Rapid establishment and impact assessment of the Redclaw crayfish (Cherax quadricarinatus) invasion in the Kruger National Park, South Africa

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Global stressors to freshwater ecosystems

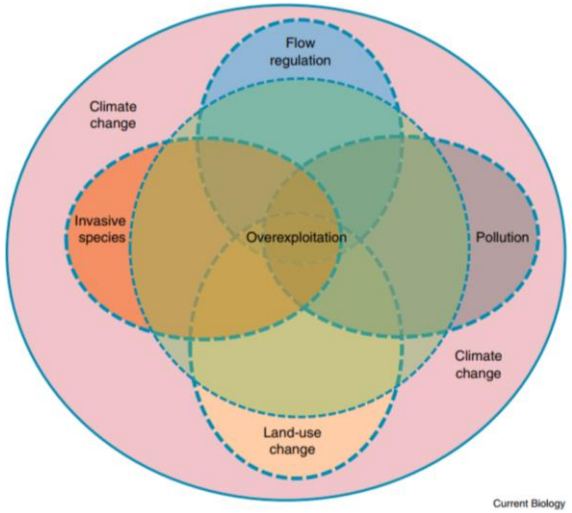
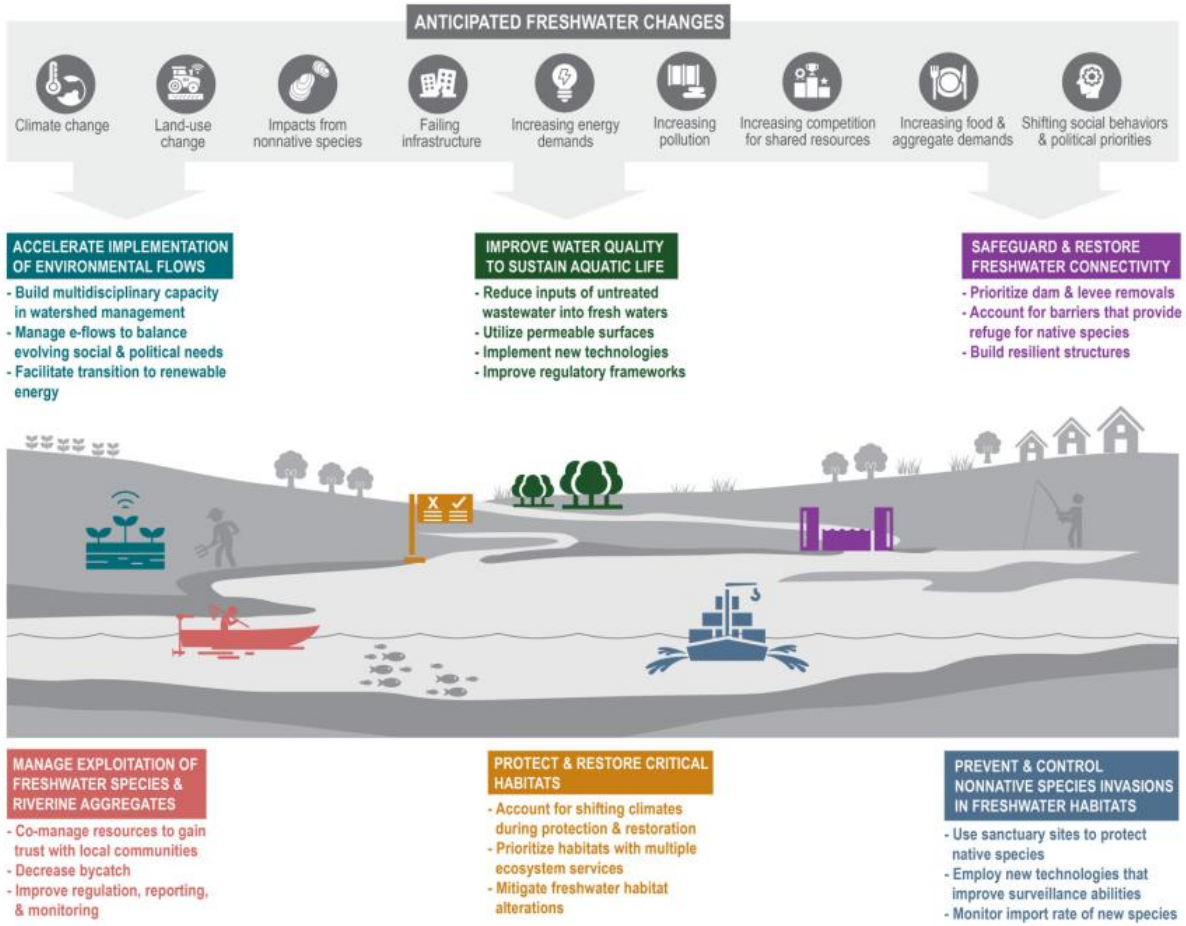


Figure 1. A conceptual diagram of global threats to freshwater ecosystems. The total planetary operating space is equivalent to the climate-change ellipse, and individual freshwater bodies can be positioned within this space according to the combination of threat categories that they experience. Overexploitation occupies the centre of the space because this is the earliest and sometimes the only threat to freshwater biodiversity in remote or sparsely populated localities. Most fresh waters are located within spaces where three or more threat categories overlap.

Dudgeon 2019

Canadian Science Publishing

Fig. 1. Example of response options for future-proofing the six key actions of the Emergency Recovery Plan for freshwater biodiversity to current and emerging stressors. River cross-section base layer courtesy of Tracey Saxby, Integration and Application Network (ian.umces.edu/media-library).



Lynch et al. 2023

Crayfish invasions: African context

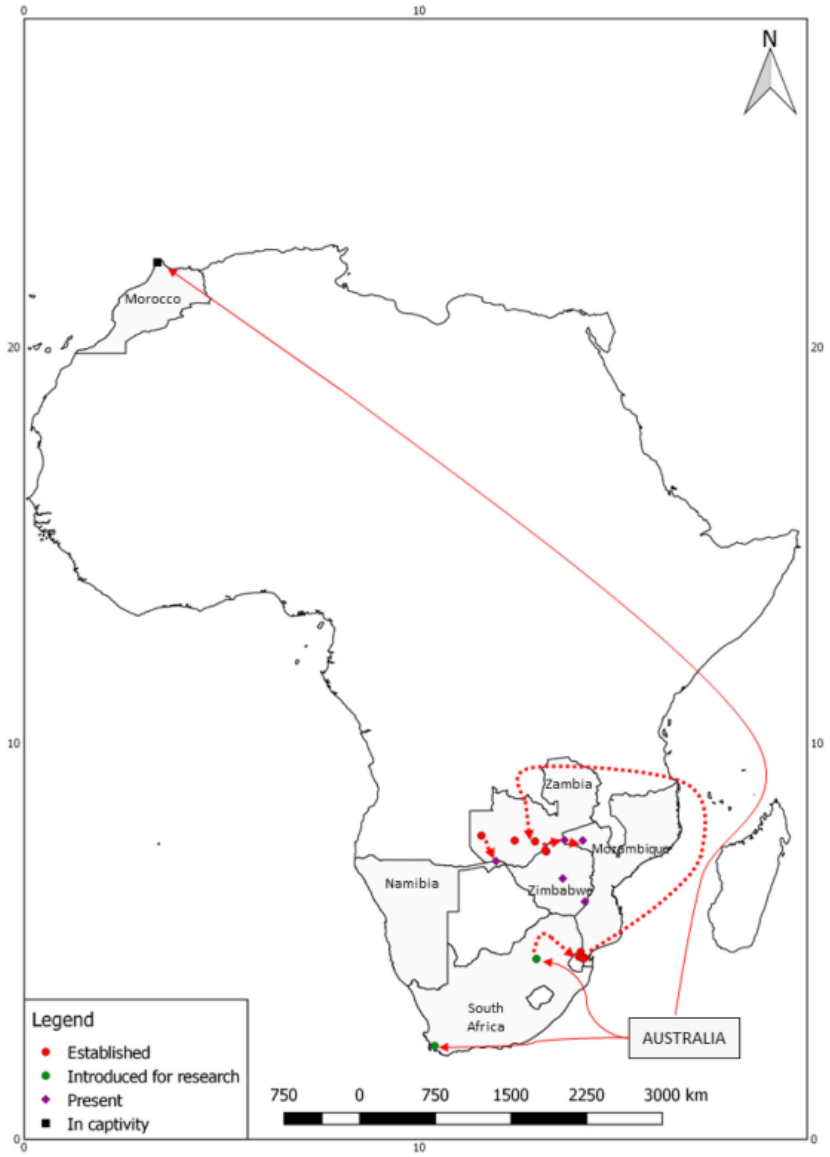
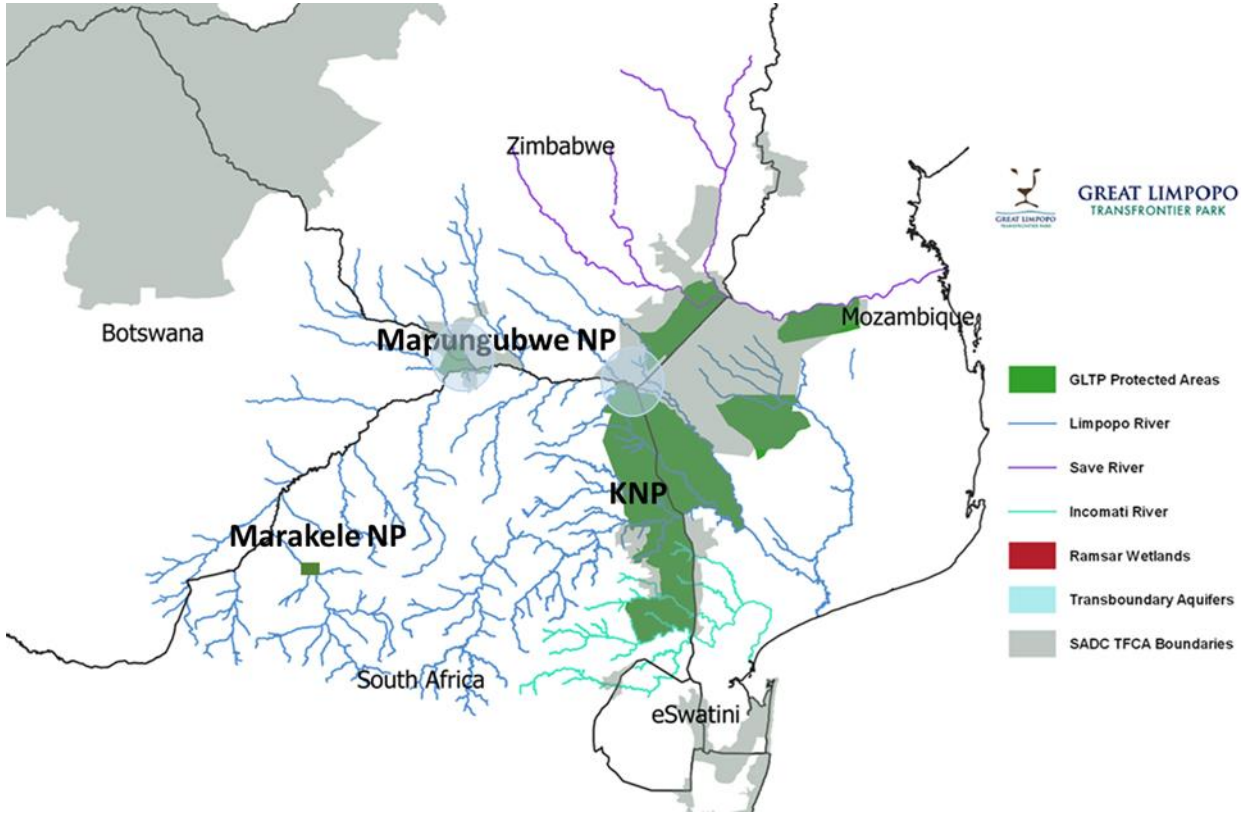


Figure 2. Introduction routes of *Cherax quadricarinatus* from Australia to Africa and introduction locations within the continent. Dashed red lines show translocations within the African continent whilst the continuous red line shows introductions from outside the continent.

Madzivanzira et al. 2021

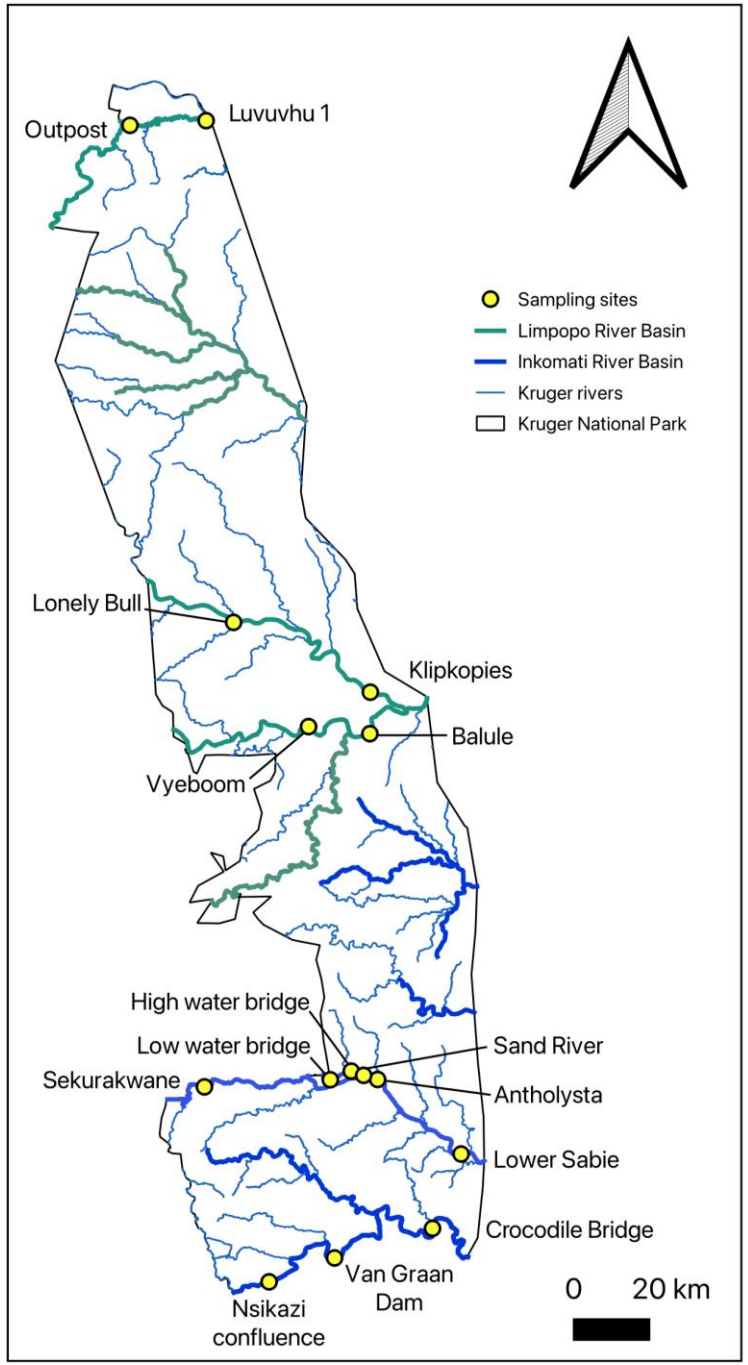
Rivers in protected areas and biological invasions



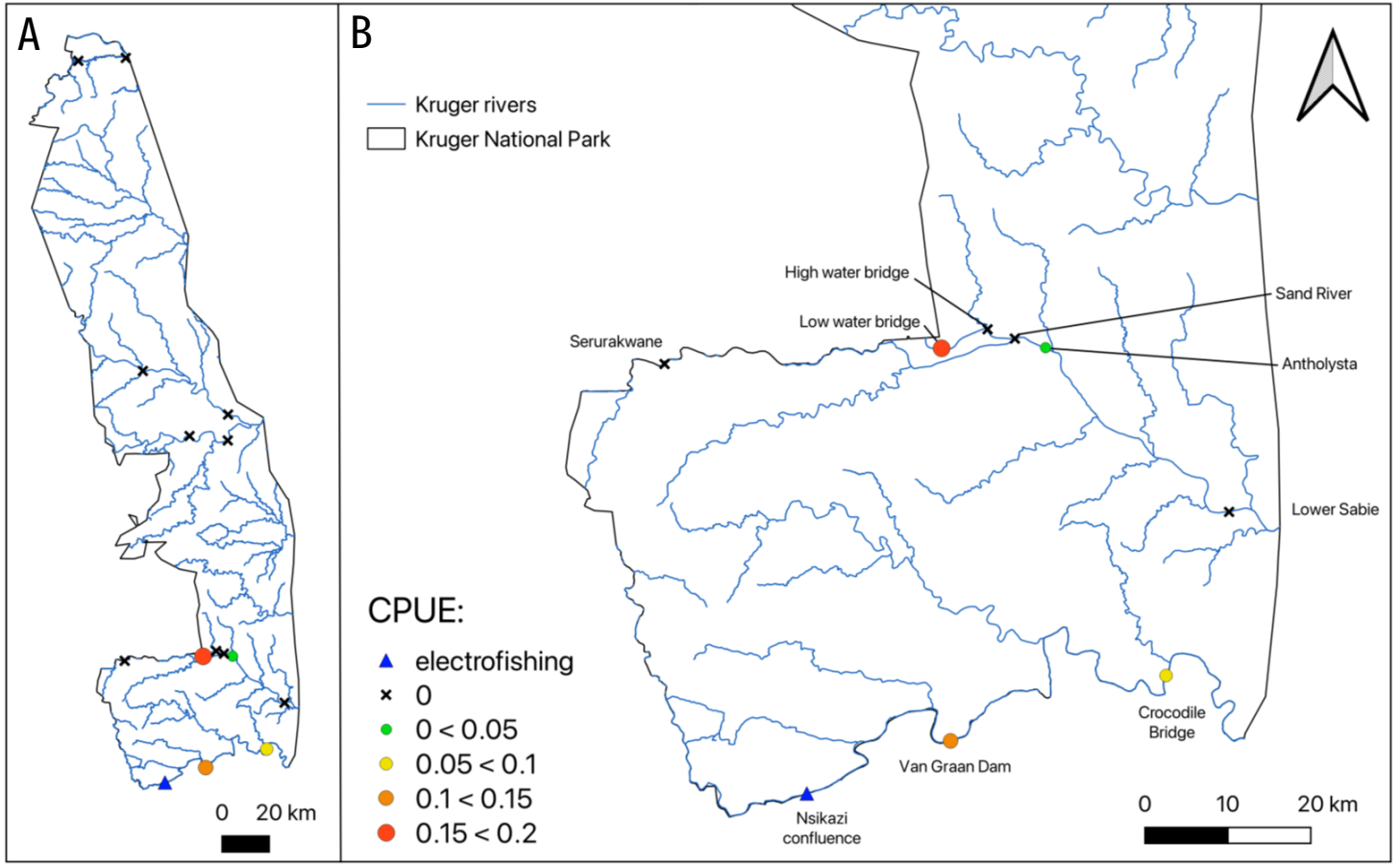
Takes a Systems Approach which recognizes
Socio-Ecological Systems worldview

Where is crayfish in the KNP?

61 × 46 × 20 cm; mesh size: 10 mm

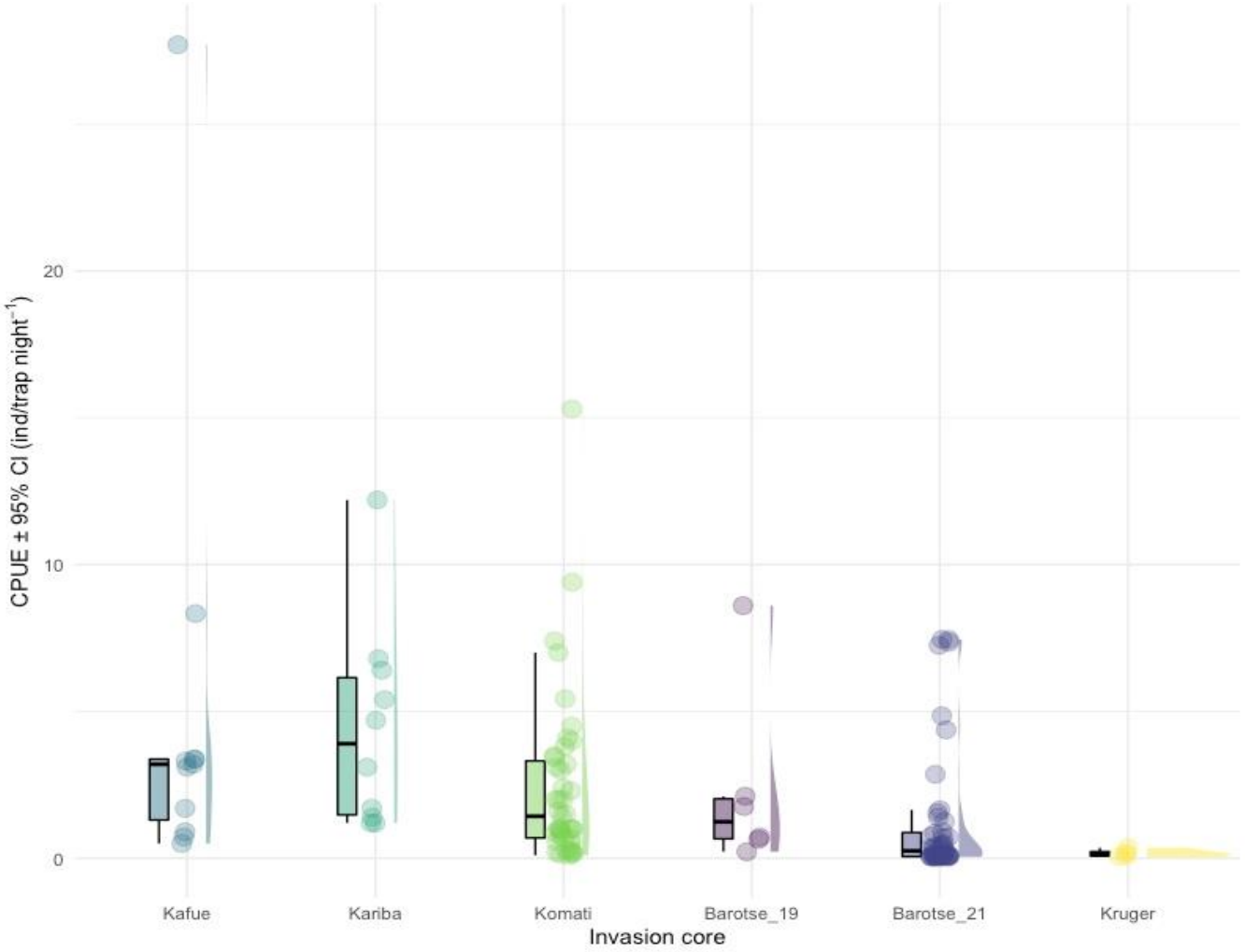


Relative abundance and spatial distribution



A) Relative abundance and spatial distribution of invasive Redclaw crayfish (*Cherax quadricarinatus)* in sampling sites within the KNP from trapping and B) spatial distribution of the invasion in just the invaded Crocodile and Sabie Rivers. Catch per unit effort (CPUE) is represented by coloured circles and absence of crayfish is represented by black crosses, presence of crayfish detected by electrofishing but not trapping is indicated at one site (Nsikazi confluence) by a blue triangle.

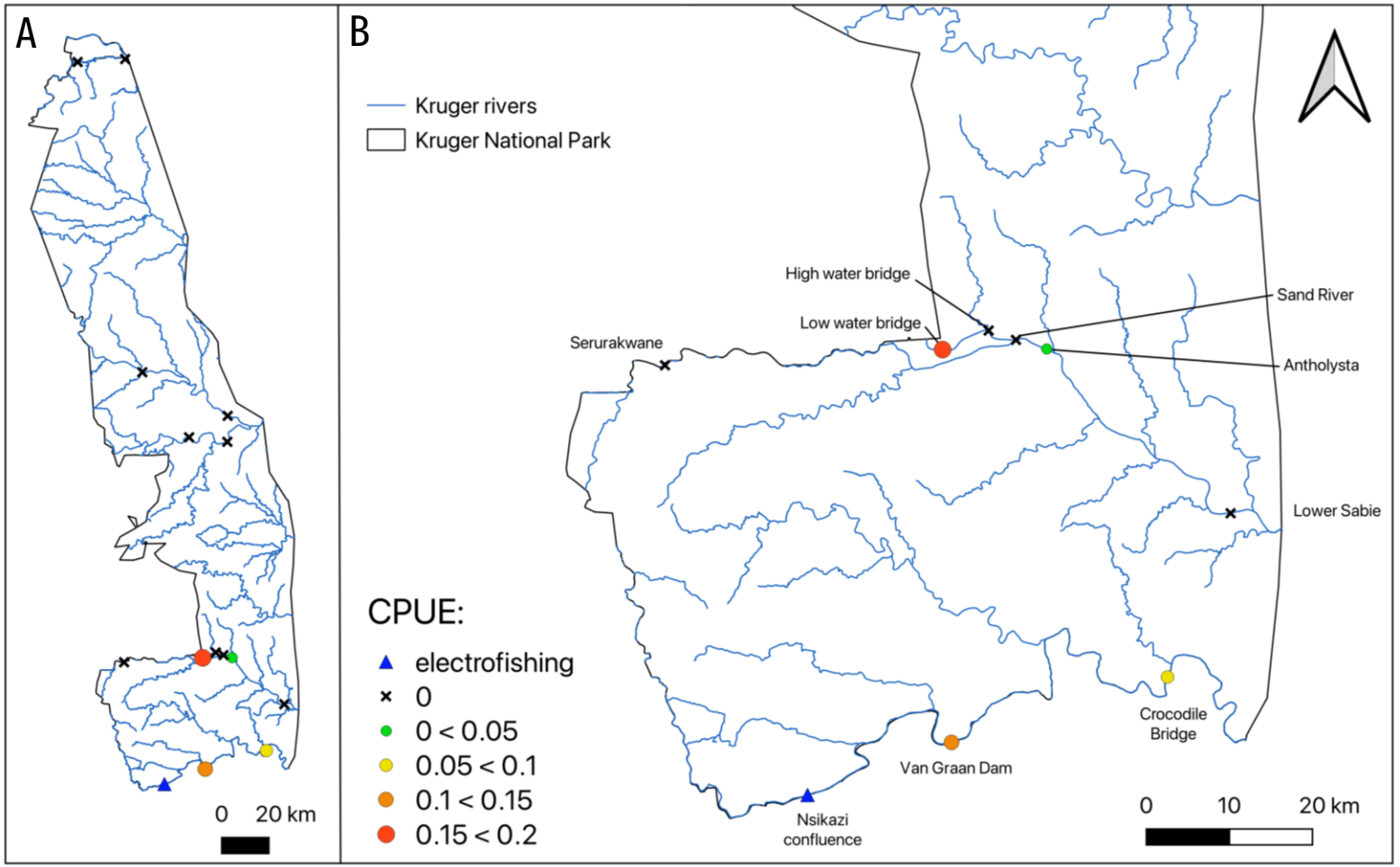
Relative abundance and spatial distribution



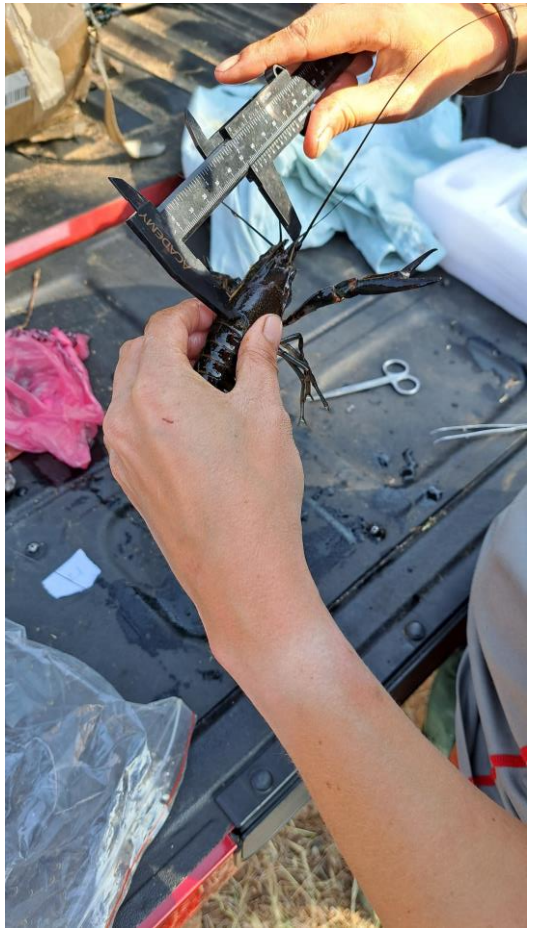
Invasion dynamics

Crocodile River invaded portion ~ 81.36 km
Downstream spread rate ~ 6.38 km/yr
Upstream spread rate ~ 3.78 km/yr

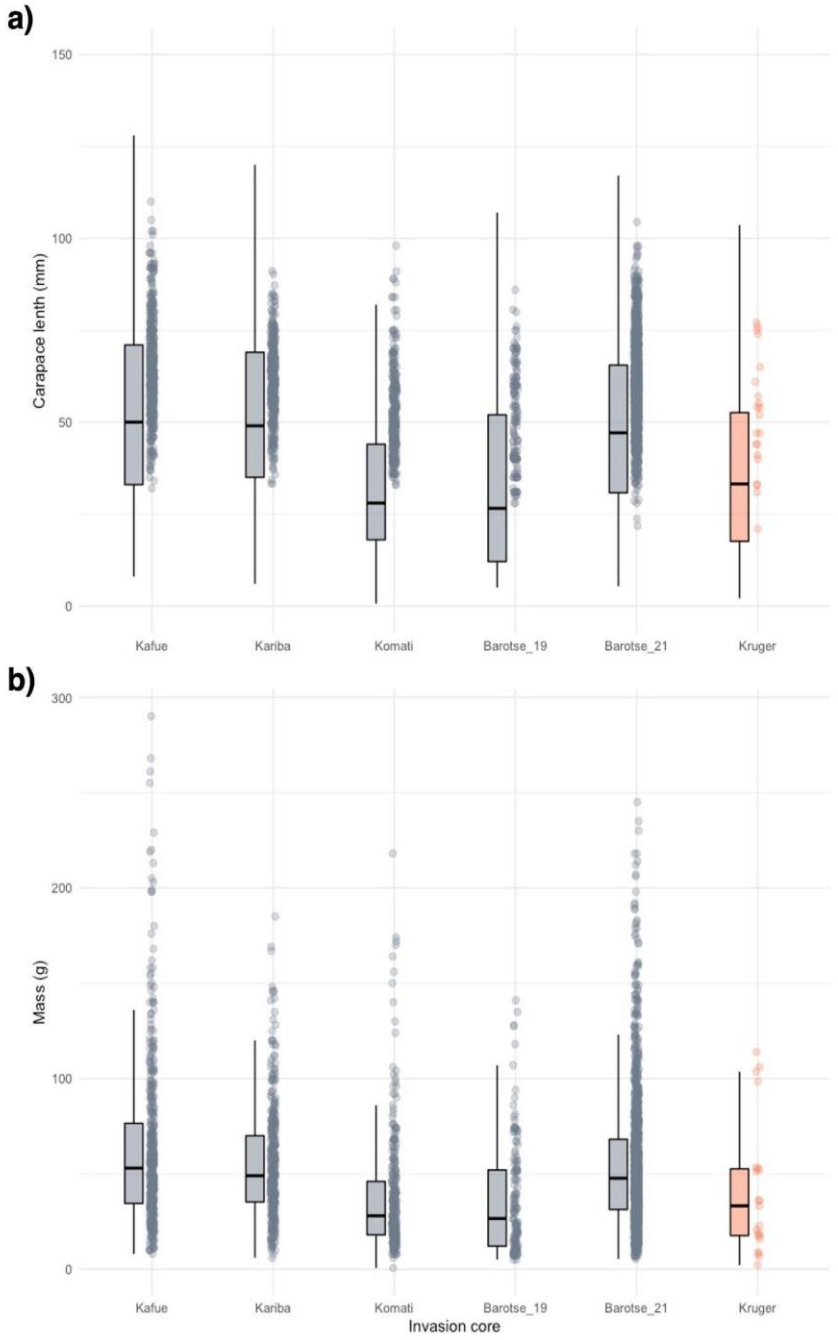
Sabie-Sand invaded portion ~ 14.8 km
Downstream spread rate ~ 7.4 km/yr



Invasion dynamics



CL: χ^2 = 251.94, df = 5, $p < 0.001$
Mass: χ^2 = 200.59, df = 5, $p < 0.001$



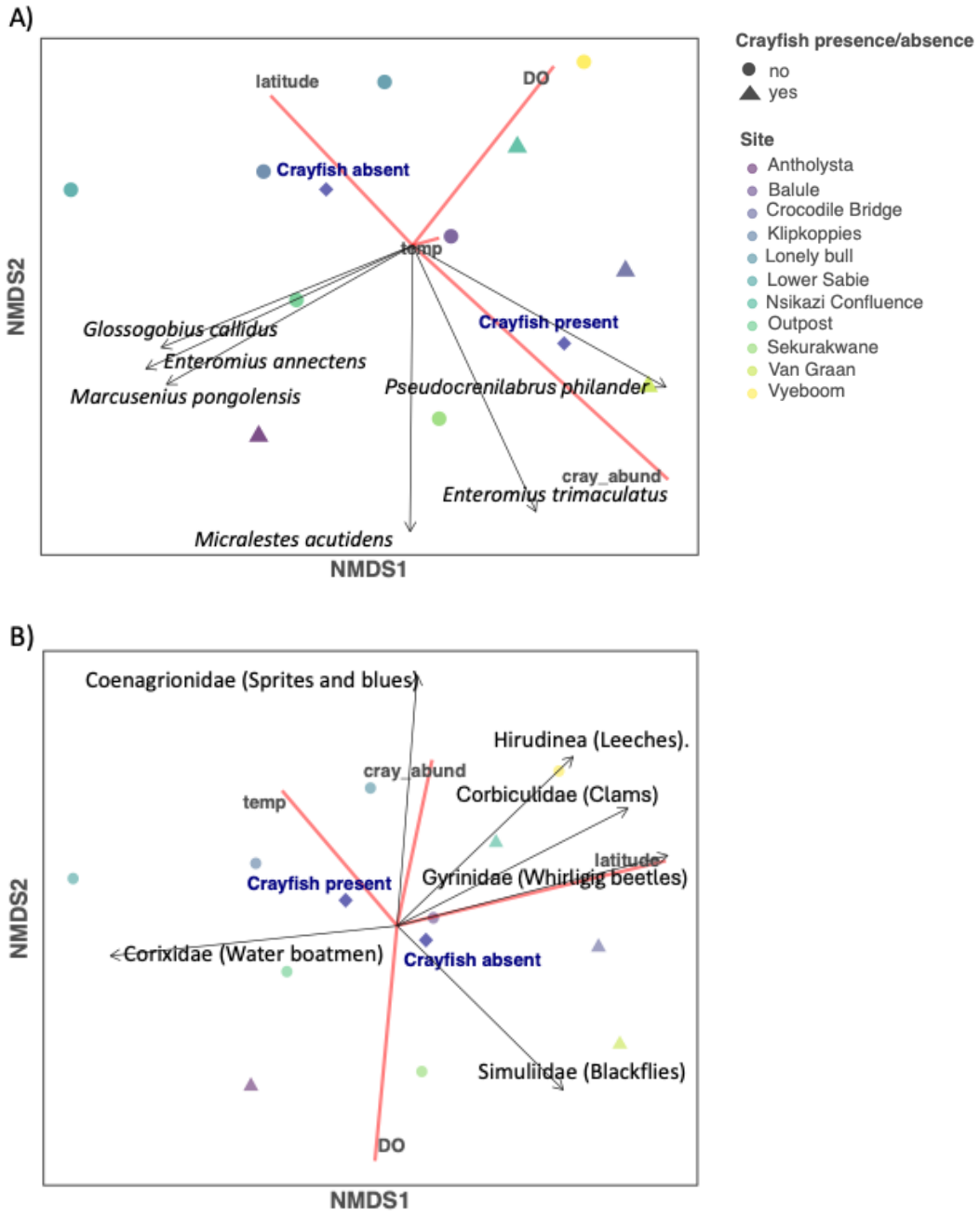
KNP: 59% females, 14% males and 5% intersex
KNP: χ^2 = 8, df = 6, p = 0.23
Invasion cores: χ^2 = 30, df = 25, p = 0.22

Ecological impacts

Species richness
Fish: F =0.73, df = 3, p=0.56
Macroinvertebrates: F = 0.02, df=1, p =0.87)

Crayfish presence (PERMANOVA)
Fish: pseudo-F1,10= 1.44 R2= 0.13, p-value = 0.18
Macroinvertebrate: pseudo-F1,10 = 0.55, R2= 0.05, p-value = 0.87

Crayfish abundance (MANTEL)
Fish: R^2=0.25, p=0.11
Macroinvertebrate: R^2 = -0.09, p=0.66



Establishment of Crayfish in the KNP

- Redclaw crayfish is a Category 1b: (NEM:BA) 10 (2004)
- Relative abundance of Redclaw crayfish is comparatively low
- Trajectory of an invasion in its infancy and provide opportunity to mitigate ecological damage and costs
- There were no signals of spatial sorting nor ecological impact
- Local hydrology and geomorphology are a driving factor in crayfish invasion (e-flows)
- Dams serves as hubs for biological invasion (e.g., Van Graan Weir)

Acknowledgements

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Water resources underpin the functioning of both the ecosystem and the facilities provided by the park and concessions