Alien plant invasions in the Kruger National Park: impacts of *Parthenium hysterophorus*, *Datura innoxia* & *Xanthium spinosum*

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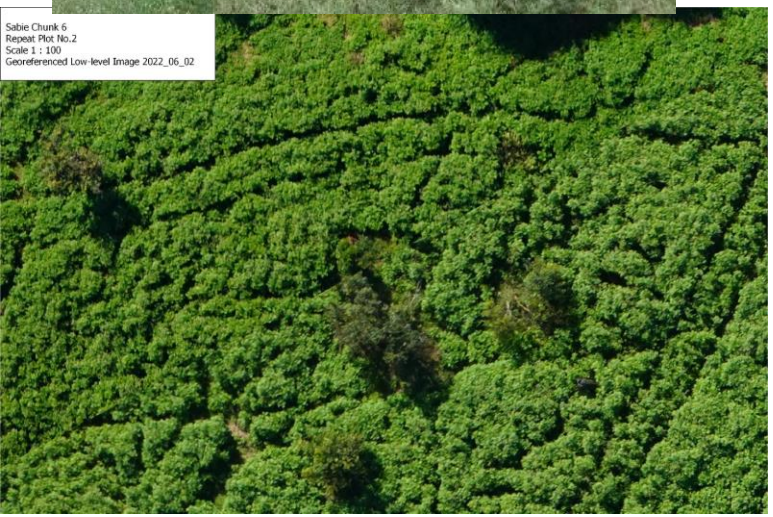
Parthenium hysterophorus



Xanthium strumarium

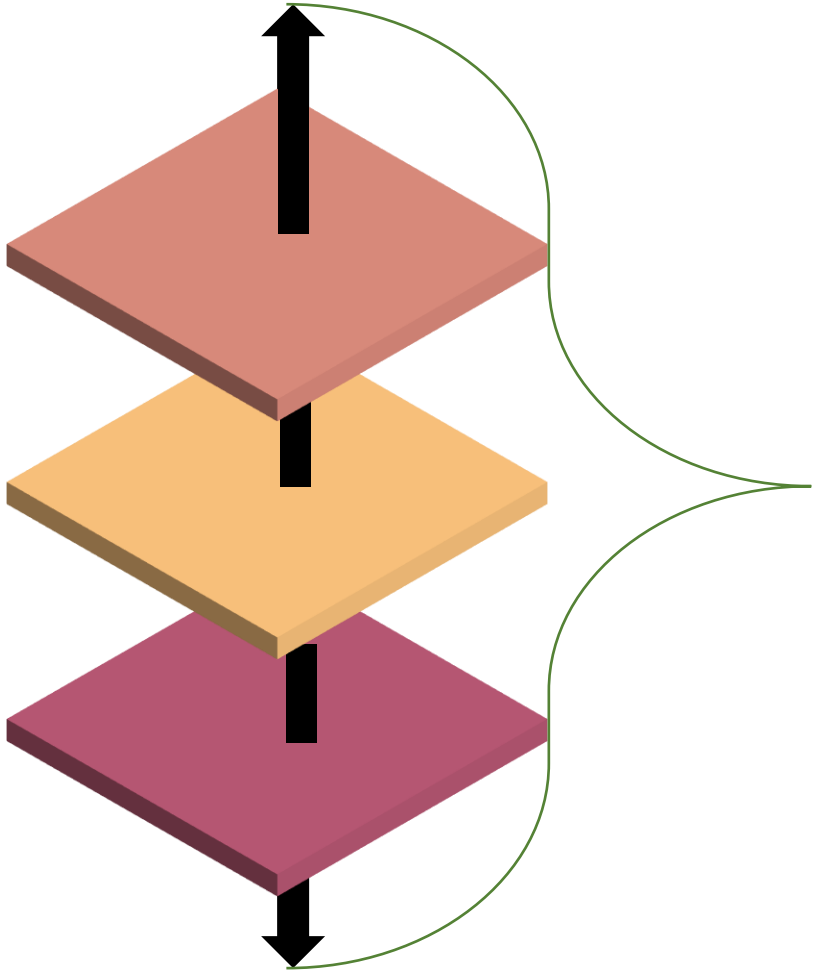
Datura innoxia

Measuring the Impact

How are animals responding to the invasions?

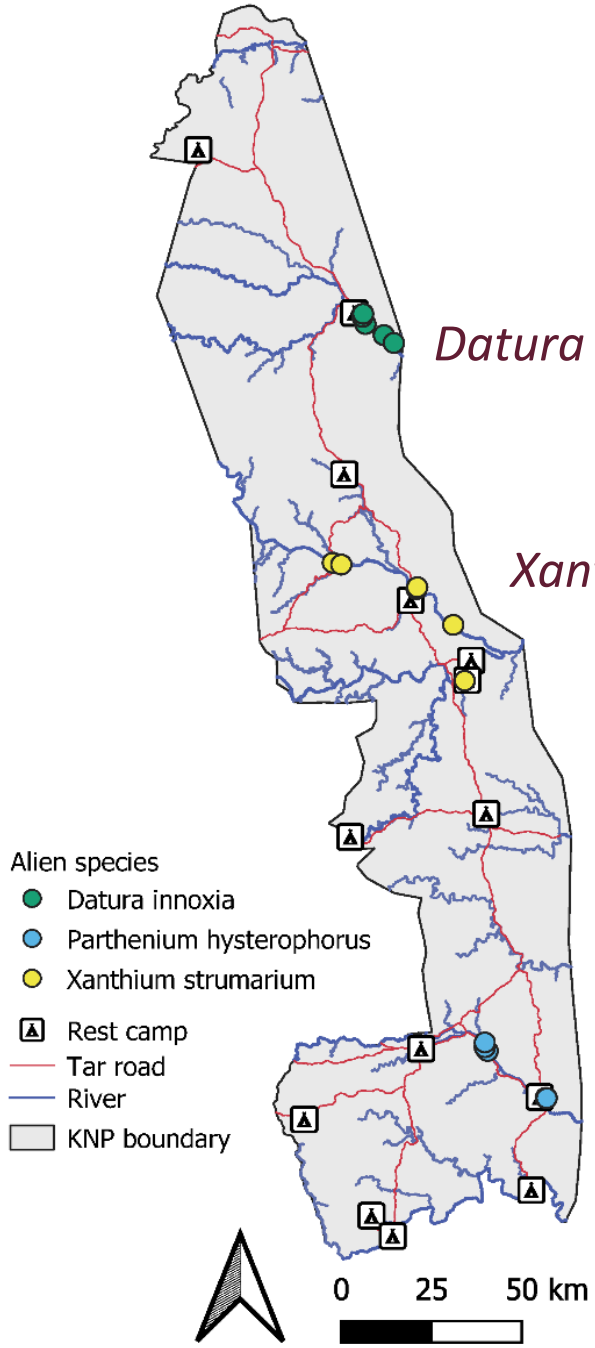
What's happening to the vegetation?

What's happening in the soil?

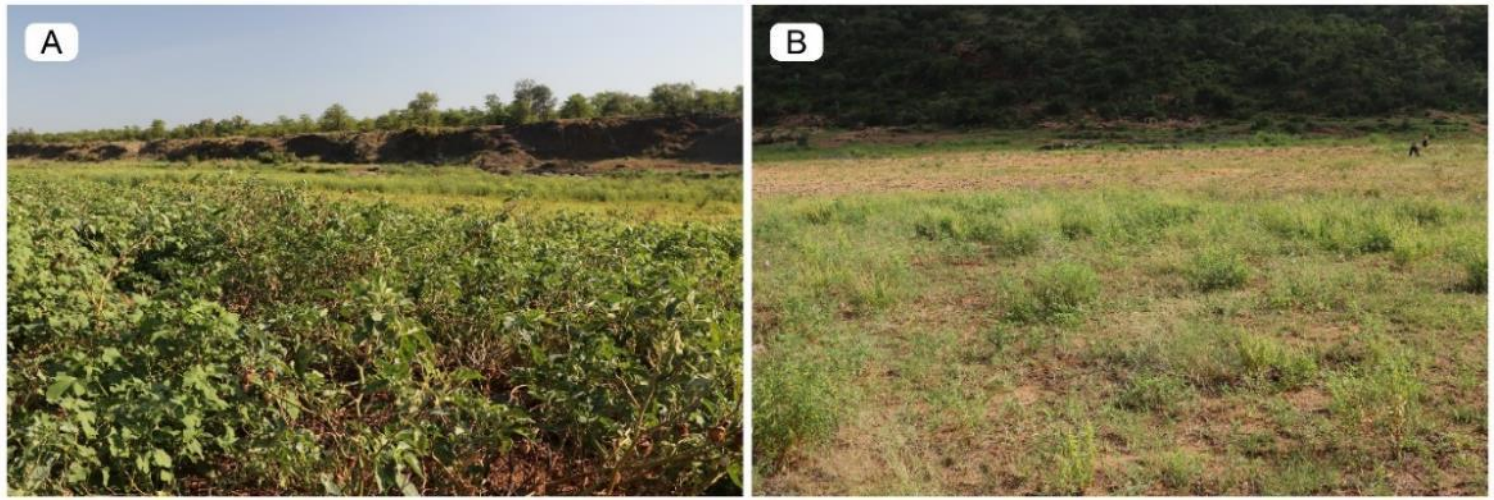


What does it mean for managing plant invasions?

A small window into our [incomplete] story



Datura innoxia



Xanthium strumarium

7 sites with populations of each target species

Pairs of invaded and uninvaded plots in each site

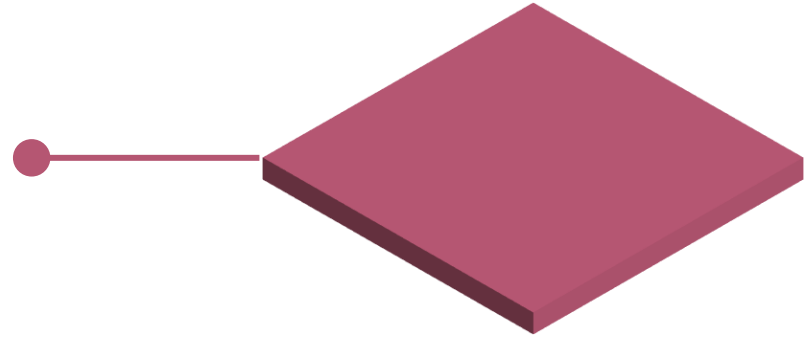
Parthenium hysterophorus

What's happening in the soil?

Assessed, in January and April:

Soil pH, humidity, nutrients	Enzymatic activities	Bacterial and fungal diversity & composition
pH	**Phosphatase** (µmol/g h)	**Species Richness**
Humidity (%)	**β-Glucosidase** (µmol/g h)	**Exponent of Shannon**
P (mg/Kg)	**Urease** (µmol/g h)	**Inverse Simpson**
C (%)		**Pielou's evenness**
NH_4^+ (mg/Kg)		
NO_3^- (mg/Kg)		
Ca (cmol/Kg)		

Soil survey



JANUARY

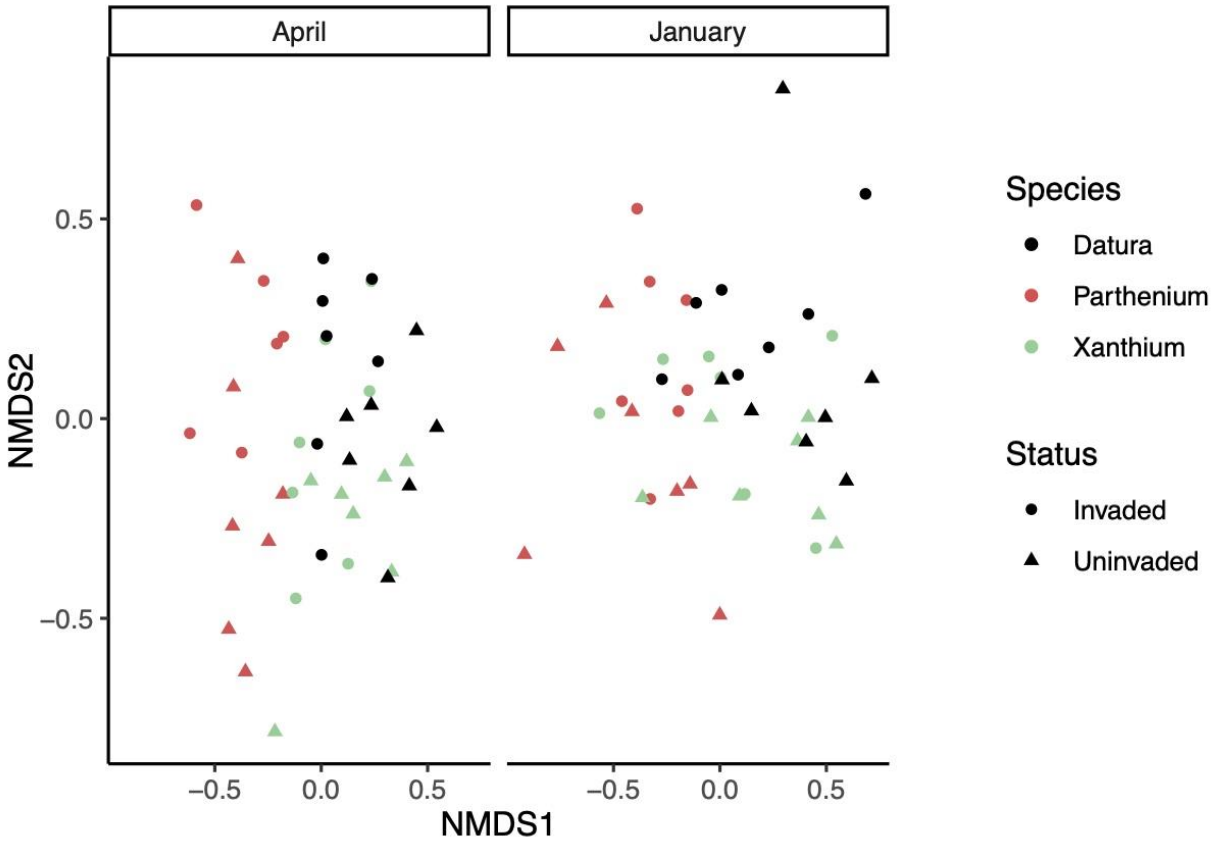
	Parthenium		Datura		Xanthium	
	Invaded	Uninvaded	Invaded	Uninvaded	Invaded	Uninvaded
pH	5.89	6.09	6.31	6.27	6.32	6.26
Humidity (%)	5.33	5.62	5.22	4.40	7.34	3.85
⇧ **P** (mg/Kg)	**26.9***	**13.1***	20.2	28.2	15.1	24.2
C (%)	1.23	0.867	0.828	0.73	0.7	0.573
NH_4^+ (mg/Kg)	17.1	14.9	11.3	11.6	9.02	8.49
⇧ **NO_3^-** (mg/Kg)	2.69	4.78	3.07	3.57	1.41	1.18
⇧ **Ca** (cmol/Kg)	**2268***	**1528***	2629	2346	2520	2341
Phosphatase (µmol/g h)	0.45	0.29	2.22	1.87	1.80	1.08
β-Glucosidase (µmol/g h)	1.26	1.30	2.24	2.17	1.52	1.41
⇩ **Urease** (µmol/g h)	**0.00009***	**0.00011***	0.00009	0.00008	0.00009	0.00009

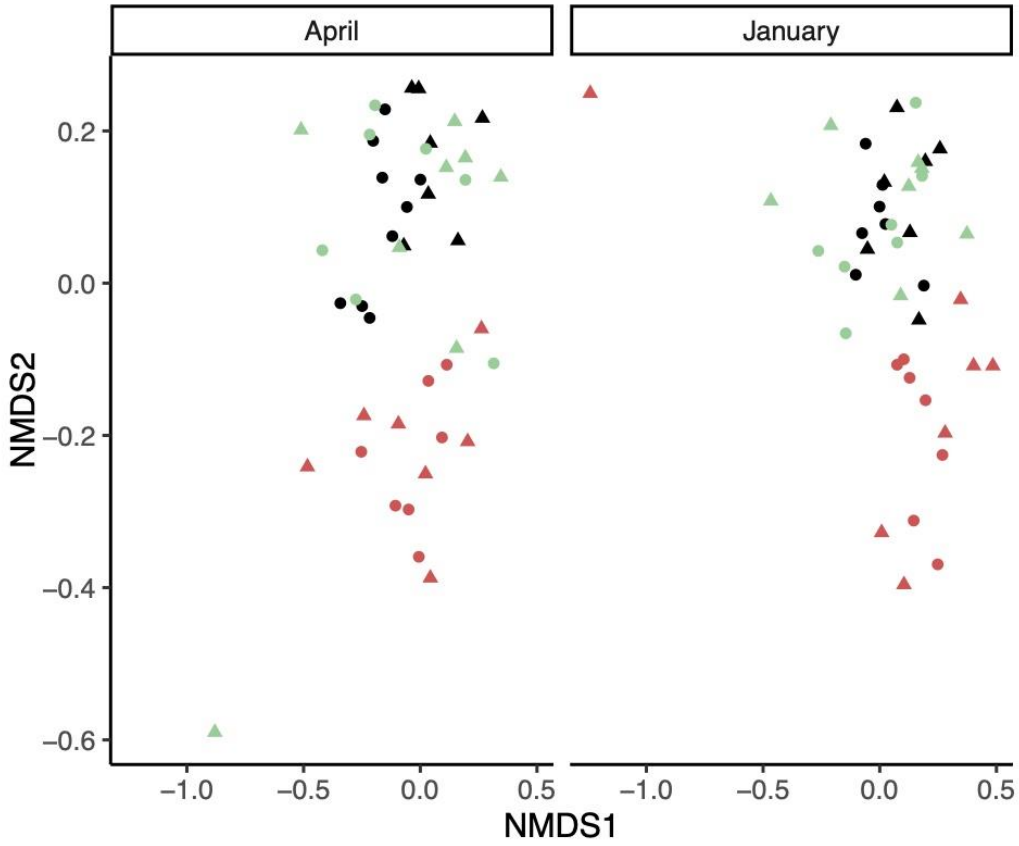
April

pH	5.84	6.00	6.54	6.46	6.43	6.32
Humidity (%)	5.25	4.49	2.50	2.37	4.65	2.94
P (mg/Kg)	25.3	15.7	28.2	24.5	13.5	15.8
C (%)	1.42	0.88	0.647	0.92	0.62	0.332
NH_4^+ (mg/Kg)	21.4	15.7	13.9	16.1	8.58	9.95
NO_3^- (mg/Kg)	4.05	3.5	3.04	1.18	1.74	1.03
⇧ **Ca** (cmol/Kg)	2278*	1392*	1903	2805	1809	2024
Phosphatase (µmol/g h)	0.29	0.32	1.69	1.79	1.31	0.81
β-Glucosidase (µmol/g h)	1.33	1.35	1.97	2.35	1.32	1.22
Urease (µmol/g h)	0.00009	0.00011	0.00009	0.00008	0.00010	0.00009

		Parthenium		Datura		Xanthium	
		Invaded	Uninvaded	Invaded	Uninvaded	Invaded	Uninvaded
JANUARY	Richness	578	598	660	619	678	632
	Exponent of Shannon	172	176	215	199	223	208
	Inverse Simpson	67.7	66.5	92.9	84.9	93.4	88.1
	Pielou's evenness	0.81	0.81	0.83	0.82	0.83	0.82
April	Richness	641	611	703	631	695	569
⇧	Exponent of Shannon	198*	159*	237	201	242	166
	Inverse Simpson	75.8	48.5	97.3	82.1	108	64.3
	Pielou's evenness	0.82	0.79	0.83	0.82	0.84	0.79
JANUARY	Richness	231	240	195	159	219	175
	Exponent of Shannon	43.5	49.8	45.0	29.8	52.8	40.6
	Inverse Simpson	18.6	22.5	21.5	13.7	24.4	18.9
	Pielou's evenness	0.67	0.71	0.66	0.67	0.74	0.72
April	Richness	228	240	187	158	198	177
	Exponent of Shannon	38.5	49.8	29.1	26.1	37.2	38.8
	Inverse Simpson	16.2	22.5	12.5	12.4	17.8	19.1
	Pielou's evenness	0.67	0.64	0.64	0.63	0.67	0.70

Impact on: community composition





All three species impact bacterial and fungal community composition

What's happening to the vegetation?

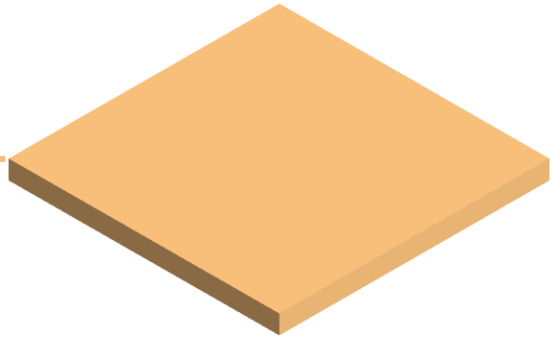
Species Richness

Shannon Diversity

Pielou's evenness

Species / relative invasive cover

Botanical survey

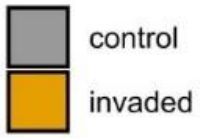


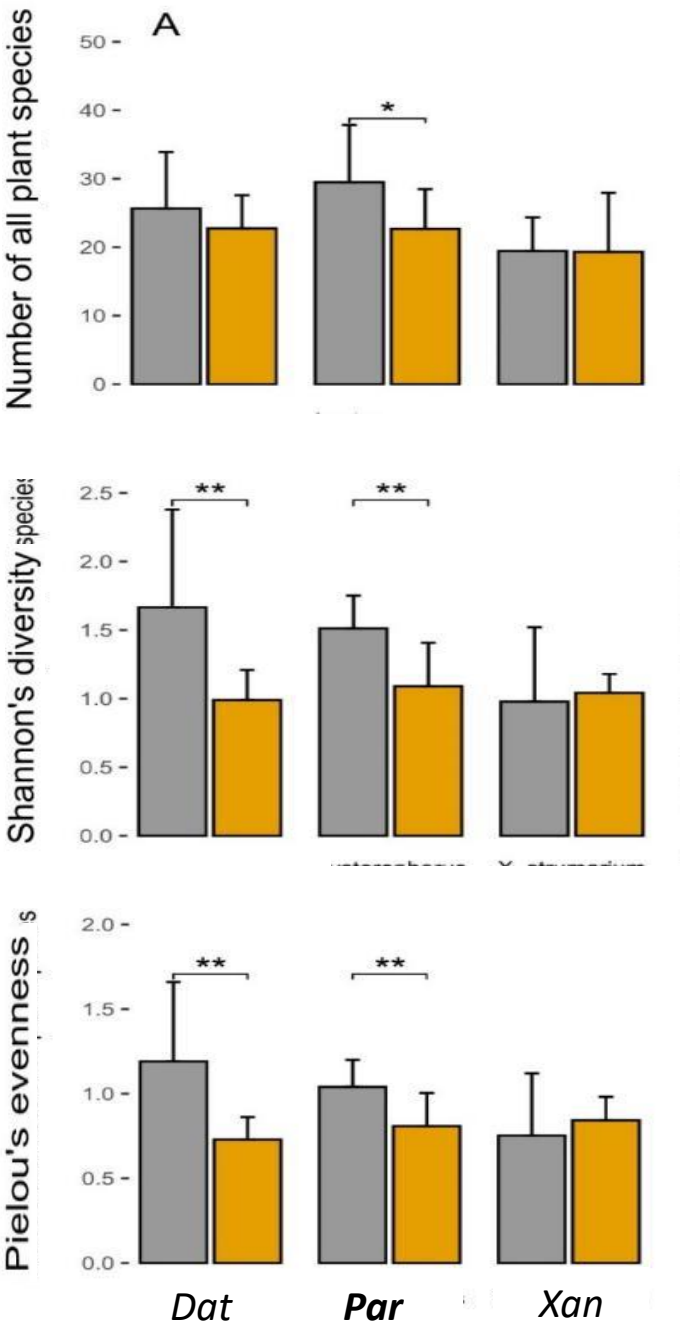
Hejda, et al. (2023) J. Trop. Ecol.

Impact on vegetation – richness & diversity

- Lower species richness in invaded plots compared to uninvaded; the largest difference for *Parthenium*; non-significant for *Datura* and *Xanthium*
- Lower Shannon diversity invaded plots; the largest difference for *Datura*, followed by *Parthenium*
- Lower Pileou evenness in invaded; the largest difference detected for *Datura*, followed by *Parthenium*
- **No loss of native species**

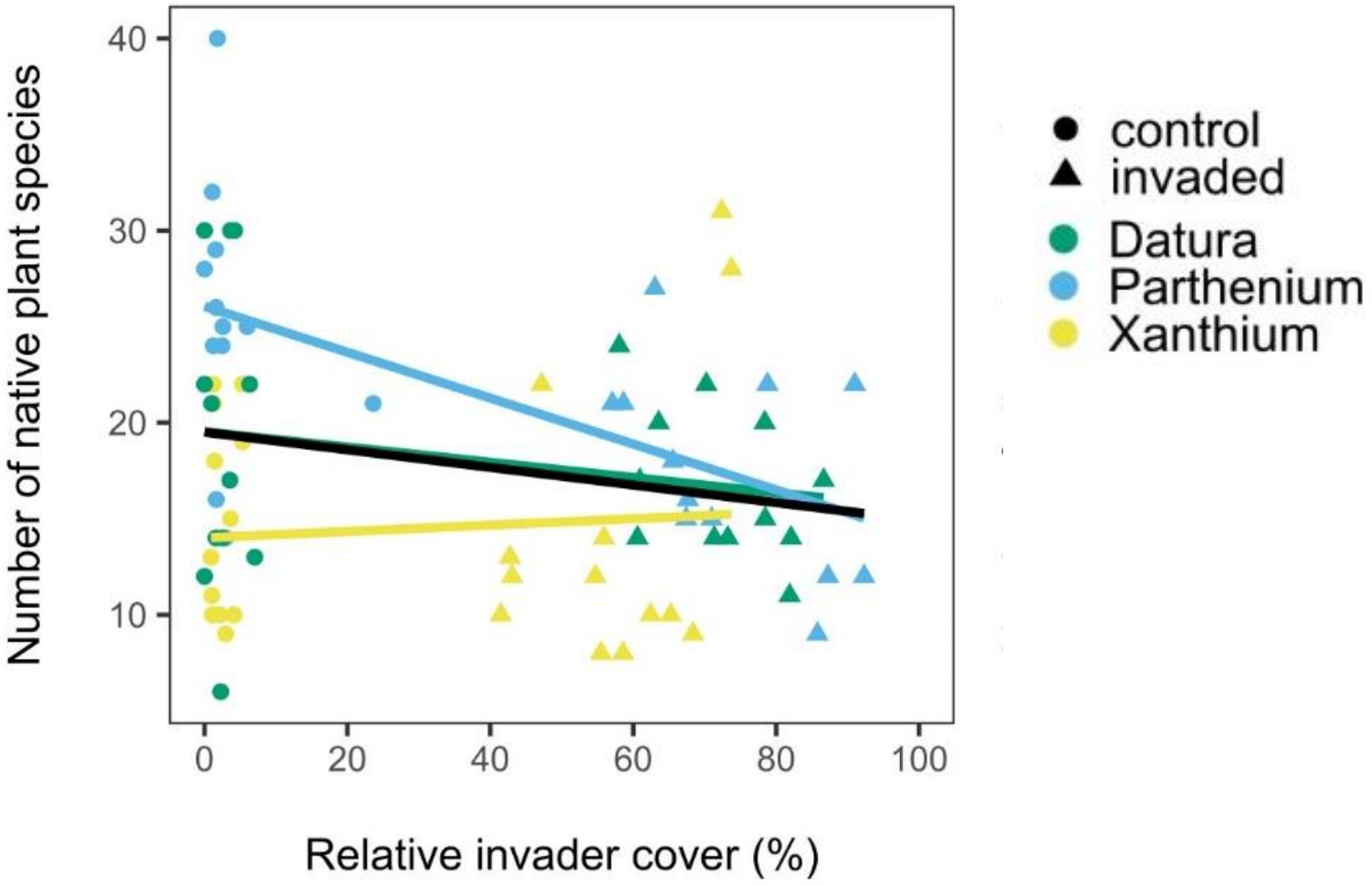
	species richness	Shannon diversity	Pielou evenness
All species	0.001	0.005	0.03
Datura innoxia	NS	0.002	0.003
Parthenium hysterophorus	0.009	0.004	0.007
Xanthium strumarium	NS	NS	NS



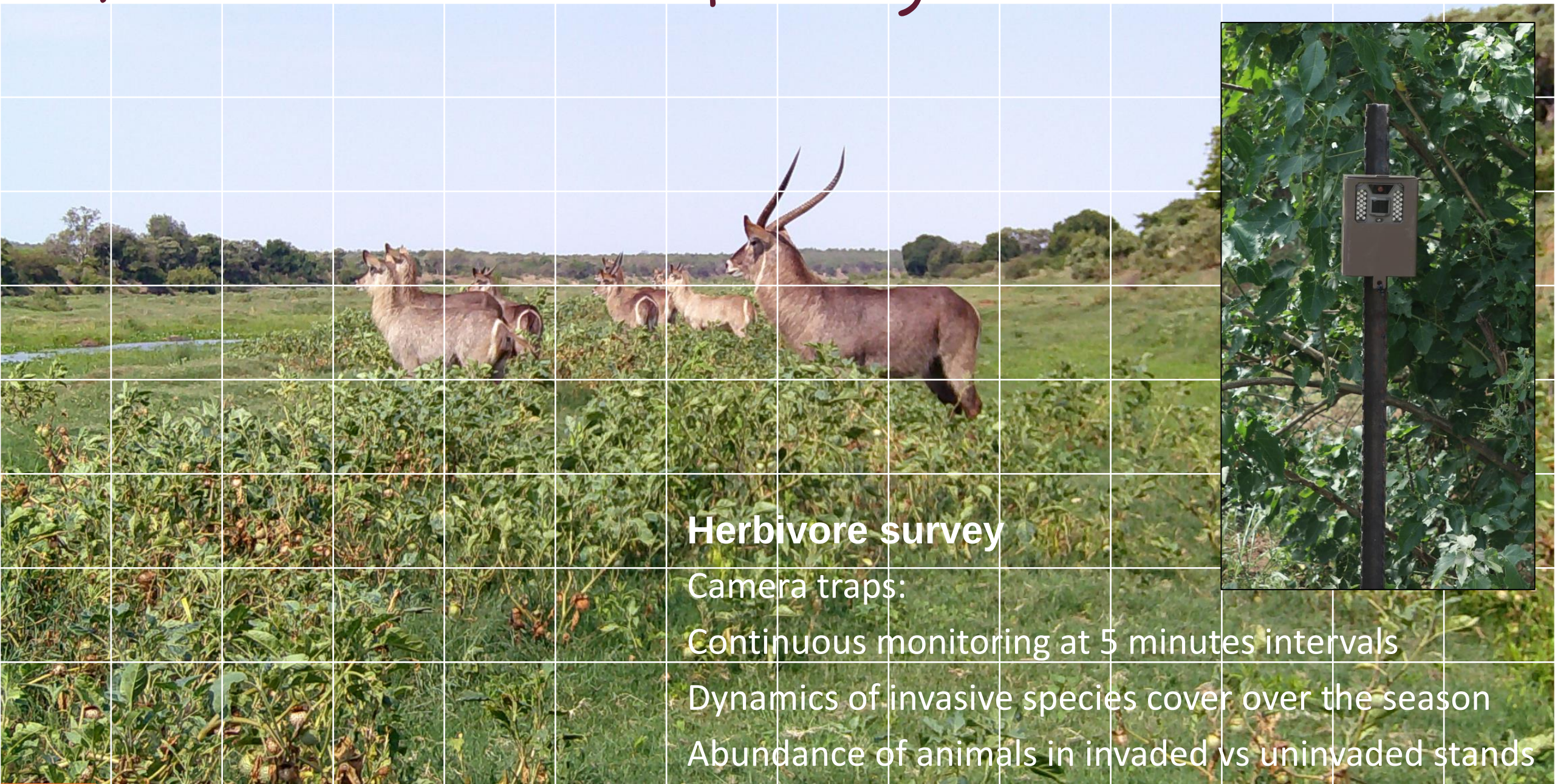


Impact on vegetation – richness & cover

- Decrease in number of species with increasing invader cover
- Strongest decrease Parthenium



How are animals responding to the invasions?



Herbivore survey

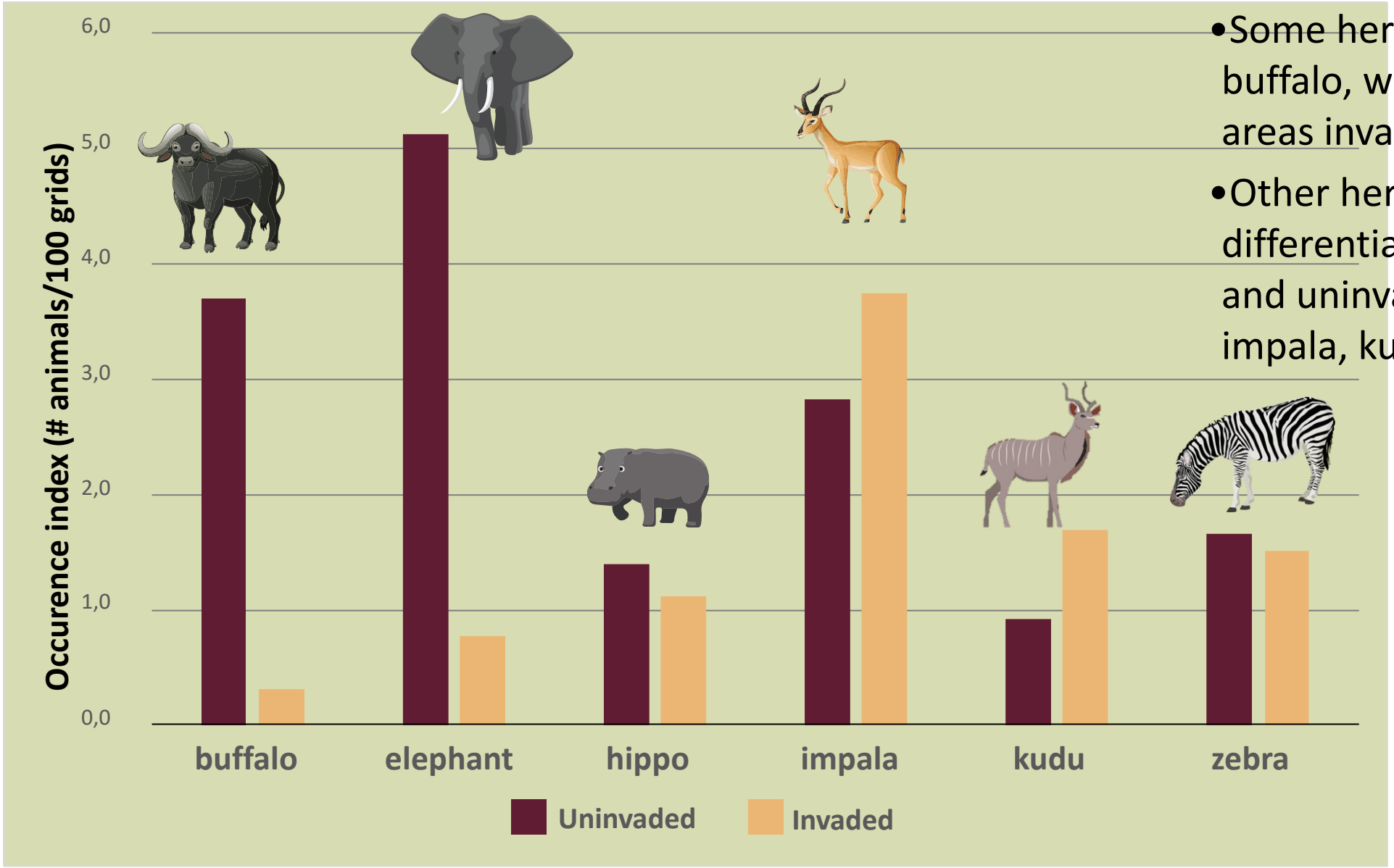
Camera traps:

Continuous monitoring at 5 minutes intervals

Dynamics of invasive species cover over the season

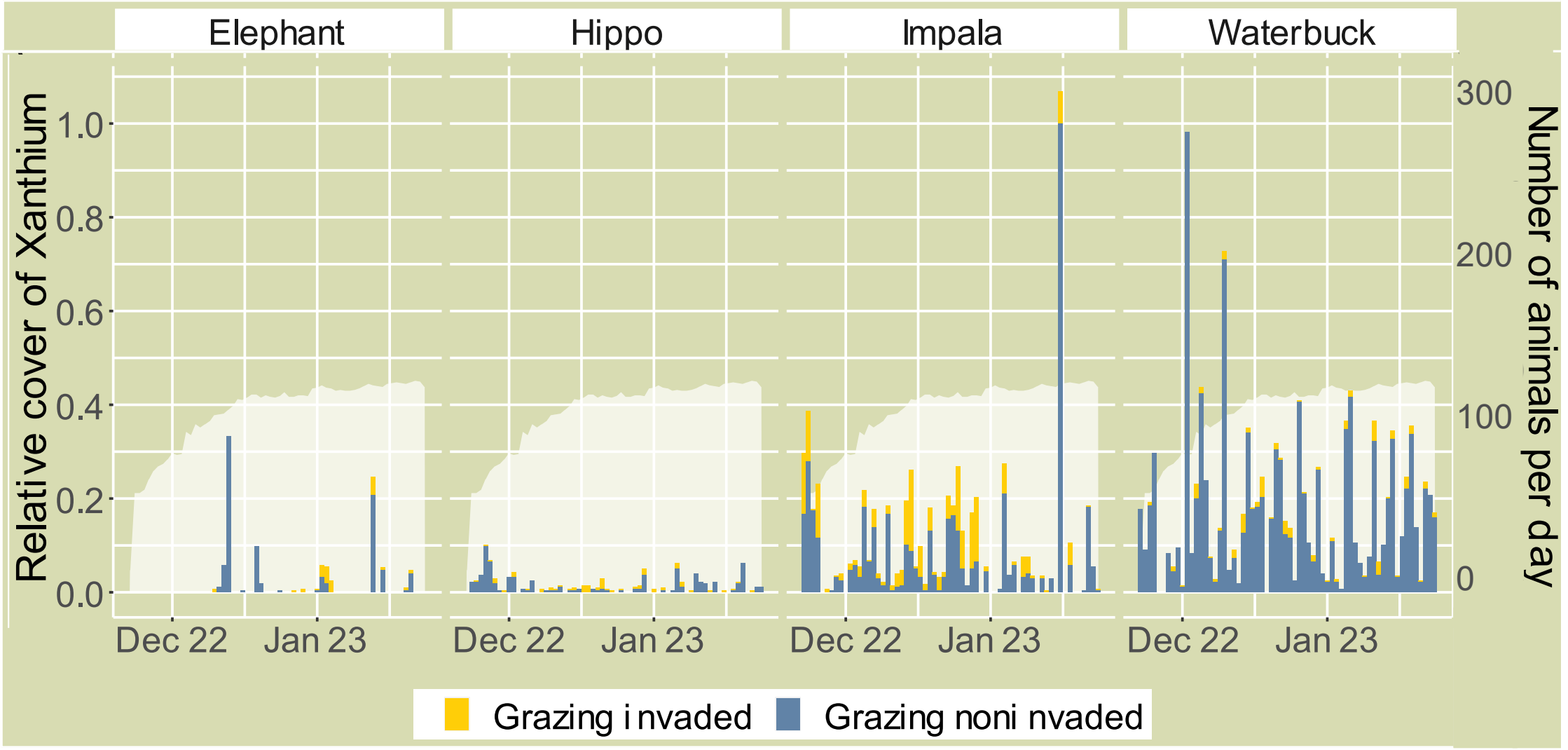
Abundance of animals in invaded vs uninvaded stands

Use of *Xanthium* invaded plots by herbivores



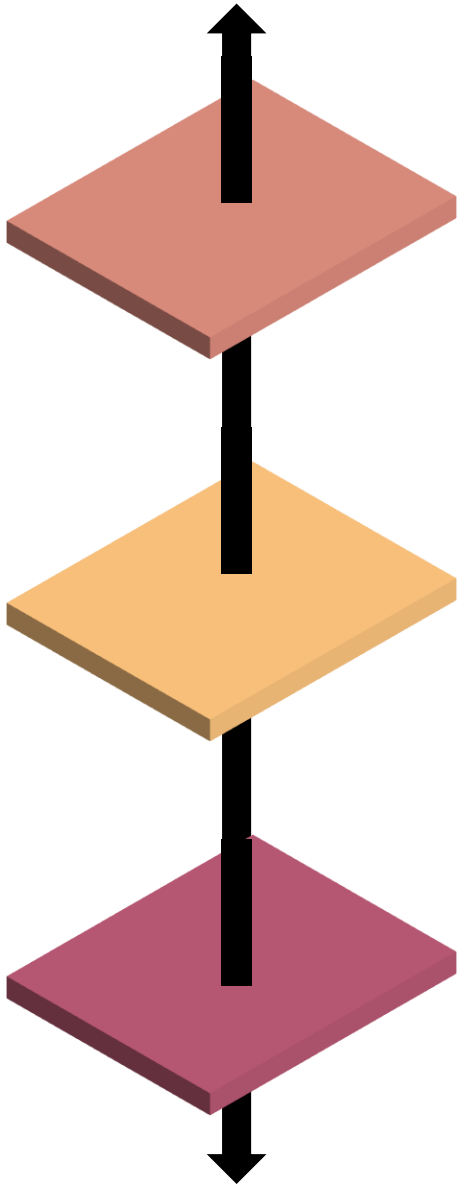
- Some herbivores - elephant, buffalo, waterbuck seem to avoid areas invaded by *Xanthium*
- Other herbivores do not differentiate between invaded and uninvaded sites (hippo, impala, kudu)

Use of *Xanthium* invaded plots by herbivores: Dec 22 & Jan 23



A brief summary

How are animals responding to the invasions?



- Some herbivores seem to avoid invaded areas
- Loss of important small scale resources & foraging area availability?

What's happening to the vegetation?

- Invaded vegetation showed lower species richness compared to the uninvaded, with the strongest effect observed for *Parthenium*
  - without a loss of native species
- Number species with increasing invader cover

What's happening in the soil?

- Only *Parthenium* impacts some soil characteristics, bacterial species diversity
- All three species impact bacterial and fungal community composition to small extent

What does this mean?

Invaded sites do have impacts
Not a complete system collapse

Eradication impossible
What to manage?

Parthenium high priority
Xanthium Not enough evidence for control
Datura sp. Not enough evidence for control

Parthenium R8.3m 2003-2016
Xanthium R15.4m 1997-2015
Datura sp. R6.4m 1997-2015

Not all factors tested were equally impacted
Impacts not caused by all invaders
Parthenium appears to be most consistently showing impacts

Annuals
Rivers - seasonal high flows
Datura & Xanthium commonly on sandbanks (or river floor)
Parthenium riverbanks & riparian

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