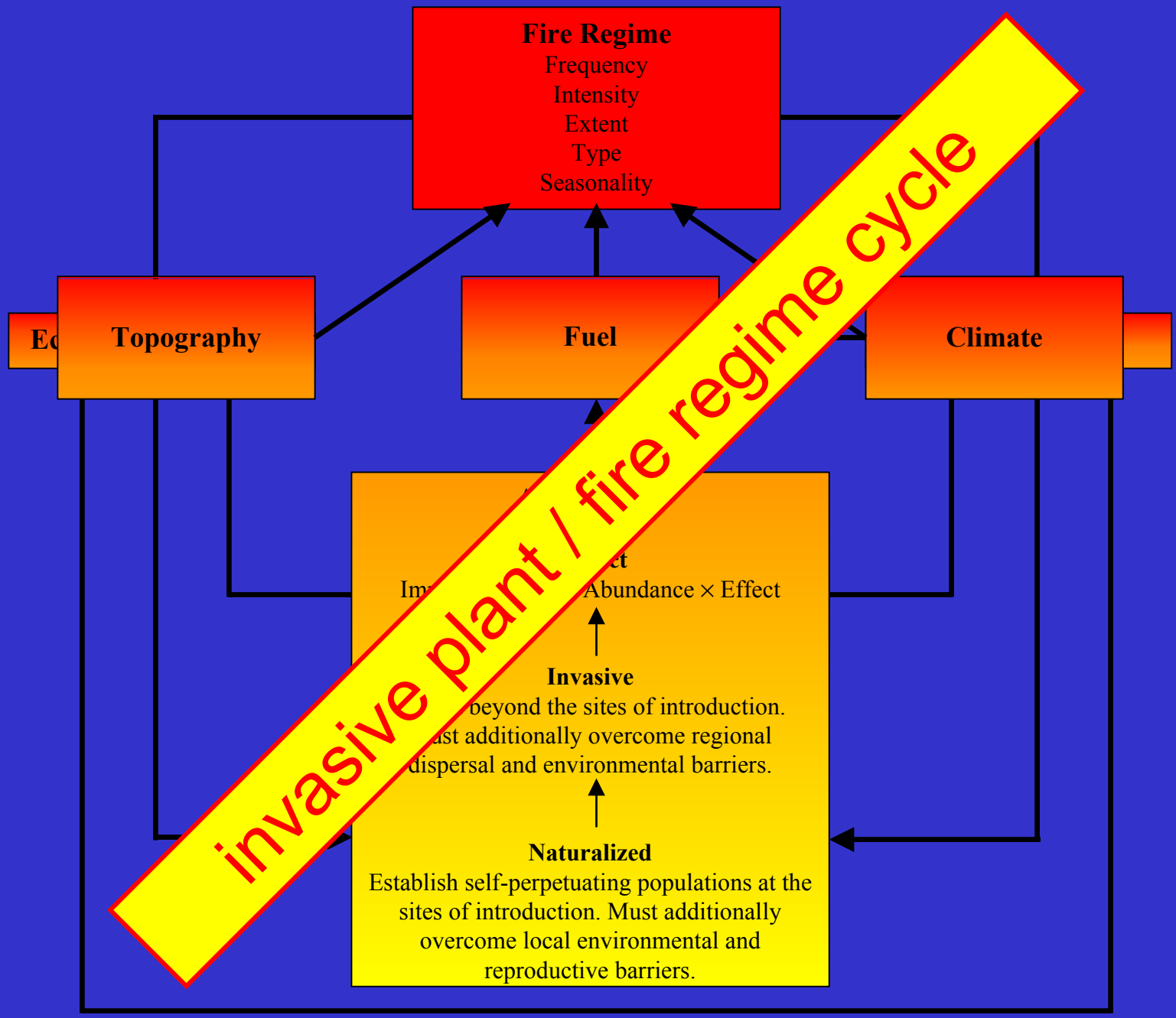
Fire Regimes and Potential for Ecosystem Recovery after Plant Invasions

Matt Brooks and Mike Pellant
USGS, Western Ecological Research Center
BLM, Boise State Office

with contributions from co-authors Carla D'Antonio, David Richardson, James Grace, Jon Keeley, Joseph DiTomaso, Richard Hobbs, and David Pyke


Fire Regime
Frequency
Intensity
Extent
Type
Seasonality
Topography
Fuel
Climate
Abundance × Effect
Invasive
beyond the sites of introduction.
dispersal and environmental barriers.
Naturalized
Establish self-perpetuating populations at the sites of introduction. Must additionally overcome local environmental and reproductive barriers.
invasive plant / fire regime cycle

Ways by Which Plant Invasions Can Change Fuel and Fire Regime Attributes

Extrinsic fuel attributes

Fuel attribute changed	Fire regime attribute changed
Increased horizontal continuity	Increased fire frequency and size, decreased fire patchiness, fires earlier in the year
Decreased horizontal continuity	Decreased fire frequency and size, increased fire patchiness, fires earlier in the year
Increased vertical continuity	Surface to crown fires
Decreased vertical continuity	Crown to surface fires

Cheat grass *increases* horizontal fuel continuity

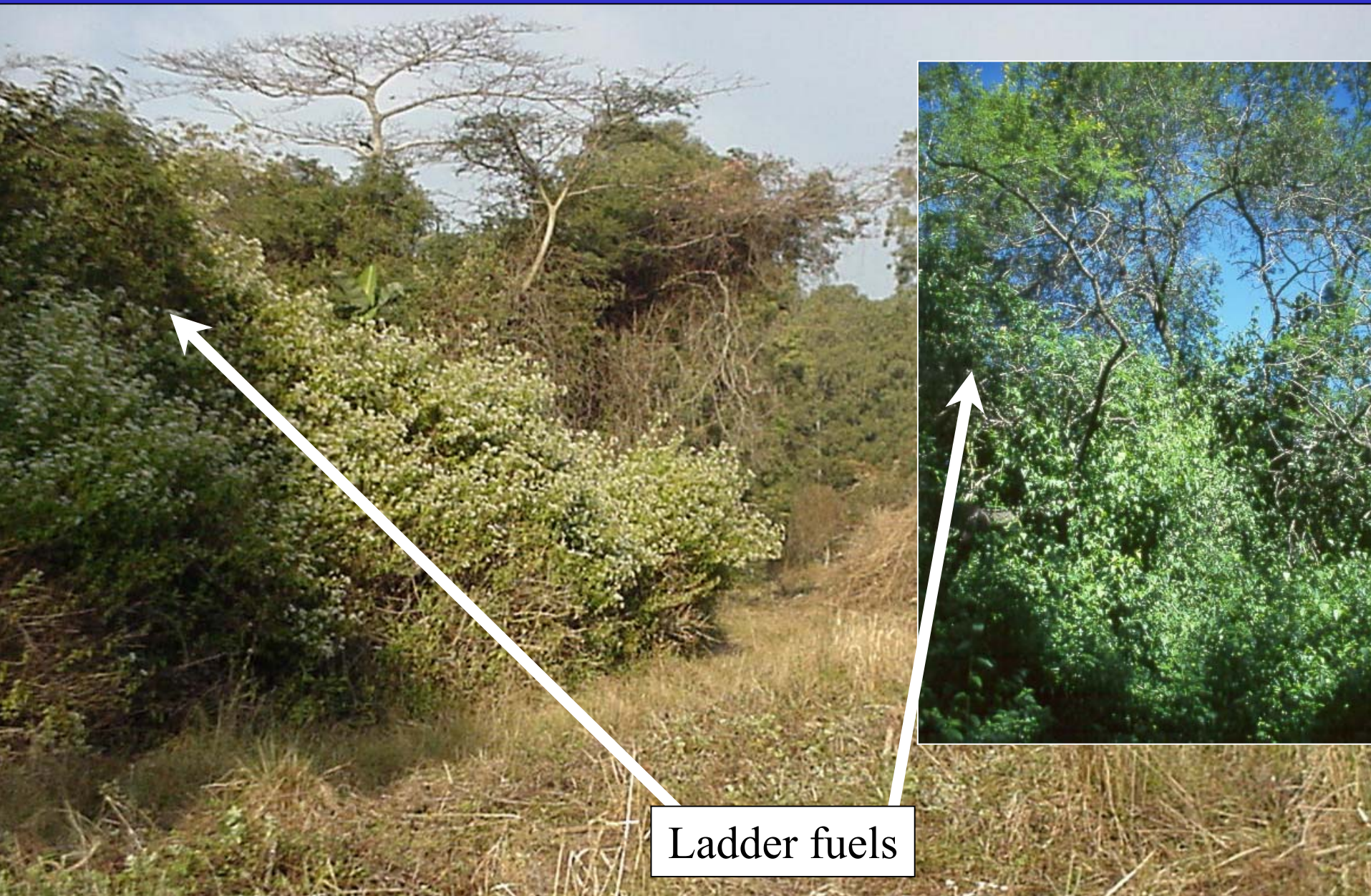
Effects of grass invasions on horizonatal fuel continuity, fire frequency and vegetation type-conversions are well known in many ecosystem worldwide…

but plant invasions can affect fire regimes and vegetation in many other ways.

Giant reed *increases* vertical fuel continuity

Photo: Geoff Nichols

Chromoleana odorata *increases* vertical fuel continuity



Rubber vine *increases* vertical fuel continuity

Chinese Tallow *decreases* horizontal fuel continuity

Ways by Which Plant Invasions Can Change Fuel and Fire Regime Attributes

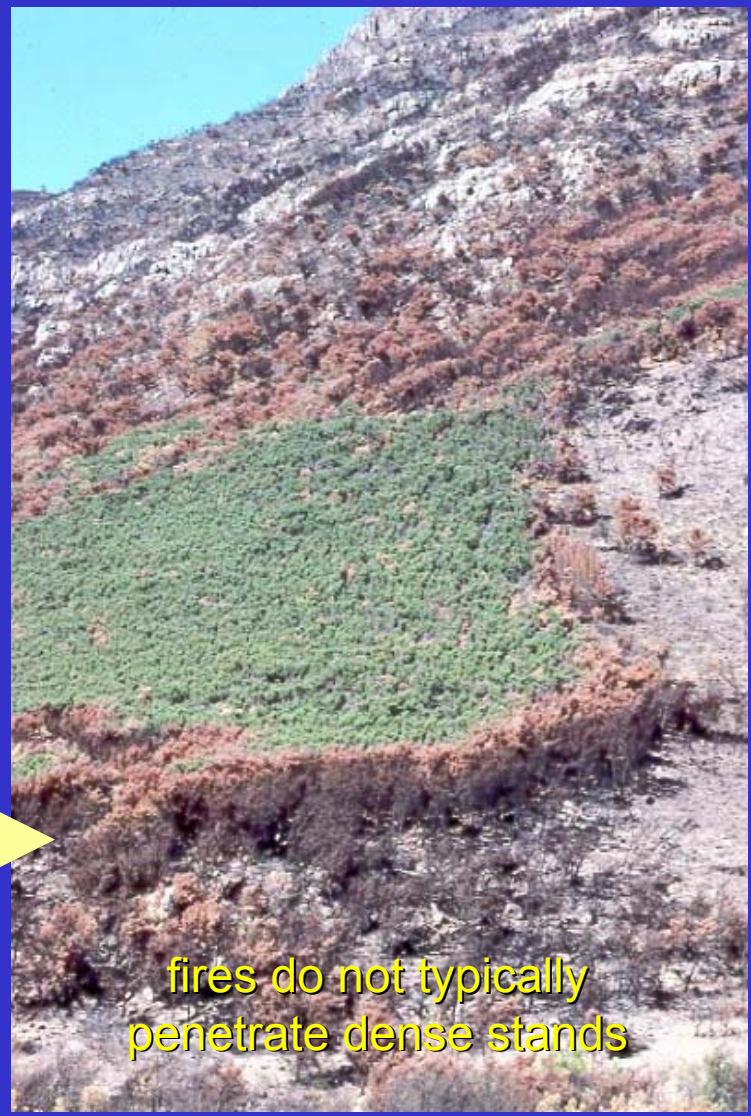
Extrinsic fuel attributes

Fuel attribute changed	Fire regime attribute changed
Increased fuel load	Increased fire intensity and size
Decreased fuel load	Decreased fire intensity and size
Change in packing ratio	Change in fire frequency and size, decreased patchiness, change in annual window of fire activity

Gamba grass *increases* fuel loads and vertical fuel continuity

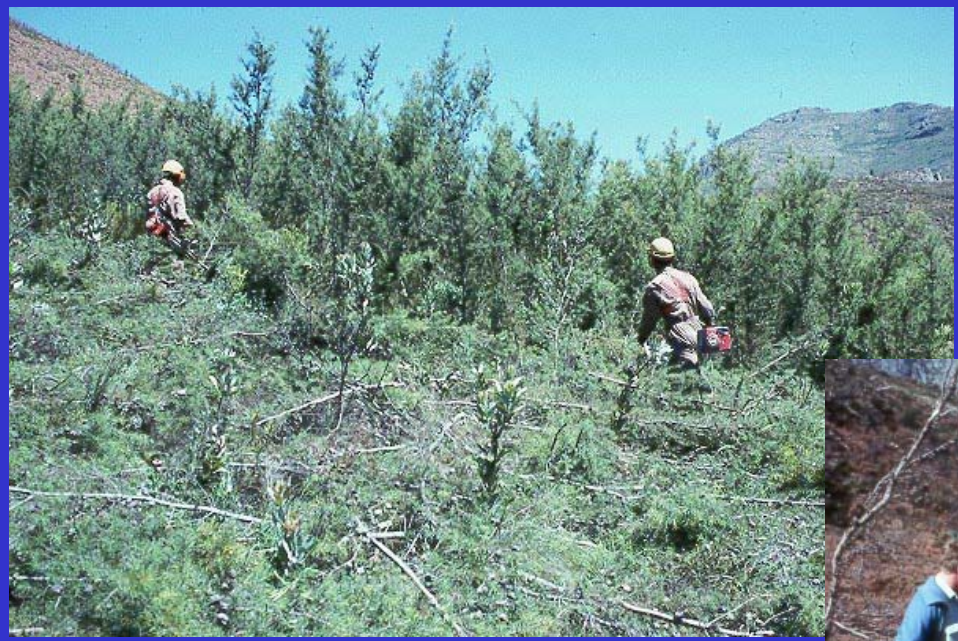

High-intensity canopy fire in savanna invaded by gamba grass
Low-intensity ground fire in uninvaded savanna

Hakea sericea *increases* fuel loads, but alters the fuel packing ratio to the point were fires will not easily spread



When Hakea sericea does burn, it fuels intense crown fires

Control of Hakea sericea requires pretreatment of fuels, to create moderate intensity fires, that are then followed by native plant restoration.



The allelopathic Centaurea diffusa inhibits growth of other herbacesous plants, leading to a decline in community biomass, possibly *reducing* fire frequency.

Ways by Which Plant Invasions Can Change Fuel and Fire Regime Attributes

Intrinsic fuel attributes

Fuel attribute changed	Fire regime attribute changed
Increased plant tissue flammability	Increased fire frequency and intensity, and increased annual window of fire activity.
Decreased plant tissue flammability	Decreased fire frequency and intensity, and decreased annual window of fire activity.

Eucalyptus increases plant tissue flammability

Acacia saligna *increases* fuel loads, but also *increases* plant tissue moisture content 270%, *decreasing* flammability

System to evaluate effects of invasive species on fire regimes and prioritize them for control and restoration of pre-invasion conditions

Phase 1
Plant species has not been introduced to the region of interest.

→

Evaluate its potential to naturalize, become invasive, cause ecological impact, and alter fire regimes.
Prioritize for exclusion from the management unit.

- High potential to cause ecological impact and alter fire regimes → High priority for exclusion
- High potential to only naturalize an become invasive → Moderate priority for exclusion
- Low potential to naturalize → Low priority for exclusion

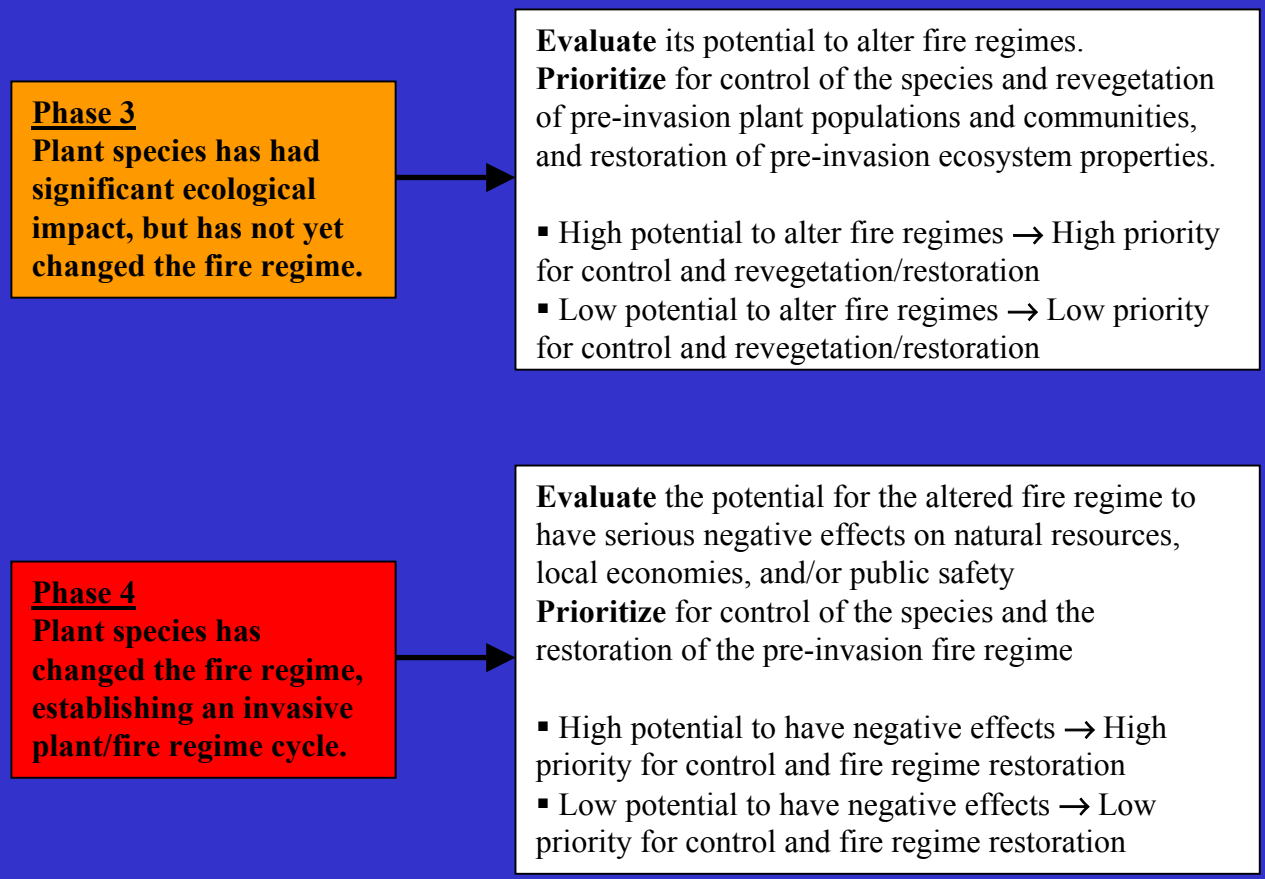
Phase 2
Plant species is either naturalized or invasive, but has not yet caused significant ecological impact.

→

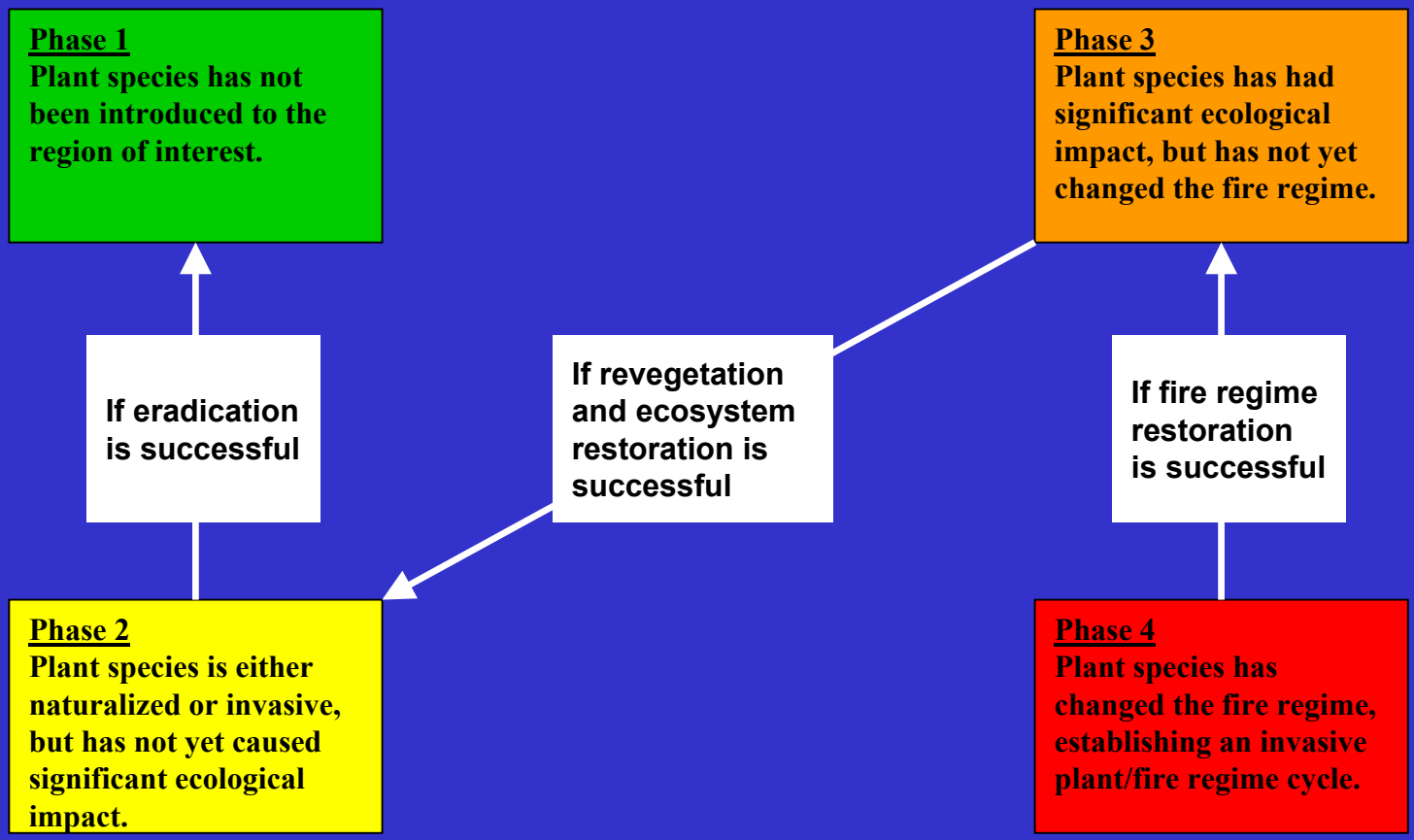
Evaluate its potential to have significant ecological impact, especially by altering fuel structure.
Prioritize for eradication or control of the species.

- High potential for significant ecological impact → High priority for eradication and control.
- Low potential for significant ecological impact → Low priority for eradication and control.

System to evaluate effects of invasive species on fire regimes and prioritize them for control and restoration of pre-invasion conditions



Pathway to Ecosystem Recovery



Management Options for Breaking the Invasive Plant / Fire Regime Cycle

If invaders promote any aspect of the fire regime (e.g. fire frequency, intensity, extent, or seasonal burn window).

Then consider:

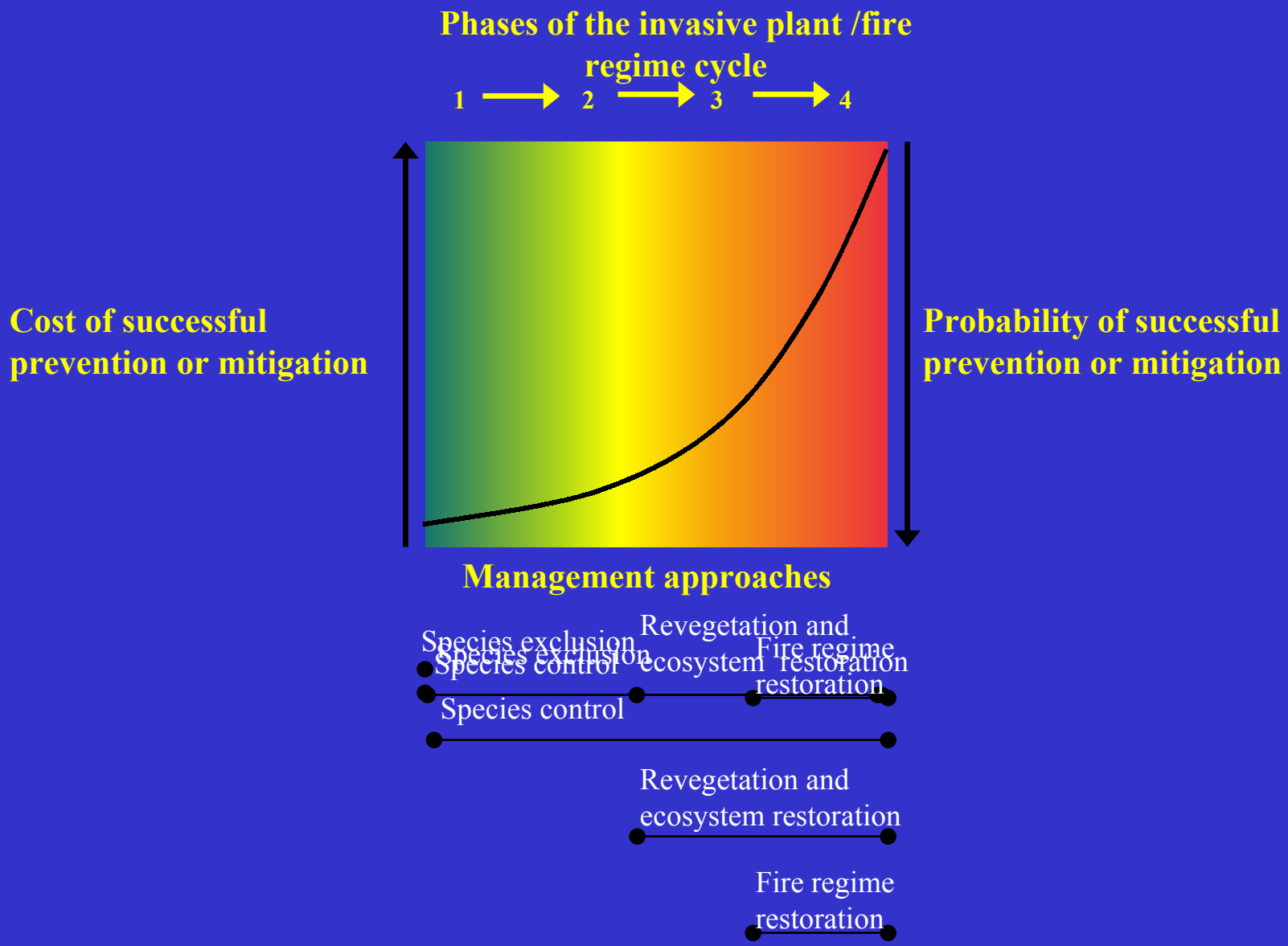
- Managing fuels
  - Vegetating with fire-resistant plants that can compete with invaders and reduce their effects on the fuelbed.
  - Creating fire-breaks by green-stripping or mechanical methods to protect native landscapes.
  - Manipulating other ecosystem properties/processes necessary to restore pre-invasion vegetation and fire regime conditions.
  - Limiting land use activities that increase the dominance of invaders and their effects on the fuelbed and fire regime, while promoting those that reduce invader effects.
- Managing ignition sources
  - Adopting local ordinances to reduce the frequency of ignitions by humans.

Management Options for Breaking the Invasive Plant / Fire Regime Cycle

If invaders suppress any aspect of the fire regime (e.g. fire frequency, intensity, extent, or seasonal burn window).

Then consider:

- Managing fuels
  - Using mechanical or chemical treatments to increase fuel flammability.
  - Vegetating with plants that restore pre-invasion fuel structure, or otherwise increase its flammability.
  - Manipulating other ecosystem properties/processes necessary to restore pre-invasion vegetation and fire regime conditions.
  - Limiting land use activities that increase the dominance of invaders and their effects on the fuelbed and fire regime, while promoting those that reduce invader effects.
- Managing ignition sources
  - Using prescribed fire after the fuelbed has been altered to increase its flammability.
  - Using prescribed fire when weather conditions permit burning (e.g. high winds, high temperature, low humidity).


Phases of the invasive plant /fire regime cycle
1
2
3
4
Cost of successful prevention or mitigation
Probability of successful prevention or mitigation
Management approaches
Species exclusion
Species control
Revegetation and ecosystem restoration
Fire regime restoration
Species control
Revegetation and ecosystem restoration
Fire regime restoration