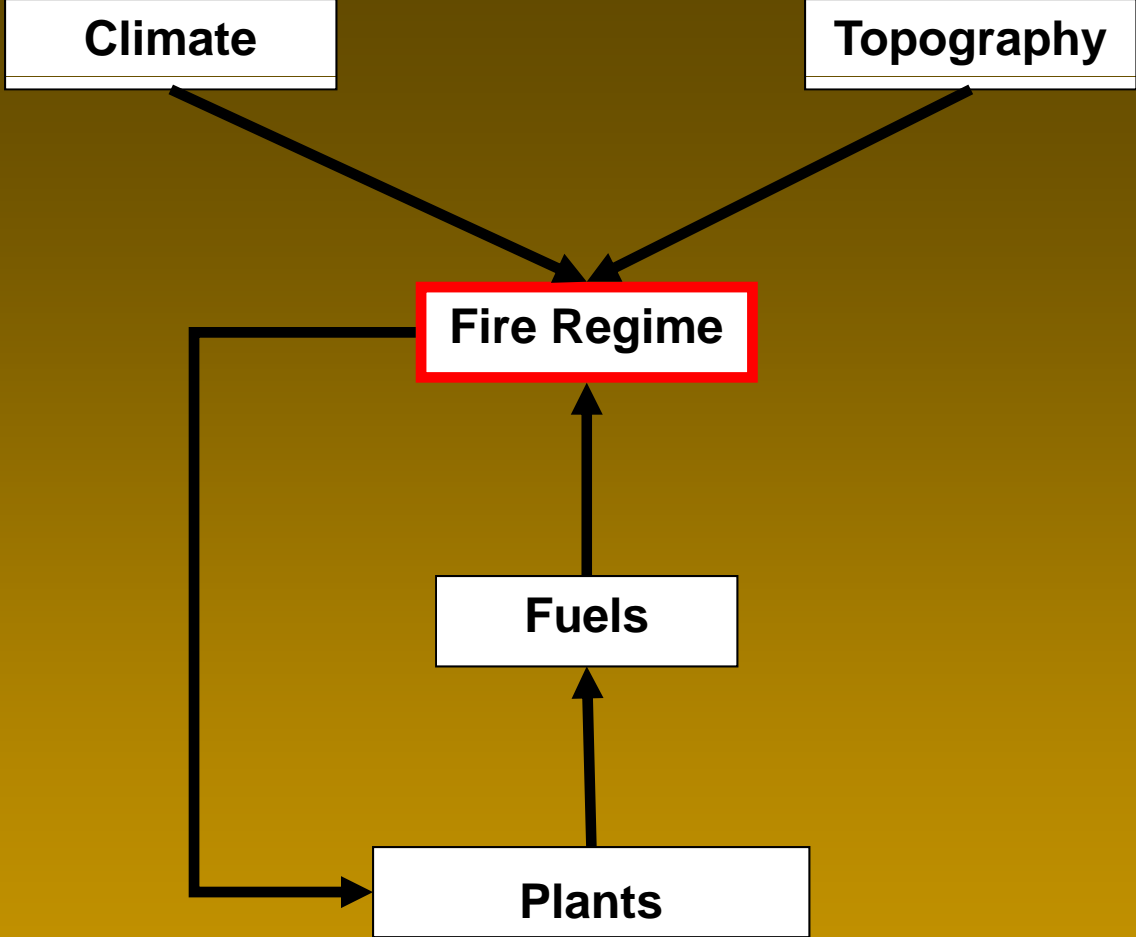
Fire Regimes

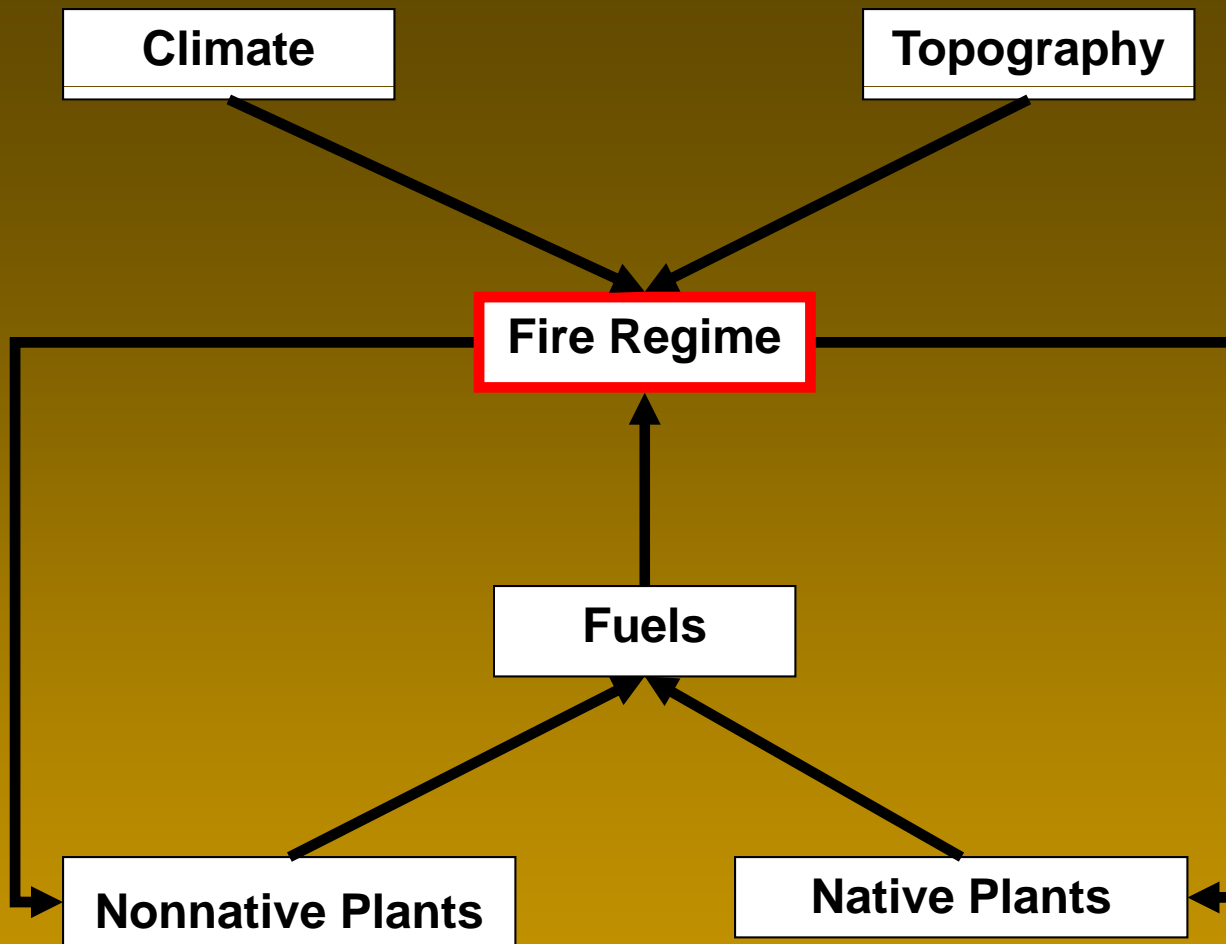
Fire regimes can be strong forces in the evolution of species traits. When fire regimes are rapidly altered, individual species and species assemblages may be significantly affected.



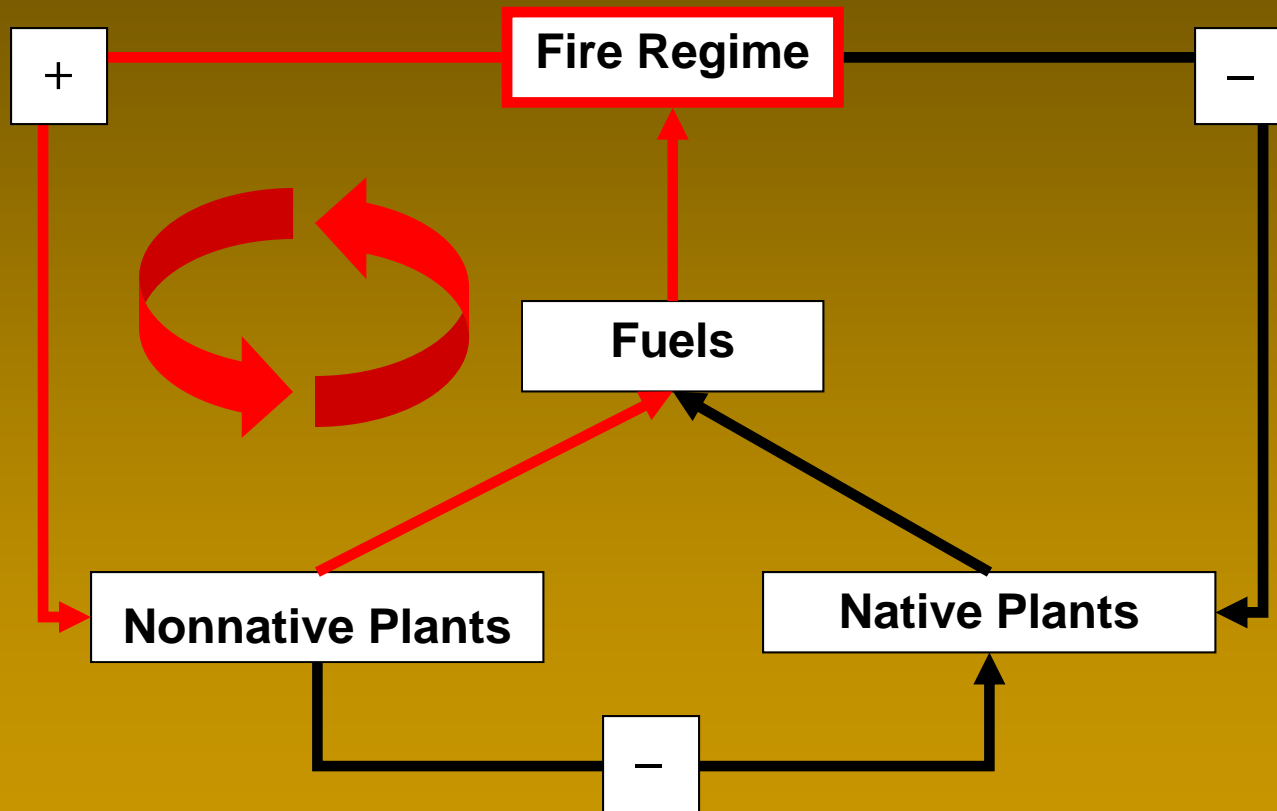
photo by Lesley DeFalco







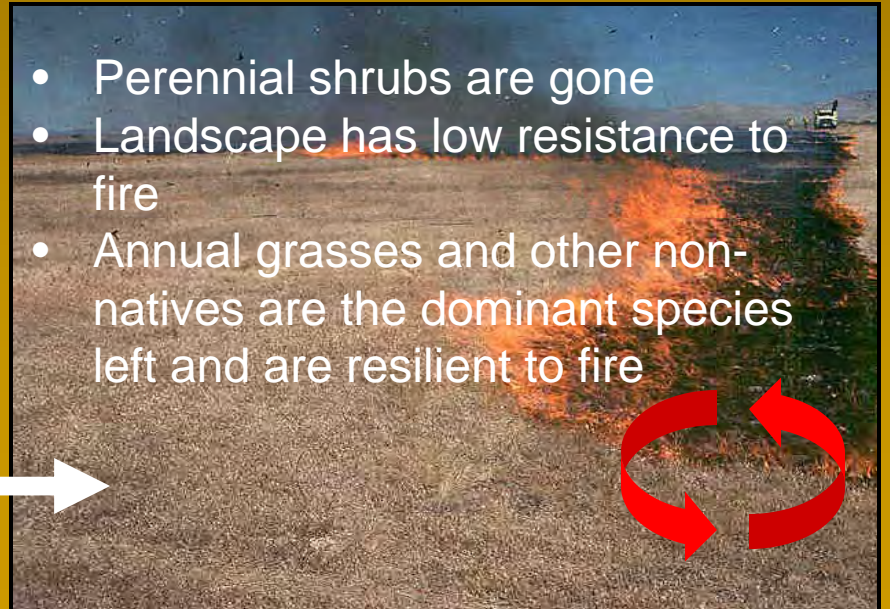
Invasive Plant / Fire Regime Cycle



Determining that an invasive plant/fire regime cycle has become established

1. Plant invasion has changed fuel structure and fire behavior
2. The invasive species benefit from these changes, often to the detriment of natives
3. These changes lead to an altered fire regime
 - this last step can be very difficult to document
 - must show change of a fire regime factor (time, space, or magnitude) to an alternative stable state

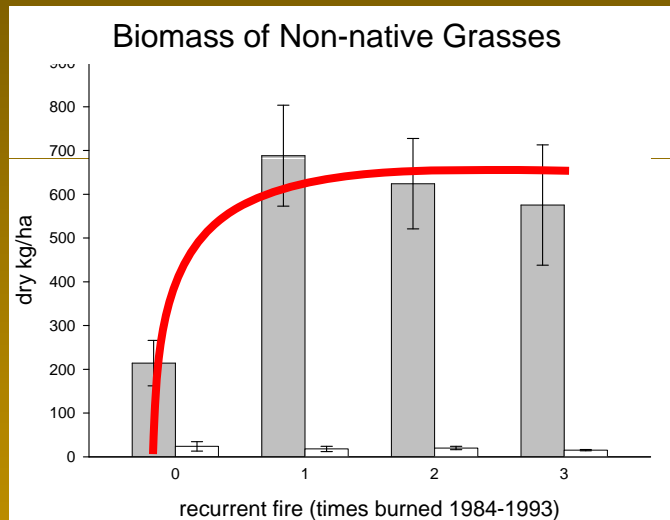
Annual grasses invading desert shrublands



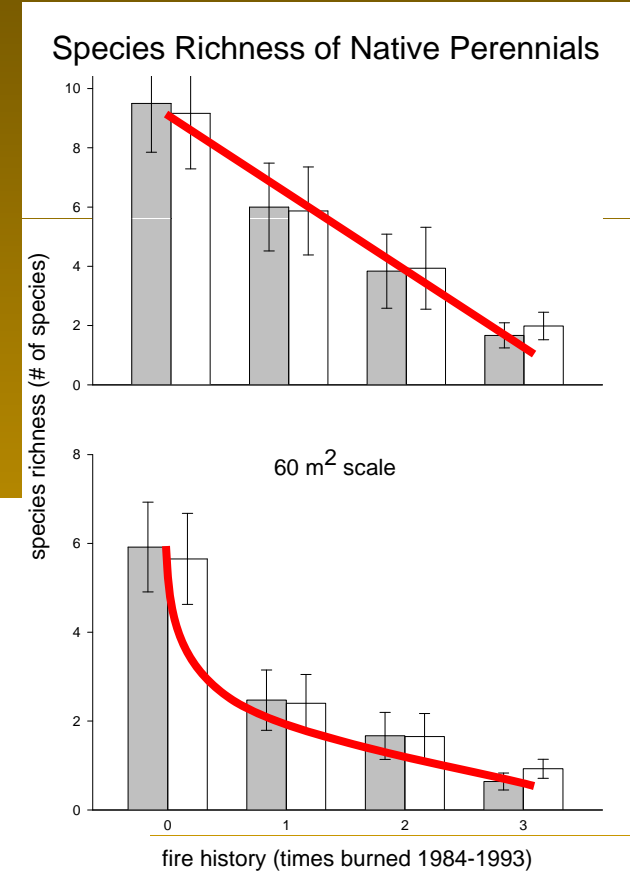
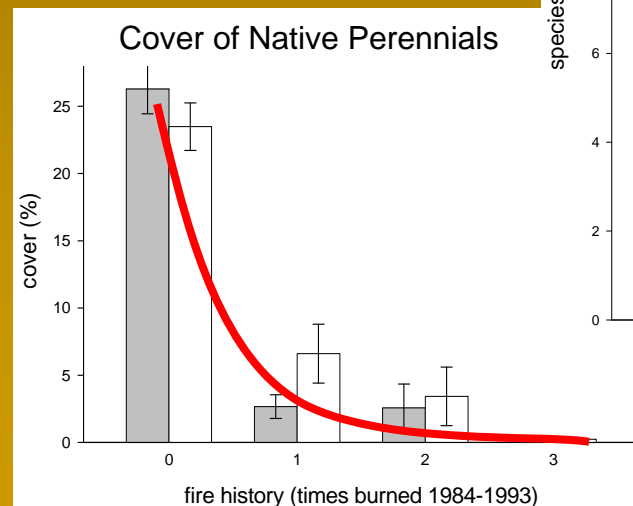
- Perennial shrubs are gone
- Landscape has low resistance to fire
- Annual grasses and other non-natives are the dominant species left and are resilient to fire

Resiliency of Non-native Grasses and Native Perennials Following Fire

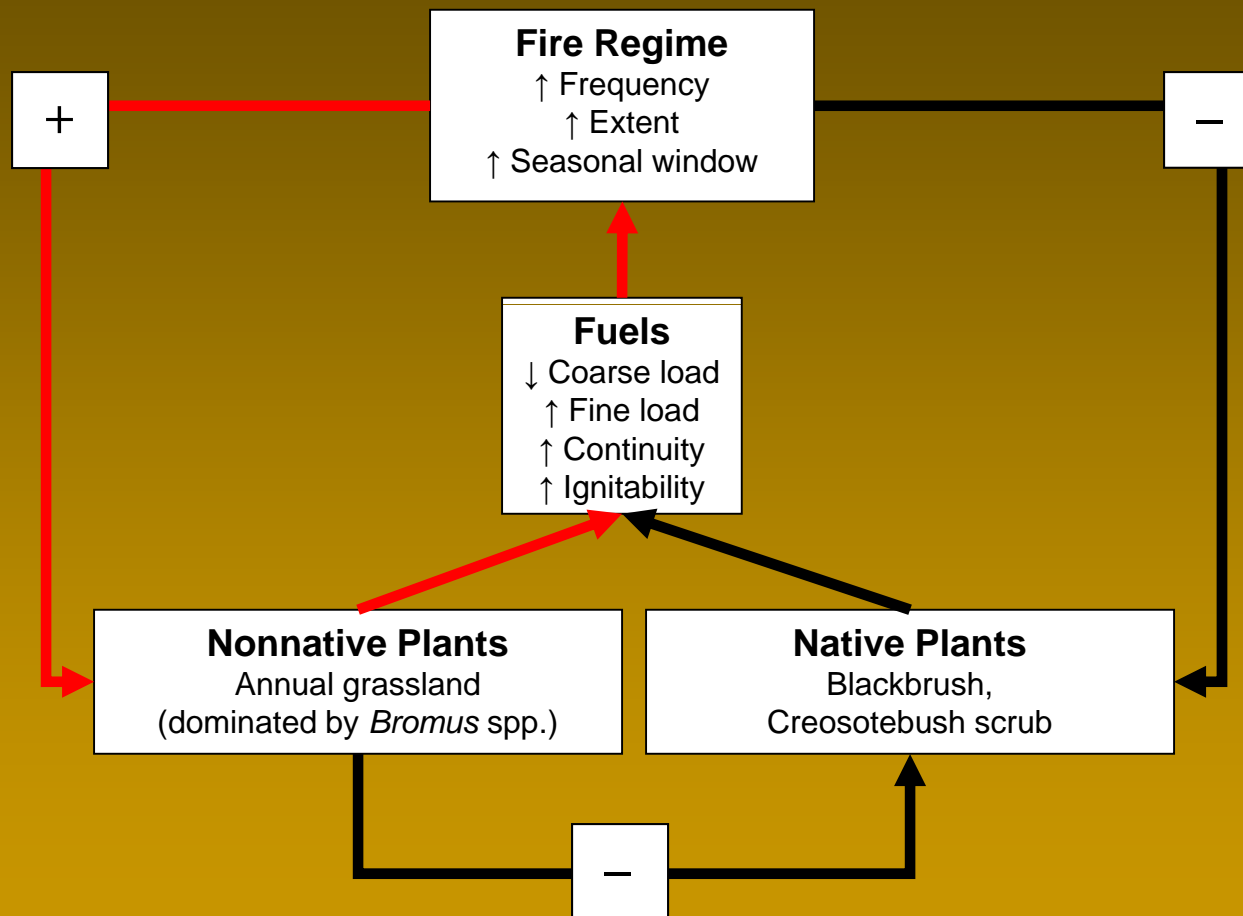
Non-native grasses have high resiliency to fire.



Native perennials have low resiliency to fire



Grass / Fire Cycle in Hot Desert Shrublands of North America

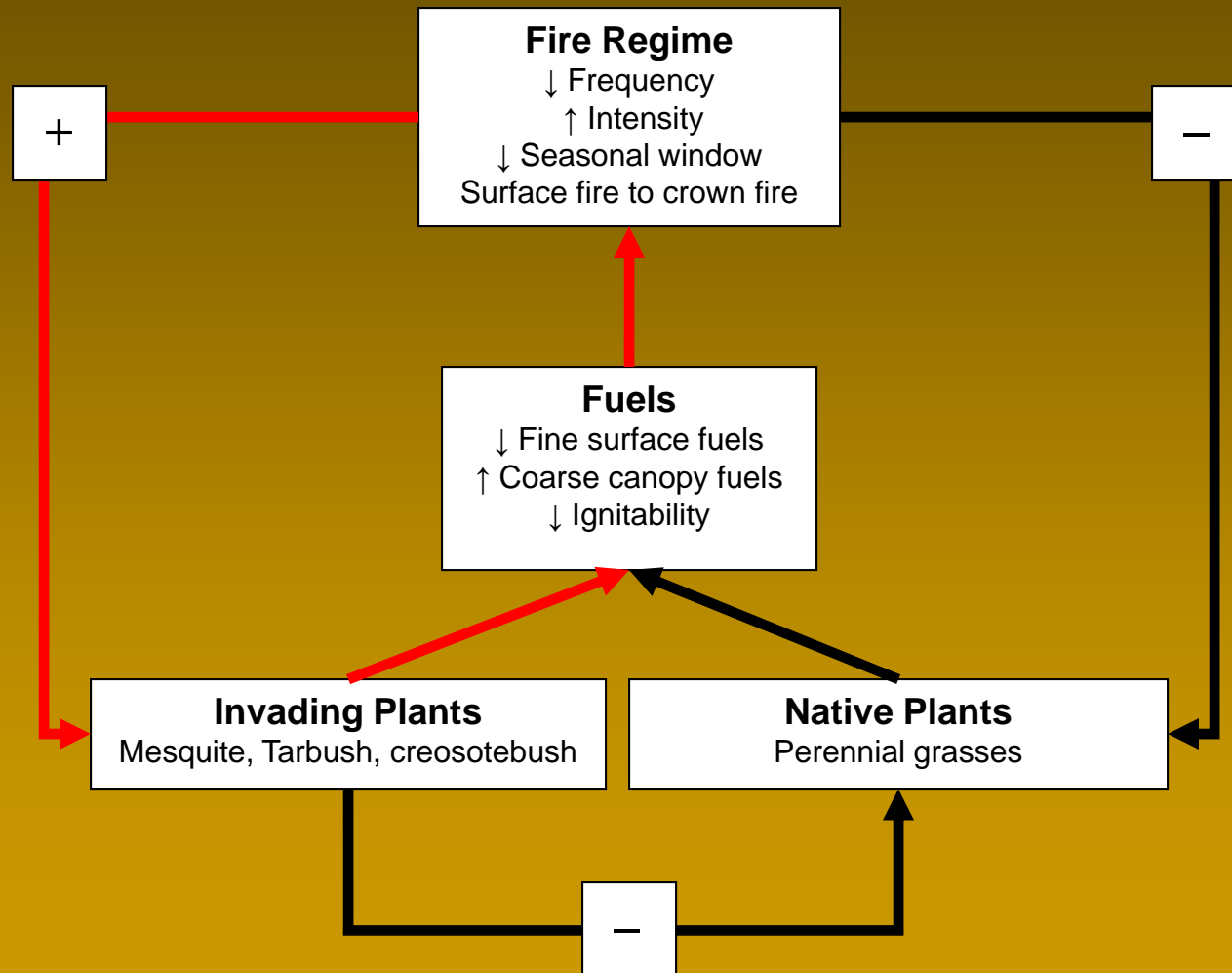


Woody plants invading hot desert grasslands



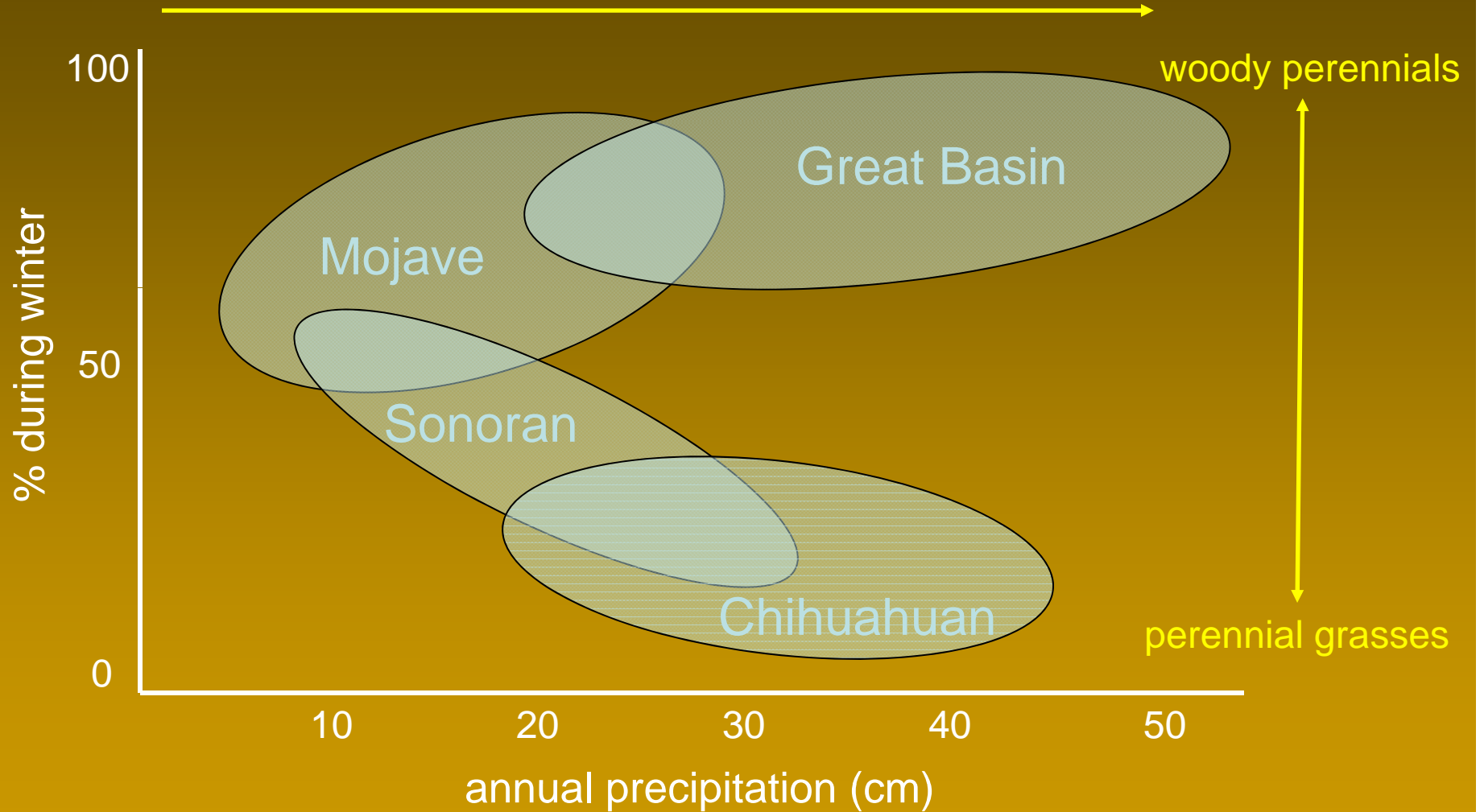
- Perennial grasses are gone
- Landscape has high resistance to fire
- Woody species are the dominant species left to recover if a fire happens to occur

Woody Plant / Fire Suppression Cycle in Hot Desert Grasslands of North America



Deserts of North America

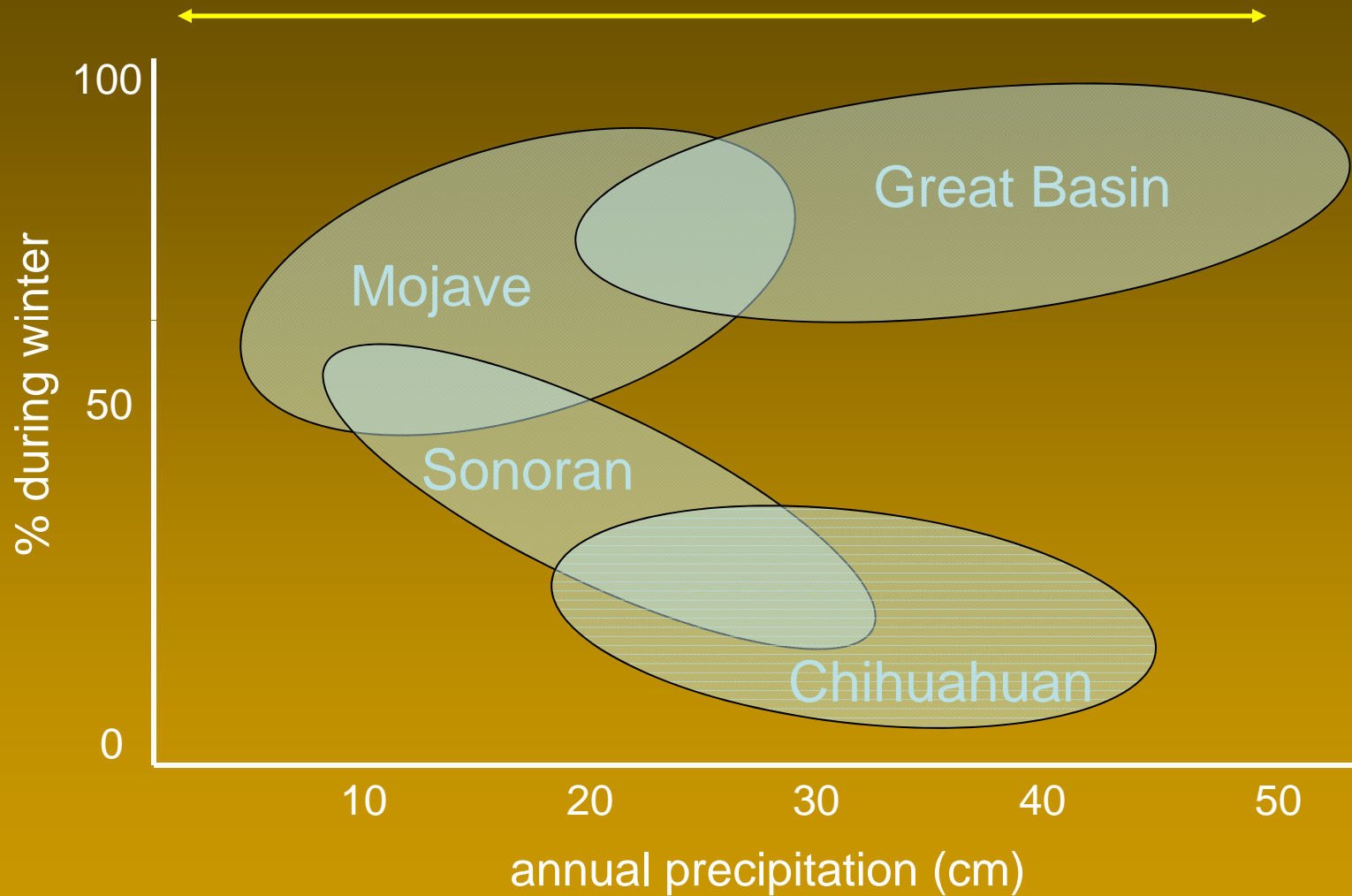
increasing productivity



Deserts of North America

Native vegetation insufficient to fuel historical fires

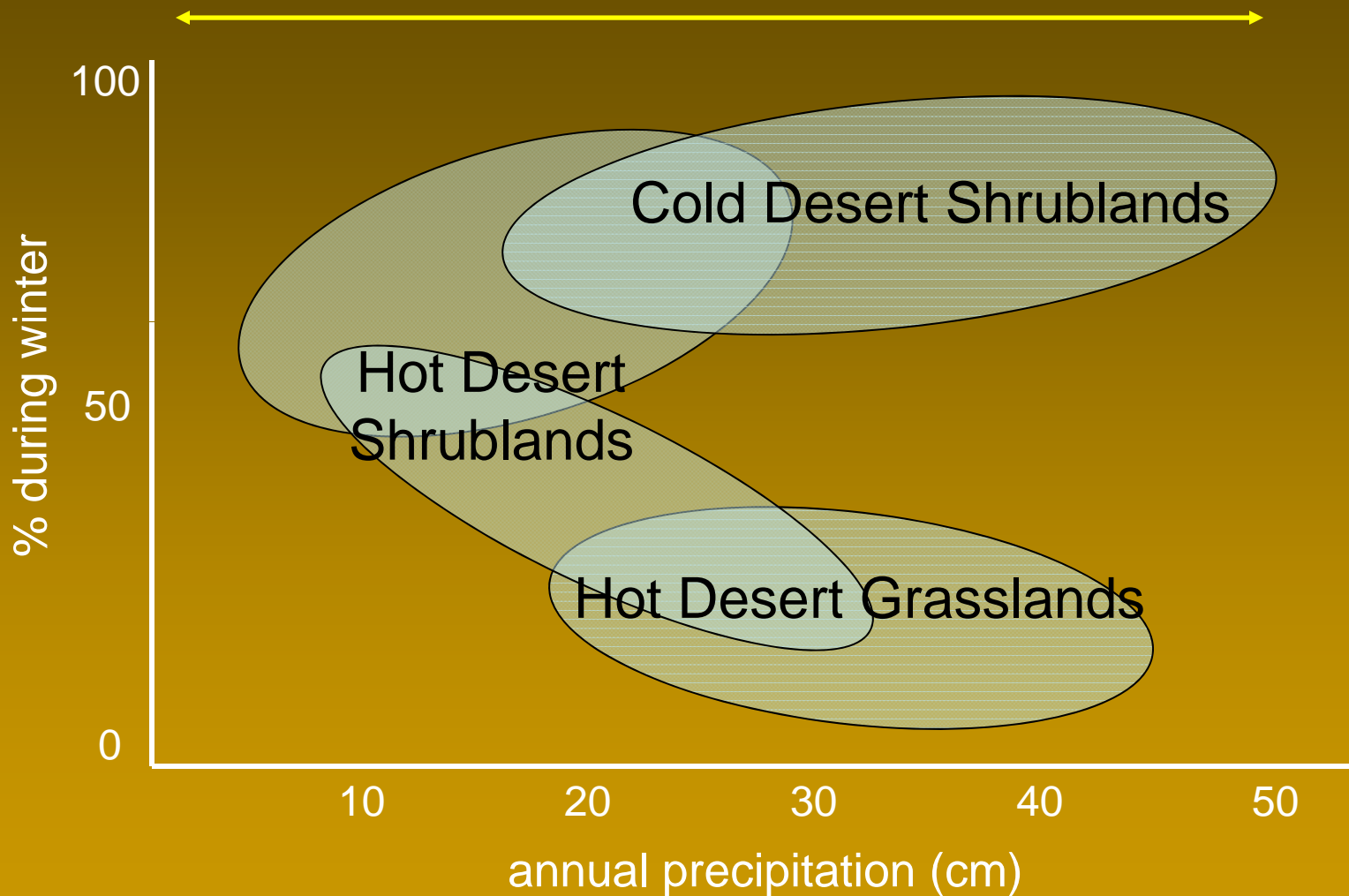
Native vegetation sufficient to fuel historical fires



Deserts of North America

Native vegetation insufficient to fuel historical fires

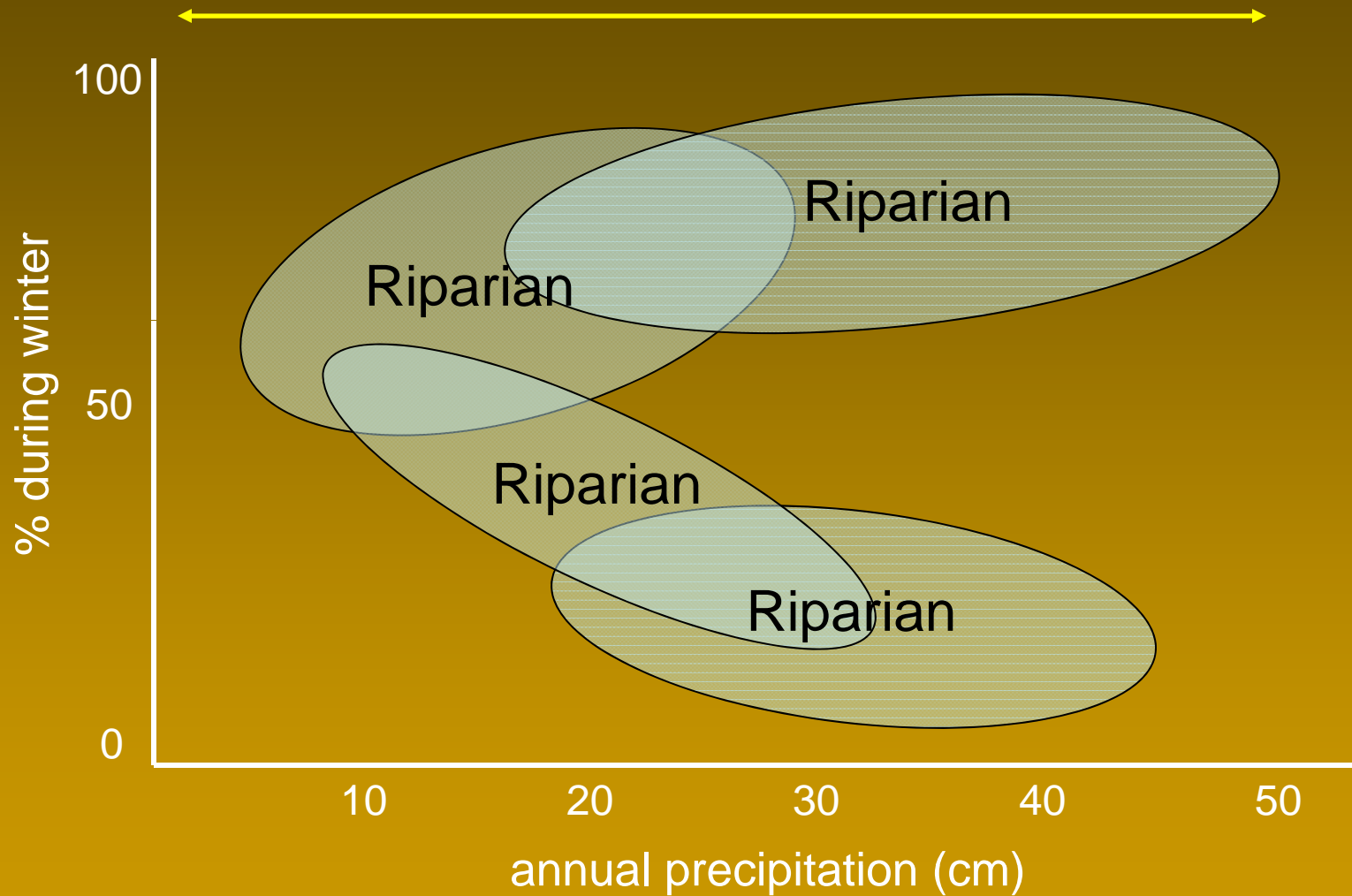
Native vegetation sufficient to fuel historical fires



Deserts of North America

Native vegetation insufficient to fuel historical fires

Native vegetation sufficient to fuel historical fires



Hot Desert Shrublands



Low elevation shrubland



Middle elevation shrubland



High elevation shrubland/woodland

High elevation



Middle elevation



Low elevation



Perennial fuel driven

Annual fuel driven

High elevation



Middle elevation



Low elevation

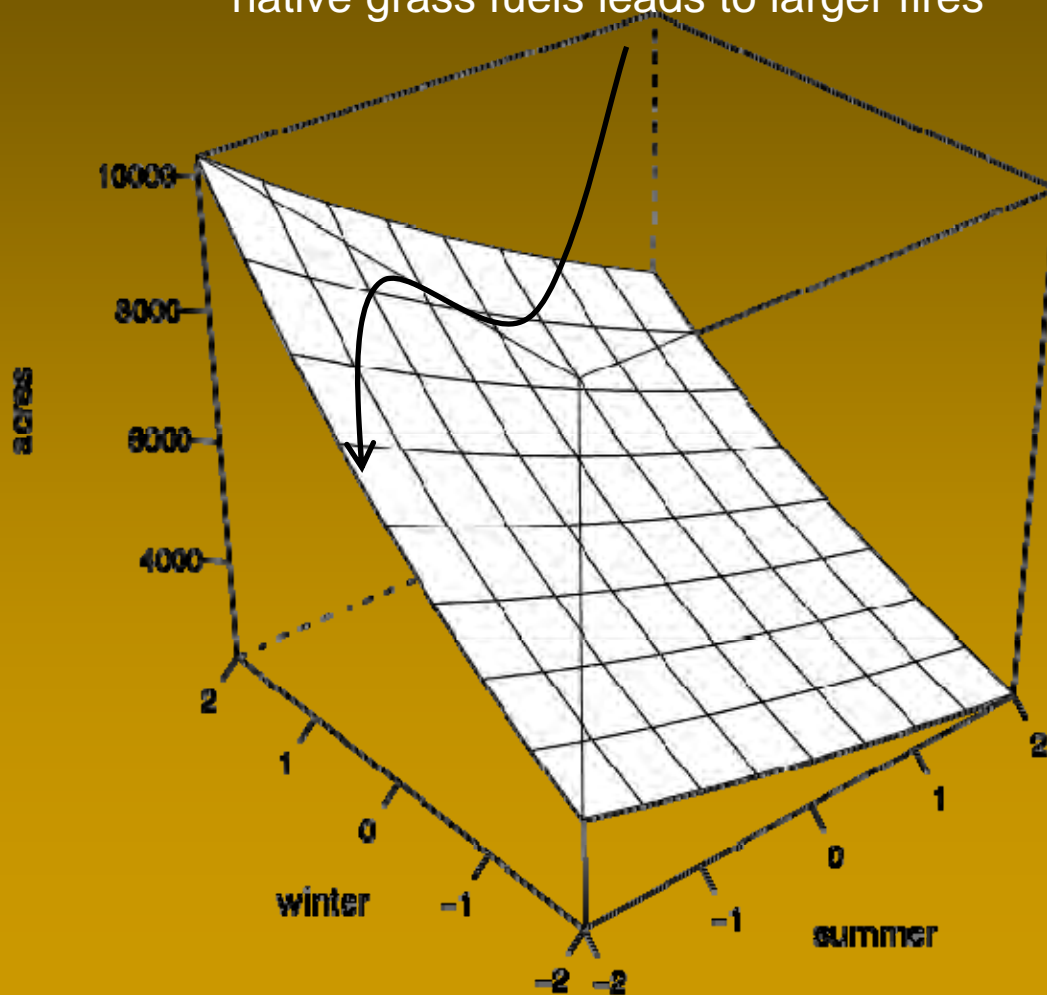


More resilient to fire

Less resilient to fire

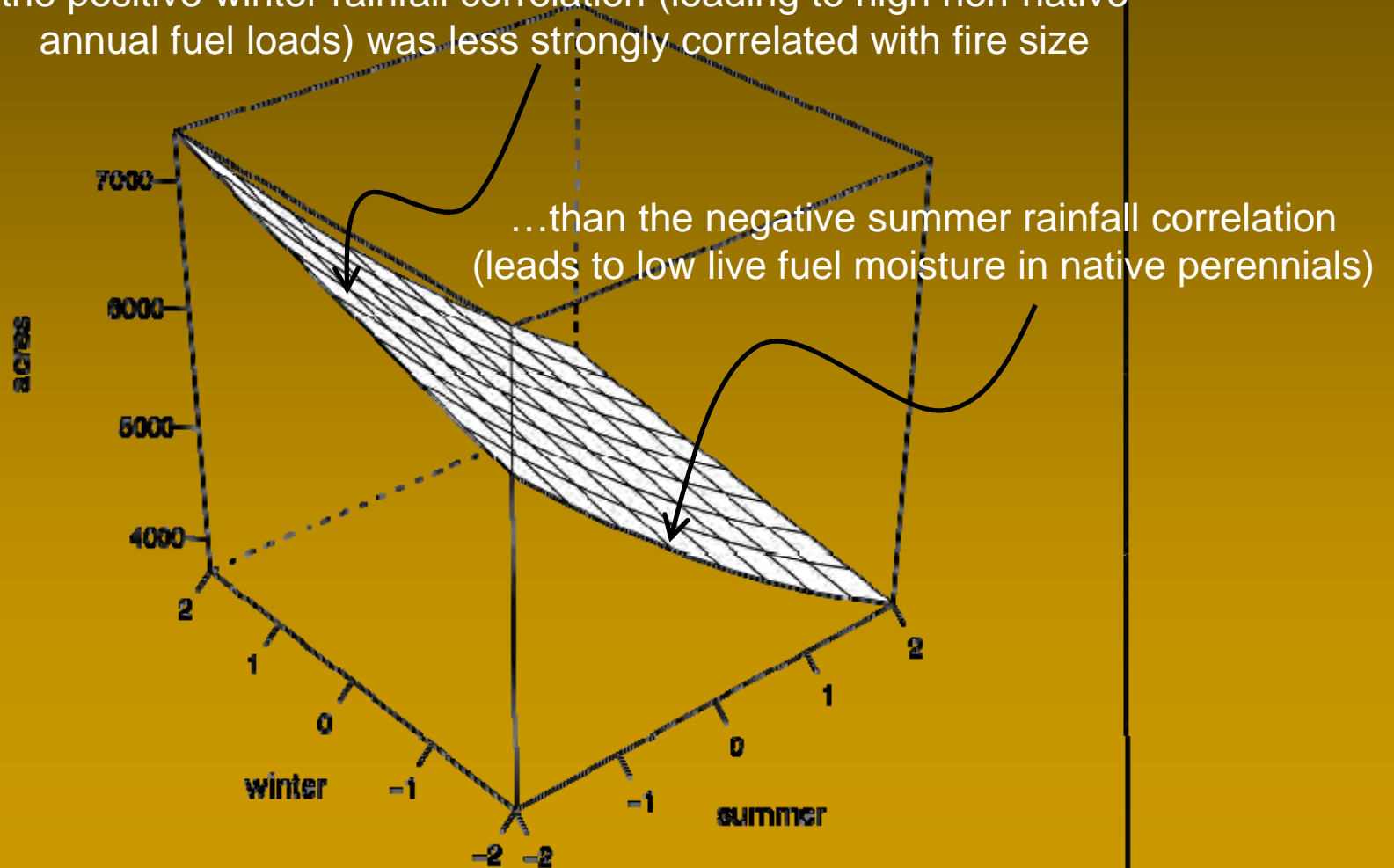
Among all vegetation types, high winter rainfall is the primary predictor of large fires in the Mojave Desert 1980 - 2007 - an indicator of the invasive plant / fire regime cycle

A positive correlation of fire size with winter rainfall during the current year is evidence that high productivity of non-native grass fuels leads to larger fires



The pattern in the Great Basin for comparison to the Mojave Desert

the positive winter rainfall correlation (leading to high non-native annual fuel loads) was less strongly correlated with fire size



Current Hot Desert Shrubland Fire Regimes

Non-native Annual Fuel Regime

- Driven by single- or consecutive-year rainfall patterns causing episodic fine fuel buildup (e.g. due to ENSO)
- Low and middle elevations where native woody fuels are typically too sparse to carry fire
- Fires were historically rare to non-existent and native vegetation has low resiliency to fire
- Significant fire management intervention may be warranted to break the invasive plant / fire regime cycle

Current Hot Desert Shrubland Fire Regimes

Native Perennial Fuel Regime

- Driven by decade and century scales of rainfall patterns causing gradual woody fuel buildup (e.g. due to PDO)
- High elevations where native woody fuels can carry fire
- Fires occurred historically and native vegetation has some resiliency to fire
- Fire suppression may be warranted at the WUI, but on a landscape scale periodic fire on 75-100+ years intervals may be desirable

How might future increased temperatures affect hot desert fire regimes?

- Climate models predict increasing temperatures.
- Conditions in higher elevation and more mesic shrublands may become more conducive to dominance by non-native grasses and the grass/fire cycle, and reduced resistance and resiliency of native vegetation to fire.

How might future changes in precipitation affect hot desert shrubland fire regimes?

- Potential future precipitation is much more difficult to predict than temperature.
- Proportions of summer:winter and rainfall:snow, in addition to increases or decreases and interannual variations, all have differing implications for invasive plants, fire regimes, and interactions between the two.
- Increasing temperatures will mean increasing evapo-transpiration rates, so increased rainfall may still lead to decreased soil moisture and concomitant effects on fine and woody fuels.

Hypothesized Changes in Fire Size and Vegetation Based on Future Precipitation Scenarios in the Mojave Desert

summer rainfall

		summer rainfall	
		lower	higher
winter rainfall	lower	<p><u>Much Smaller Fires</u></p> <ul style="list-style-type: none"> • non-native annuals ↓ • <i>no change in perennial resiliency</i> 	<p><u>Smaller Fires</u></p> <ul style="list-style-type: none"> • non-native annuals ↓ • native perennial <i>resiliency</i> ↑
	higher	<p><u>Much Larger Fires</u></p> <ul style="list-style-type: none"> • non-native annuals ↑↑↑ • <i>native perennial resiliency</i> ↓↓ 	<p><u>Larger Fires</u></p> <ul style="list-style-type: none"> • non-native annuals ↑↑ • <i>native perennial resiliency</i> ↓

Hot Desert Grasslands

pre-settlement

- Historically, most hot desert grasslands burned at an average return interval of 5-15 years (range of 2-30 years).
- Fires typically occurred at the beginning on the monsoon season in late June to early July.
- Most woody species are killed by fire and don't reproduce until they are >10 years old.
- Most perennial grasses survive fire and only have reduced productivity for a few years.
- As a result, perennial grasses dominate landscapes that burn about every decade.



Hot Desert Grasslands

post-settlement

- Livestock grazing has reduced fine fuel loads to the point that fires cannot spread even under extreme fire weather conditions.
- Fire suppression activities and landscape scale fuel fragmentation from roads have further reduced the amount of area burned.
- As a result, fire return intervals have increased, woody plants have established, and perennial grasses and other herbaceous species have declined, converting grasslands to shrublands.



Hot Desert Grasslands

post-settlement

- Fires have been reintroduced in an effort to convert shrublands back to grasslands.
- However fire is typically applied in March or April, outside of the historical summer fire season.
- While these may favor grasses over shrubs, early-season fires tend to favor the dominance of a widespread non-native perennial grass (Lehmann lovegrass), which leads to low diversity vegetation stands.

Desert Riparian Ecosystems

- Historically, FRIs of desert riparian areas likely were influenced by drought, lightning strikes, FRIs of the surrounding landscape, and Native Americans, but in most cases were probably very long.
- Fire size and patchiness were influenced by fuel and fire characteristics, geomorphic setting, and hydrologic regime.



Altered Fire Regimes and Invasive Species

- Tamarisk (8 *Tamarix* sp.) and Russian olive (*Elaeagnus angustifolia*) were introduced in 1800s.
 - Altered flow regimes resulted in drier floodplain environments where the more drought tolerant invaders are replacing native cottonwoods and willows.
 - Floods that provided conditions for native species establishment and cleared live and dead vegetation are suppressed.
 - Tamarisk and Russian olive now form dense thickets of contiguous fuels with high amounts of woody debris and leaf litter, and create volatile fuel ladders under native cottonwoods.
- *Fires of higher severity now occur every 10 to 20 years in some riparian areas (Lovich et al. 1994).*



Altered Fire Regimes and Invasive Species

- Tamarisk resprouts after fire, and both invaders have longer-lived seeds and less specific establishment requirements than native cottonwoods and willows.
- Established native vegetation can suppress tamarisk seedlings and decrease susceptibility to invasion (Sher et al 2000, 2002).
 - *Changes in flow regimes have increased both flammability of riparian areas and the spread of invaders*
 - *Fires have replaced floods as the primary disturbance in many southwestern riparian ecosystems*



Breaking Invasive Plant / Fire Cycles

Must manage both the invasion process and the fire regime at landscape scales

- Managing for more desirable FRIs requires maintaining or increasing ecosystem resistance to invasion and ecosystem resilience or the ability to recover after fire
- Inherent differences exist in resistance and resilience among desert vegetation types
 - Abiotic and biotic characteristics
 - Current ecological conditions
- Management activities need to consider likely FRIs for target vegetation types and current ecological conditions

Prevention of Altered Fire Regimes

Routinely assess current ecological conditions to prioritize areas for management.

Increase resistance in areas with intact native communities

- Promote historically analogous fire regimes
- Control invasion vectors and corridors (e.g. roads, trails, etc.)
- Eliminate/reduce ongoing stressors (e.g. overgrazing)
- Increase early detection and eradication efforts

Increase resilience in areas with intact native communities

- Decrease non-native fuel loads
- Seed with native species
- Actively manage to minimize new invasions
- Minimize other stressors both before and after fire

Restoration of Areas with Altered Fire Regimes

Increase resistance and resilience of transitional or converted vegetation stands in high priority management areas (e.g. near intact native vegetation stands, areas of high resource value)

- Use an integrated management approach
 - Eliminate or reduce invader abundance and propagule supply
 - Restore native species in areas where necessary and feasible
 - Create communities with high resilience and desirable FRIs
- Actively manage to minimize invasion, disturbance, and stressors