

# Going nowhere or moving on ?

How do changes in species distribution  
impact marine food webs?

*Indo a lugar nenhum ou passar ?*

*Como as mudanças na distribuição das espécies  
impactar teias alimentares marinhas ?*



Coleen Moloney *et al.*

*Marine Research Institute  
University of Cape Town, SOUTH AFRICA*



## With thanks to:

- Many colleagues  
(on whose work I have based this presentation)
- Symposium Organisers and Session Convenor  
(for financial support and the invitation to speak)
- Google Translate  
(for the *Portuguese* text in my slides)

## Com agradecimentos a:

- *Meus colegas*  
(em cujo trabalho Baseei esta apresentação)
- *Simpósio Organizadores e Session Convenor*  
(para apoio financeiro e ao convite para falar)
- *Traduz Google*  
(Peço desculpas se algumas das traduções não fazem sentido !)

## Session 9

Impact of climate change on ecosystem carrying capacity via food web spatial relocations

## Sessão 9

*Impacto das mudanças climáticas sobre a capacidade de suporte do ecossistema via deslocalizações espaciais comida web*

# STRUCTURE OF THE TALK

- Observed changes in species distributions across functional groups or trophic levels
  - Southern African perspective, coastal ocean
  - Three case studies
  - Reflections on key points
- As mudanças observadas na distribuição de espécies entre grupos funcionais ou níveis tróficos
  - Perspectiva do Sul Africano, oceano litoral
  - Três estudos de caso
  - Alguns pensamentos sobre pontos-chave

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Two dolphins are captured in mid-leap above the surface of the ocean. They are moving from left to right, leaving a trail of white water behind them. The dolphins have a dark grey back and a lighter, yellowish-brown belly. The water is a deep blue with small ripples.

Observed changes in species distributions

*As mudanças observadas na distribuição de espécies*

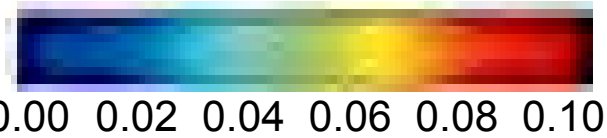


# Northward shifts of copepod assemblages, North Atlantic

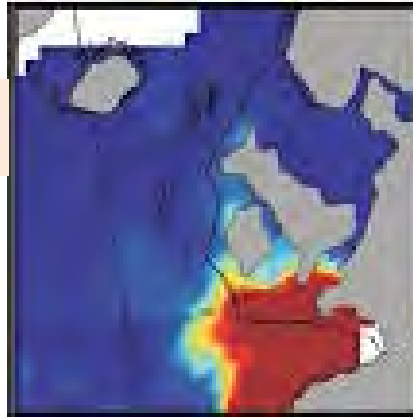
*Northward turnos de assembléias de copépodos , Atlântico Norte*

1958-1981

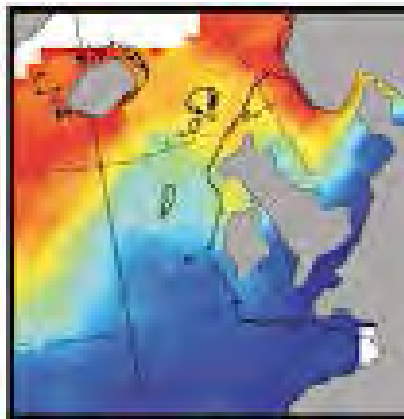
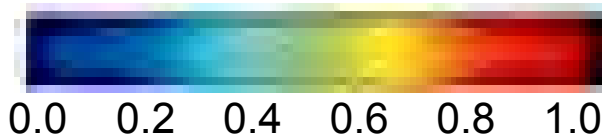
**Warm temperate**  
*Temperado quente*



Mean number of species per sample / *Número de espécies por amostra média*



**Subarctic**  
*Subártico*



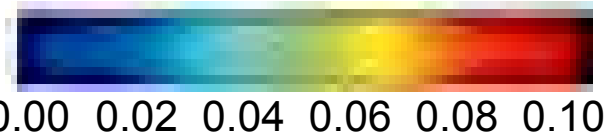
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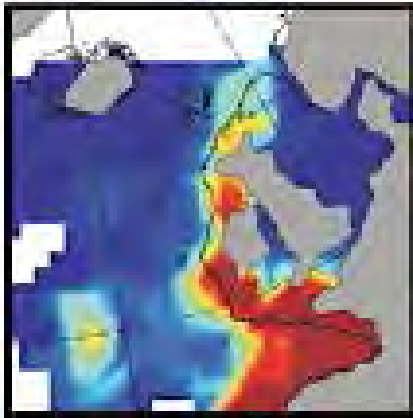
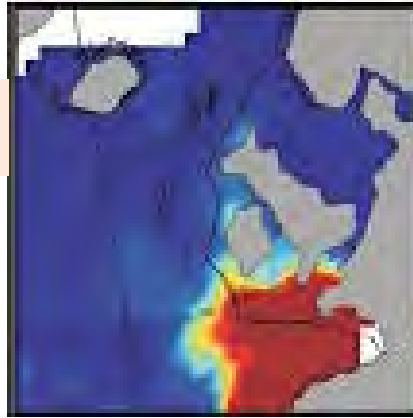
1958-1981

1982-1999

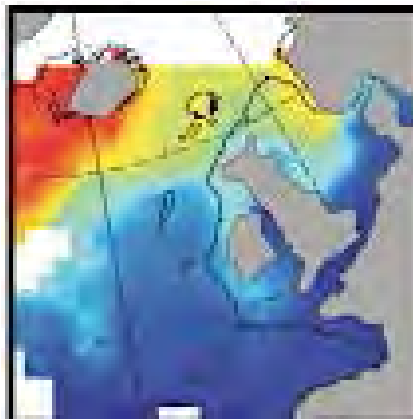
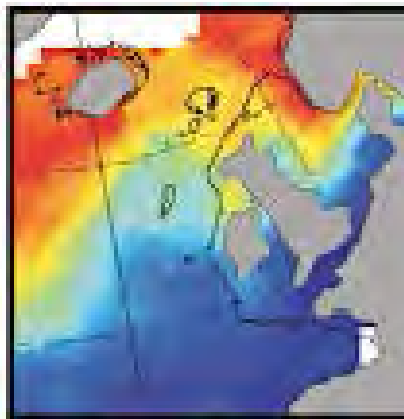
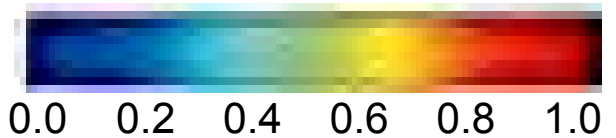
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Mean number of species per sample / *Número de espécies por amostra média*



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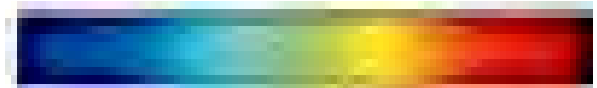
1958-1981

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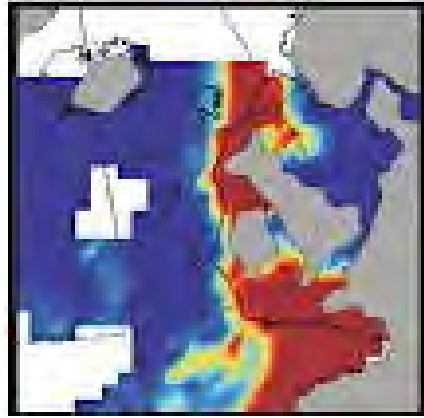
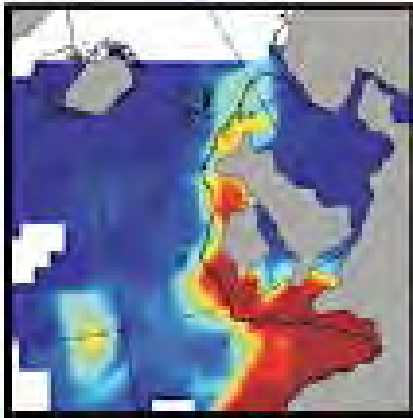
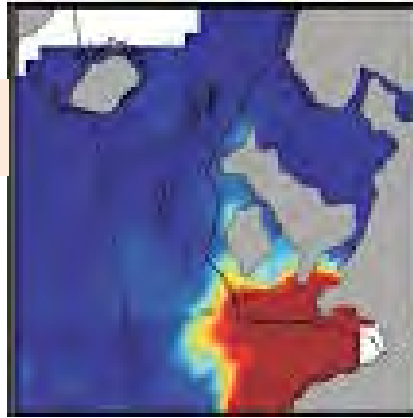
2000-2002

**Warm temperate**

*Temperado quente*



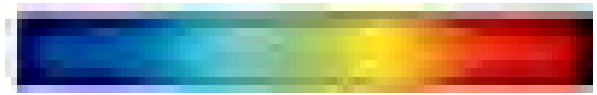
0.00 0.02 0.04 0.06 0.08 0.10



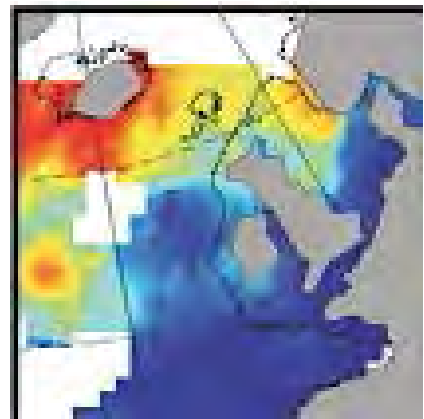
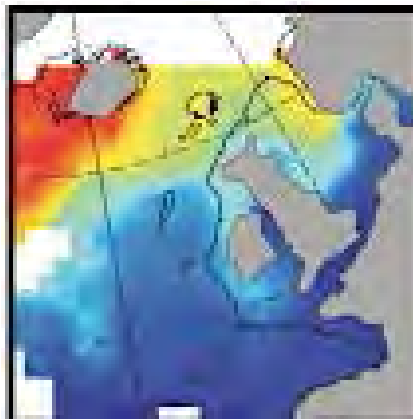
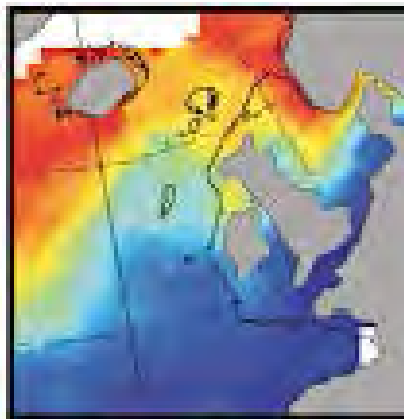
Mean number of species per sample / *Número de espécies por amostra média*

**Subarctic**

*Subártico*



0.0 0.2 0.4 0.6 0.8 1.0



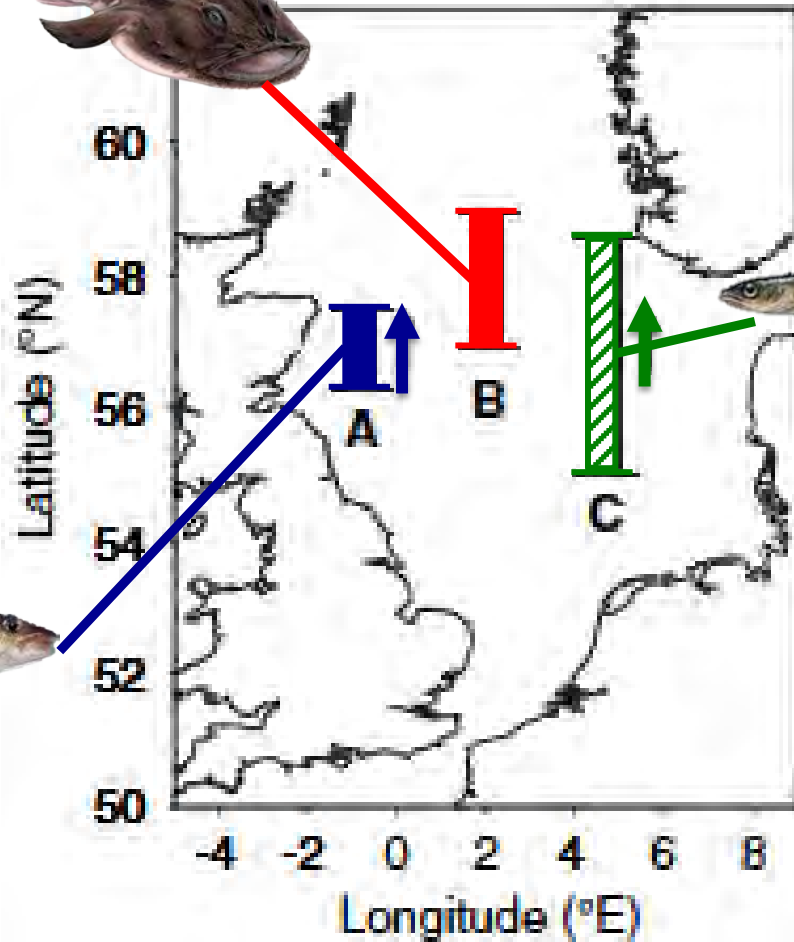
# Ranges of northward shifts in mean latitudes, North Sea

*Intervalos de turnos para o norte em latitudes médias, Mar do Norte*

Anglerfish  
*Lophius piscatorius*



Atlantic cod  
*Gadus morhua*



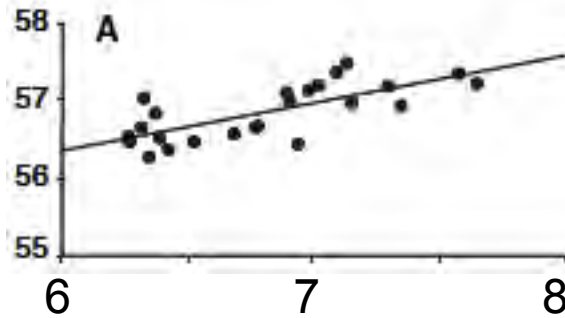
Snake blenny  
*Lumpenus lampretaeformis*



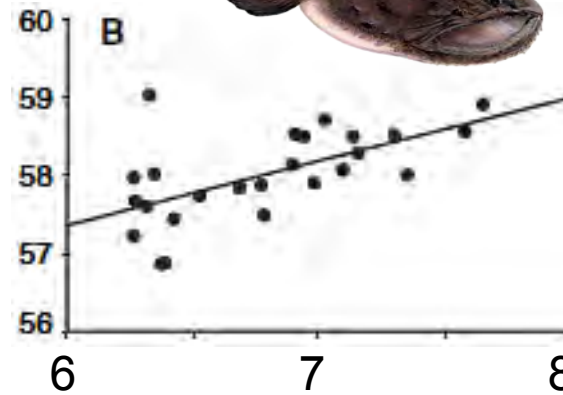
# Relationship between mean latitude and bottom temperature

*Relação entre a média latitude e temperatura inferior*

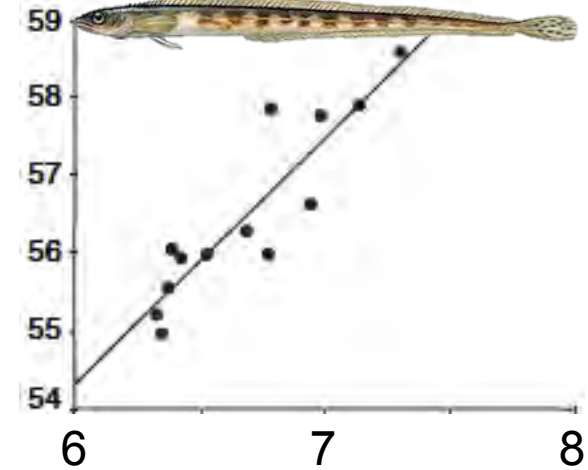
Atlantic cod  
*Gadus morhua*



Anglerfish  
*Lophius piscatorius*



Snake blenny  
*Lumpenus lampretaeformis*



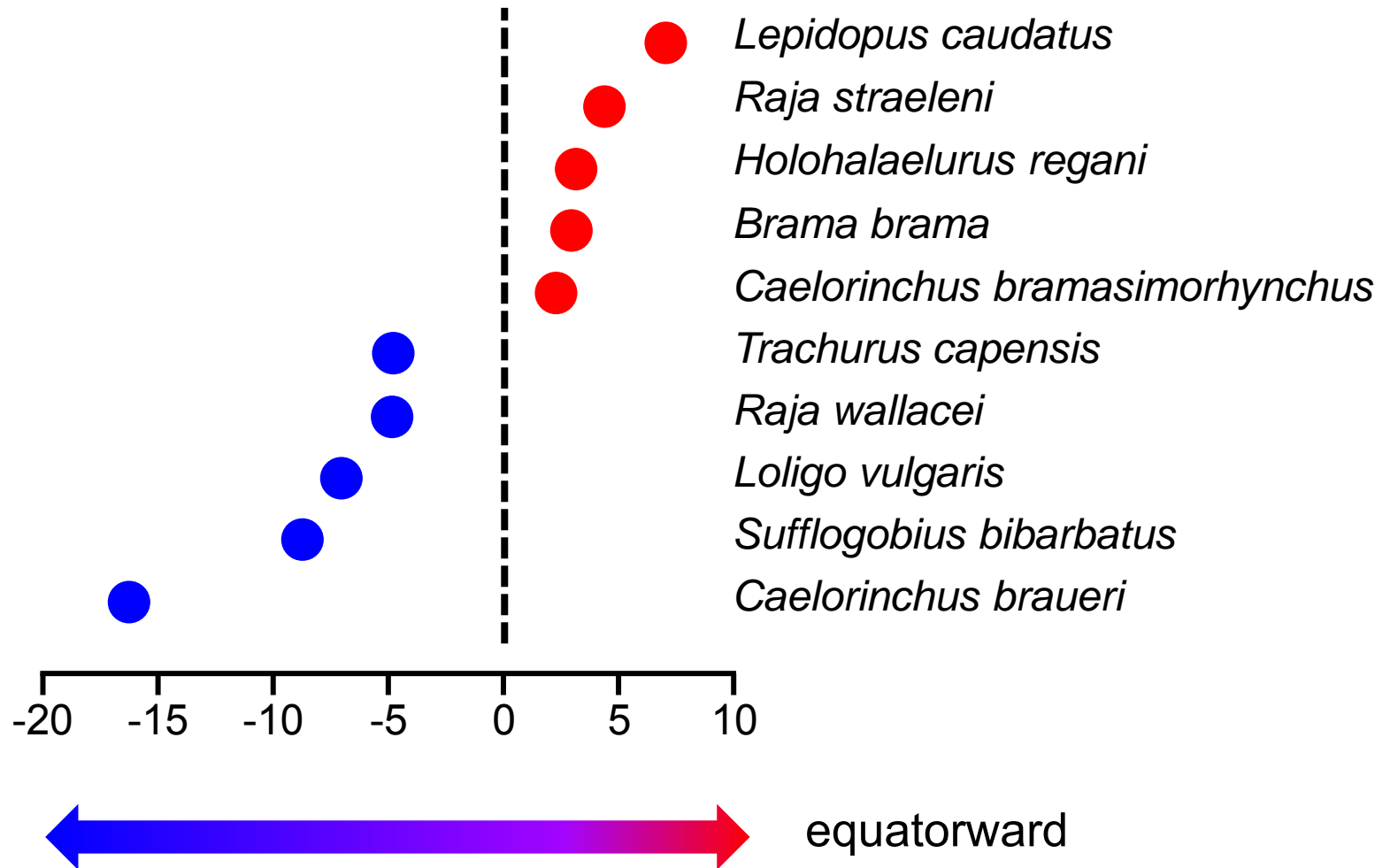
Mean latitude (°N)

Winter bottom temperature (°C) (5-year running mean)

*Temperatura do inverno inferior (C) ( 5 anos média em execução)*

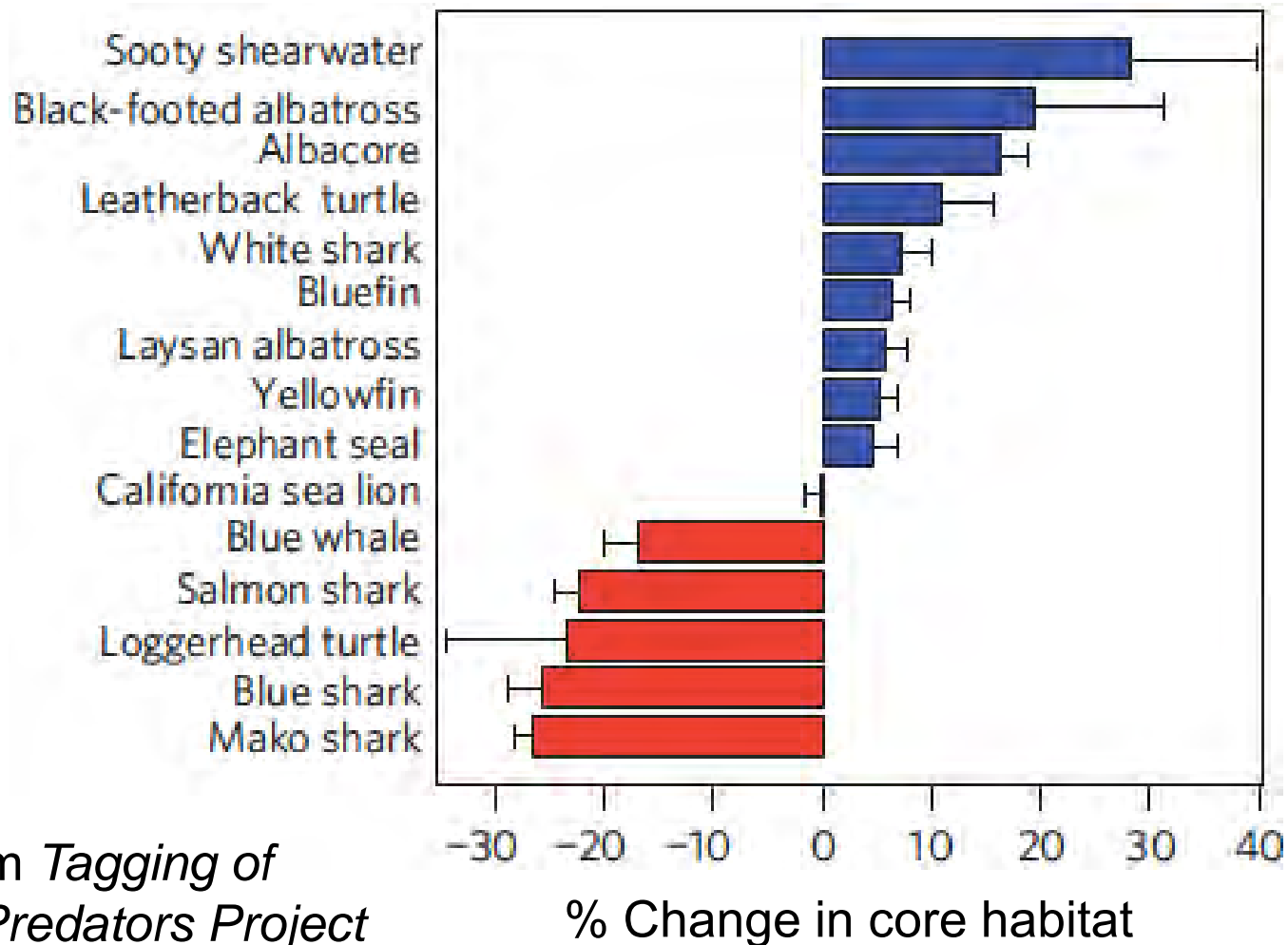
# Changes in mean latitudes of demersal fishes, chondrichthyans and cephalopods on the west coast of South Africa, 1985–2010

*Mudanças nas latitudes médias de peixes demersais, condropterígeos e cefalópodes , na costa oeste da África do Sul , 1985-2010*



# Predicted mean ( $\pm$ SD) habitat change (2001-2100, N. Pacific)

## Previsto mudança habitat médio (2001-2100, N. Pacífico)



data from *Tagging of Pacific Predators Project*

**What happens to marine food webs  
when some species leave or new  
species arrive?**

*O que acontece com teias alimentares  
quando algumas espécies saírem ou  
novas espécies chegam*

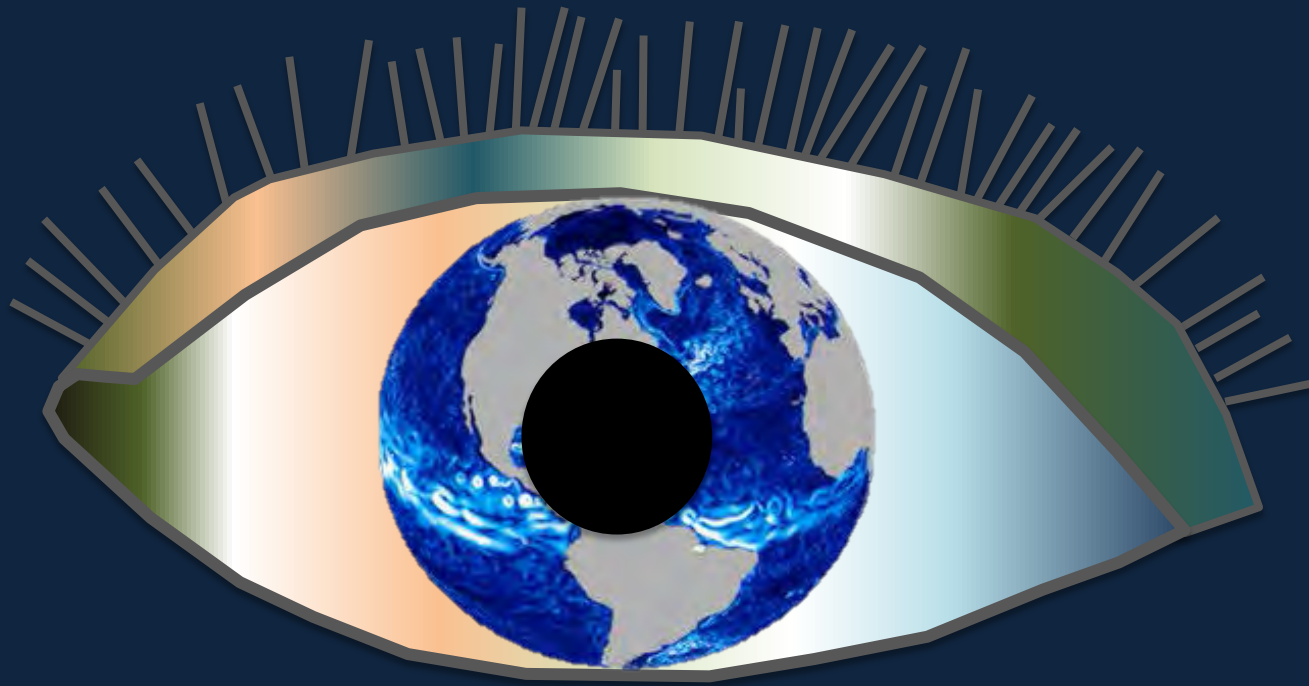


## Three dramas

1. Benthic, subtidal ecosystem
2. Pelagic upwelling ecosystem
3. Benthopelagic upwelling ecosystem

The eye of a SYSTEMS modeller - simplify

*O olho de um modelador SYSTEMS - simplificar*



## Three dramas

1. **Benthic, subtidal ecosystem**
2. Pelagic upwelling ecosystem
3. Benthopelagic upwelling ecosystem

# Impact of Rock Lobsters



Lead actor

Rock Lobster

Supporting actors

Macrophyte algae

Abalone

Urchins

Cast

Scavengers

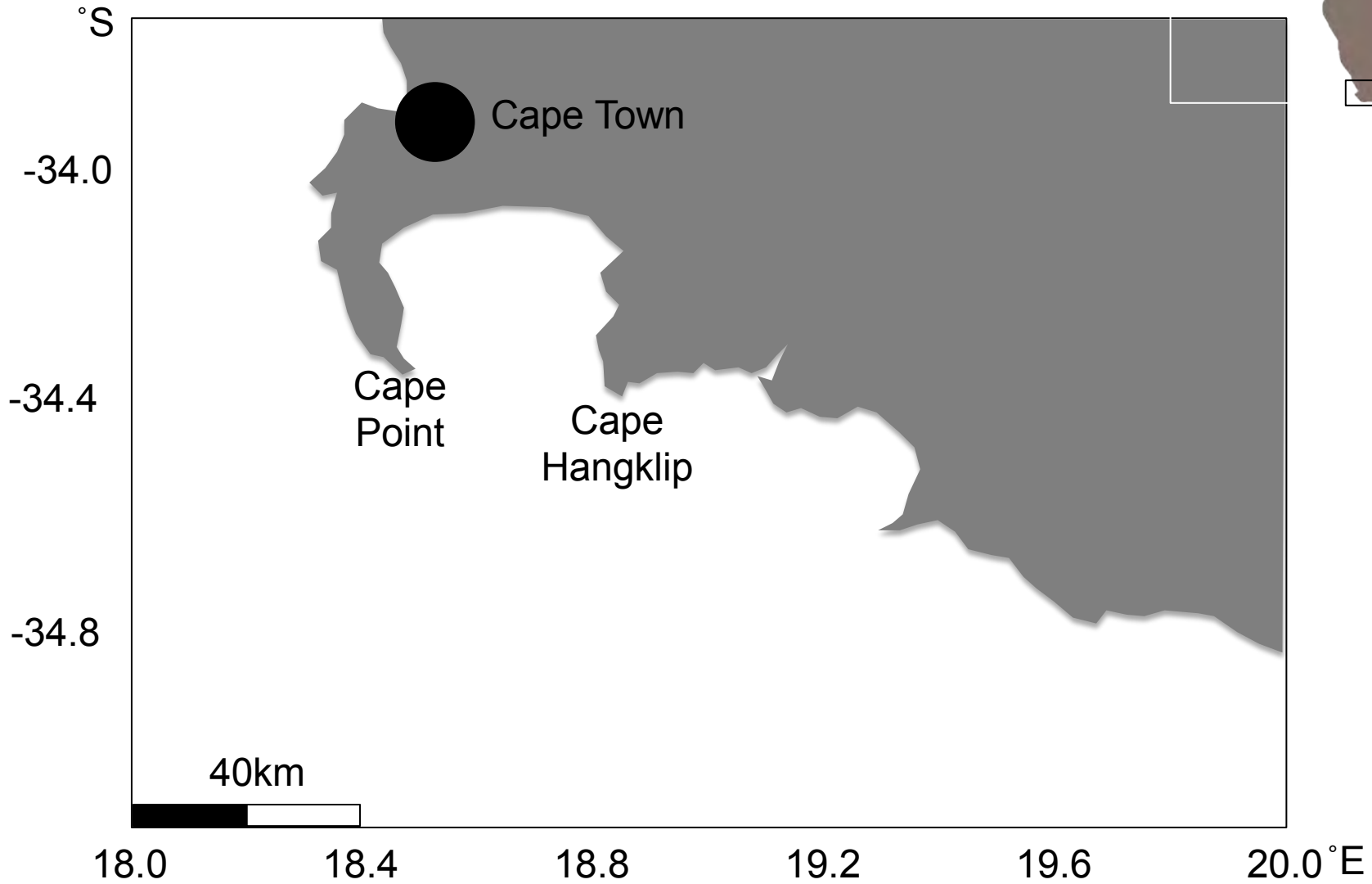
Sessile animals

Other gastropods

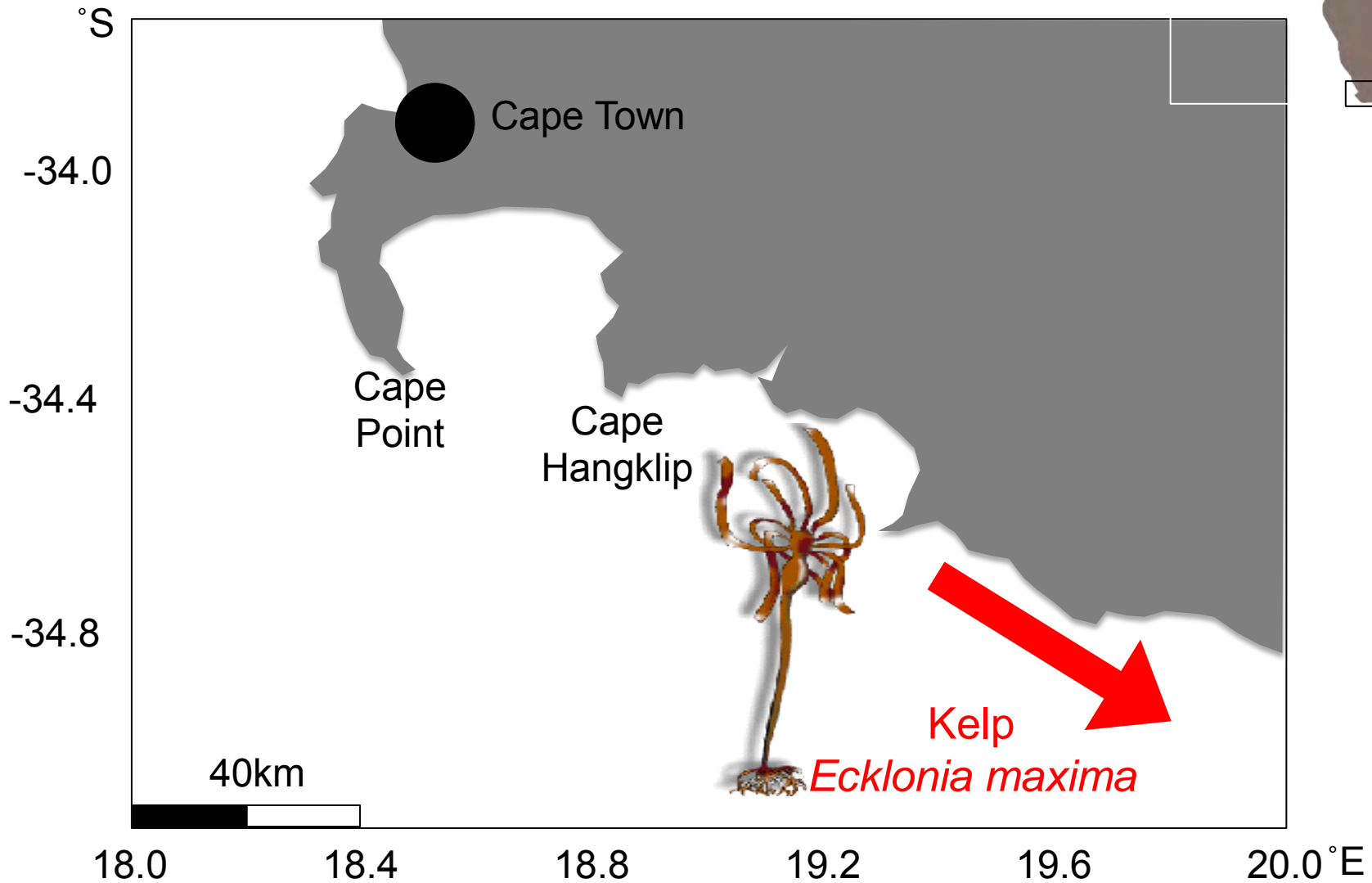
Encrusting coralline algae

Location: SW coast of South Africa

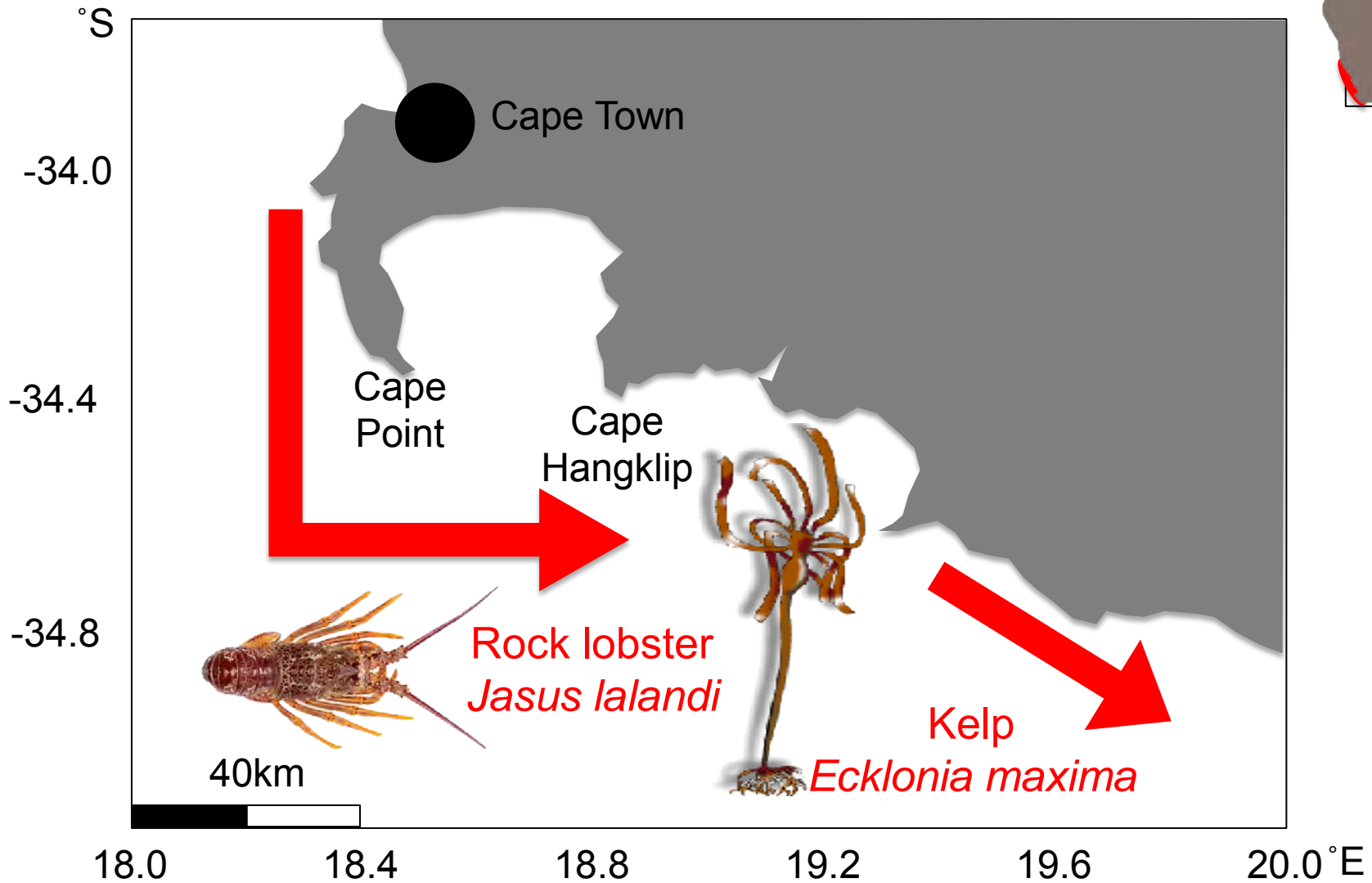
# Southwest coast of South Africa



# Southwest coast of South Africa

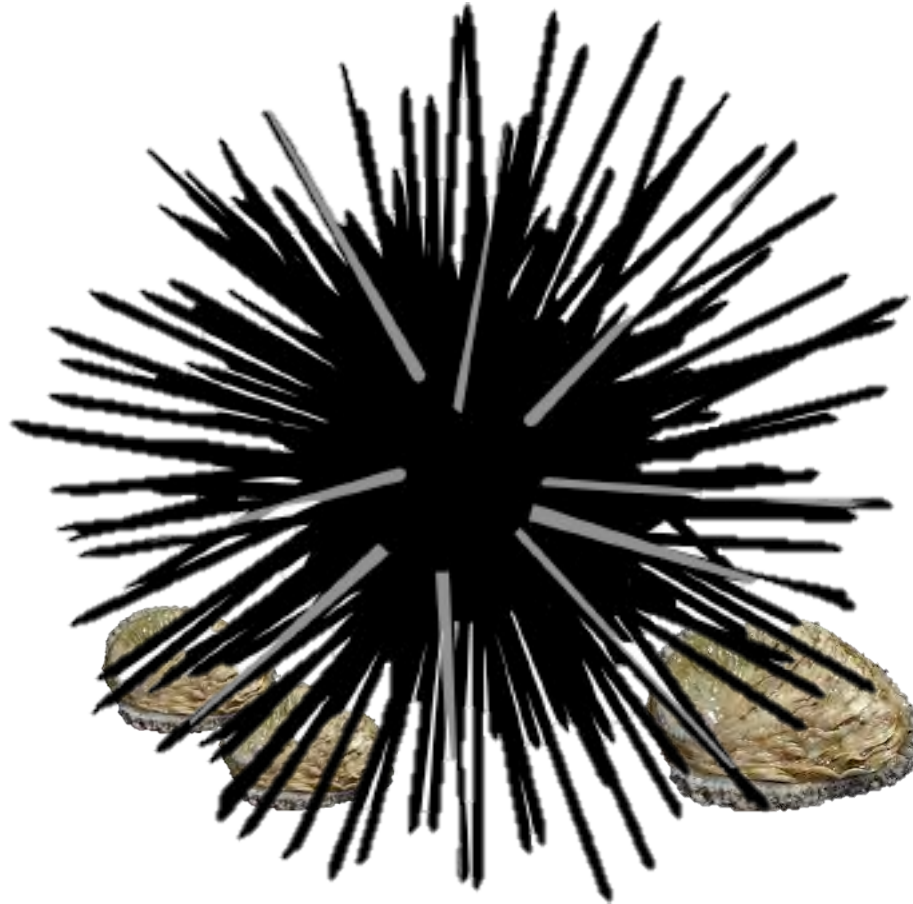


# Southwest coast of South Africa





Juvenile **abalone** shelter under **sea urchins** for protection from predators



*Abrigo **abalone juvenil** sob **ouriços do mar** para proteção contra predadores*

# Rock lobsters ABSENT

## *Lagostas* ABSENT

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



Encrusting coralline algae



Macroalgae

# Rock lobsters ABSENT

## *Lagostas* ABSENT

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



**Interactions**

Grazing/ *Pastando*



Encrusting coralline algae

Macroalgae

# Rock lobsters ABSENT

## *Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



### Interactions

Grazing/ *Pastando*

Settlement/ *Liquidação*



Encrusting coralline algae



Macroalgae

# Rock lobsters ABSENT

## *Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



### Interactions

Grazing/ *Pastando*  
Settlement/ *Liquidação*  
Removal/ *Remoção*



Encrusting coralline algae



Macroalgae

# Rock lobsters ABSENT

## *Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



### Interactions

Grazing/ *Pastando*

Settlement/ *Liquidação*

Removal/ *Remoção*

Facilitation/ *Facilitação*



Encrusting coralline algae



Macroalgae

# Rock lobsters ABSENT

*Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



Encrusting coralline algae



Macroalgae

## Interactions

- Grazing/ *Pastando*
- Settlement/ *Liquidação*
- Removal/ *Remoção*
- Facilitation/ *Facilitação*

# Rock lobsters PRESENT

*Lagostas PRESENTE*



# Rock lobsters ABSENT

*Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



## Interactions

Grazing/ *Pastando*

Settlement/ *Liquidação*

Removal/ *Remoção*

Facilitation/ *Facilitação*

Predation/ *Predação*

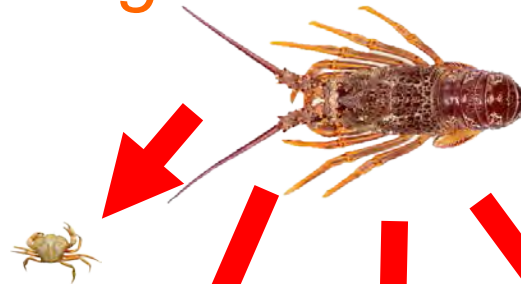
Macroalgae



Encrusting coralline algae

# Rock lobsters PRESENT

*Lagostas PRESENTE*



No Urchins



# Rock lobsters ABSENT

*Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



Encrusting coralline algae

Macroalgae

## Interactions

Grazing/ *Pastando*

Settlement/ *Liquidação*

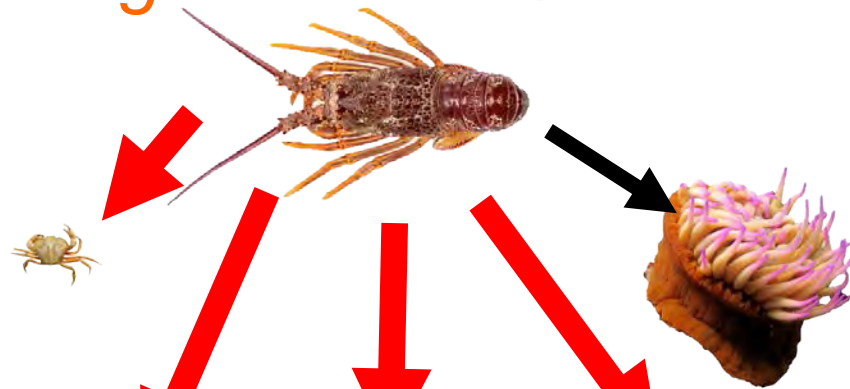
Removal/ *Remoção*

Facilitation/ *Facilitação*

Predation/ *Predação*

# Rock lobsters PRESENT

*Lagostas PRESENTE*



No Urchins

# Rock lobsters ABSENT

*Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



Encrusting coralline algae

Macroalgae

## Interactions

Grazing/ *Pastando*

Settlement/ *Liquidação*

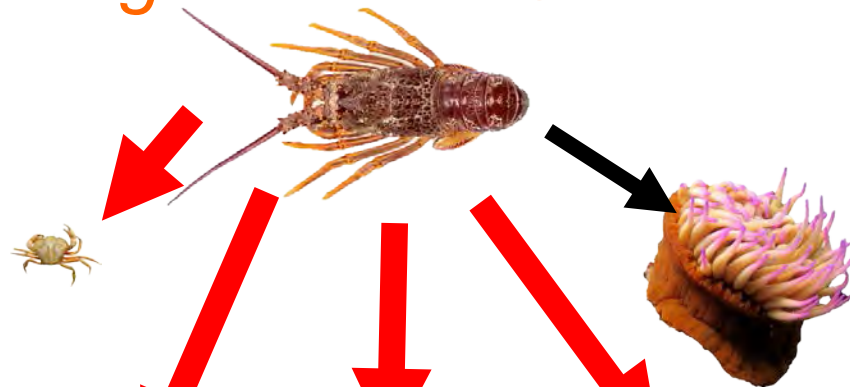
Removal/ *Remoção*

Facilitation/ *Facilitação*

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# Rock lobsters PRESENT

*Lagostas PRESENTE*



No Urchins

# Rock lobsters ABSENT

## *Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



### Interactions

Grazing/ *Pastando*

Settlement/ *Liquidação*

Removal/ *Remoção*

Facilitation/ *Facilitação*

Predation/ *Predação*

Shading/ *Shading*

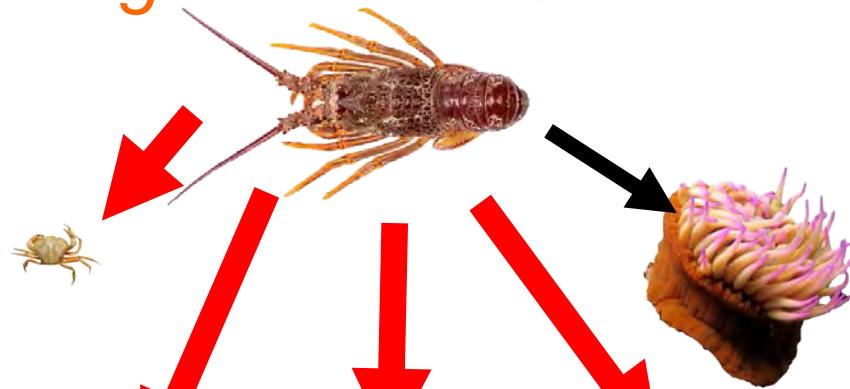
Macroalgae



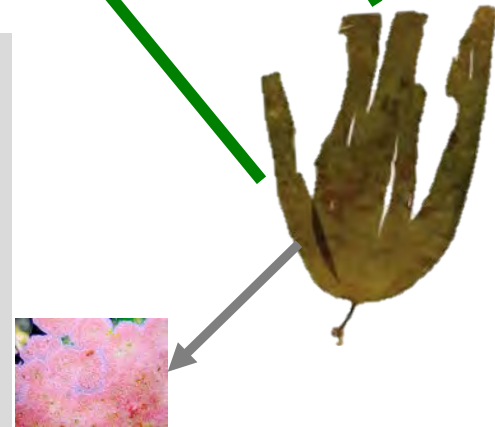
Encrusting coralline algae

# Rock lobsters PRESENT

## *Lagostas PRESENTE*



No Urchins



# Rock lobsters ABSENT

## *Lagostas ABSENT*

Scavengers



Sessile animals



Other gastropods



Abalone



Urchins



### Interactions

Grazing/ *Pastando*

Settlement/ *Liquidação*

Removal/ *Remoção*

Facilitation/ *Facilitação*

Predation/ *Predação*

Shading/ *Shading*

Competition/ *Concorrência*



Encrusting coralline algae

Macroalgae



# Rock lobsters PRESENT

## *Lagostas PRESENTE*



No Urchins



The "Rambo" effect

*Efeito de "Rambo"*



## Reflections....

- Trophic cascade (Blamey and Branch 2012)
- Interactions strongly affected by fishing
- Historical overfishing reduced ecosystem resilience (Blamey et al. 2014)

## *Algumas reflexões...*

- *Cascata trófica (Blamey and Branch 2012)*
- *Interações fortemente afetada pela pesca*
- *Historical sobrepesca reduziu a resiliência dos ecossistemas (Blamey et al. 2014)*

Predictable in advance  
using models?

*Previsível com antecedência  
usando modelos ?*

## Three dramas

1. Benthic, subtidal ecosystem
2. Pelagic upwelling ecosystem
3. Benthopelagic upwelling ecosystem



Lead actors

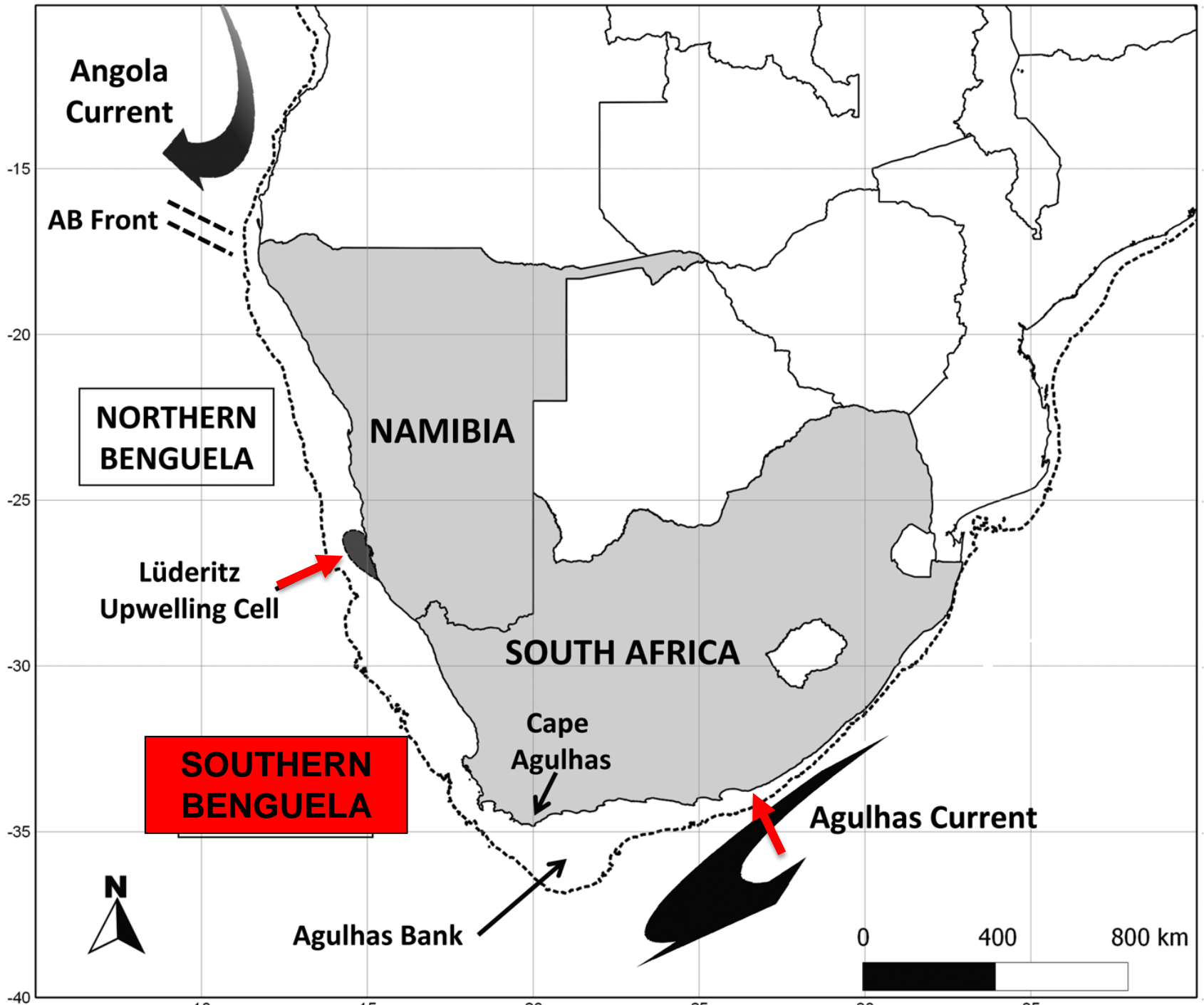


Small pelagic fishes  
(anchovy and sardine)

Supporting actors

Plankton  
Predators (seabirds)  
Pelagic fishery

Location: Eastern boundary upwelling ecosystem, South  
Africa



# Southern Benguela Pelagic Foodweb



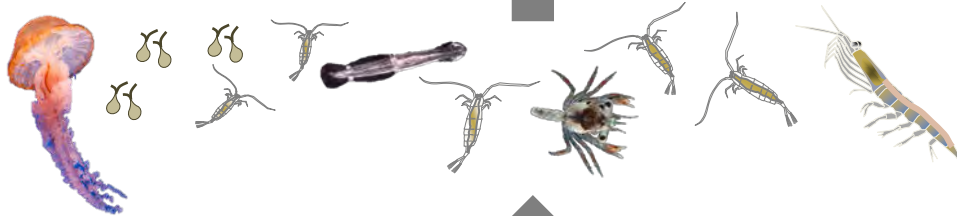
Predators

*Predadores*



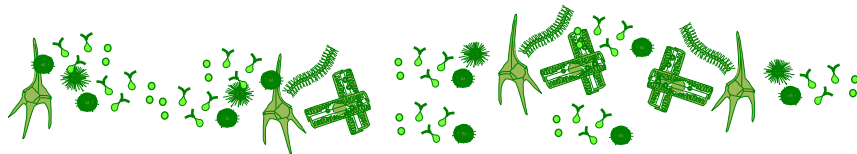
Forage Fish

*Peixe forrageiro*



Zooplankton

*Zooplâncton*

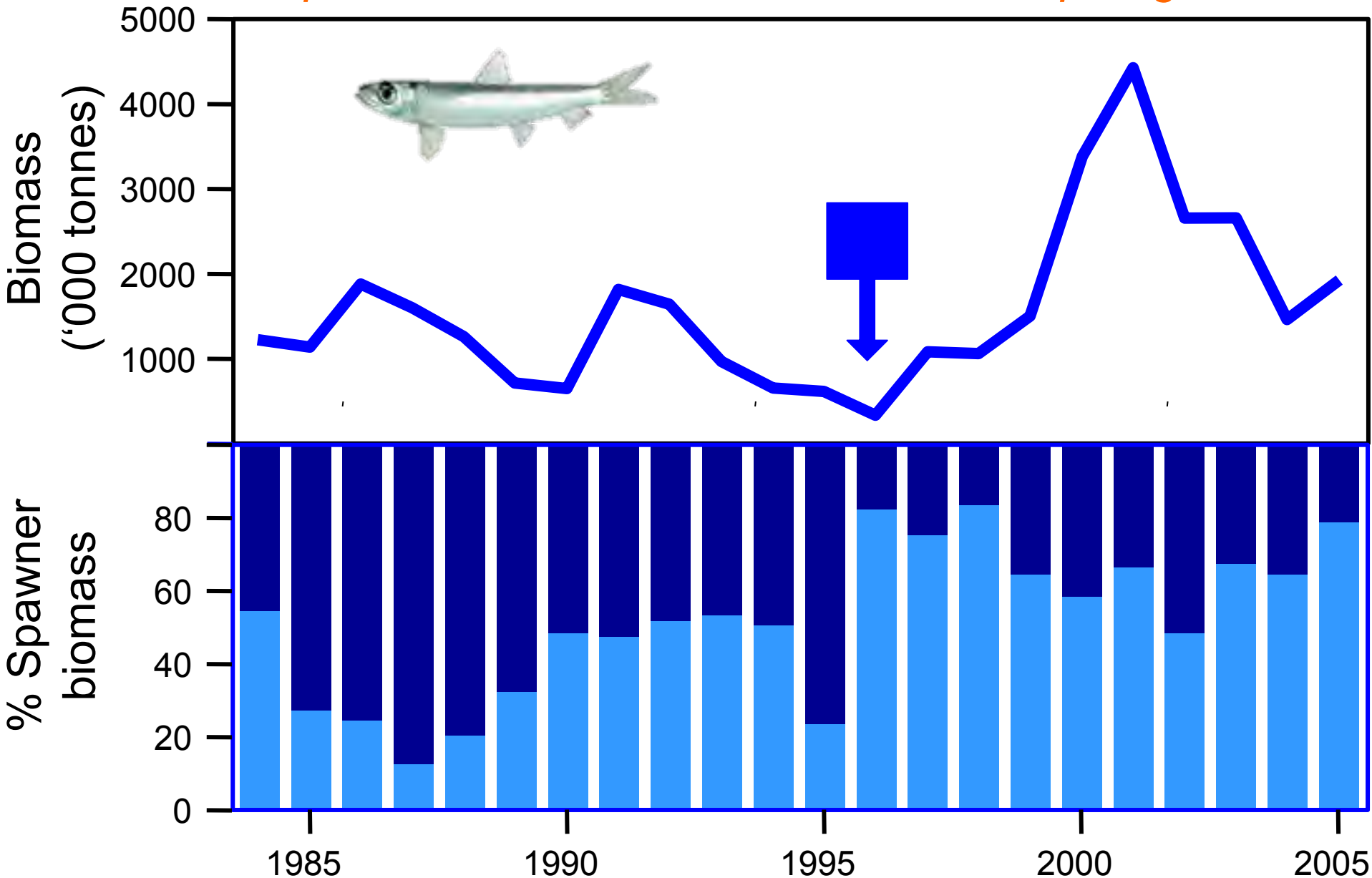


Primary producers

*Produtores primários*

# Anchovy spawner biomass: west & east of Cape Agulhas

*Biomassa spawner anchova: oeste e leste de Cape Agulhas*

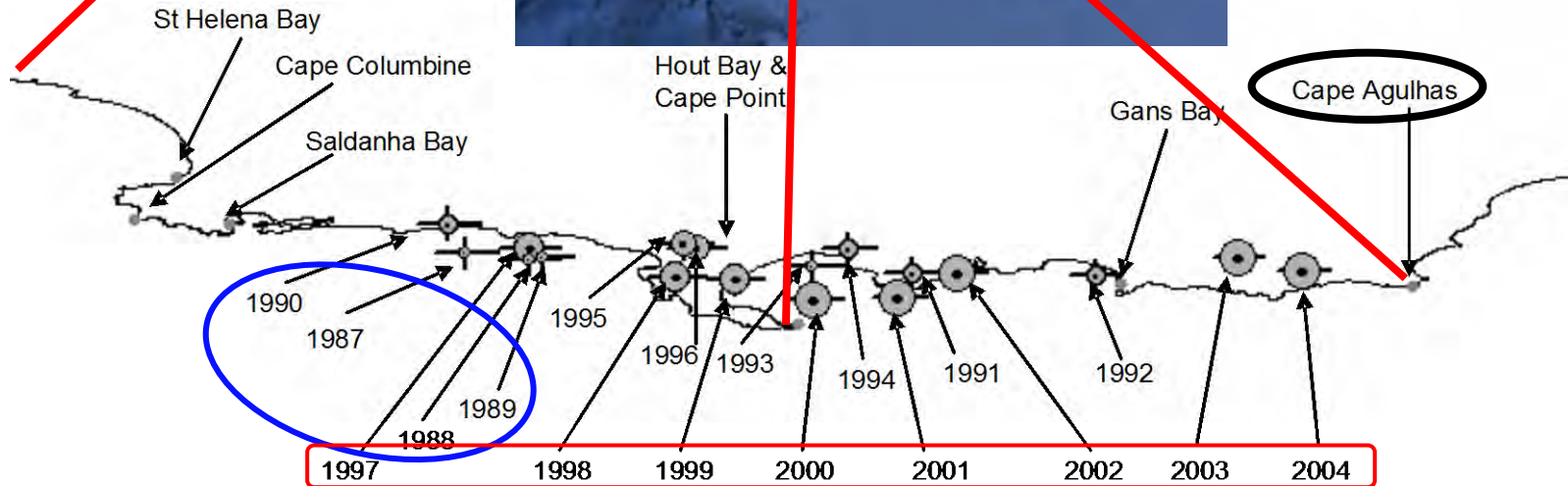


# Mean location of sardine catches: 1987-2004

*Local das capturas de sardinha média: 1987-2004*

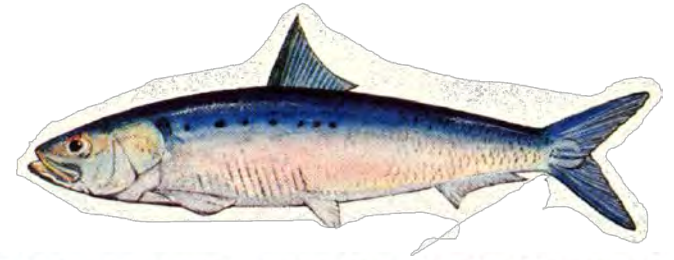
Note that the coast has been linearized

*Note-se que a costa foi linearizado*

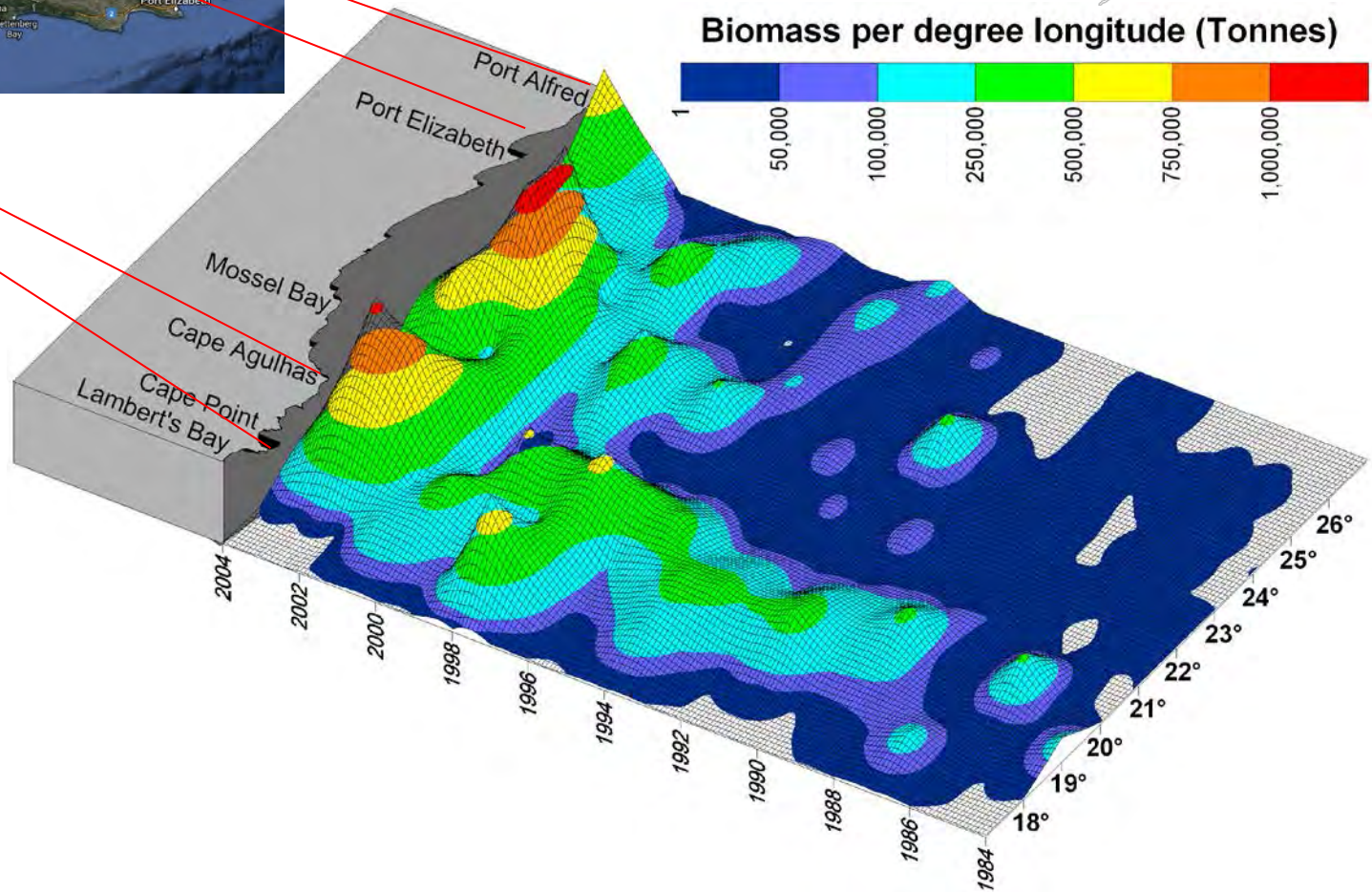
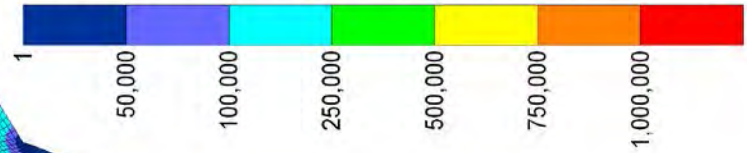


# Sardine biomass distribution: 1984-2004

## *Distribuição de biomassa sardine: 1984-2004*

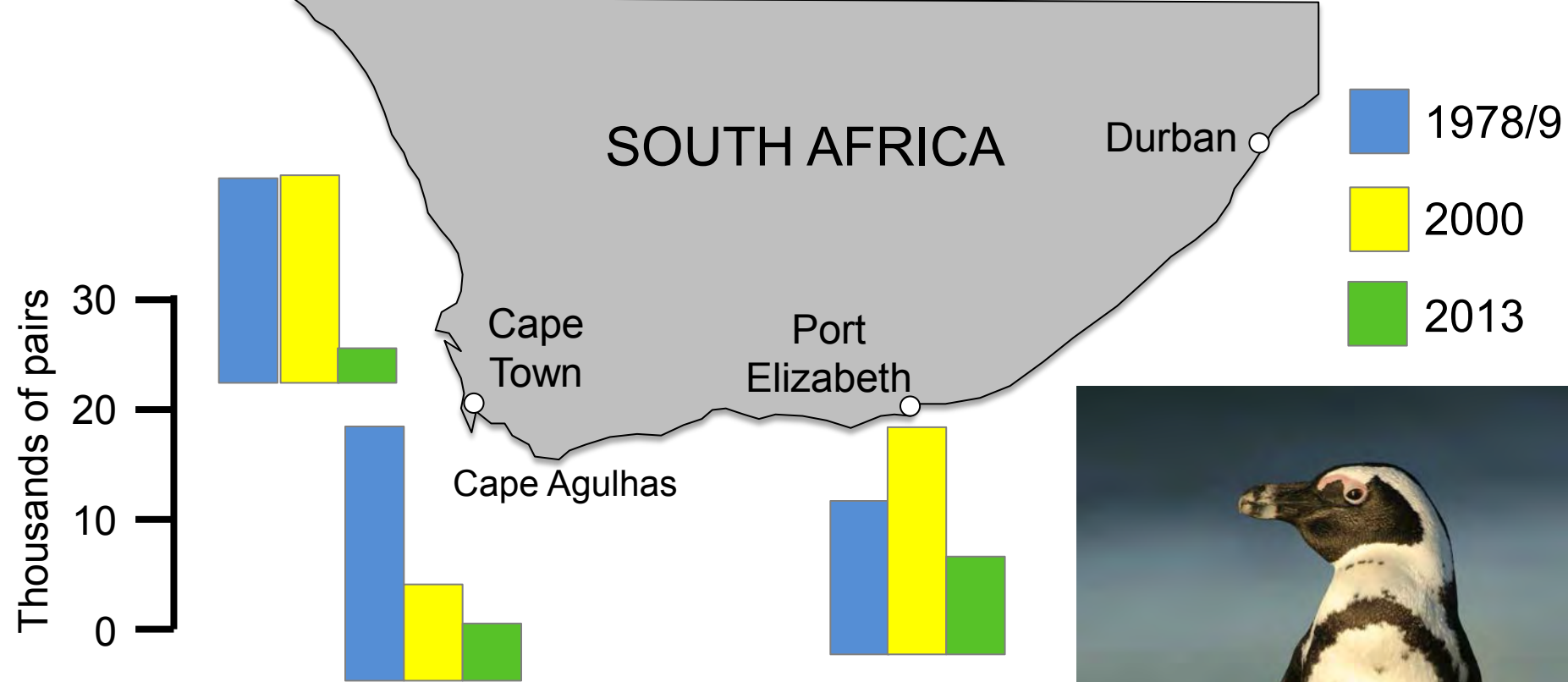


Biomass per degree longitude (Tonnes)

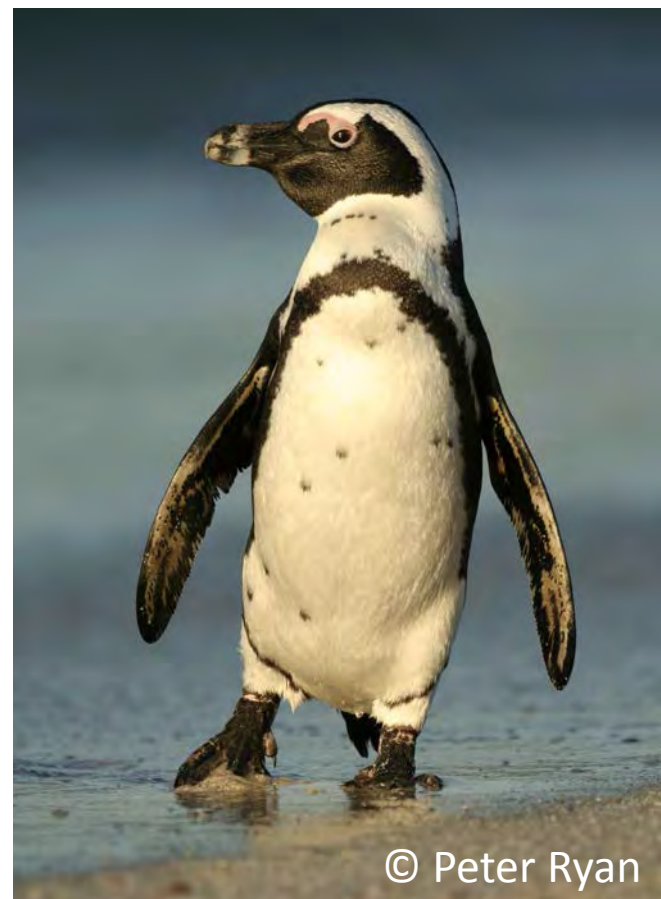


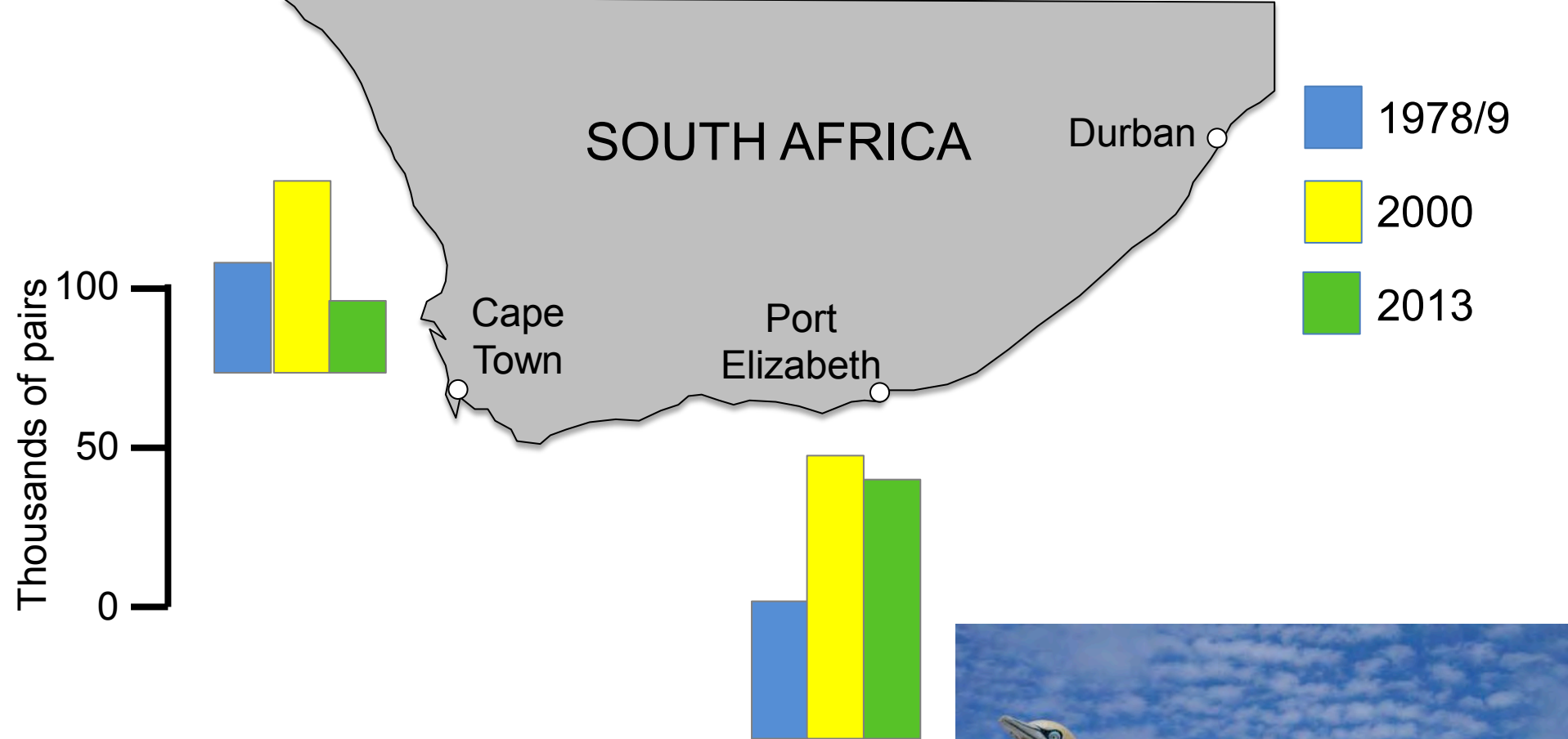
Note that the coast has been linearized

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# African Penguin





# Cape Gannet





# Lambert's Bay fishing harbour



**2012**  
Cannery converted to potato processing



Jarre, Ragaller, Hutchings  
(2013). *Ecology and Society*.

## Reflections....

- Did plankton prey increase / decrease?
- Did fish predators decrease / increase?
- Are there compensatory mechanisms?

## *Algumas reflexões...*

- Será que aumento plâncton presa / diminuir?
- Será que os predadores de peixes aumentar / diminuir?
- Existem mecanismos de compensação?

Lots of linkages

*Lotes de ligações*



Predictable in advance  
using models?

*Previsível com antecedência  
usando modelos ?*

## Three dramas

1. Inshore, subtidal ecosystem
2. Pelagic upwelling ecosystem
3. Benthopelagic upwelling ecosystem

Lead actors



Sardine

Bearded goby

Supporting actors

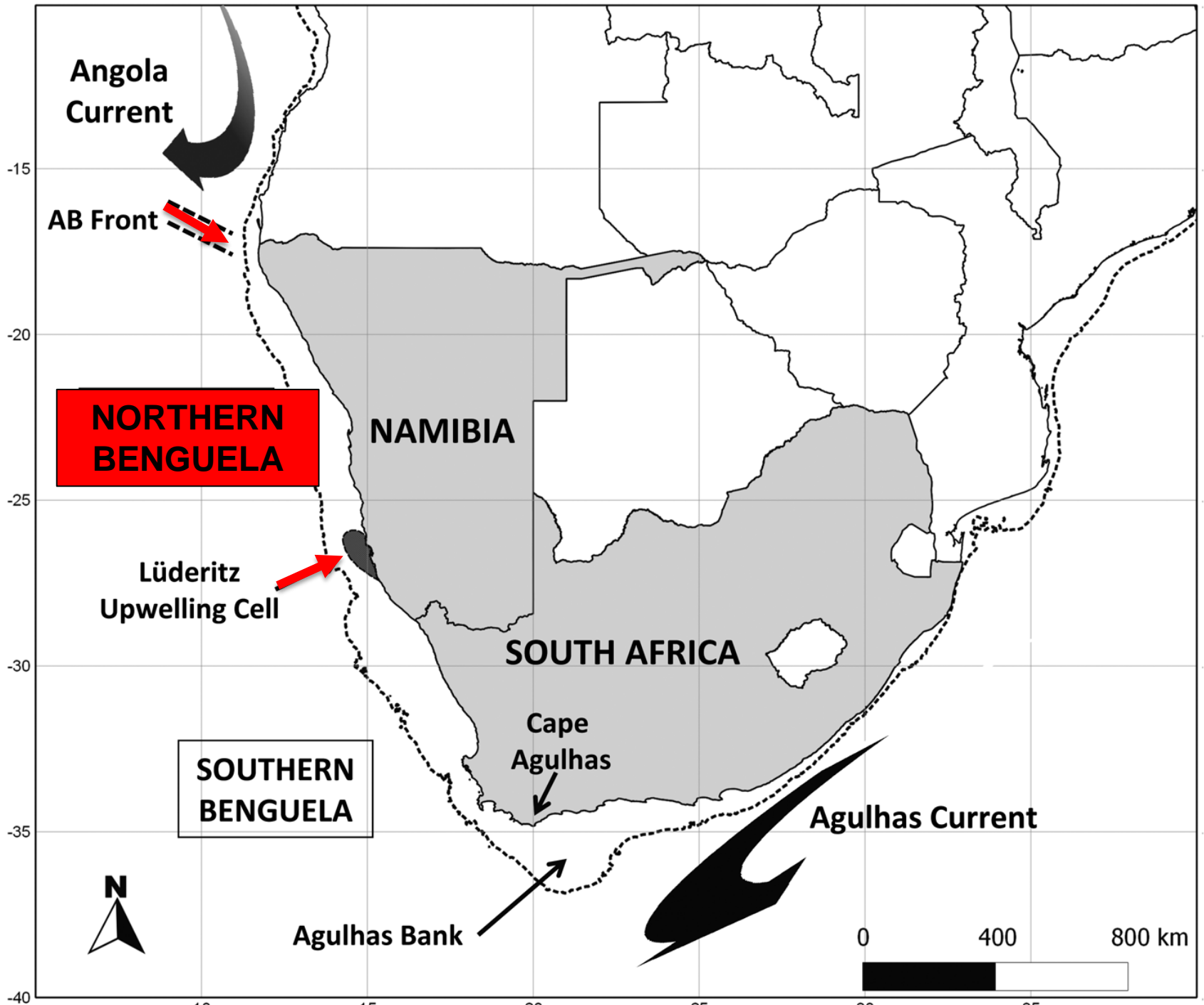
Jellyfish

Horse mackerel

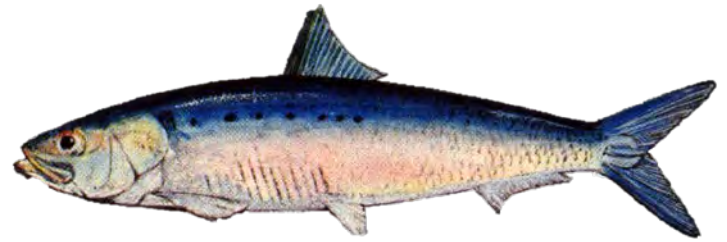
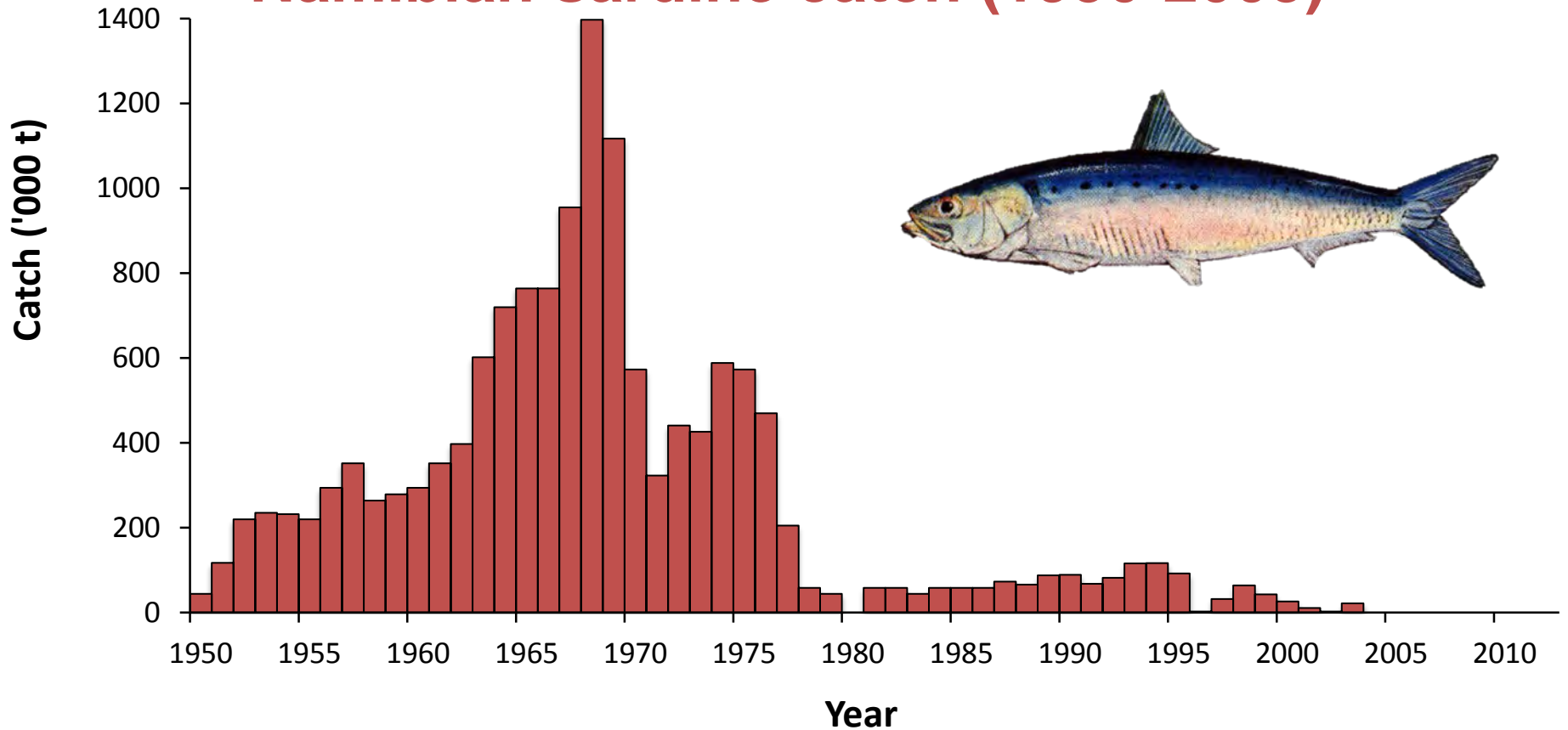
Predators (seabirds)

Pelagic fishery

Location: Eastern boundary upwelling ecosystem,  
Namibia



# Namibian sardine catch (1950-2003)





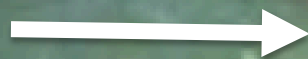
# Bearded Goby *Sufflogobius bibarbatus*



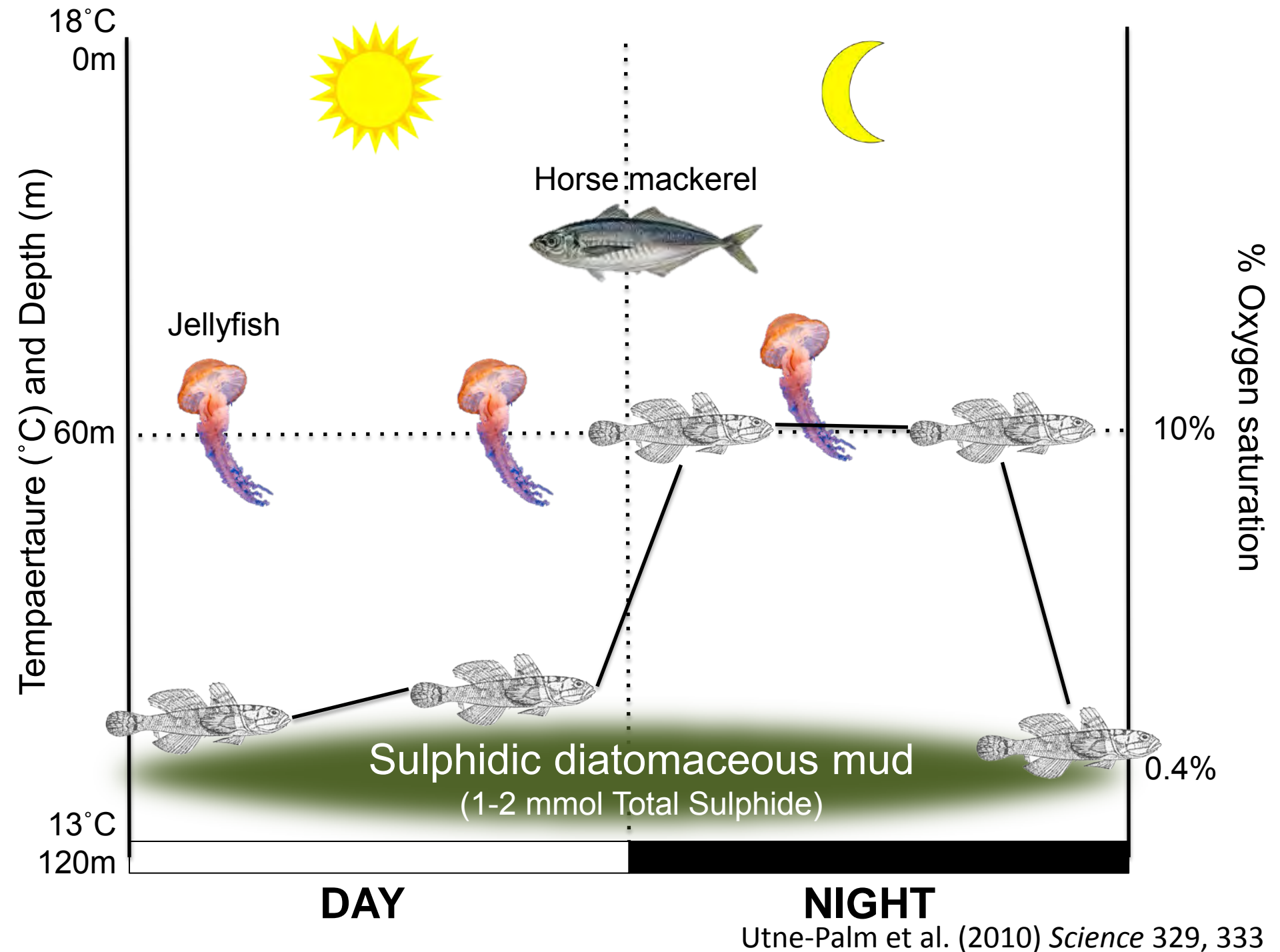
© Hege Vestheim

Diatom mud mat with bearded gobies

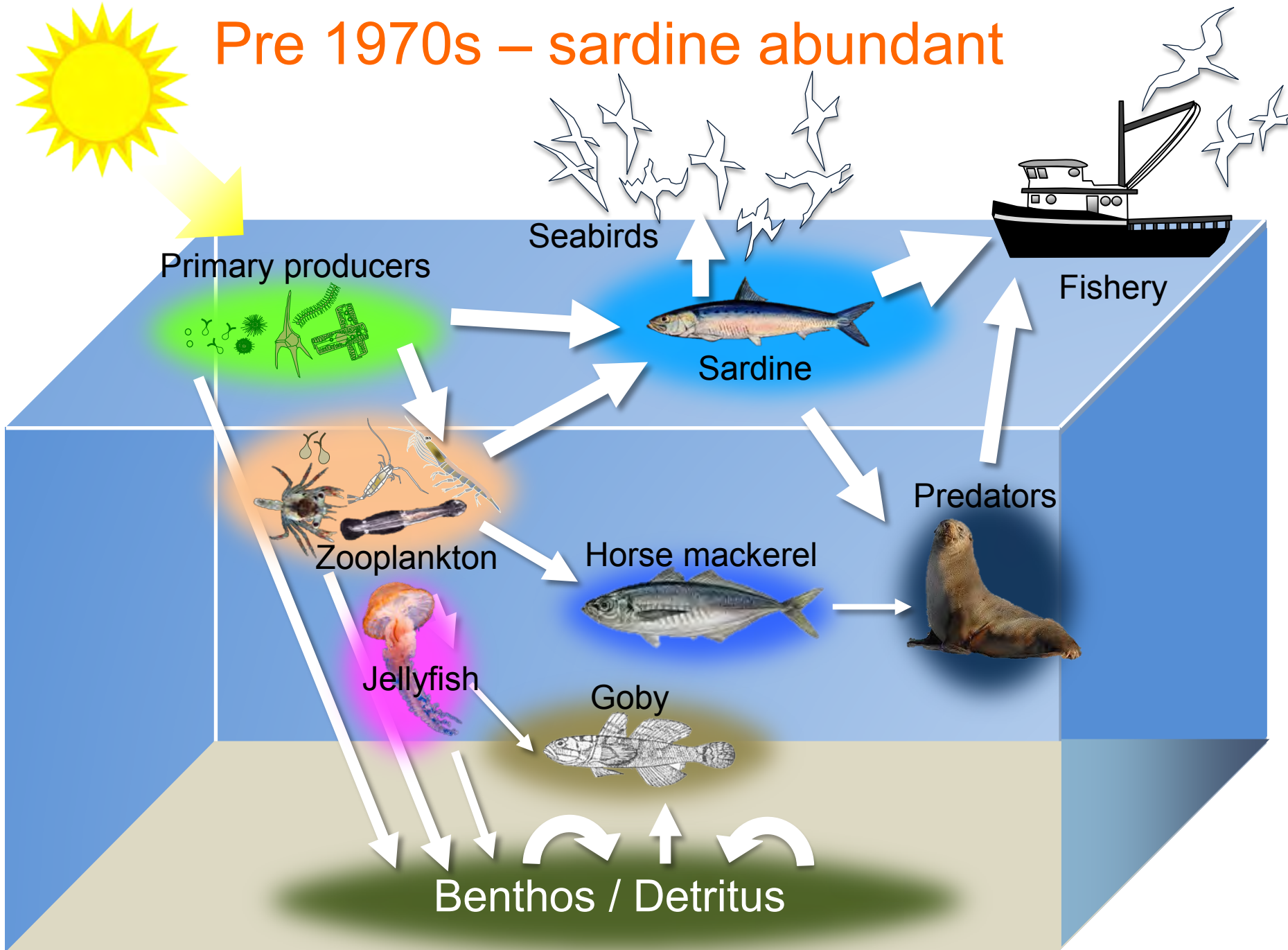
*Mat lama diatomáceas com góbios barbudos*



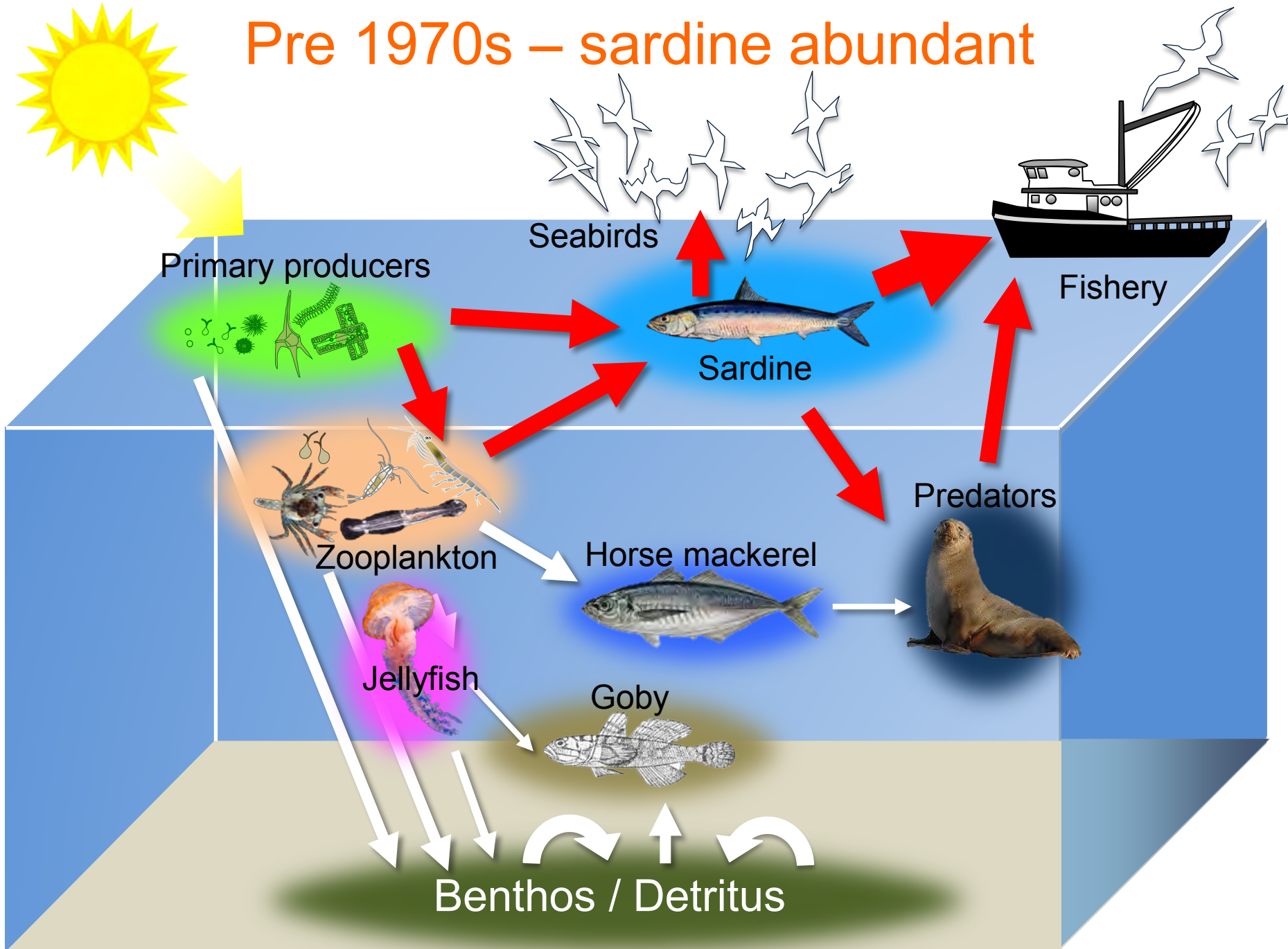
7 : 31 : 52  
17 : 4 : 1999



# Pre 1970s – sardine abundant

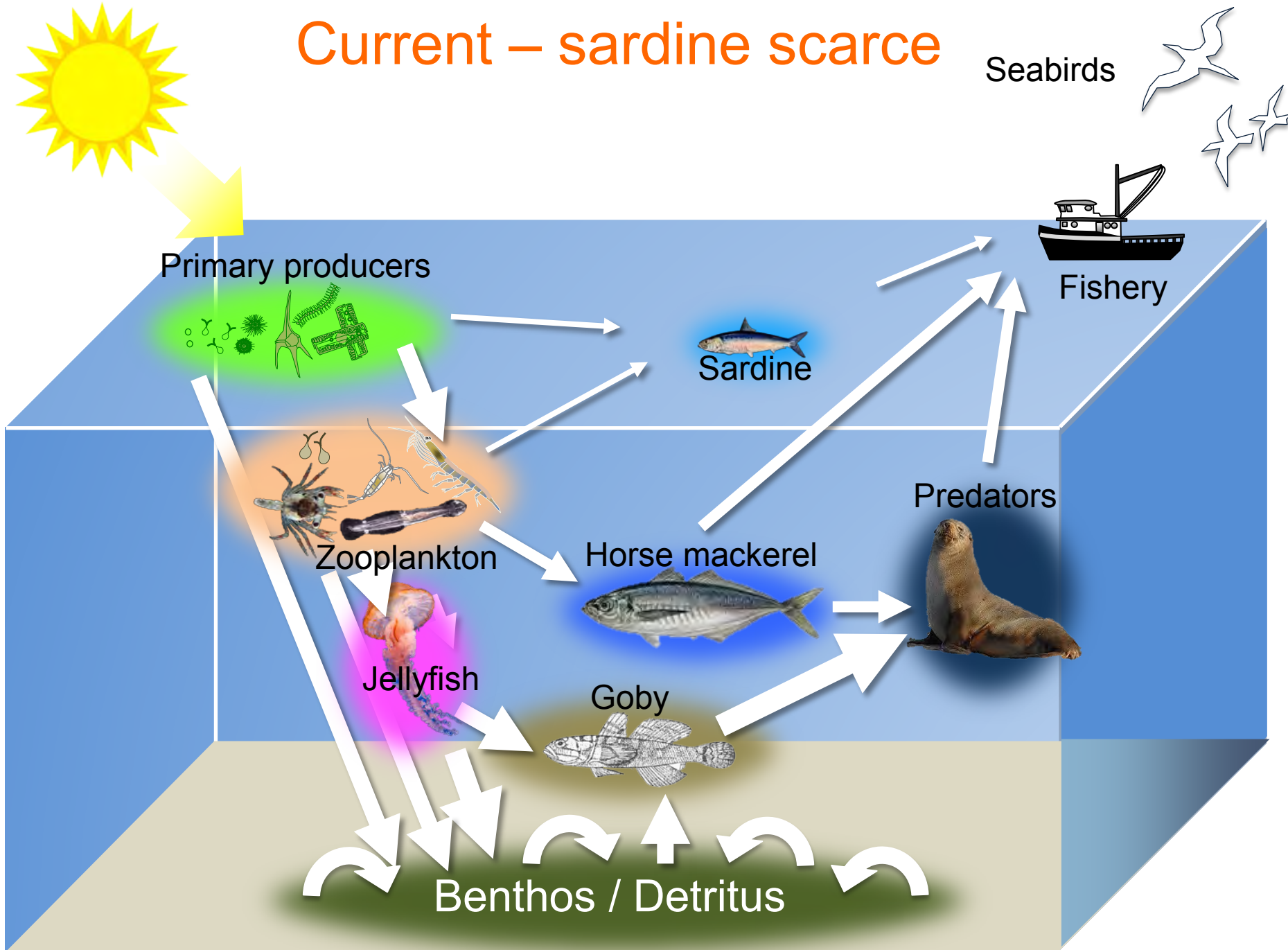


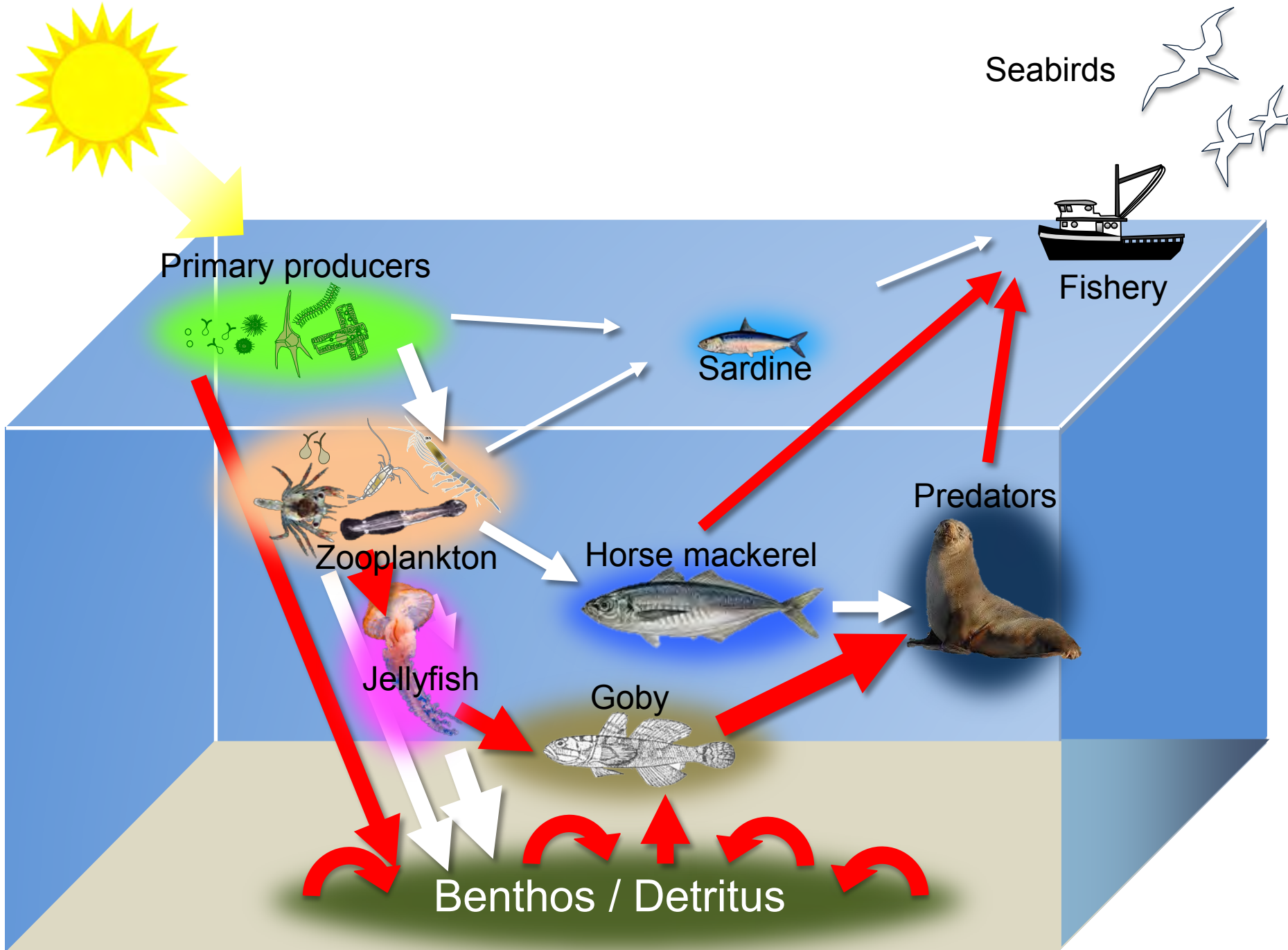
# Pre 1970s – sardine abundant



Modified after Roux et al. (2013) Bulletin of Marine Science 89: 249-284

# Current – sardine scarce





Modified after Roux et al. (2013) Bulletin of Marine Science 89: 249-284

The small bottom-feeder triumphs...

*Os pequenos triunfos  
bottom-alimentadores...*





## Reflections....

- The main interactions have shifted deeper
- Bearded goby is a remarkable little beast!

## *Algumas reflexões...*

- *As principais interações mudaram mais profunda*
- *Goby Bearded é um notável pouco besta !*

Were these three outcomes predictable in advance using our current models?

*Foram estes três resultados previsíveis com antecedência usando nossos modelos atuais ?*

**NO / NÃO**

Some key aspects required system-specific knowledge

*Alguns aspectos do conhecimento específico do sistema exigido*

## **A way forward:**

- Make system-specific details into globally-applicable characteristics
- Learn from others elsewhere – the comparative approach

## ***Um caminho a seguir:***

- *Faça detalhes específicos do sistema em características globalmente aplicáveis*
- *Aprender com os outros em outros lugares - a abordagem comparativa*

Thank you  
*Obrigado*



Muizenberg Beach, South Africa, Oct 2009