Mangrove resilience and fiddler crabs in South Africa

Renzo Perissinotto, Janine B Adams, Ricky H Taylor, Anusha Rajkaran, Nelson AF Miranda, **Nasreen Peer**, Jacqueline L Raw**.**

Ecosystem stability and resilience

…a **greater biodiversity** promotes ecosystem stability and resilience through the assured maintenance of ecosystem processes and reduced susceptibility to species invasion.

…a **greater biodiversity** insures the delivery of ecosystem goods and services which are economically valuable.

Macarthur 1955, Goodman 1975, Loreau 2000, Chapin et al. 2000

Ecosystem stability and resilience

Adaptation to Environmental Change: Contributions of a Resilience Framewor

Donald R. Nelson,[1,4] W. Neil Adger,[1
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Key Words

adaptive management, governance, risk, social-ecc

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PLoS BIOLOGY

Perspective

Rethinking Ecosystem Resilience in the Face of Climate Change

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Resilience is usually defined as the capacity of an ecosystem to absorb disturbance without shifting to an alternative state and losing function and services [1–3]. The concept therefore encompasses two separate processes: resistance—the magnitude of disturbance that causes a change in structure—and recovery—the speed of return to the original structure [4,5]—which are fundamentally different but rarely distinguished. Yet, resilience has become a central concept in the management of natural ecosystems [6,7]. Many current management actions aim to alleviate local stressors in an effort to increase ecosystem resilience to global climate change [8,9]. Such a management philosophy is premised on the belief that eliminating local drivers of ecological degradation. It is therefore not surprising that the concept of resilience—to climate change in particular—is perhaps more strongly advocated as an underpinning of management for coral reefs than for any other ecosystem [9,11–16]. Marine reserves or no-take areas, the most popular form of spatial management for coral reef conservation, are widely thought to have the potential to increase coral reef resilience [11,13,14,17]. But do they really?

The Conventional View of Resilience

The concept of managing for resilience is underpinned by the notion that unstressed coral communities are highly resilient to climate change and that [...]inated by fleshy macroalgae [13] but other alternative states are possible [20]—only at high levels of climate disturbance (Figure 1A). As non-climatic, local disturbances degrade the original ecosystem (Figure 1A; open block arrows), the tipping point in response to climate change shifts to the left (Figure 1A; black arrows), making the ecosystem less resistant to climate disturbance. Management that seeks to control local stressors and reverse degradation (Figure 1A; red block arrows) is therefore expected to increase resilience by shifting the tipping point back to the right and keeping reefs further away from this ecological precipice (Figure 1A; red arrows).

If resilience to climate change varies in relation to ecosystem state as depicted in

Ecosystem stability and resilience

“Systems need to be managed for flexibility rather than stability”

“managing for resilience requires directing a system in a way that provides flexibility during times of disturbance and that allows a way to take advantage of the latent diversity within the system and the range of opportunities following release.”

Ecosystem stability and resilience

Stress events are not always negative

"Thus, with continued degradation caused by local stressors, altered communities become composed of disturbance-tolerant species…making the ecosystem more resilient to climate disturbance"

Available online at www.sciencedirect.com

IUCN
The World Conservation Union

Managing Mangroves for Resilience to Climate Change

Elizabeth McLeod and Rodney V. Salm

REVIEW

The Impact of Climate Change on the World's Marine Ecosystems

Ove Hoegh-Guldberg[1]* and John F. Bruno[1,2]

ELSEVIER

Aquatic Botany 89 (2008) 237–250

botany

www.elsevier.com/locate/aquabot

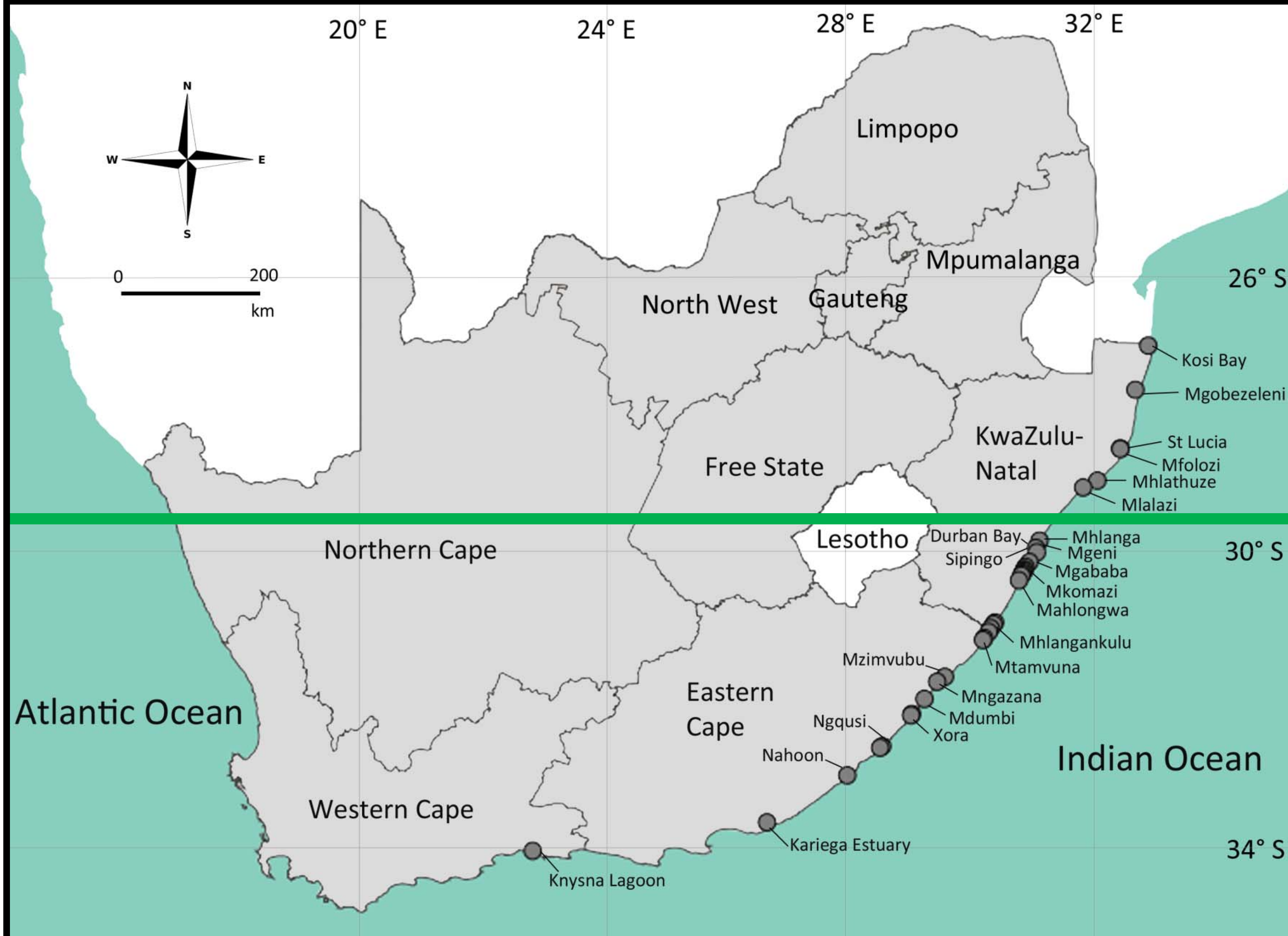
Review

Threats to mangroves from climate change and adaptation options: A review

Eric L. Gilman [a,*], Joanna Ellison [b], Norman C. Duke [c], Colin Field [d]


South African mangroves
In sheltered bays or estuaries
Subtropical and temperate
Thrive at latitudinal limits
Macnae 1963

South African mangroves



NORTHERN GROUP

SOUTHERN GROUP

What has changed….

What has changed….

Wetlands Ecology and Management **12:** 531–541, 2004.

The distribution and state of mangroves along the coast of Transkei, Eastern Cape Province, South Africa

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Southern Forests 2015: 1–9

This is the final version of the article that is published ahead of the print and online issue

SOUTHERN FORESTS
ISSN 2070-2620 EISSN 2070-2639
http://dx.doi.org/10.2989/20702620.2014.1001622

Mangrove expansion and population structure at a planted site, East London, South Africa

Sabine CL Hoppe-Speer[1], Janine B Adams[1*] and Anusha Rajkaran[2]

[1] *Department of Botany, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa*
[2] *Department of Botany, Rhodes University, Grahamstown, South Africa*
* *Corresponding author, e-mail: janine.adams@nmmu.ac.za*

What has changed….

African Journal of Marine Science 2014, 36(4): 517–522

AFRICAN JOURNAL OF MARINE SCIENCE
ISSN 1814-232X EISSN 1814-2338
http://dx.doi.org/10.2989/1814232X.2014.984757

Short Communication

Decline of *Terebralia palustris* in South African mangroves

JL Raw[1*], R Perissinotto[1,2], RH Taylor[3], NAF Miranda[1] and N Peer[1]

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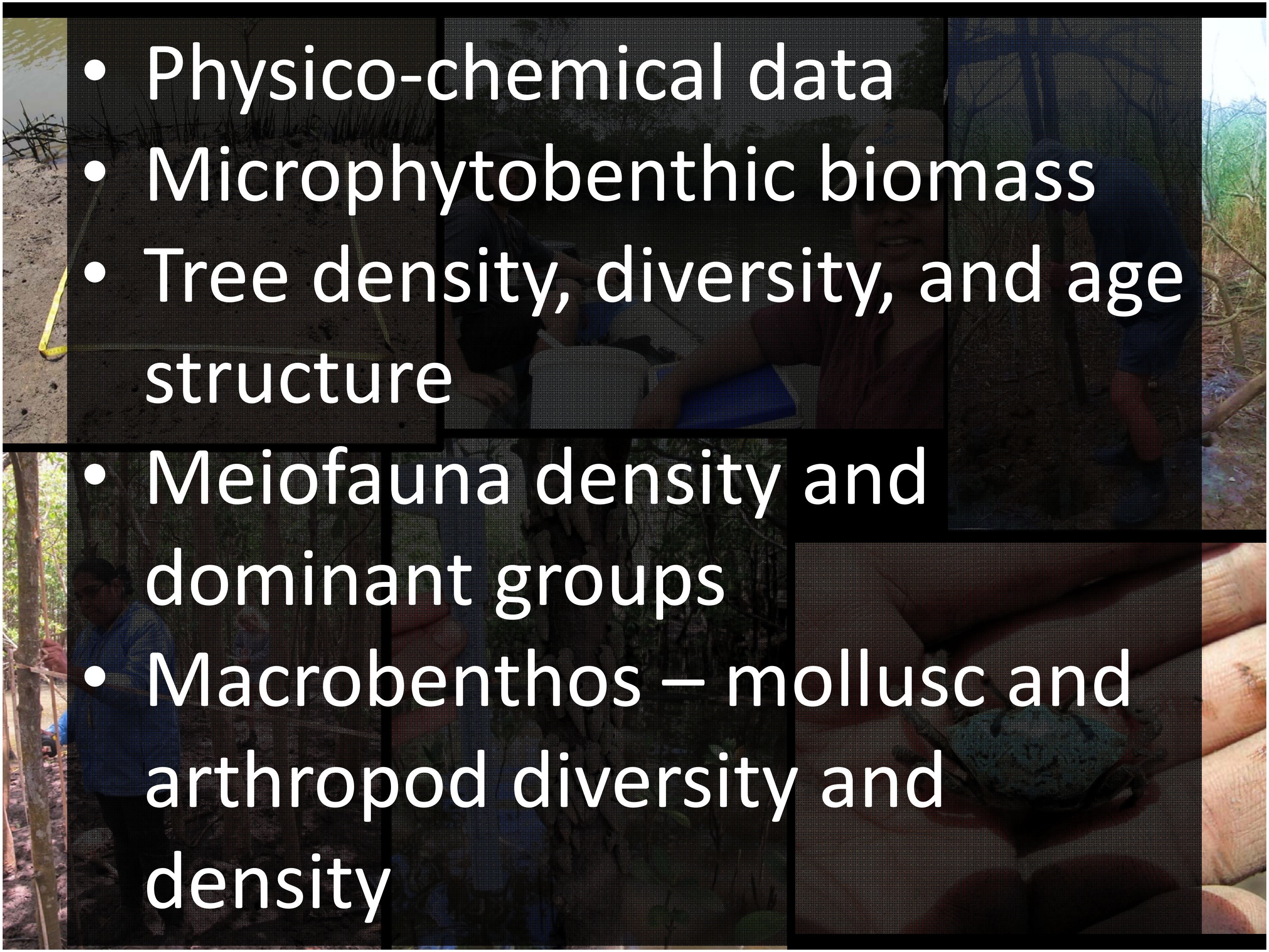
[2] *School of Life Sciences, University of KwaZulu-Natal, Durban, South Africa*
[3] *School of Hydrology, University of Zululand, KwaDlangezwa, South Africa*
* *Corresponding author, e-mail: s213476967@nmmu.ac.za*

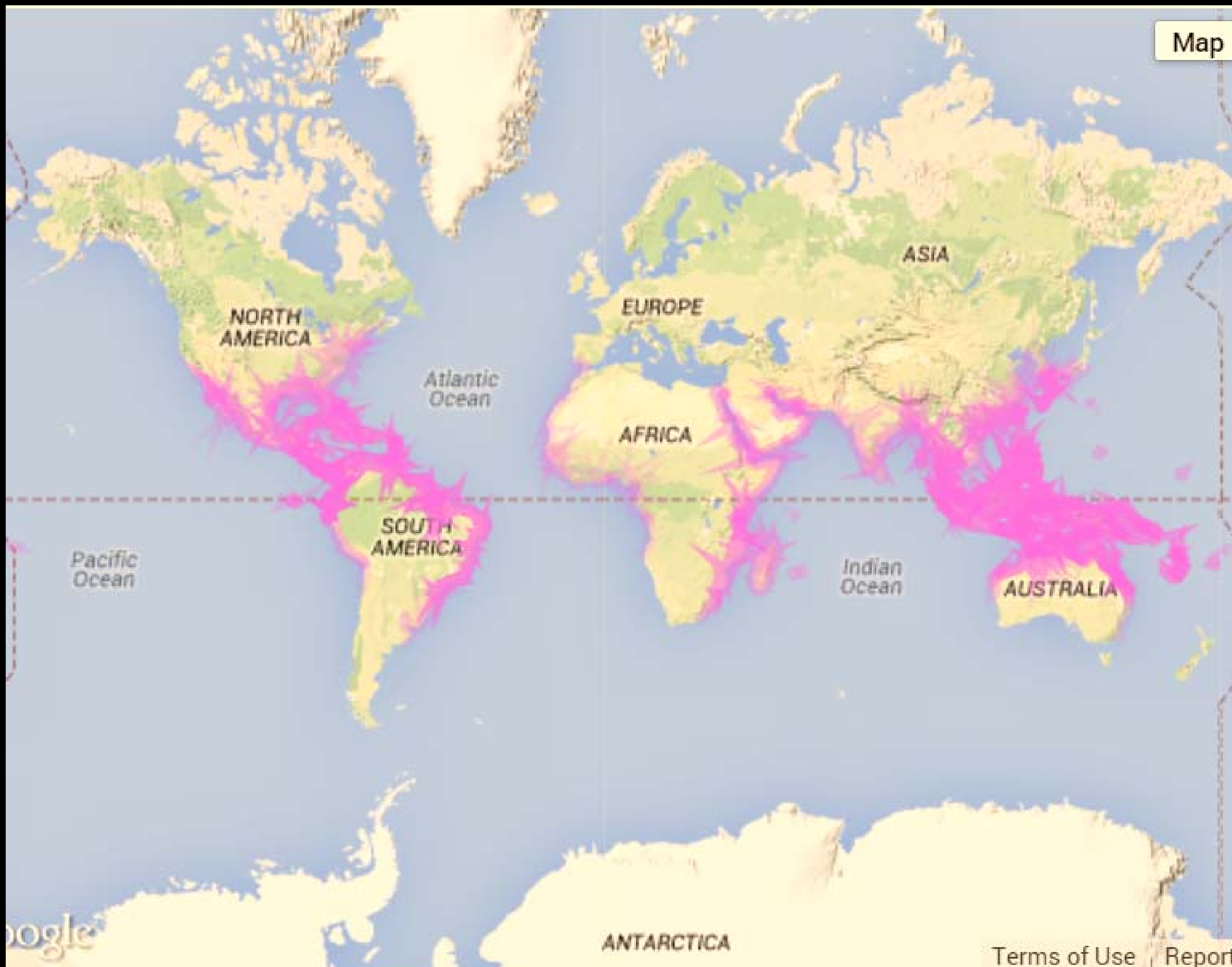

Wild Coast
Sun



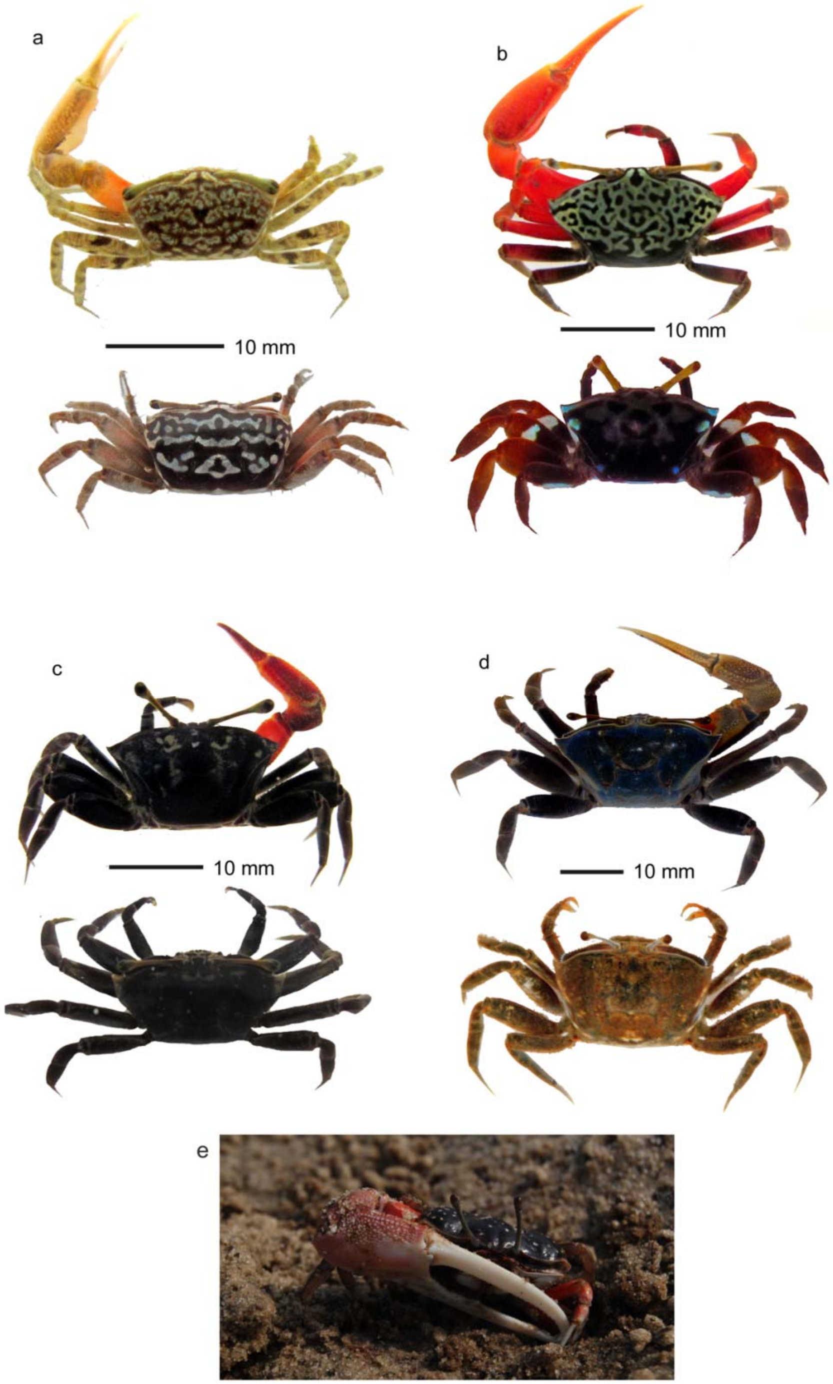
- Physico-chemical data
- Microphytobenthic biomass
- Tree density, diversity, and age structure
- Meiofauna density and dominant groups
- Macrobenthos – mollusc and arthropod diversity and density


From the depths of the sea... A TIDAL WAVE OF TERROR!
ATTACK OF THE
CRAB
MONSTERS
starring
RICHARD GARLAND · PAMELA DUNCAN · RUSSELL JOHNSON
A ROGER CORMAN PRODUCTION · Screenplay by CHARLES B. GRIFFITH · Produced and Directed by ROGER CORMAN · AN ALLIED ARTISTS PICTURE

The cosmopolitan distribution of fiddler crabs



www.fiddlercrab.info/uca_ranges.html



a. Uca annulipes

b. Uca chlorophthalmus

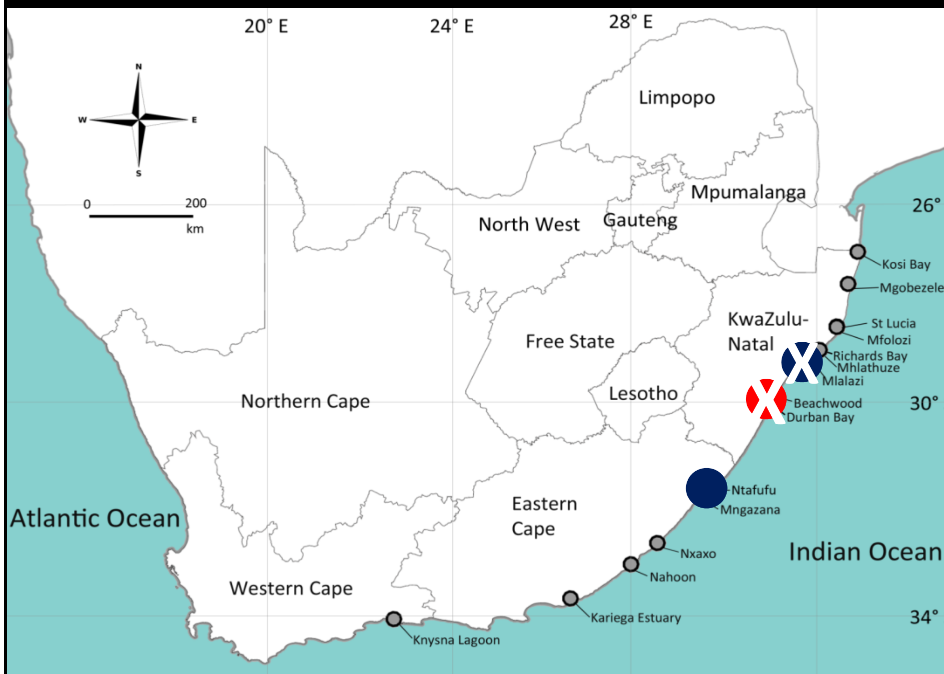
c. Uca hesperiae

d. Uca urvillei

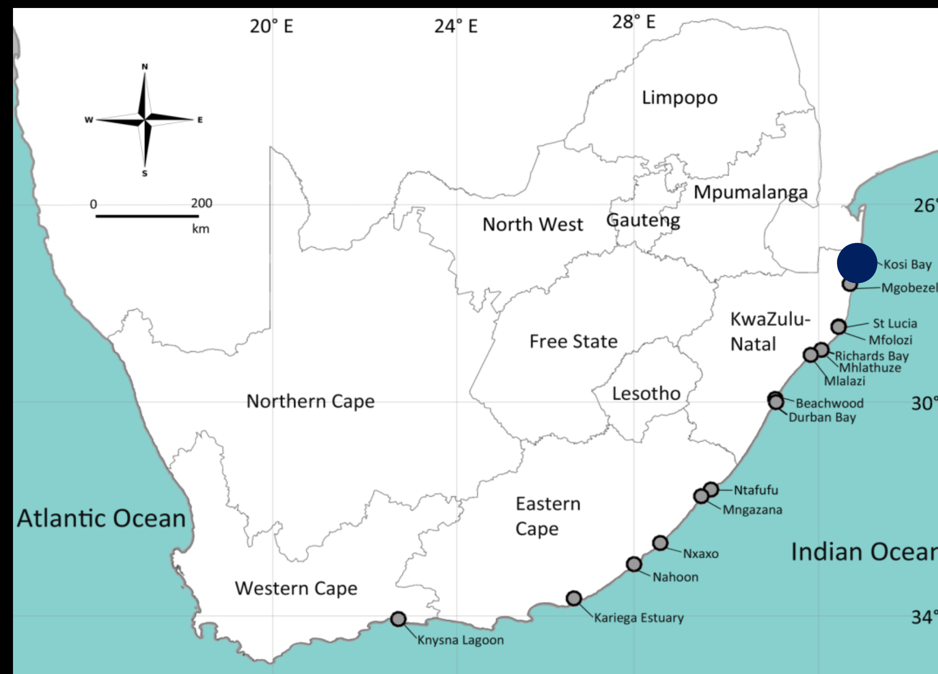
e. Uca inversa

(Photo courtesy of Branch et al. 2010)

Uca hesperiae

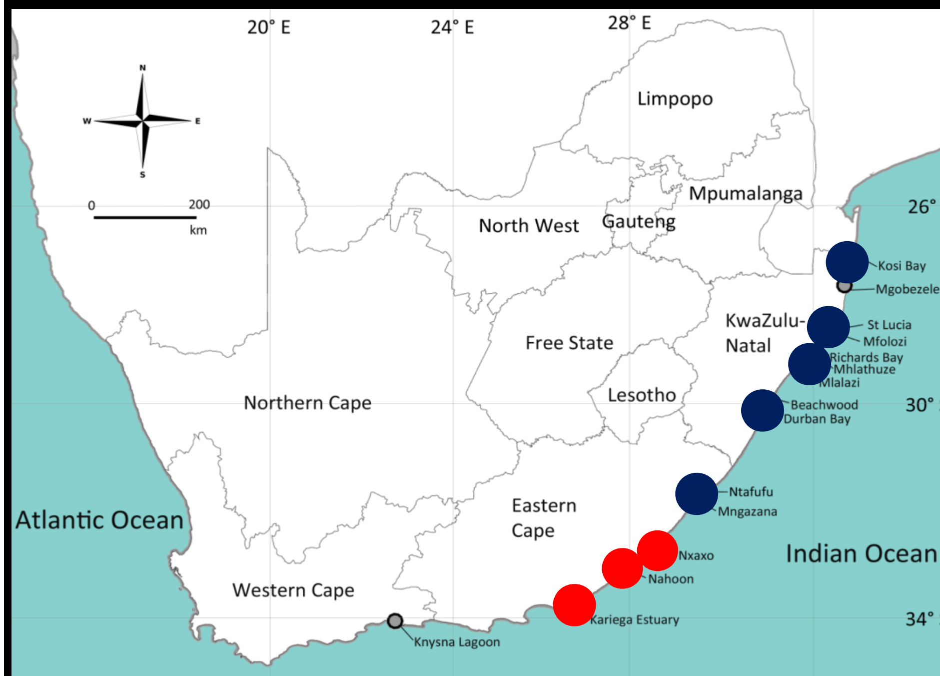


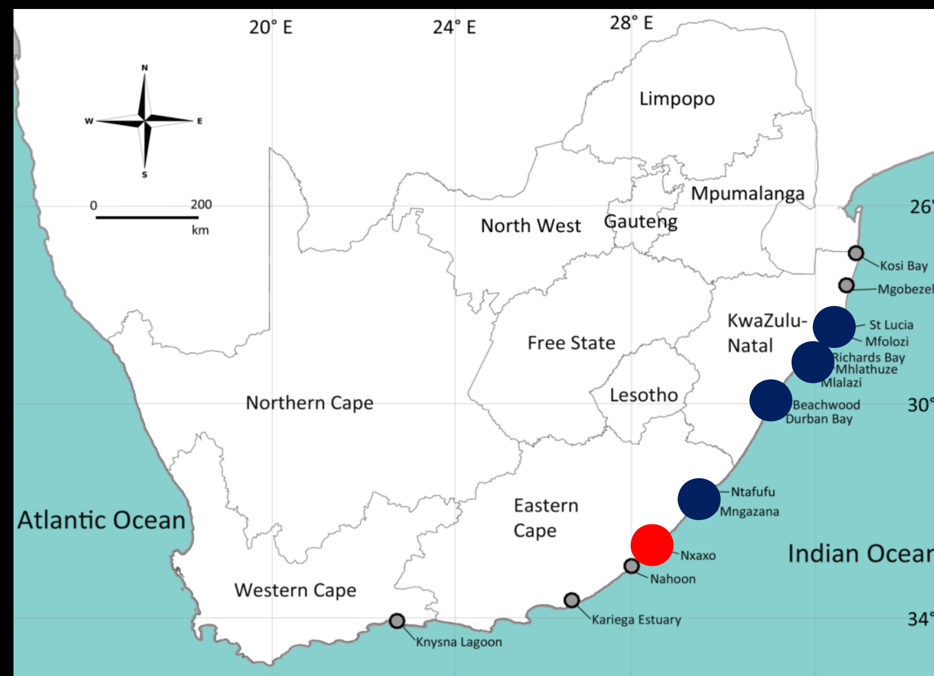
Uca inversa



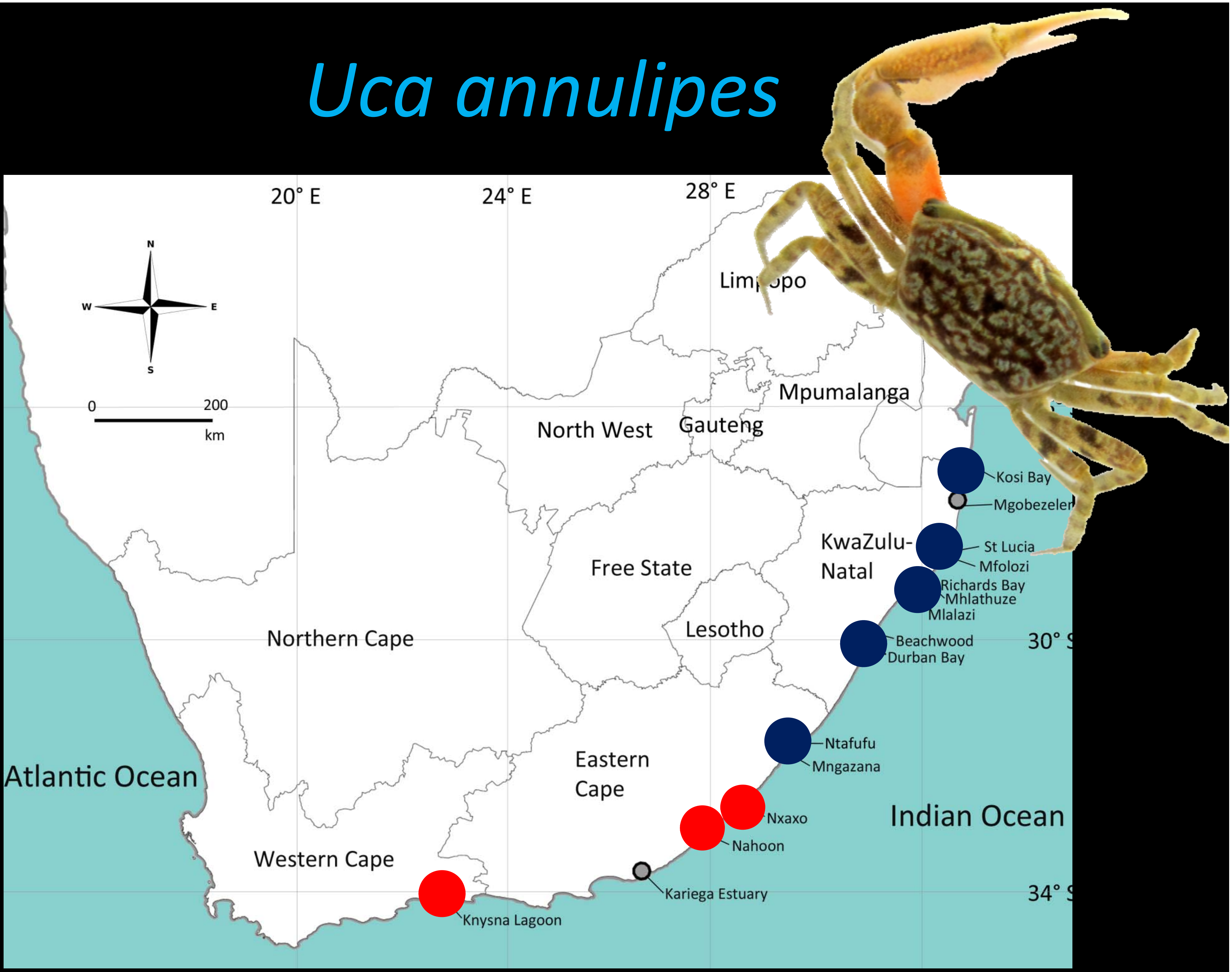
Uca chlorophthalmus

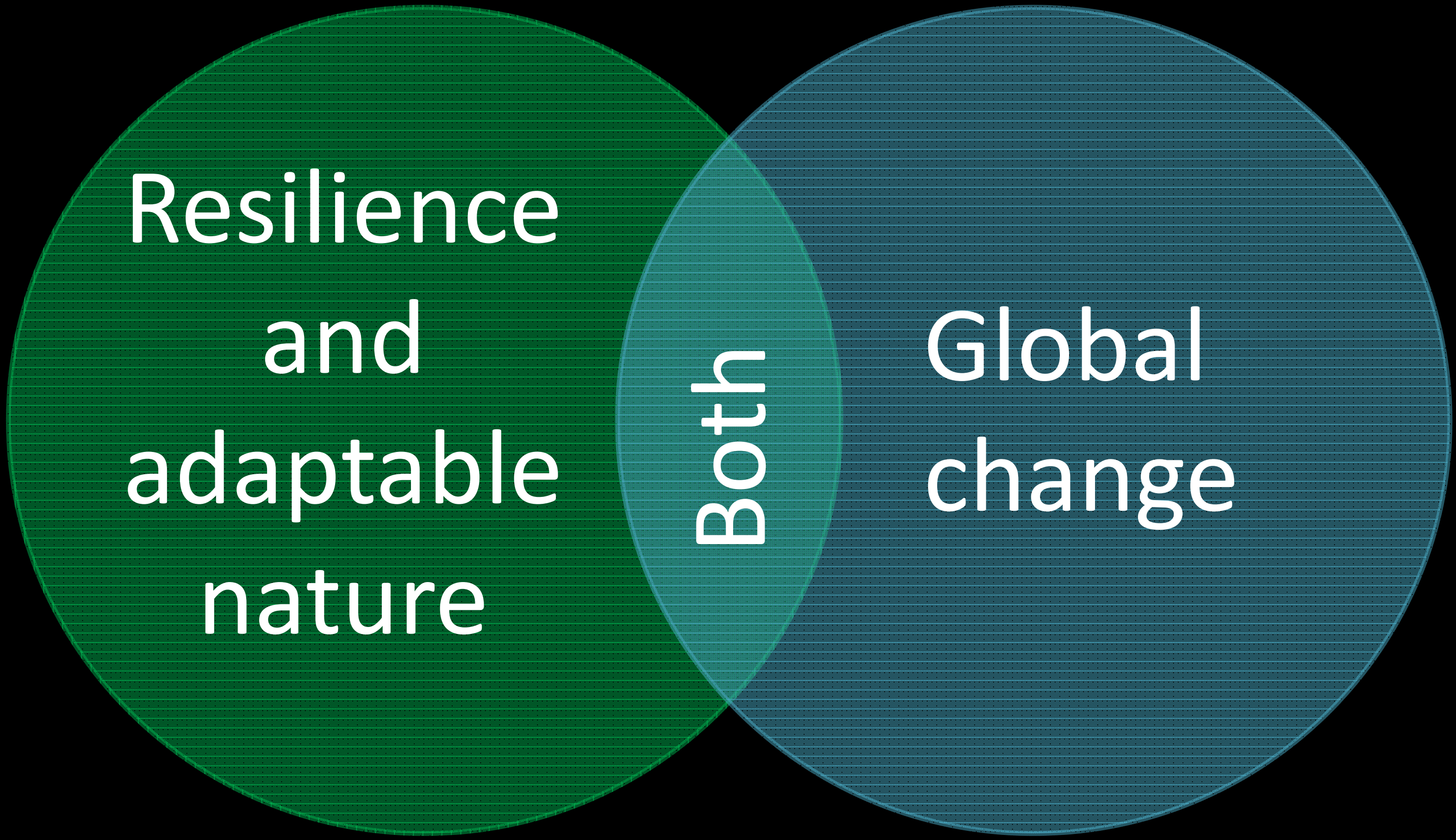
Uca urvillei





Uca annulipes

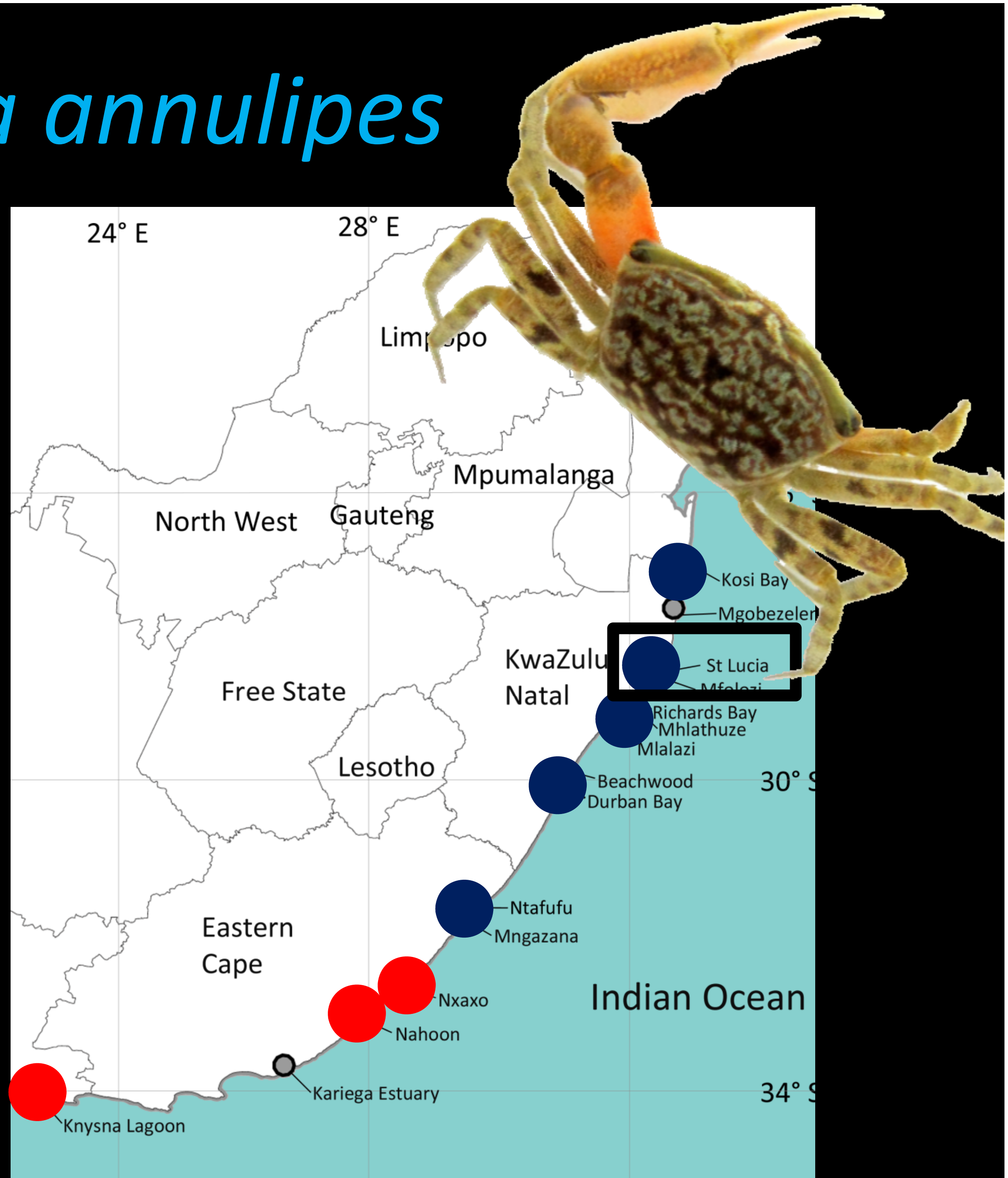




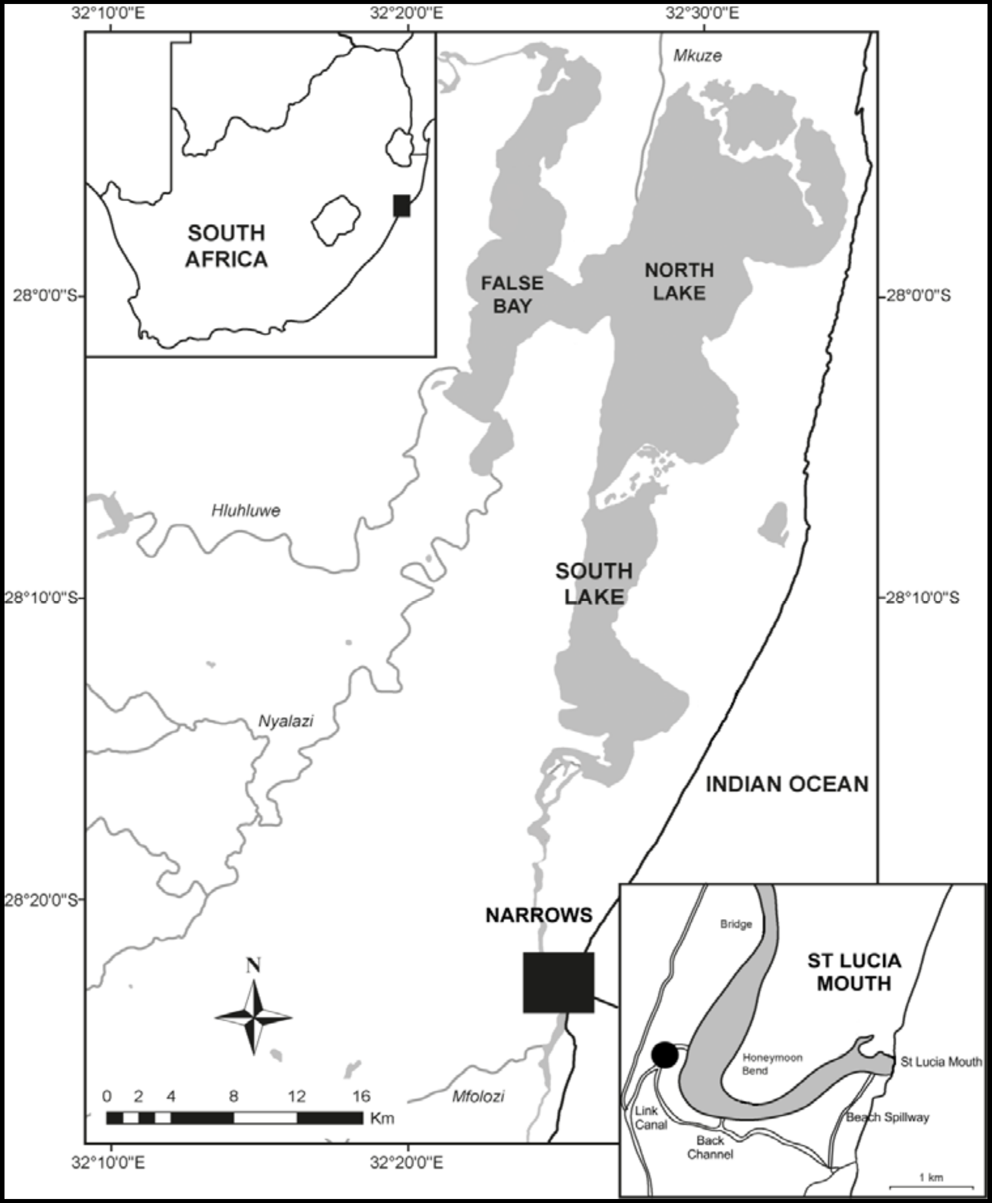
Complications – continuous climate and land use changes

Uca annulipes

The St Lucia fiddler crab community as a case study…



The St Lucia fiddler crab community as a case study…




ESTUARY
UMFOLOSI RIVER

Fiddler crab resilience

Influenced by:

physico-chemical variables

- Eurythermal (Edney 1961)
- Euryhaline (Khanyile 2012)
- Soil moisture (Macnae 1963)

environmental cycles

- Diel
- Tidal
- Seasonal

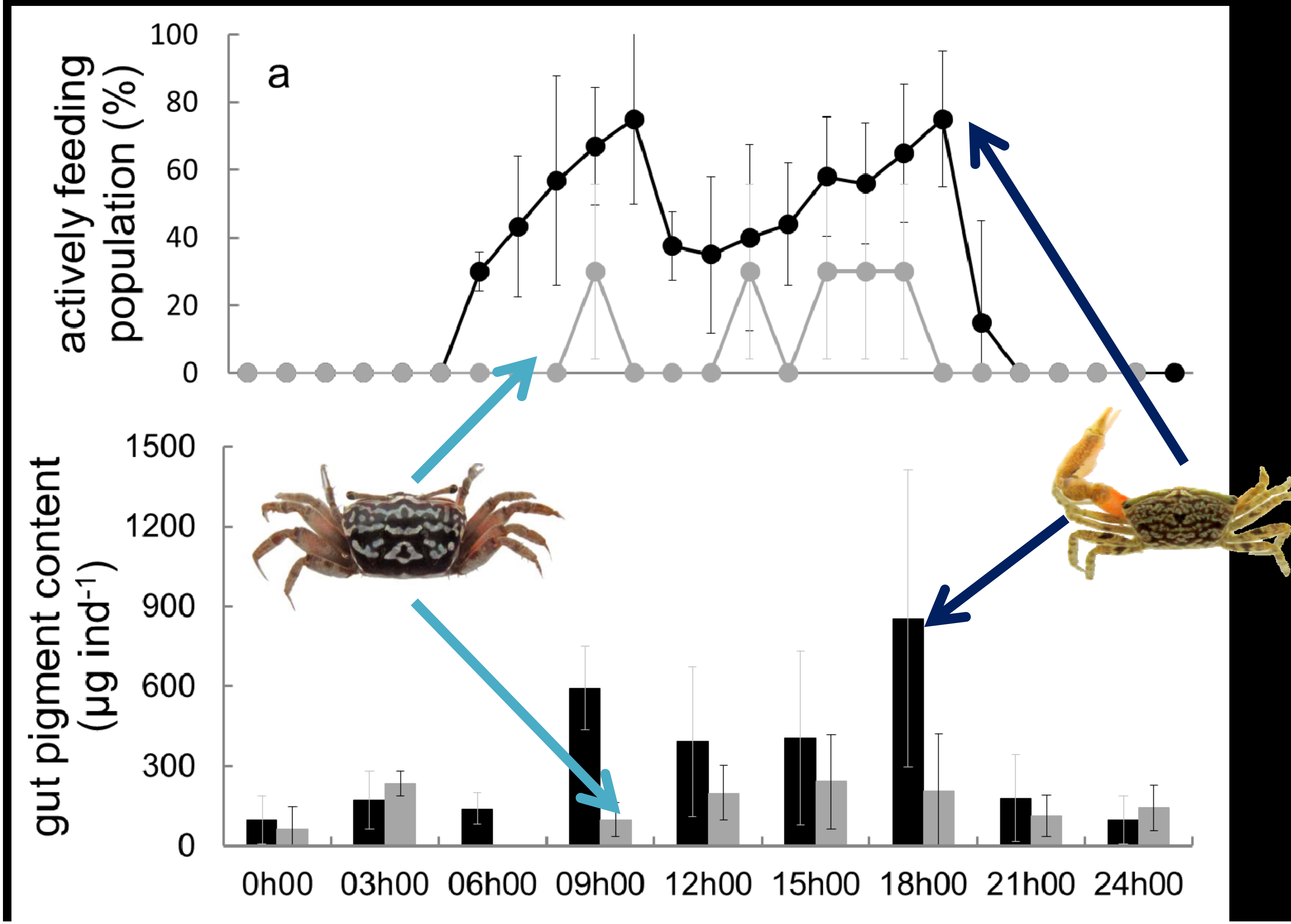
?

Feeding dynamics of the fiddler crab *Uca annulipes* in a non-tidal mangrove forest

Feeding dynamics of the fiddler crab *Uca annulipes* in a non-tidal mangrove forest

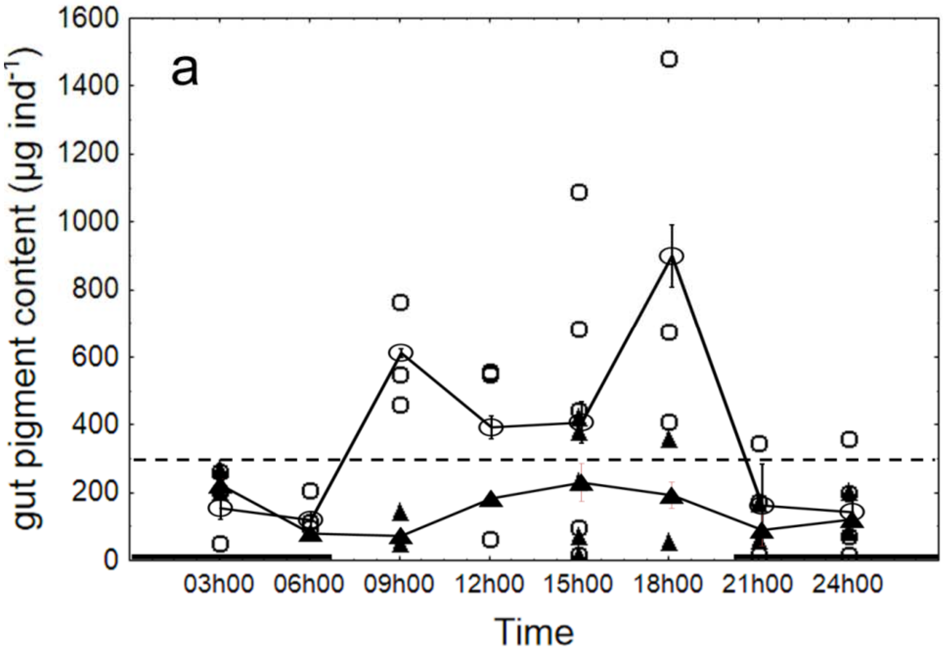
- Fiddler crabs are largely herbivores feeding on microphytobenthos (MPB)
- Feeding behaviour is affected by tidal rhythms, temperature, time of day, sexual dimorphism

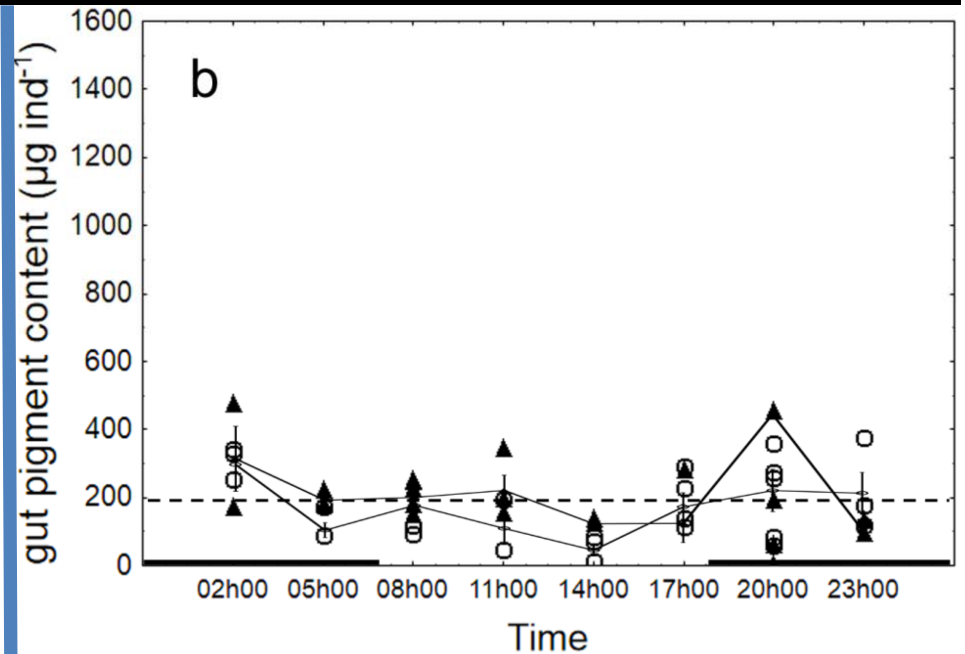
Seasonal and diel variation



Seasonal and diel variation

summer | winter

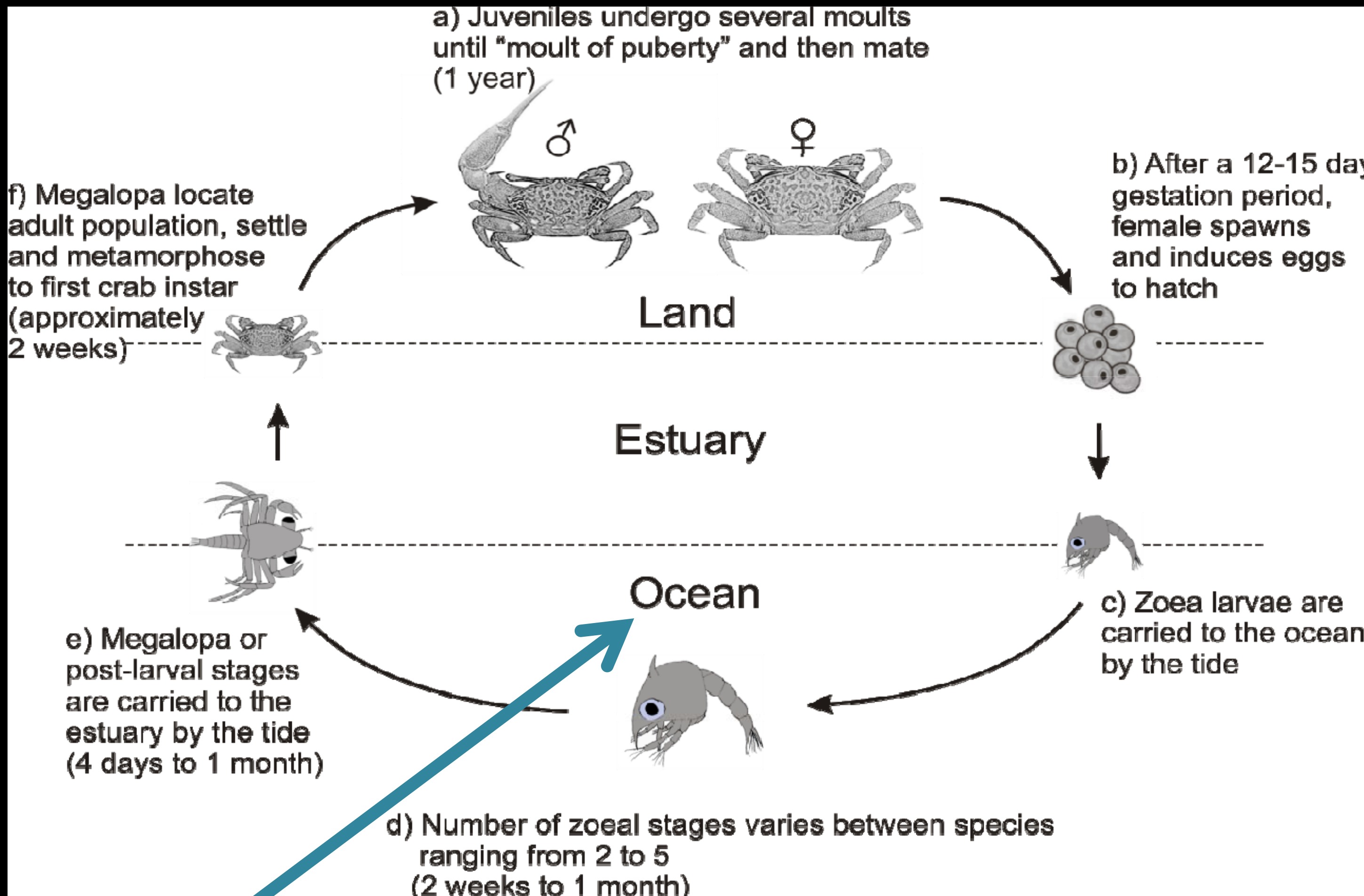




% of available MPB consumed per day in each season

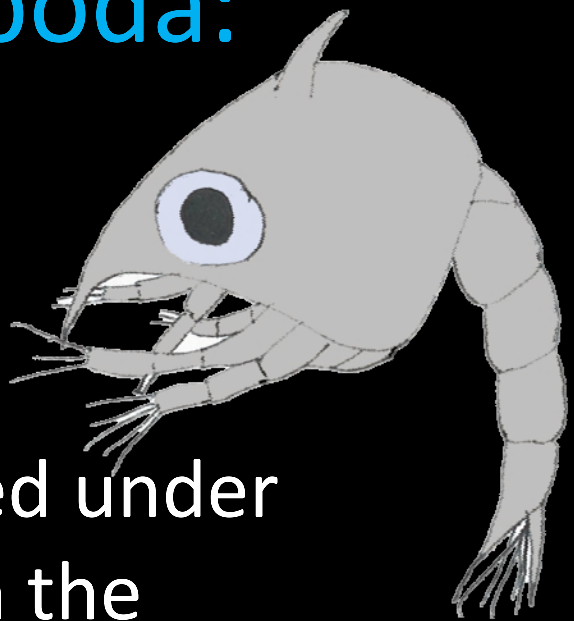
4.0 – 10.7	**3.4 – 6.4**

LIFE CYCLE



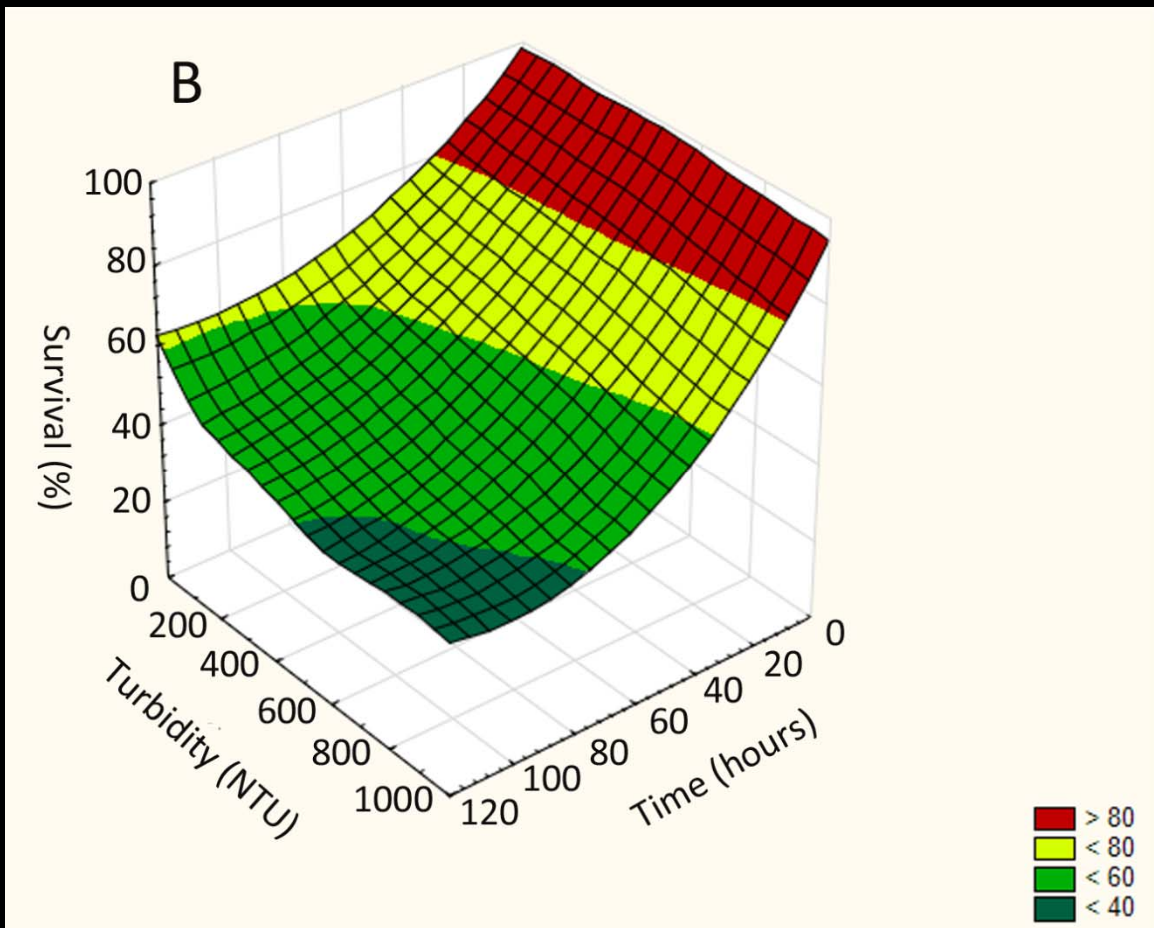
Requires an open connection to the ocean

Suspended silt and salinity tolerances of the first zoeal stage of the fiddler crab *Uca annulipes* (Decapoda: Brachyura)



- First stage larvae were maintained under various salinities and silt levels in the laboratory
- They were well cared for
- Mortality was measured at 2, 4, 8, 16, 24, 48, 72, 96, and 120 hours

RESPONSE TO SILT LOADING

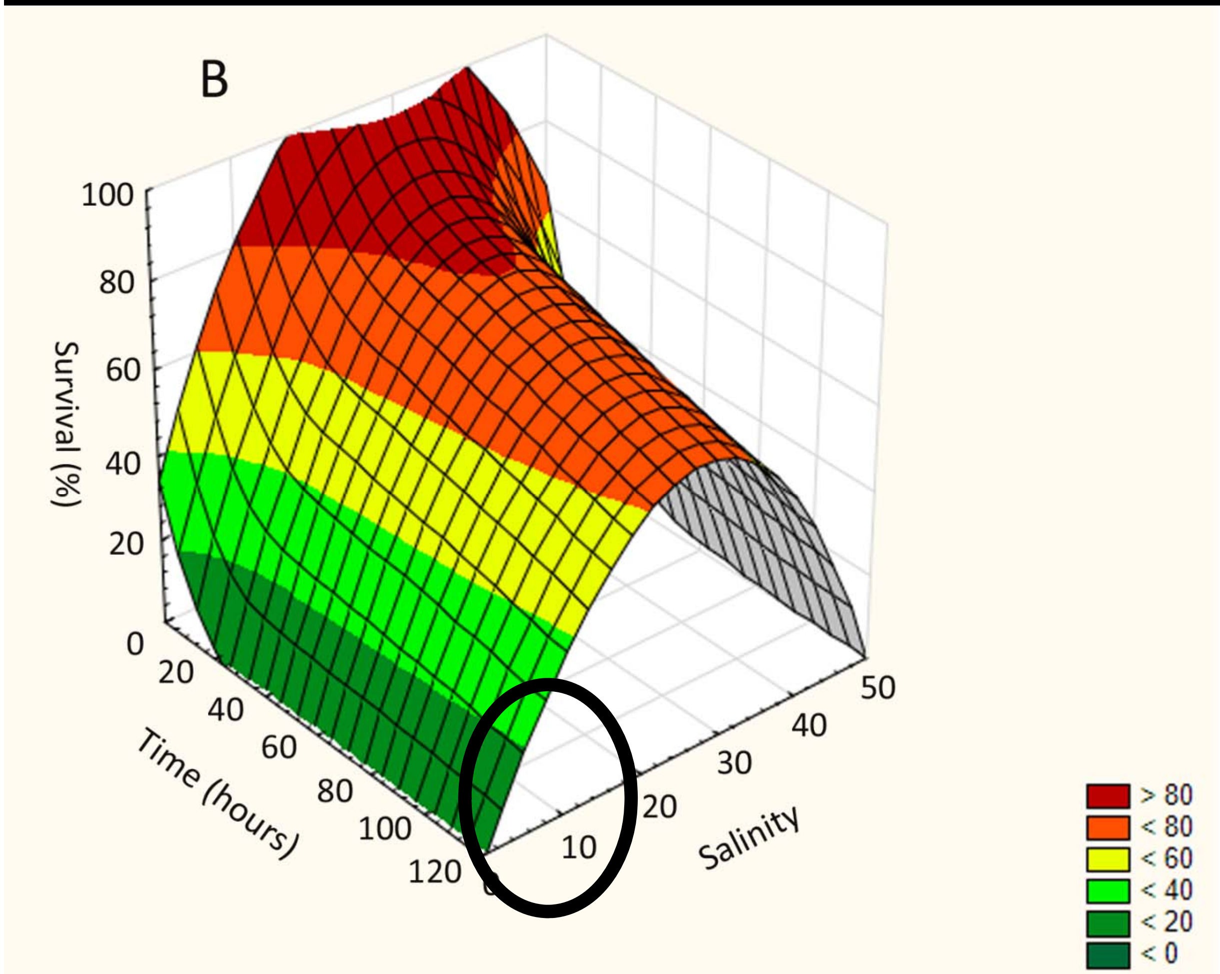


No significant difference in survival but a lower turbidity level appears to be optimal

Between 40 – 60 % survival rate overall

Turbidity in the Narrows -> 50 – 100 NTU

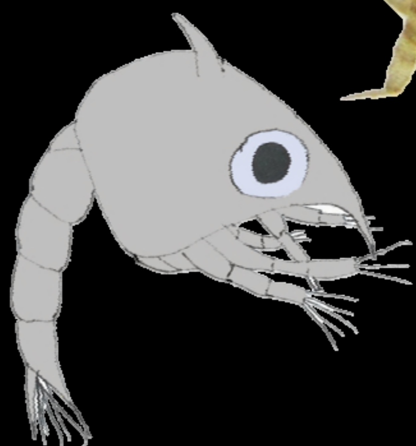
RESPONSE TO SALINITY FLUCTUATIONS



20 – 35 is the ideal salinity for development (~ 60 % survival rate)

At salinities < 20 and > 35 survival is 0%

Salinity in the Narrows -> 5 - 10



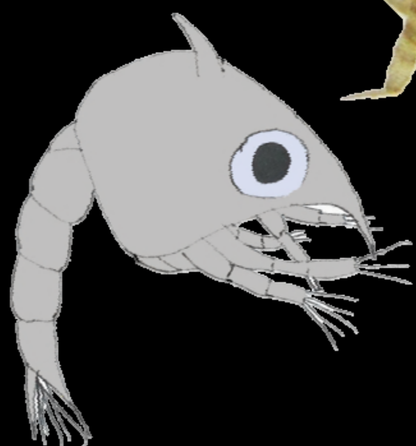
Conclusion

- Adaptable
- Maintain ecological role in the absence of important environmental rhythms
- Potentially resilient species

BUT

require a connection to the marine environment

Not all life stages display the same level of resilience



Conclusion

- Adaptable
- Maintain ecological role in the absence of important environmental rhythms
- Potentially resilient species

BUT

require a connection to the marine environment

Only sustainable due to refuge populations

IMPLICATIONS FOR CONSERVATION?

- Consider what the most resilient ecosystem components require to survive

- This knowledge gives us a direction and priority for conservation efforts

…In this case…marine connectivity is key


THANK YOU