Invasive Plant Biology and Ecology

San Joaquin Valley Livestock Symposium

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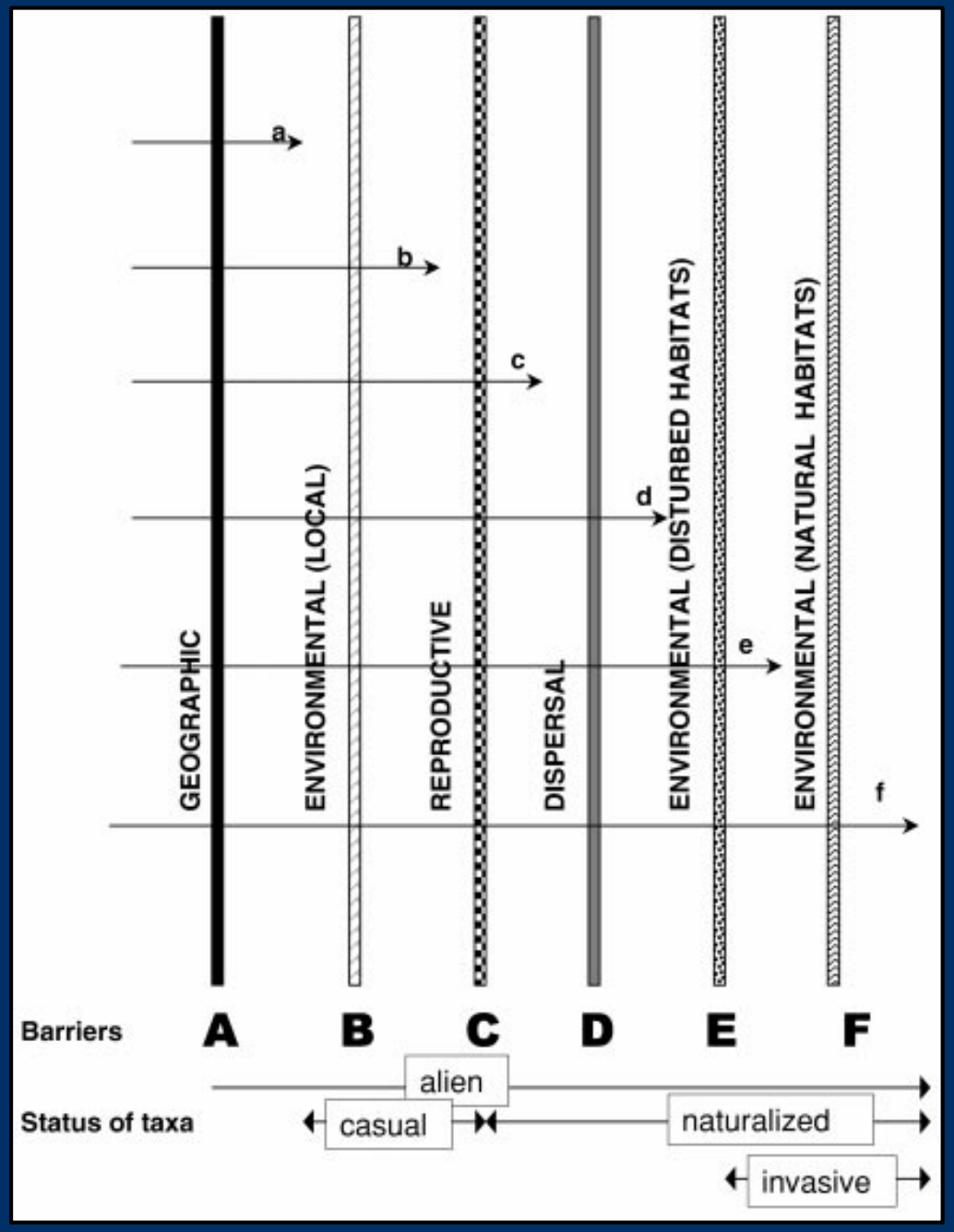


Invasive Plants

Not necessarily “weeds”

No inherent environmental or economic impact

Time and space dependent

- **Alien**
- **Casual**
- **Naturalized**
- **Invasive**

Subset are “transformers”

Compare with definition of weeds

The term “weed” is often anthropocentric (and outdated)

- **Undesirable location (WSSA 1956)**
- **Competitive with more valuable plants (Brenchley 1920)**
- **Unwanted or with undiscovered virtues (Bailey & Bailey 1941, Emerson 1878)**
- **Anything we didn’t plant (Brenchley 1920, Harper 1944)**
- **Unsightly (Thomas 1956)**

“… weeds are little more than plants that have aroused a certain level of human dislike at some particular time or place”

Not useful in helping explain:

- **Why and where weeds exist**
- **How they interact with crops**
- **How to manage them effectively**

A more useful definition

Any plant species that interferes with the *management objective* for particular *time* and *place*

Usually very:

- **Prolific**
- **Competitive**
- **Harmful/destructive**
- **Difficult to control**

Not all weeds are invasive… (and vice versa)

Invasiveness and Invasibility

Ecology of plant invasion = interaction of biology and environment

Invasiveness (biological component)

- Capacity of a plant species to spread beyond introduction site and establish at new sites

Invasibility (environmental component)

- Susceptibility of habitat to colonization and establishment of new species

Invasiveness: biological characteristics

- **“General purpose” – high fitness over range of environments**
- **Plants that grow and reproduce quickly**
- **Easily dispersed by humans & animals**
- **Vegetative propagation**
- **Alien status (absence of enemies?)**
- **Not dependent on mutualisms**
- **Persistent seed banks**

Rejmanek and Pitcairn (2002)

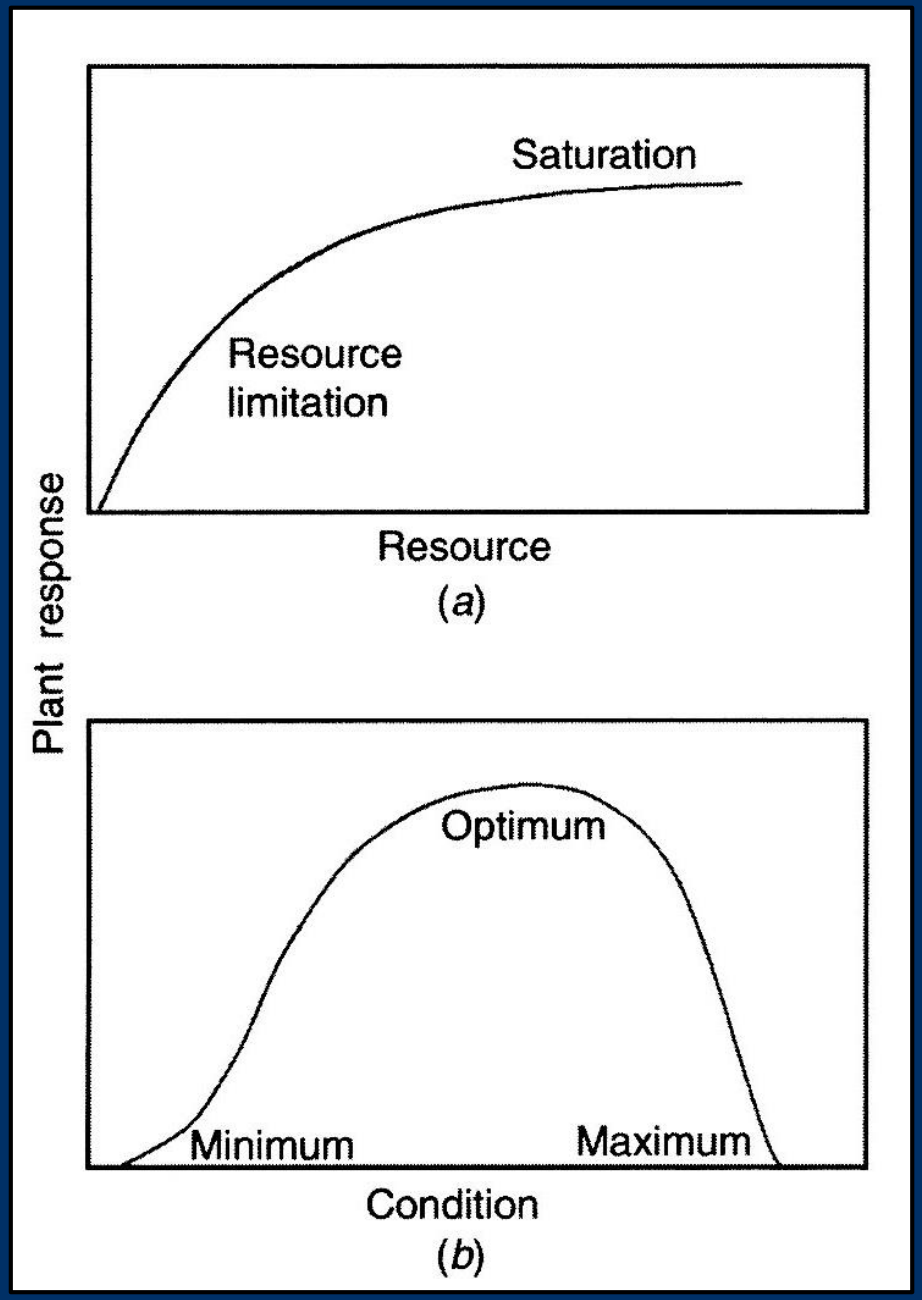
Invasiveness: the environment

Resources (consumable)

- light
- water
- nutrients

Conditions (not consumed)

- temperature
- frequency of fire
- soil pH



The concept of “niche”

Niche = the environment and resources of a particular site used by a species

Competitive exclusion principle (Guase, 1934):

- **Multiple species cannot coexist indefinitely in the same niche competing for the same resources**
- **Differential specialization between species allows species to avoid direct competition**

Concept of ”safe site”

Most species fail to germinate, most that do fail to survive

Safe sites provide:

- **Stimuli for breaking seed dormancy**
- **Conditions for germination to proceed**
- **Resources for seedling growth**
- **Absence of hazards**

Inter-relationship of Invasiveness and Invasibility

Invasibility linked to resource availability

- **Spatial – resources available in specific locations on landscape**
- **Temporal – resources available only at certain times**

Invasive species life history components

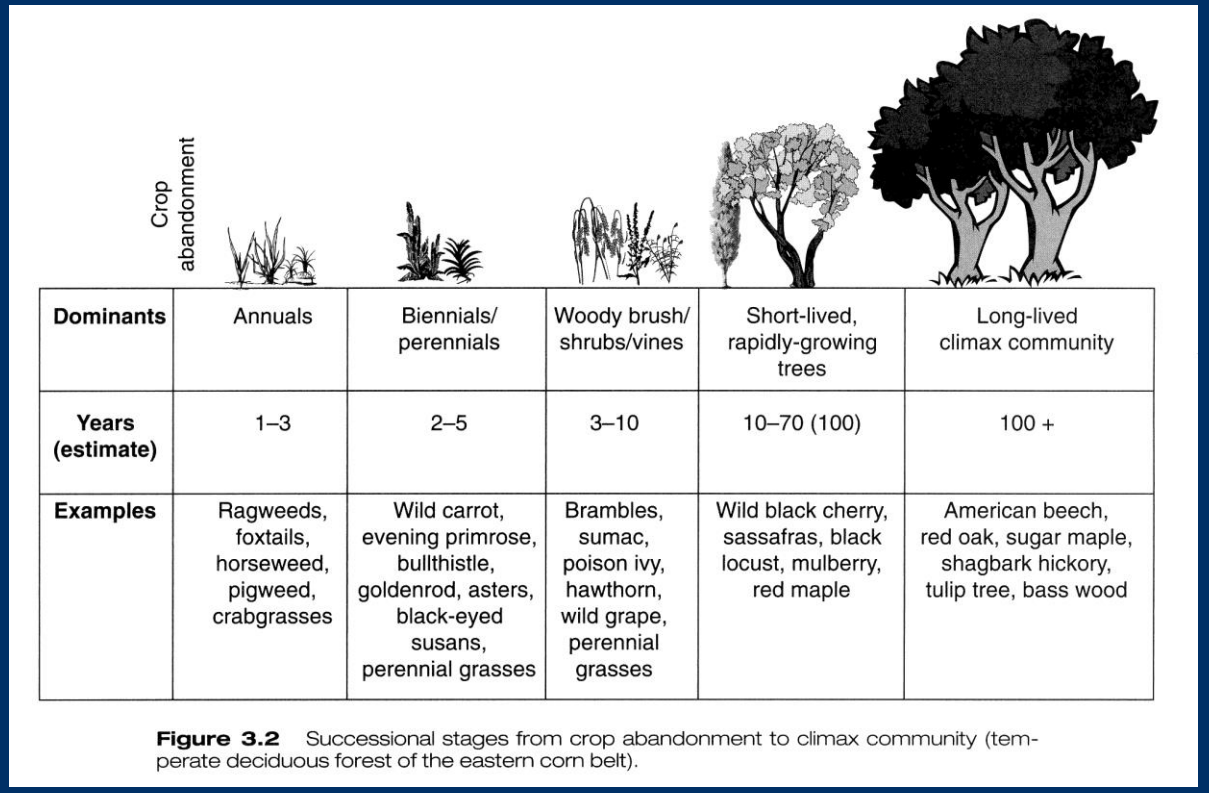
- **Seed dispersal and propagule pressure**
- **Niche matches safe sites present**
- **Shared life history with plants currently present**

Role of disturbance: succession

Disturbance = total or partial destruction of vegetative cover

Stops succession or otherwise modifies plant community diversity or complexity

- **Invasibility often increased during recovery period**
- **Creates safe sites**
  - Reduces impact of high plant densities
  - Increases probability of finding safe site



Dominants	Annuals	Biennials/ perennials	Woody brush/ shrubs/vines	Short-lived, rapidly-growing trees	Long-lived climax community
Years (estimate)	1–3	2–5	3–10	10–70 (100)	100 +
Examples	Ragweeds, foxtails, horseweed, pigweed, crabgrasses	Wild carrot, evening primrose, bullthistle, goldenrod, asters, black-eyed susans, perennial grasses	Brambles, sumac, poison ivy, hawthorn, wild grape, perennial grasses	Wild black cherry, sassafras, black locust, mulberry, red maple	American beech, red oak, sugar maple, shagbark hickory, tulip tree, bass wood

Figure 3.2 Successional stages from crop abandonment to climax community (temperate deciduous forest of the eastern corn belt).

Role of disturbance: fragmentation

Edge effects

- Pathways for propagule or seed dispersal
- Roads, utility corridors, waterways
- Gaps in natural vegetation (grazing/browsing)

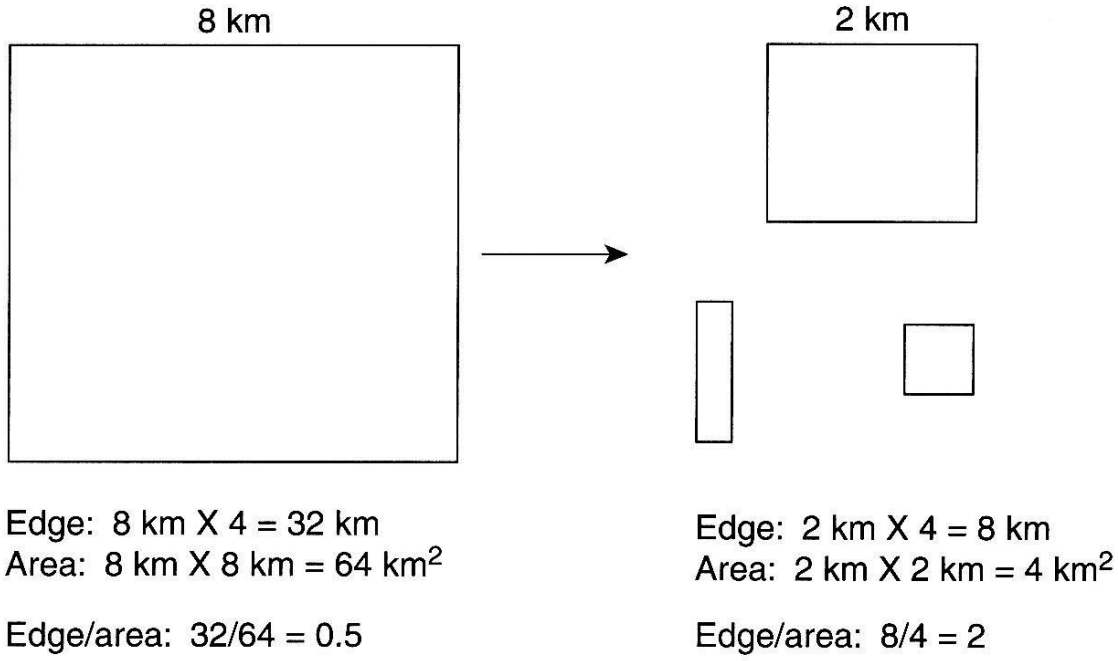


Figure 3.4 The fragmentation of large parcels of land increases the edge/area ratio in the smaller parcels (compare the 8-km diameter plot with the 2-km diameter one).

Invasibility and stress

Stress reduces physiological functioning below maxium level

1. **Low resource availability (light, water, nutrients)**
2. **Conditions that limit resource acquisition (e.g., extreme temperature)**
3. **Toxins**

Interaction between disturbance and stress

Invasion may occur when:

1. **Stress is low**
2. **Disturbance departs from natural levels**
3. **Low stress is combined with disturbance**

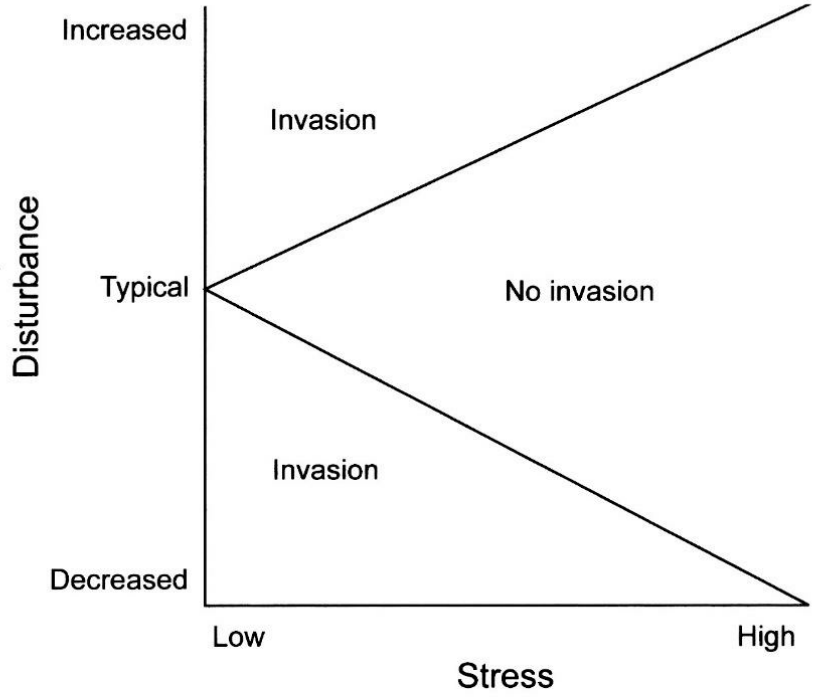


Figure 3.3 Model of interactive effects of stress and disturbance on habitat invasibility. (From Alpert et al. 2000. *Perspect. Plant Ecol. Evol. Syst.* 3:52–66. Copyright 2000 with permission from Elsevier.)

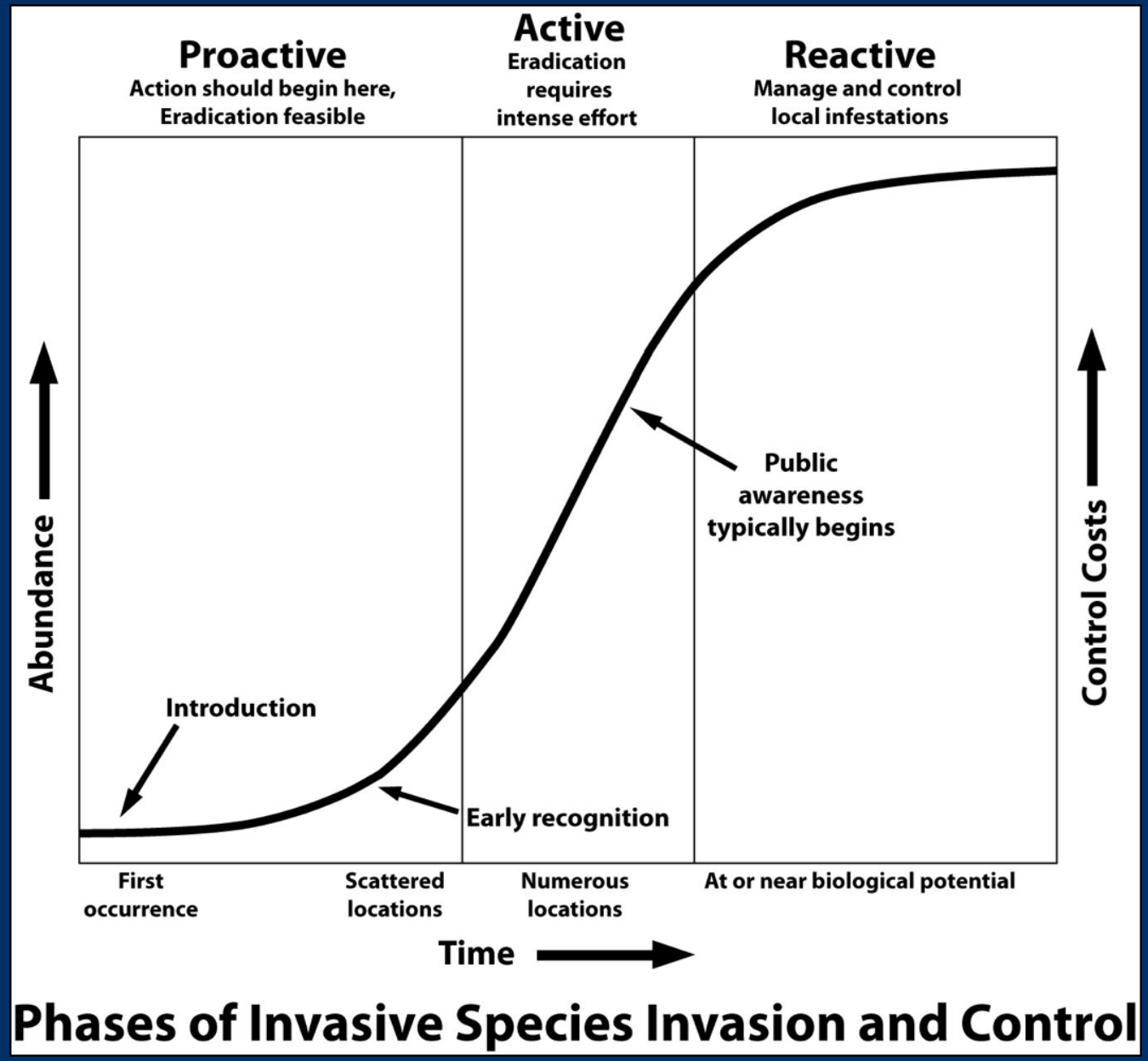
Typical invasion process

Introduction

Colonization

- Lag Phase
- Exponential growth

Naturalization



Case study: buffelgrass

Sonoran Desert

- **Hot - 99.3°F JJA mean max temp for Tucson**
- **Dry - 12.6 in/yr, bimodal with summer monsoon**
- **Sparse - 25 to 35% canopy cover**
- **Long-lived dominant plants**

Buffelgrass history and biology

- Multiple introductions into AZ starting in 1930s
- Native to Africa, Madagascar, and the Middle East
- C4 perennial bunchgrass
- Drought tolerant and resistant to heavy grazing
- Invasive in subtropical regions worldwide, including Australia, Hawaii, Mexico, Brazil, Argentina
- Often considered a desirable forage species

Buffelgrass invasion ecology

Patches double in size every 3-5 yrs

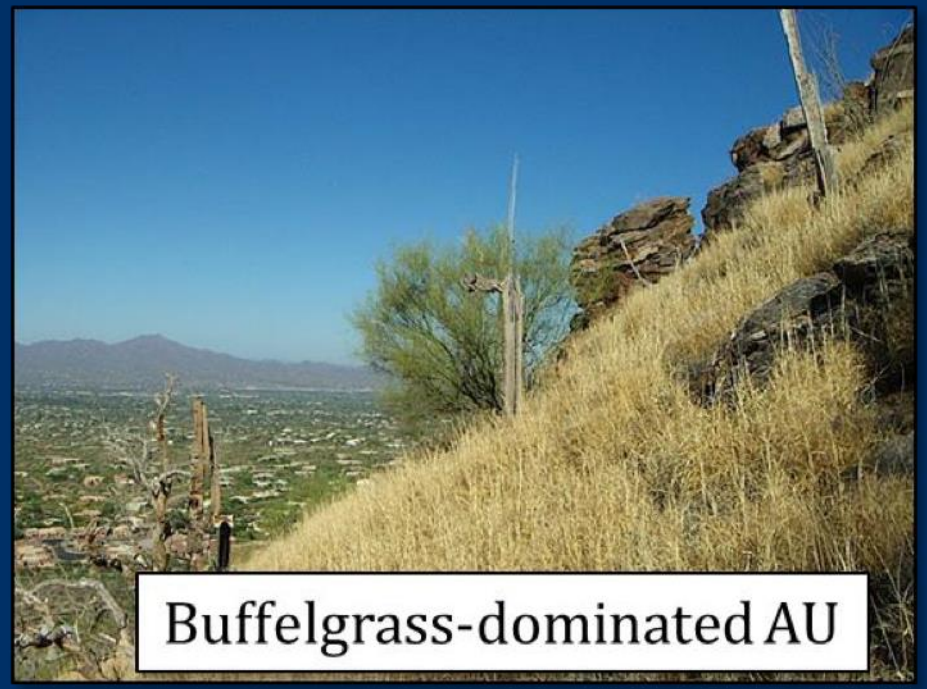
Outcompetes natives for water resource

- **Progressive elimination of adults; suppressed seedling recruitment**
- **<10-15 yrs, only adult saguaros remain embedded (Olsson *ea* 2012)**

Grass-Fire Cycle

- **Fuel loads @ 7000 lb/ac**
- **1,300 to 1,600°F**
- **Fuel linkage btw desert and forest**

Ecosystem transformation



Questions?

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Useful Textbooks:

Radosevich SR, JS Holt, CM Ghersa. 2007. Ecology of Weeds and Invasive Plants, 3rd Ed. John Wiley and Sons, Inc.

Ross MA and CA Lembi. 2008. Applied Weed Science, 3rd Ed. Prentice Hall.