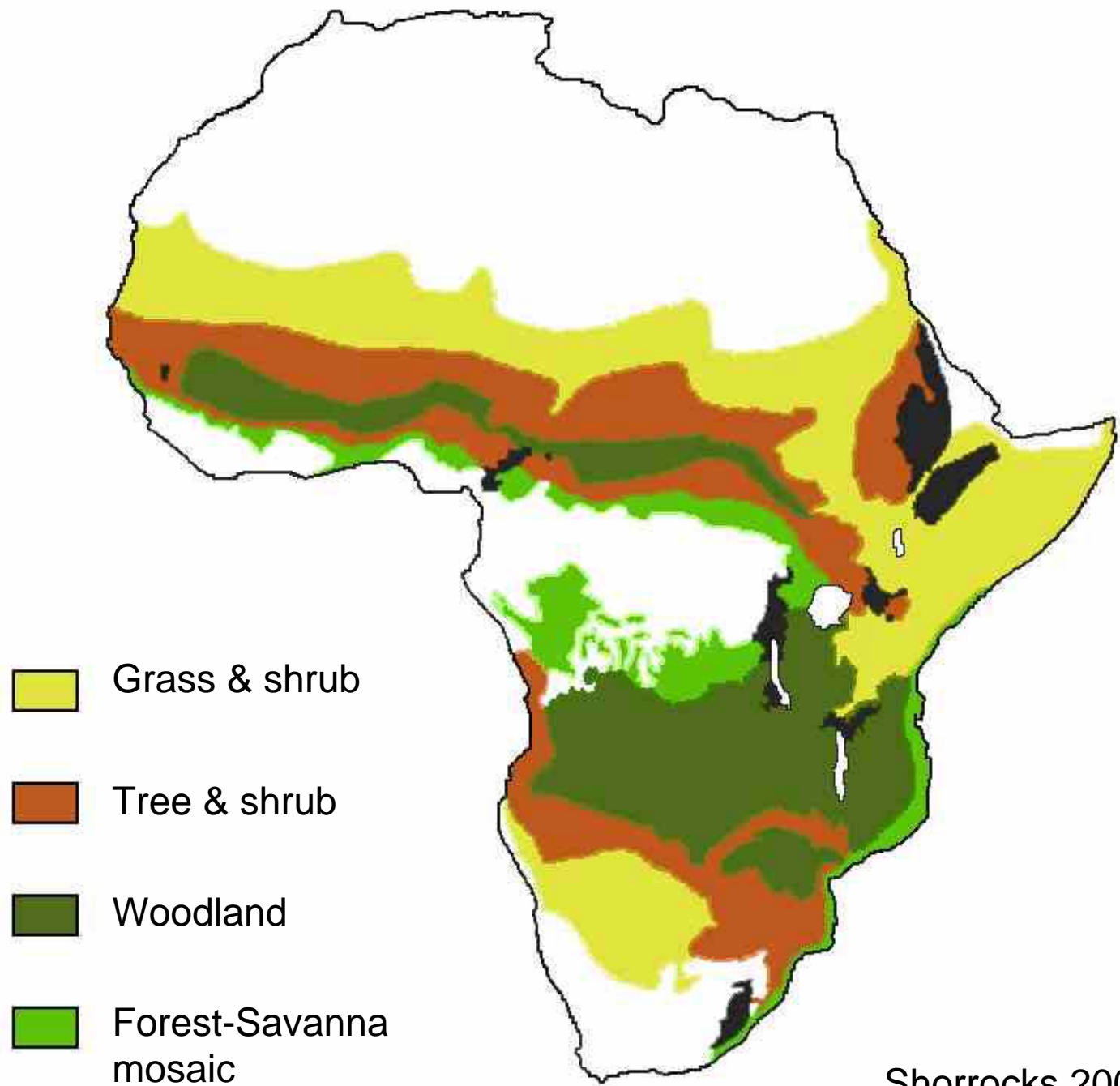
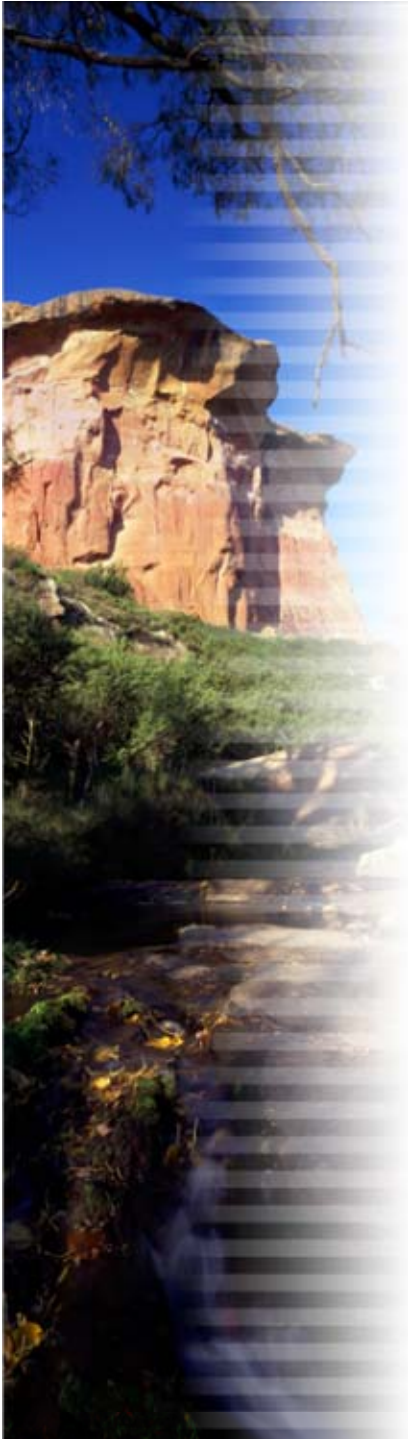
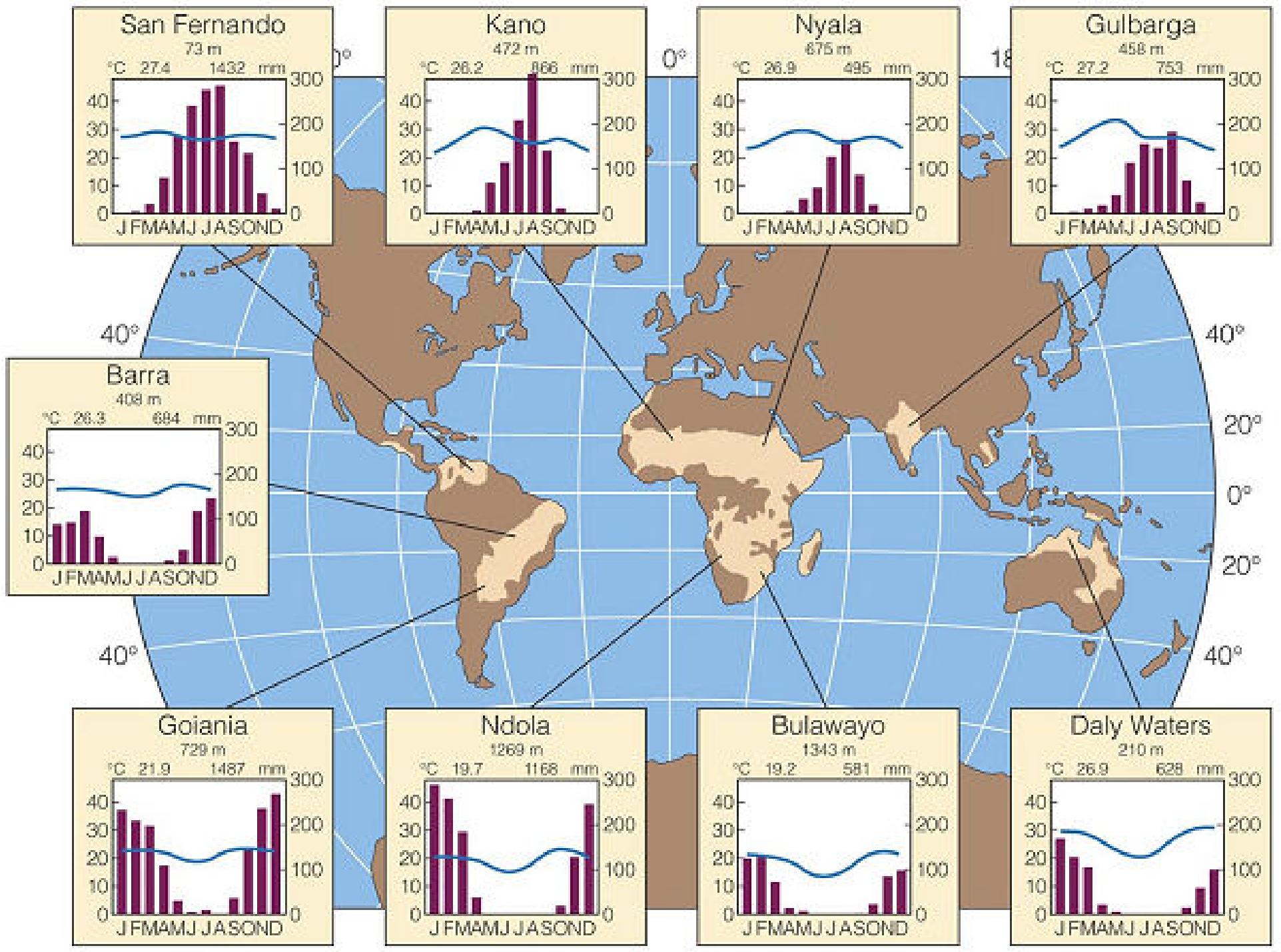


ALIEN PLANT INVASIONS IN AFRICAN SAVANNAS

Llewellyn C Foxcroft*, David M Richardson & Marcel Rejmánek



Shorrocks 2007





Introduction- what we know

- Many millions of people are dependent on savannas for sustaining their livelihoods
- wide range of land use types, including agriculture, grazing, and fuel wood harvesting (Huntley 1982, Scholes 1997).
- also subject to periodic natural disturbances -fire, drought, floods, mega-herbivores (Walker & Noy-Meir 1982, Scholes 1997)



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Introduction- but

Despite:

the range of habitats

anthropogenic use / disturbance

natural disturbances



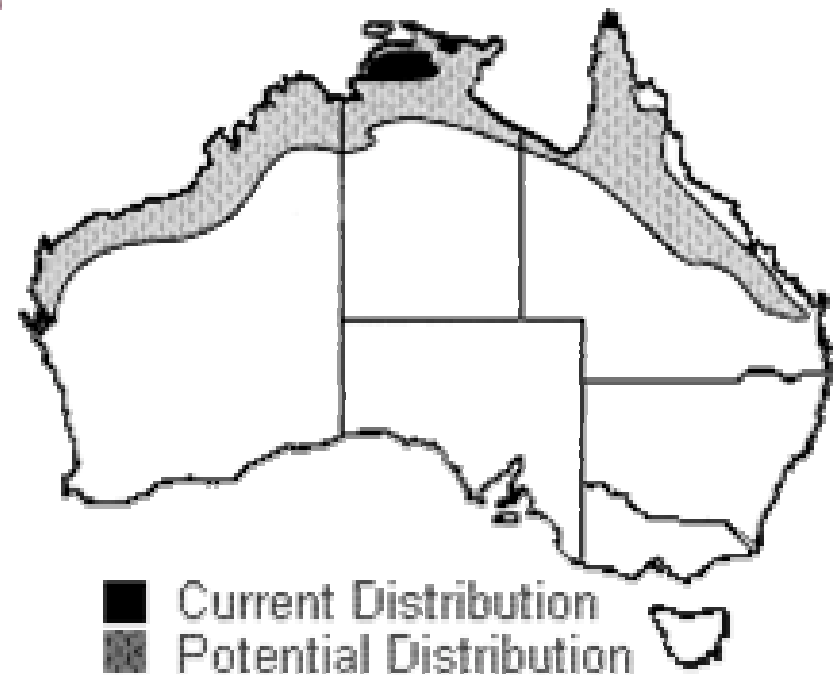
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Invasive alien plants *appear* to not be as problematic in Africa savannas as in other savannas

For example: African grasses in the Neotropics & Australian savannas

Gamba grass- Australian savannas





Or, alternatively, problems with invasive species in the African savannas have not been well reported on...



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Although a **wealth** of knowledge now exists on the composition and function of savannas globally

(for example Sinclair 1979, Huntley and Walker 1982, Brown and Gubb 1986, Henderson and Wells 1986, Werner 1991, Scholes and Walker 1993, Sinclair 1995, Baruch 1996, Silva 1996, Cowling *et al.* 1997, Coe *et al.* 1998, Mistry 2000, Du Toit *et al.* 2003, Shorrocks 2007)

Few of these works discuss the invasion of alien species





Searched internet (various search engines) & sources of literature

Examined species lists for various areas (mostly protected areas) in African savannas

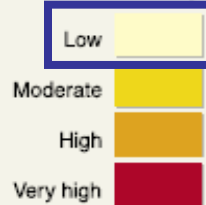


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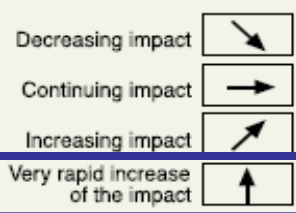


		Habitat change	Climate change	Invasive species	Over-exploitation	Pollution (nitrogen, phosphorus)
Forest	Boreal	↗	↑	↗	→	↑
	Temperate	↘	↑	↑	→	↑
	Tropical	↑	↑	↑	↗	↑
Dryland	Temperate grassland	↗	↑	→	→	↑
	Mediterranean	↗	↑	↑	→	↑
	Tropical grassland and savanna	↗	↑	↑	↘	↑
	Desert	→	↑	→	→	↑
Inland water		↑	↑	↑	→	↑
Coastal		↗	↑	↗	↗	↑
Marine		↑	↑	→	↗	↑
Island		→	↑	↘	→	↑
Mountain		→	↑	→	→	↑
Polar		↗	↑	→	↗	↑

Driver's impact on biodiversity over the last century



Driver's current trends



MEA 2005

Source: Millennium Ecosystem Assessment



Global patterns of invasions in savanna systems

Global review of plant invasions
Lonsdale (1999) stated

-savannas are among the least invaded biomes globally.

-Suggests that there are real differences in the degree of invasion between biomes, which might lead one to conclude, for example, that deserts and savannas are less invadable.



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Global patterns of invasions in savanna systems

In *World Savannas* (Mistry 2000) - invasive plants are discussed at four different occasions:

- invasive African grasses in Brazilian Cerrado,
- African grasses in Venezuelan llanos,
- invasive plants in Australian savannas.

-There is a short discussion about invasive plants in South African savannas [(based on Henderson and Wells (1986) and on Richardson *et al.* (1997)].

But invasive plants are not mentioned in the chapter on savannas in West or East Africa.



Global patterns of invasions in savanna systems



In *Biodiversity and Savanna Ecosystem Processes* (Solbrig *et al.* 1996), plant invasions are discussed in two chapters:

- Ecophysiological aspects of the invasion by African grasses and their impact on biodiversity (Baruch 1996)
- Biodiversity and stability in tropical savannas (Silva 1996).

But- in both cases only invasions into Neotropical savannas are discussed.



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Alien plant invasions in Neotropical savannas

- Discussion on how African grasses, **intentionally** introduced into Neotropical savannas to improve forage quality, have successfully spread and displaced native species (Baruch and Bilbao 1999).
- In assessing the effects of invasive alien plants on fire regimes, discuss the role of African grasses in Venezuelan savannas, which increase biomass by 50% (Brookes . 2004)





Alien plant invasions in Neotropical savannas



- Rejmánek *et al.* (2005) state that savannas, especially disturbed deforested areas in the Neotropical regions, are very often dominated by African grasses (such as *Hyparrhenia rufa* and *Melinis minutiflora*)
- while similar tropical habitats in Africa and Asia are dominated by Neotropical woody plants, such as *Lantana camara* and *Opuntia* spp. (Cactaceae).
- In an assessment of the impact of alien species in Brazilian savannas Pivello *et al.* (1999), show that the community is dominated by alien grasses, which have displaced native grasses



Alien plant invasions in Australian savannas



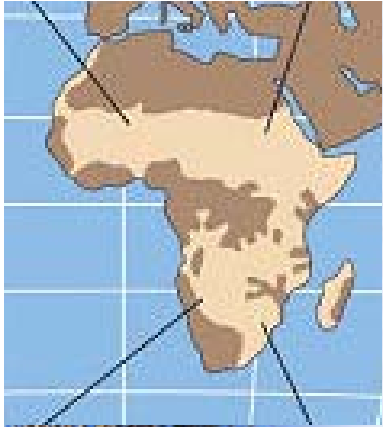
Lonsdale (1994) indicates that **466** pasture species were **intentionally** introduced into northern Australia savannas.

- **selected** vigorous competitors, hardy and of savanna origins.

Various other studies have examined the impact of invasive plant on processes such as the grass-fire cycle (Rossiter *et al.* 2003) concluding that alien grasses (eg. *Andropogon gayanus*- Gamba grass) pose a substantial threat to the Australian savannas.



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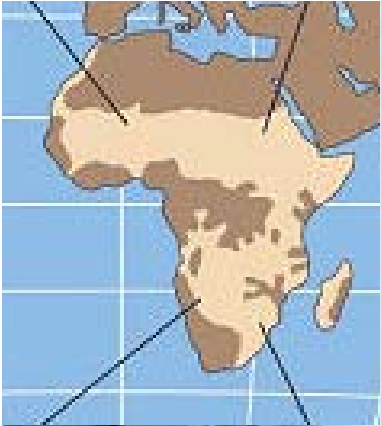


Alien plant invasions in African savannas

The little data and information that have been presented on plant invasions in Africa seem to indicate that invasions are not a major factor in these ecosystems, while the New World situation suggests completely the reverse (Parsons 1972).

However, Henderson and Wells (1986) include 583 species of naturalised alien plants in their analysis of tropical southern African savannas, stating that 151 are known to be particularly aggressive invaders.



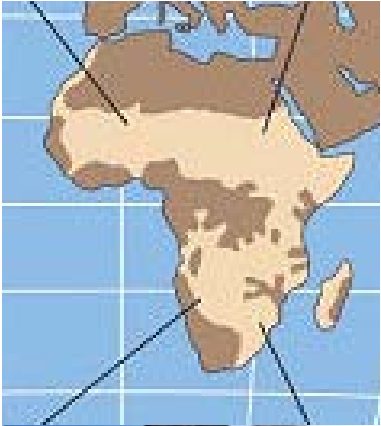


Alien plant invasions in African savannas

-The savanna ecosystem in Kruger National Park in which alien plants have been reasonably well studied currently maintains a list of 373 alien plant species (Foxcroft *et al.* 2003).

However, this list includes invasive, ruderal and ornamental species.





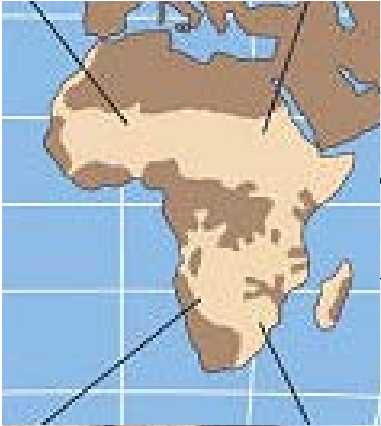
Alien plant invasions in African savannas

In a synthesis of 5 protected areas in tropical savannas (Macdonald and Frame 1988), few alien species were recorded.

- In the Serengeti-Ngorongoro ecosystem - 12 species (of which they considered 4 to be substantial problems)
- In general - thought that introduced plants were unimportant in the Serengeti ecosystem (Macdonald and Frame, 1988).
- Foxcroft (2003) recorded ten species of alien plants in the Seronera and western corridor areas of Serengeti National Park (*Opuntia stricta* var. *Dillennii* and *O. monocantha*)



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Alien plant invasions in African savannas

- Mkomazi Game Reserve (Tanzania) there were only 8 naturalized plant species reported (Vollesen *et al.* 1999)
- Economic review of alien plant control programmes in South Africa, (Turpie 2004) indicates that the grassland and savanna biomes are extensively invaded, **but** mostly in the moister regions and particularly along river courses.





What seems to be going on?

- There certainly appears to be more literature on plant invasions emanating from the Neotropics and Australian savannas

but

- There are some records to suggest that there are potentially large numbers of invasive species in the African savannas



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So..

- Does this mean that African savannas are inherently more resilient to plant invasions (traits of the habitat)

Or

- That the species that have been introduced are less aggressive invaders (traits of the species)



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Traits of the habitat

But African savannas have:

- a range of habitats,
- moisture gradients,
- nutrient gradients,
- a range of uses,
- are disturbed in many ways...

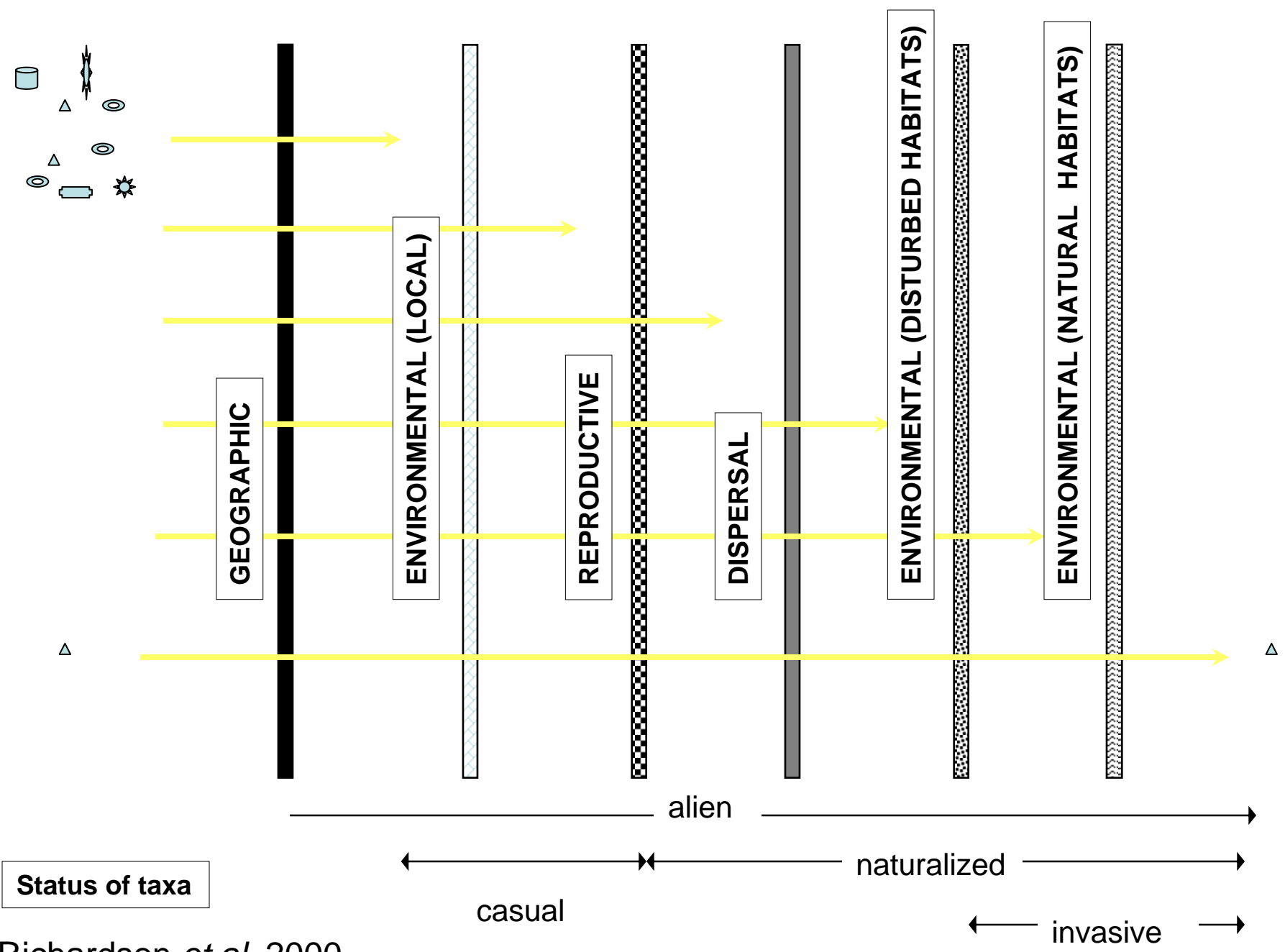
--Surely some areas/patches must be as invasible as in other savannas???



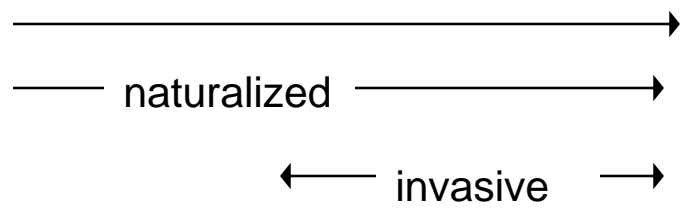
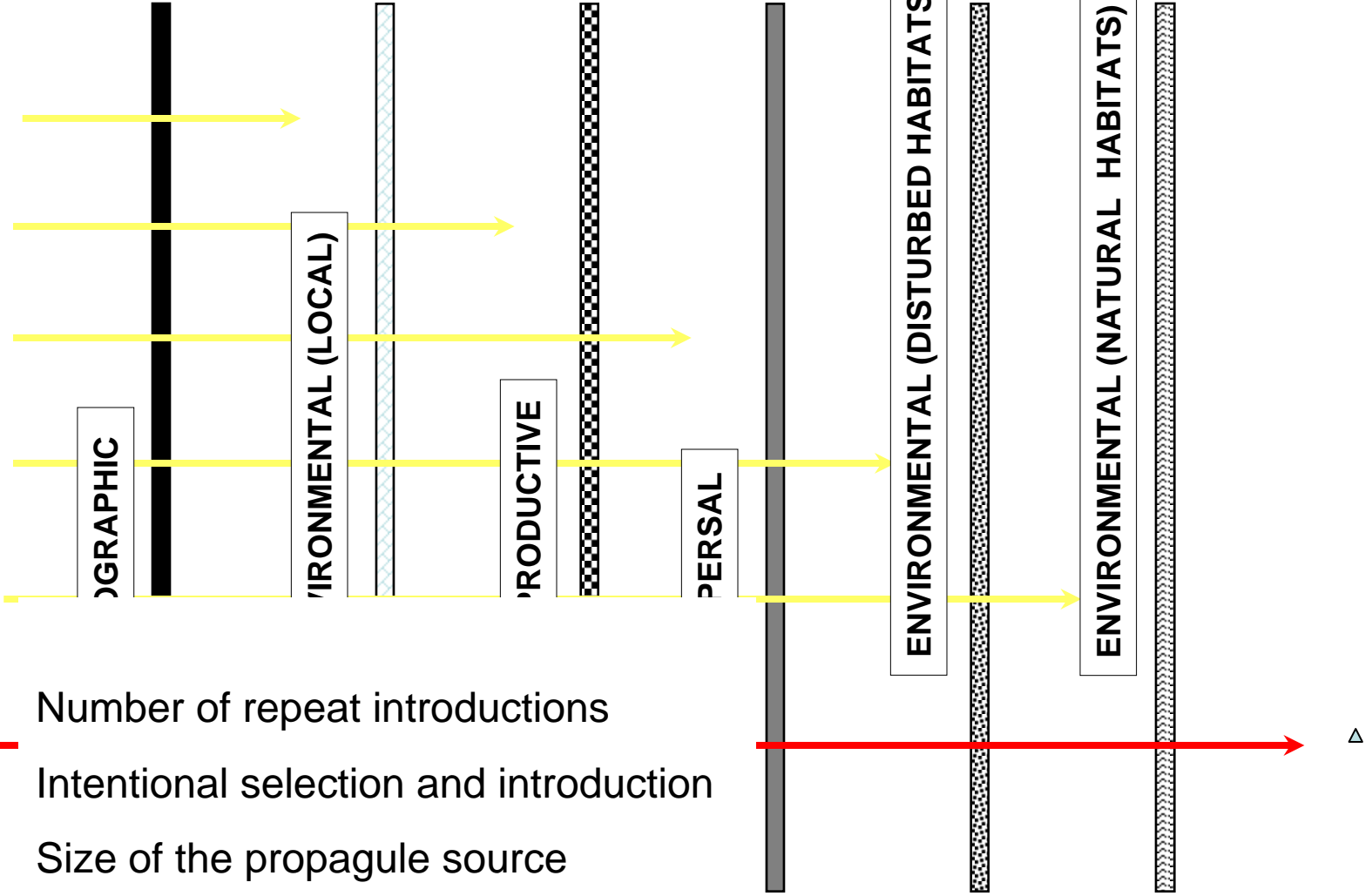
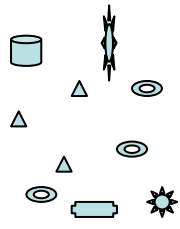
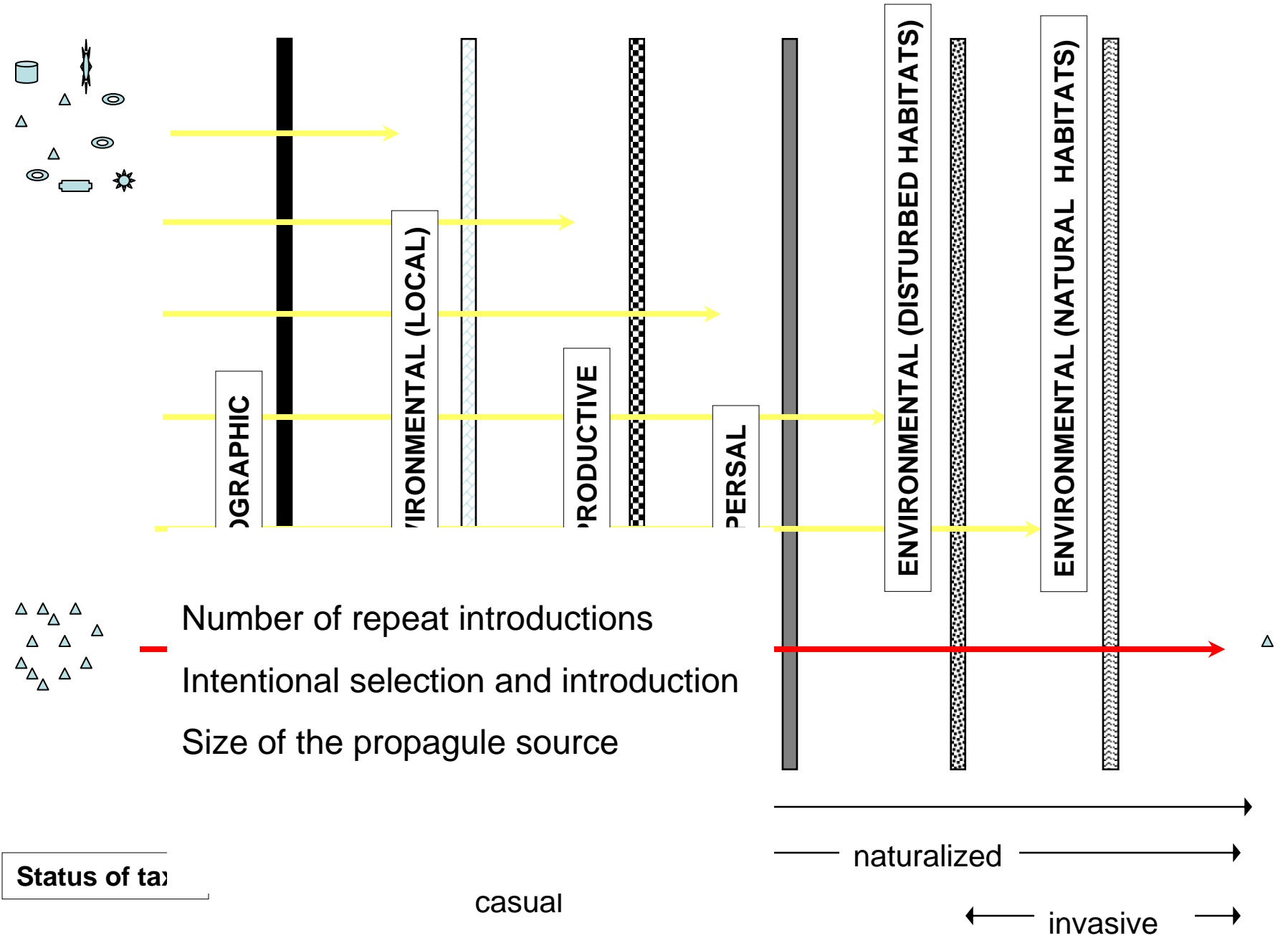


Traits of the species

- wide range of species have been introduced,
- into a range of areas,
- many of which are know invaders elsewhere in similar habitats
- so it is unlikely that there are no species that possess the traits needed to invade in some areas



Richardson *et al.* 2000



Propagule pressure: a null model for biological invasions

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Reconstructing 50 years of *Opuntia stricta* invasion in the Kruger National Park, South Africa: environmental determinants and propagule pressure

Llewellyn C. Foxcroft^{1,2}, Mathieu Rouget³, David M. Richardson² and Sandra Mac Fadyen¹

Inferring Process from Pattern in Plant Invasions: A Semimechanistic Model Incorporating Propagule Pressure and Environmental Factors

Mathieu Rouget¹ and David M. Richardson²

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Supply-side invasion ecology: characterizing propagule pressure in coastal ecosystems

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The role of propagule pressure in explaining species invasions

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COMMUNITY ECOLOGY

John G. Lambrinos

Spatially variable propagule pressure and herbivory influence invasion of chaparral shrubland by an exotic grass

Paradigms and perspectives

Allee effects, propagule pressure and the probability of establishment: risk analysis for biological invasions

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ECOLOGICAL RESISTANCE TO BIOLOGICAL INVASION OVERWHELMED BY PROPAGULE PRESSURE

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Paradigms and perspectives

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Invasion of African savanna by alien plants

Species characteristics

- 1 Propagule production
- 2 Dispersal mode
- 3 Defences
- 4 Resource demand
- 5 Competitiveness
- 6 Seed-banking
- 7 Seed size

System context

- 1 Connectivity
 - 2 Pathways
- Inc. number of repeat arrivals
- 3 Vector efficacy
 - 4 Global climate change

System susceptibility

- 1 Local vector presence
 - 2 Predation / consumer pressure
- Inc. enemy release
- 3 Resource availability
- Inc. disturbance regime, fire regime, empty niche
- 4 Patchiness / gaps
 - 5 Bioclimatic suitability
 - 6 Native species richness

Invasion of African savanna by alien plants

Species characteristics

- 1 Propagule production
- 2 Dispersal mode
- 3 Defences
- 4 Resource demand
- 5 Competitiveness
- 6 Seed-banking
- 7 Seed size

Species that have been introduced must have at least some of the characteristics required to become invasive

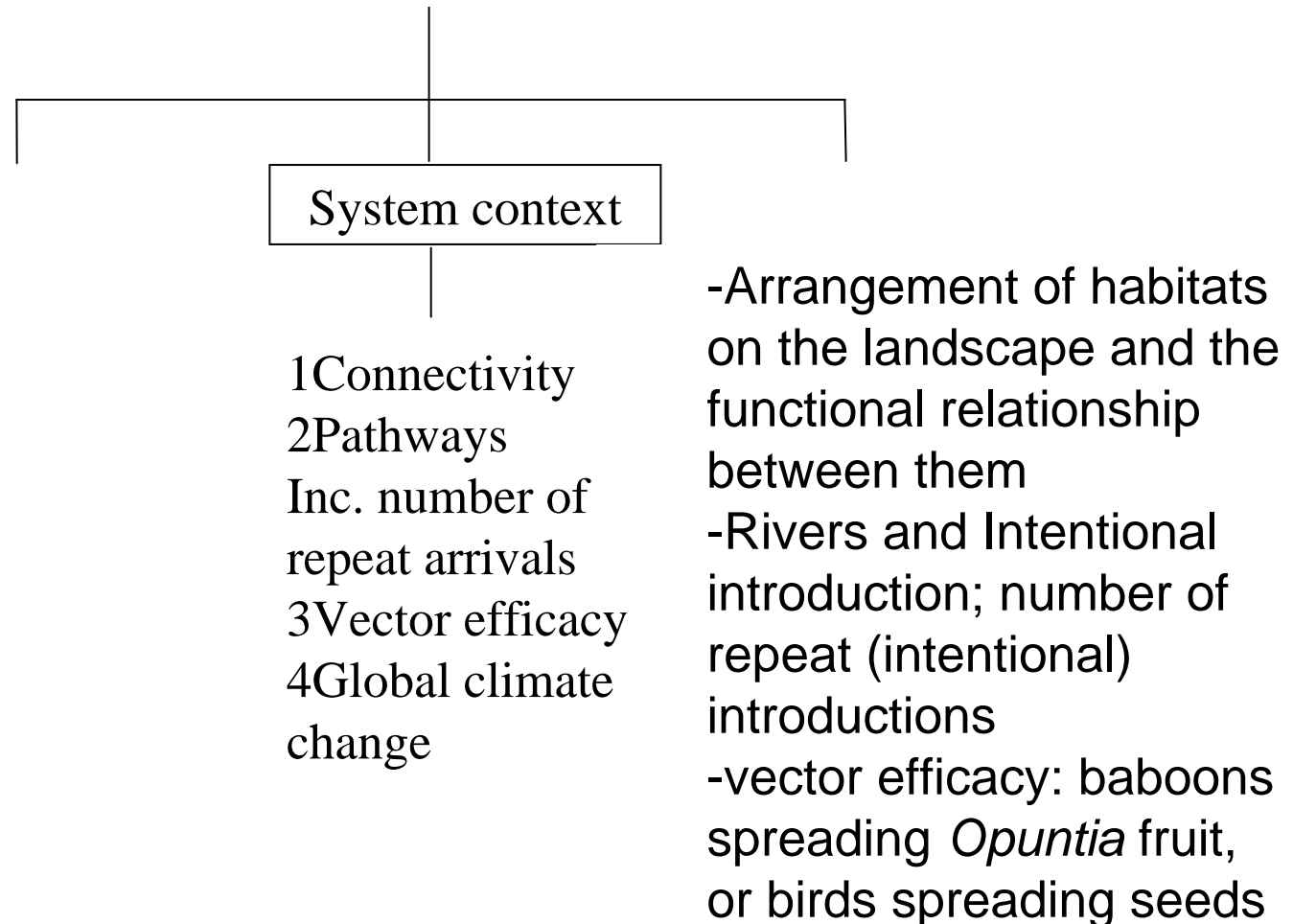
Invasion of African savanna by alien plants

Africa savannas must have
some of the factors that make
them susceptible to invasions

System susceptibility

- 1 Local vector presence
- 2 Predation / consumer pressure
Inc. enemy release
- 3 Resource availability
Inc. disturbance regime,
fire regime, empty niche
- 4 Patchiness / gaps
- 5 Bioclimatic suitability
- 6 Native species richness

System context provides a spatially explicit understanding of how the species characteristics and the susceptibility of the system relate to each other





Conclusions

- although plant invasions appear to have played a minor role in African savannas in the past, there is evidence to show that this is changing
- this may be related to the lower levels of introduction, relative to the other savanna systems where many species were intentionally introduced– propagule pressure
- need to further explore the spatial arrangement and functional relationship between patches in the landscape



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Thank you..

