CLIMATE AND GLOBAL CHANGE RESEARCH

SAIAB and RHODES ICHTHYOLOGY

science & technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

RHODES UNIVERSITY
Where leaders learn

NRF National Research Foundation
SAIAB South African Institute for Aquatic Biodiversity

TOOLS for DIFFERENT JOBS

IDENTIFY PATTERNS

- **Observations**, such as shifts in species distributions, life history characteristics and abundance related to changing temperature and extreme events. Hotspots (areas with above average warming) are very useful for this!

UNDERSTAND PROCESS

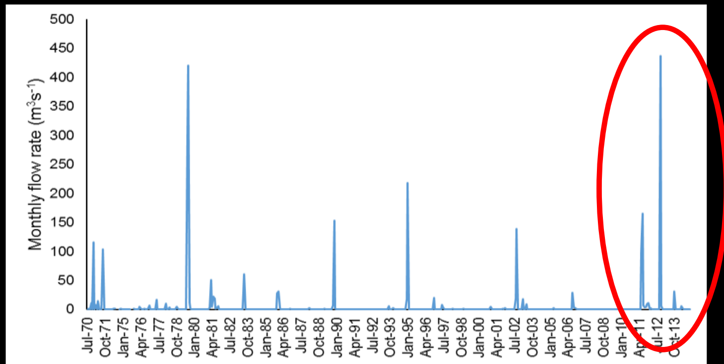
- **Ecophysiology** to identify the physiological mechanisms driving the response of fishes to changes in temperature and pH

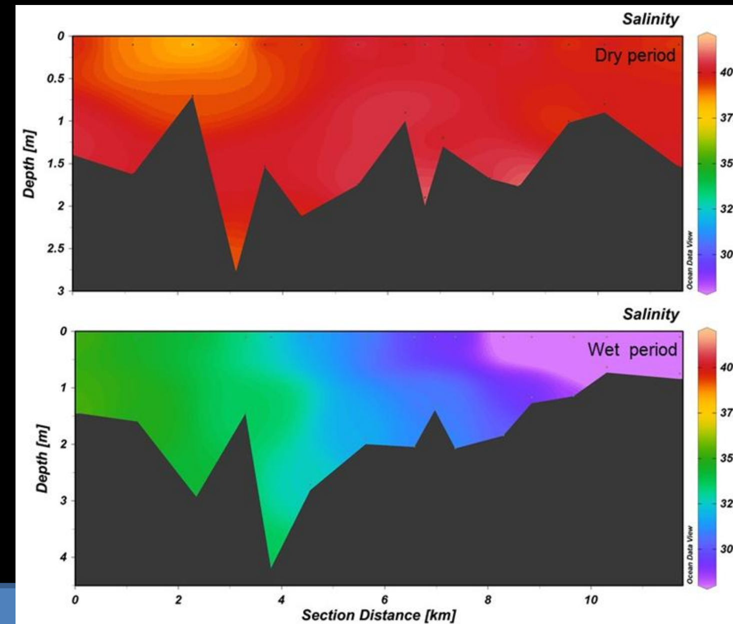
PREDICT FUTURE SCENARIOS

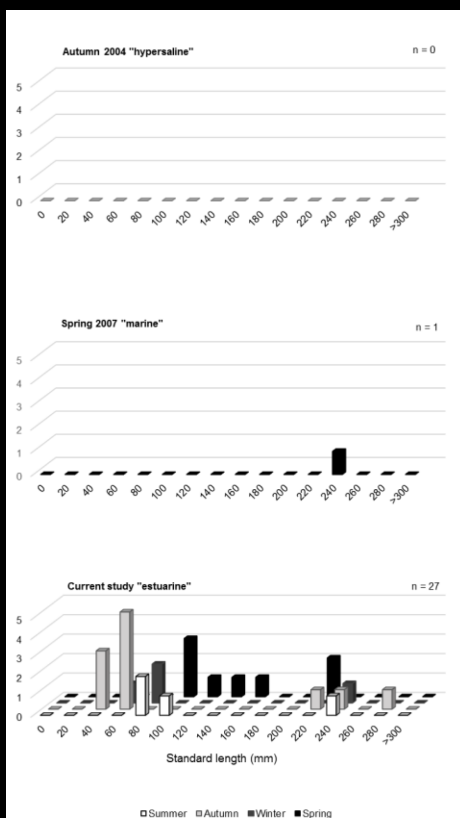
- **Ecological niche modelling** and genetic data to evaluate the responses of species to climate change .

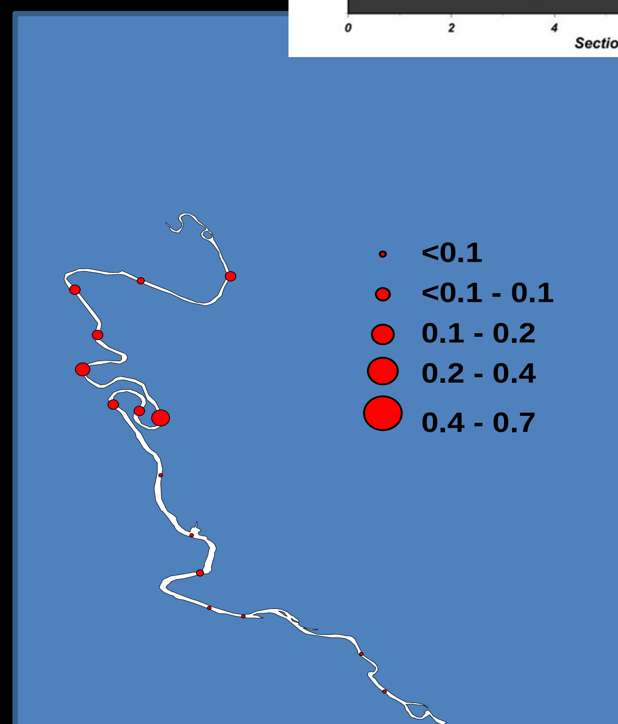
IDENTIFY PATTERNS - OBSERVATIONS

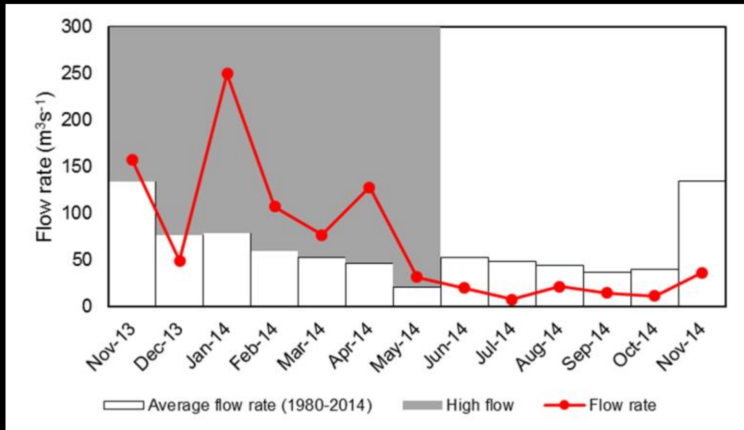
Patterns of change in fish recruitment

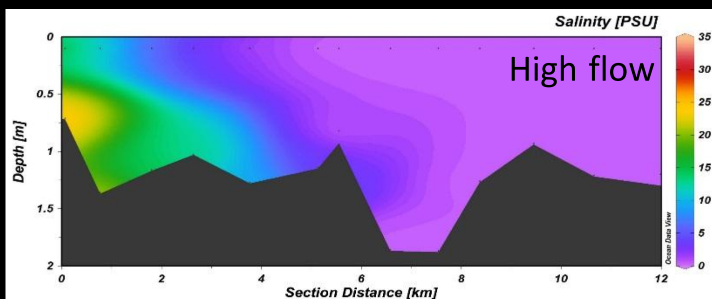


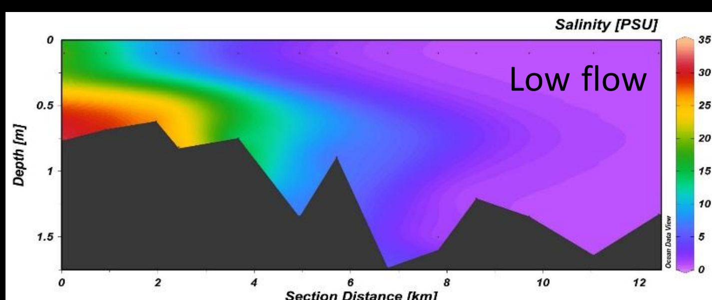


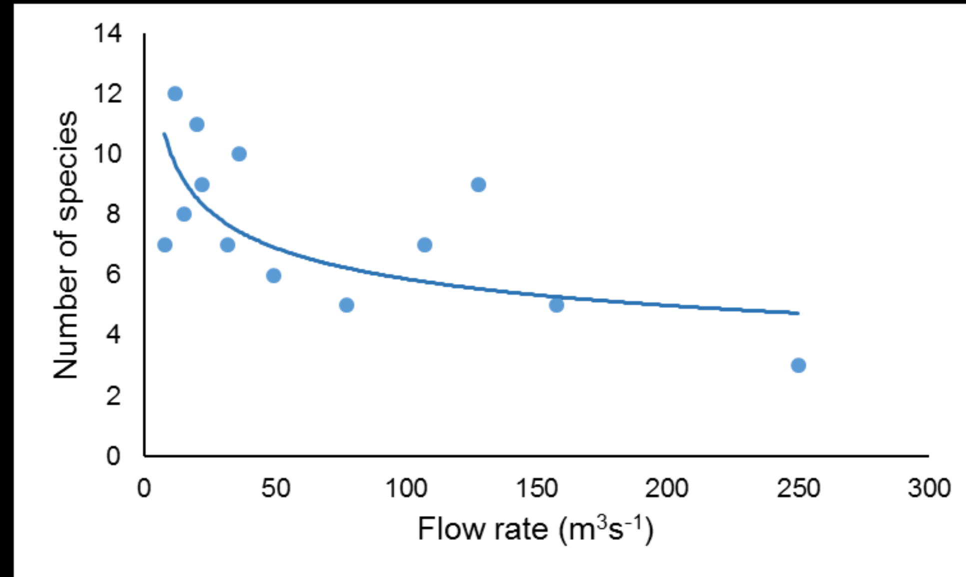


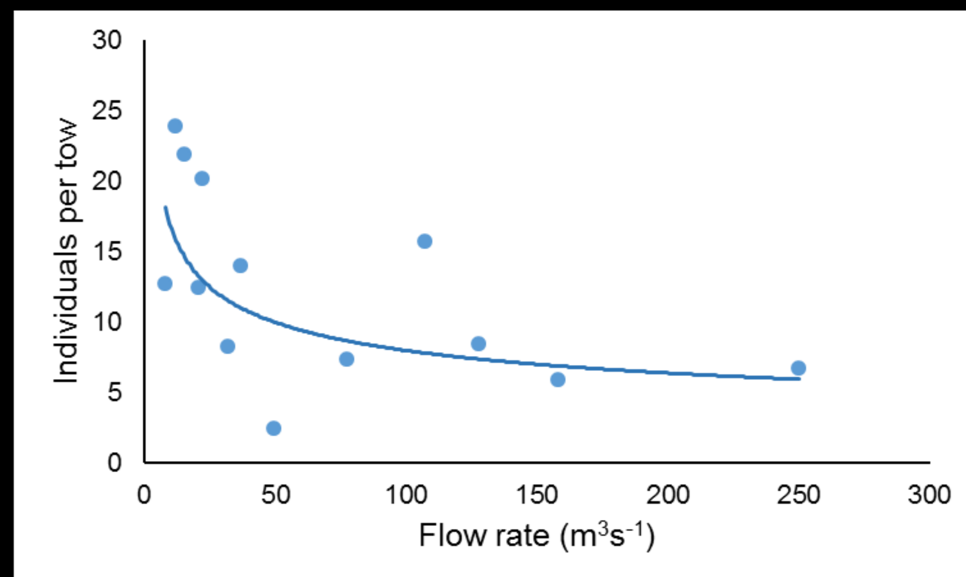



Flow rate (m^{3}s^{-1})
300
250
200
150
100
50
0
Nov-13
Dec-13
Jan-14
Feb-14
Mar-14
Apr-14
May-14
Jun-14
Jul-14
Aug-14
Sep-14
Oct-14
Nov-14
Average flow rate (1980-2014)
High flow
Flow rate

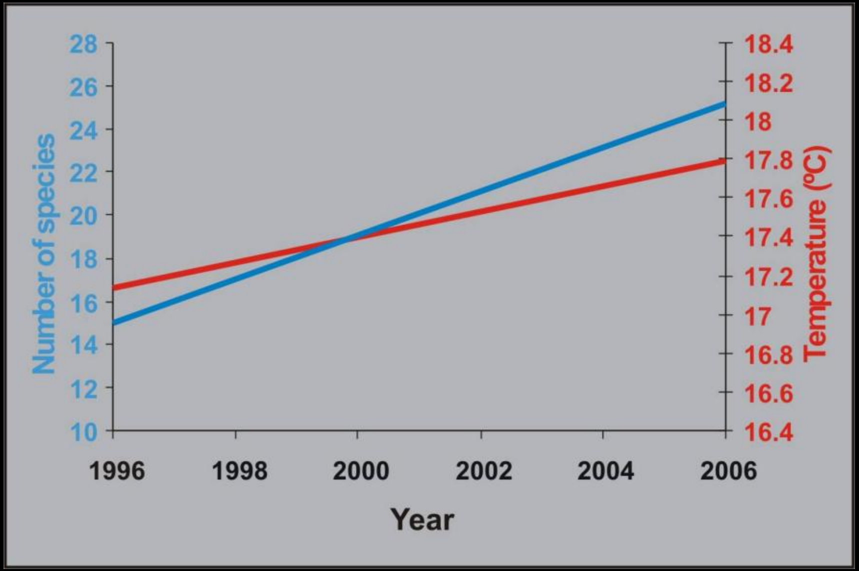

Salinity [PSU]
High flow
Depth [m]
0
0.5
1
1.5
2
0
2
4
6
8
10
12
Section Distance [km]
35
30
25
20
15
10
5
0
Ocean Data View


Salinity [PSU]
Low flow
Depth [m]
0
0.5
1
1.5
0
2
4
6
8
10
12
Section Distance [km]
35
30
25
20
15
10
5
0
Ocean Data View

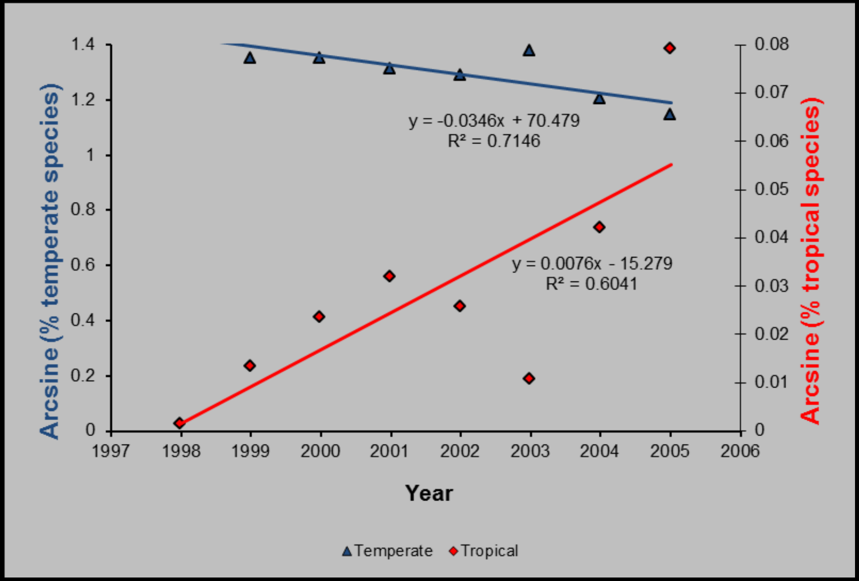

Number of species
14
12
10
8
6
4
2
0
0
50
100
150
200
250
300
Flow rate (m^{3}s^{-1})


Individuals per tow
30
25
20
15
10
5
0
0
50
100
150
200
250
300
Flow rate (m^{3}s^{-1})

Patterns of change in species composition



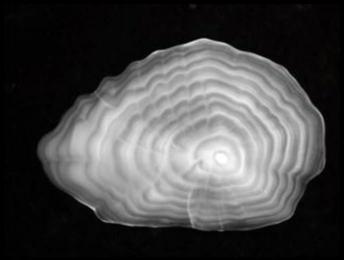
East Kleinemonde Estuary (1995 -2006)



Tsitsikamma (1997 – 2006)

Patterns of change in fish life history

DENDOCHRONOLOGY



Using tree-ring crossdating techniques to validate annual growth increments in long-lived fishes

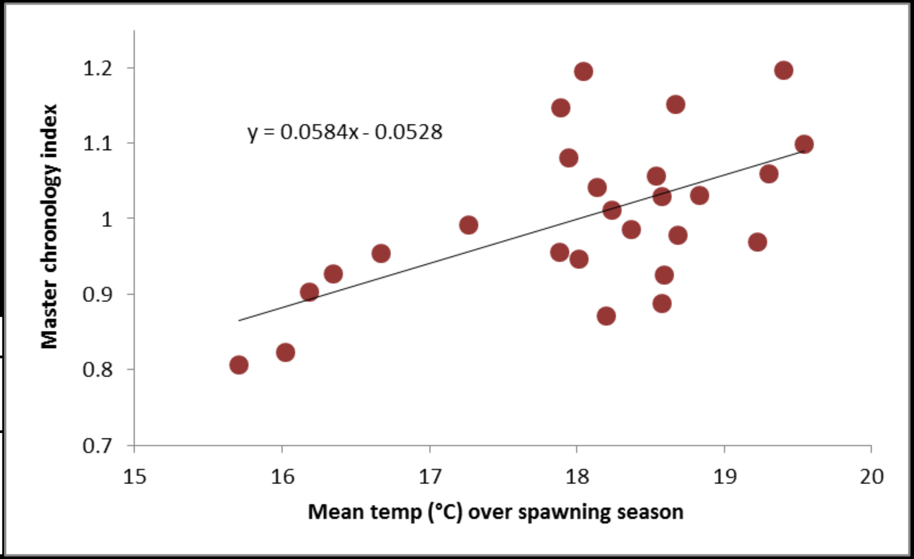
Bryan A. Black, George W. Boehlert, and Mary M. Yoklavich

Global Change Biology

Global Change Biology (2011) **17**, 2536–2545, doi: 10.1111/j.1365-2486.2011.02422.x

Winter and summer upwelling modes and their biological importance in the California Current Ecosystem

BRYAN A. BLACK*, ISAAC D. SCHROEDER†, WILLIAM J. SYDEMAN‡§, STEVEN J. BOGRAD†, BRIAN K. WELLS¶ and FRANKLIN B. SCHWING†

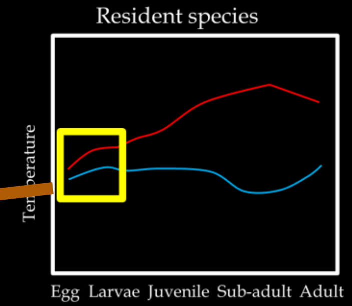


Correlations with master chronology

	Mean year temp	ENSO	SOI	Mean spawn season temp	Mean non-spawn season temp
Pearson co eff	0.26	0.03	-0.11	0.6	-0.09
Degrees freedom	24	24	24	24	24
P-value	0.19	0.86	0.58	0.001	0.65

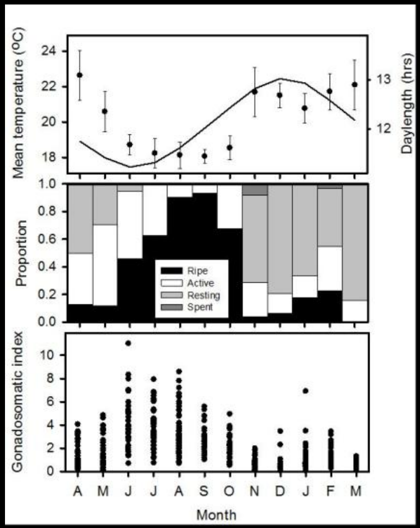
Patterns observed in global hotspots

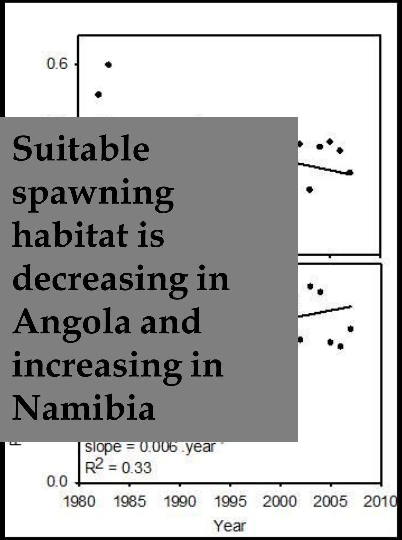
What drives distributional shifts in resident species?



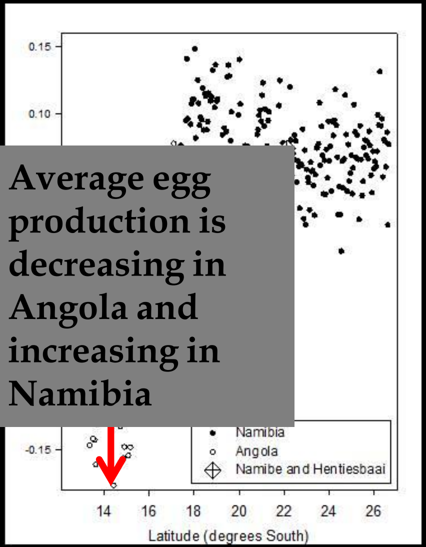
Portner and Peck 2010 – "Population-level changes may be observed via changes in the **balance between rates of mortality, growth and reproduction**."

Blacktail seabream
(Diplodus capensis)





Suitable spawning habitat is decreasing in Angola and increasing in Namibia



Average egg production is decreasing in Angola and increasing in Namibia

Patterns of change in feeding

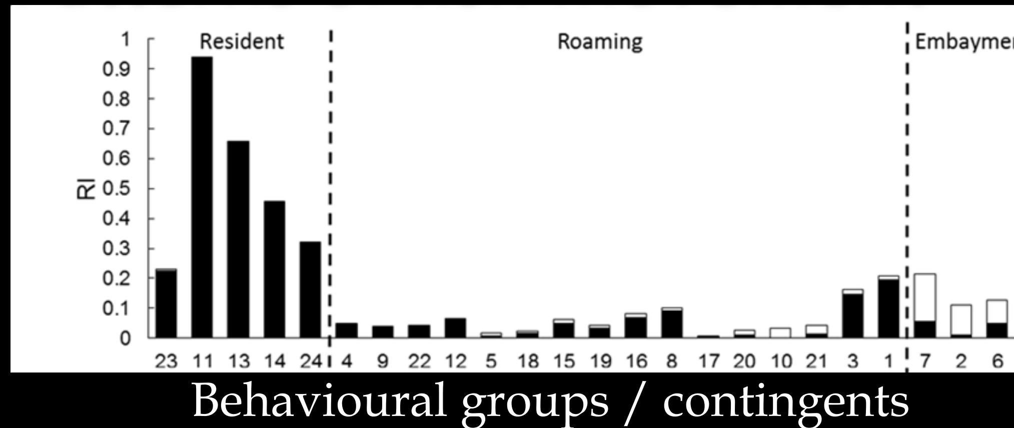
Understanding the importance of *trophic adaptability*

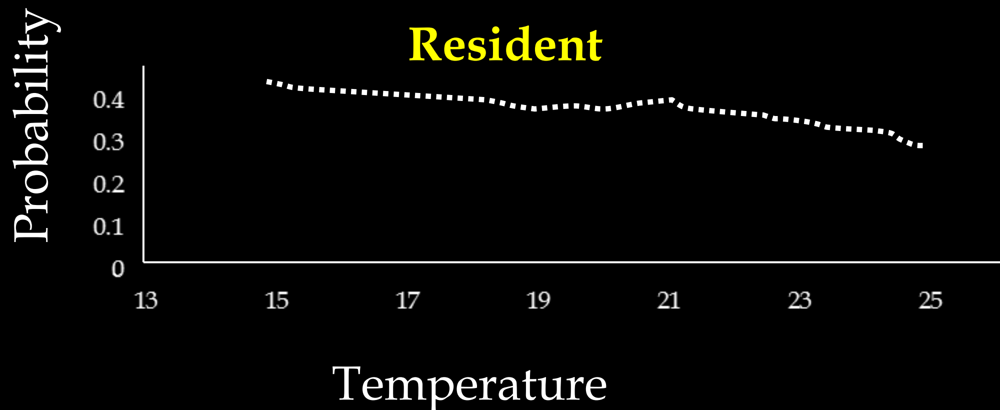
	Winter				Spring				Summer			
	2005		2012		2005		2012		2005		2012	
	%N	%F	%N	%F	%N	%F	%N	%F	%N	%F	%N	%F
Pelagic												
Sardinella aurita	87.5	87.5	0	0	89.6	89.3	36.4	44.04	5.8	12.0	81.0	80.0
Trachurus spp.	0	0	0	0	0	0	0	0	70.9	44.0	4.7	5.0
Loligo reynaudii	0	0	0	0	2.6	2.7	0	0	5.8	12.0	0	0
Sphyraena sp.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
Tetraodontida[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nearshore												
Mugilidae sp.	0	0	100	100	2.6	2.7	45.4	44.4	5.8	12.0	9.6	10.0
Lithognathus mormyrus	0	0	0	0	5.1	0	0	0	5.8	12.0	0	0
Oblada melanura	0	0	0	0	0	5.4	0	0	5.8	12.0	0	0
Dentex barnardi	0	0	0	0	0	0	0	0	0	0	4.7	5.0
Total	0	0	100	100	7.7	8.1	45.4	44.4	17.5	33.3	14.3	15.0

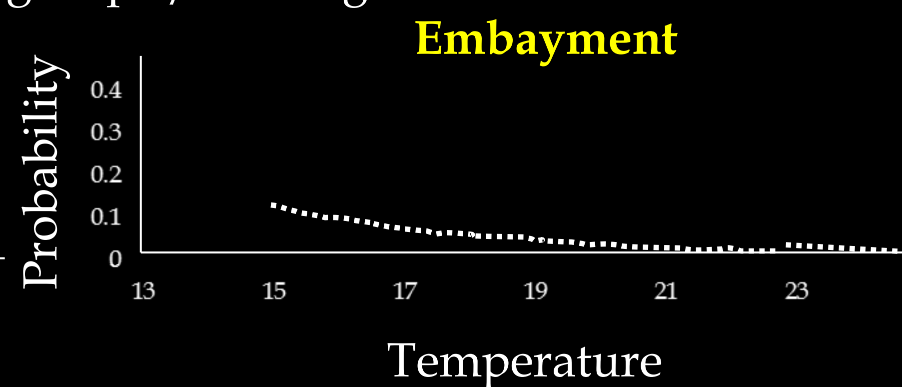
No difference in the condition factor of fish by the end of the winter periods

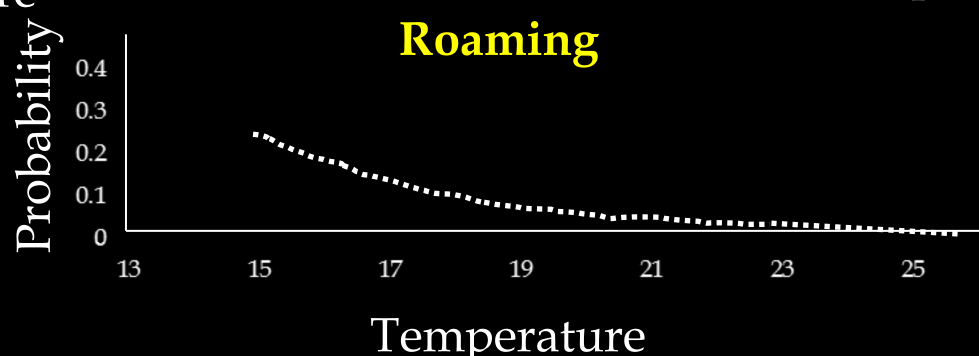
***Pomotomus saltatrix* has broad trophic adaptability and shifting prey distributions will not necessarily mean that they will shift**

Patterns of fish movement









If these represent thermal contingents, this will add complexity to the prediction of distributional shifts

PROCESS - ECOPHYSIOLOGY

AQUATIC
ECOPHYSIOLOGY
RESEARCH PLATFORM

ORGANISM | POPULATION | GLOBAL

NRF National Research Foundation | SAIAB South African Institute for Aquatic Biodiversity

RHODES UNIVERSITY
Where leaders learn

- Laboratory and equipment facility governed through a joint agreement between SAIAB and DIFS, Rhodes University
- Focus is to address the impacts of global change on marine and aquatic organisms

Current infrastructure

- Environmental manipulation

CE rooms, climate chamber, heating/cooling baths, pCO_2 manipulation systems

- Respirometry: Small (egg - pre flexion larvae) – medium (post flexion – juvenile)– large (juvenile – adult) volume

Static & flow through, optical sensing technology

- Small scale husbandry

Temporary and semi-permanent (±3 months) for small aquatic invertebrates and fish

- Fish behavior

Choice chamber

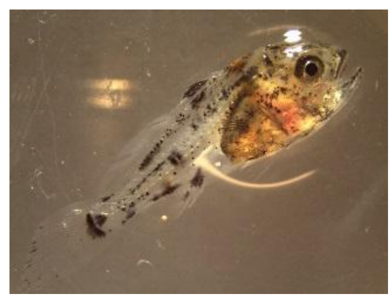
- Microscopy and image analysis

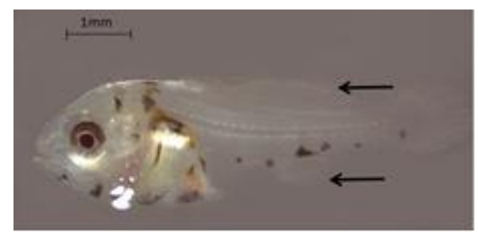
Stereomicroscope with camera, compound microscope

- Regular laboratory equipment such as freezers, pipettes, scales, water quality measurements, spectrophotometer

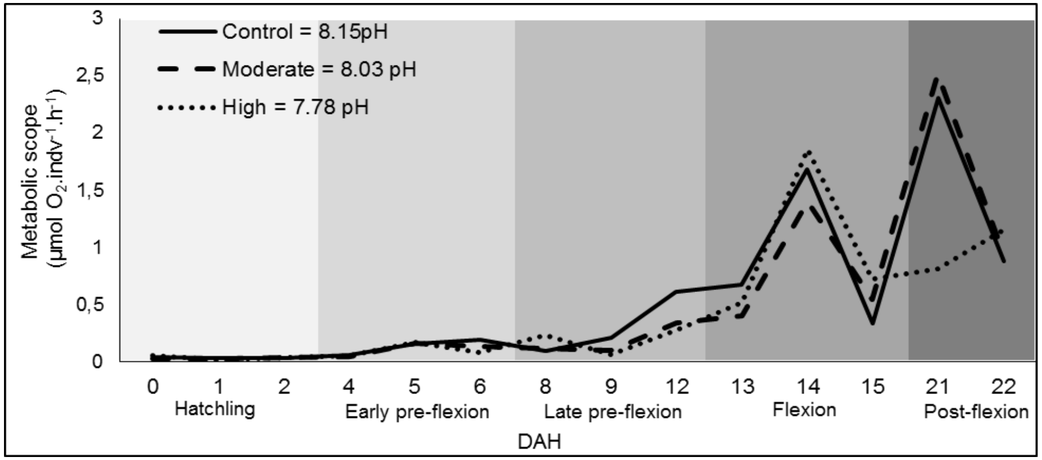
The effect of ocean acidification and temperature on the physiology of dusky kob

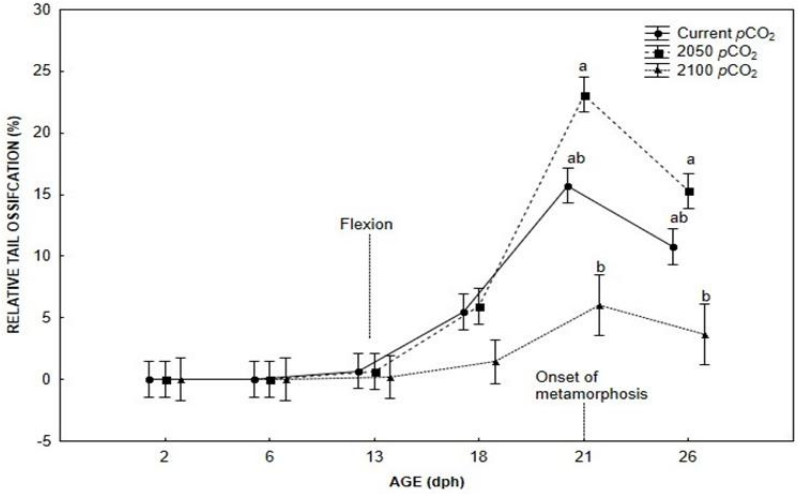
- The effect of ocean acidification treatments on the respiration of the early life-stages
- The effects of ocean acidification treatments on the growth and skeletal development of the early life-stages
- Three *p*CO_2 treatments (current, 2050 and 2100)

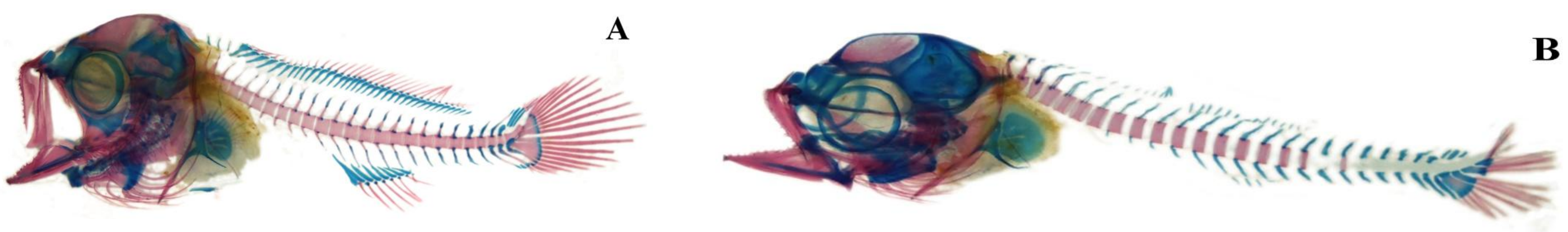


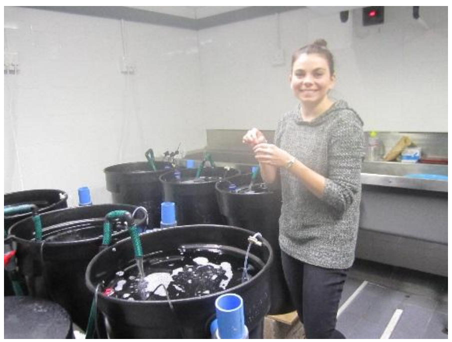


Results suggest that ocean acidification conditions predicted for 2100 may reduce metabolic scope in post-flexion larvae (energy available for larvae to maintain regular bodily functions and perform activities required for survival). This resulted in significantly lower growth, development and skeletogenesis and ultimately survival.



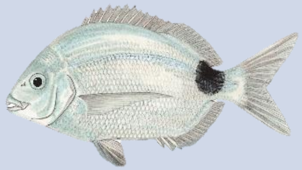
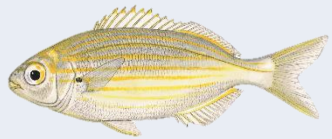


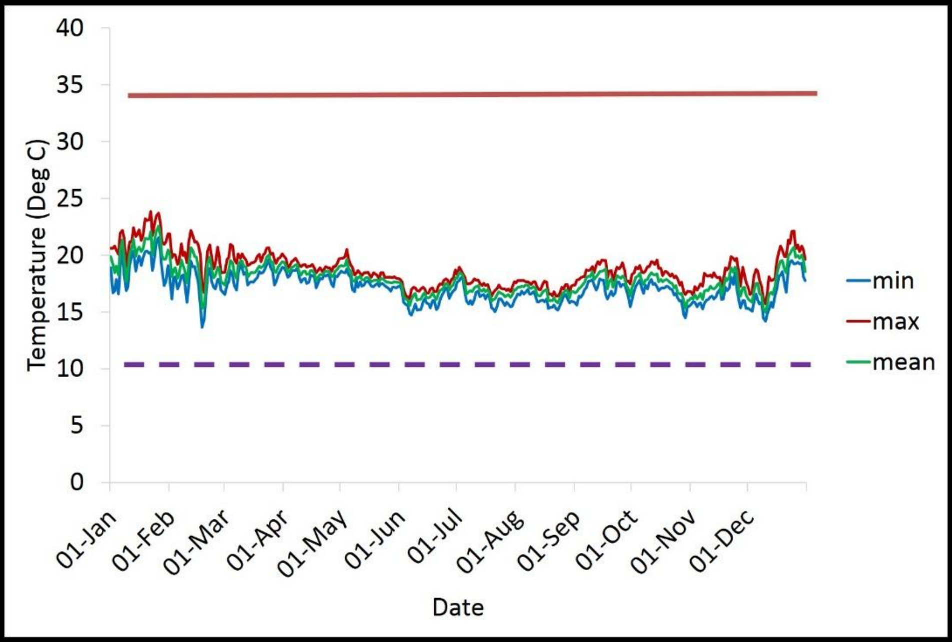




Thermal tolerance and the potential effects of climate change on coastal and estuarine organisms in the Kariega Estuary and adjacent intertidal coastline

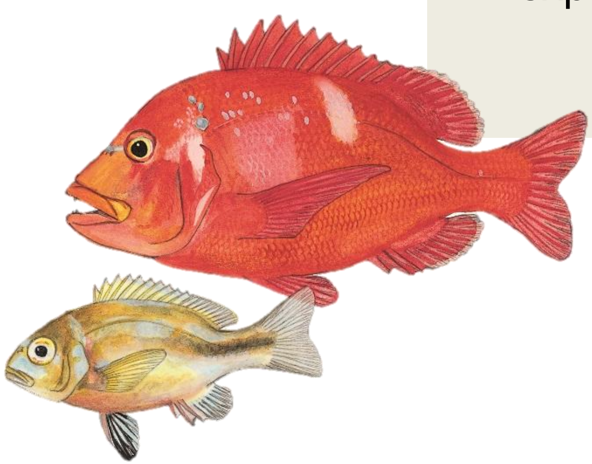
- The main aim for this study is to determine the thermal tolerance of various temperate and tropical fish and invertebrate species from different habitats occurring in the warm-temperate Kariega Estuary and adjacent intertidal environment.
- Determining CTMax and CTMin as well as stress (cortisol) and heart rate (using heart rate loggers) at different temperatures
- Comparing results to temperatures recorded in different habitats to determine which species live close to their thermal limits

Species	CTMax	CTMin
	34.9°C	8°C
	33.8°C	7.6°C
	37.8°C	8.7°C



Thermal physiology of the South African linefish, red roman, in light of exploitation and climate change

- Two of the biggest threats to capture fisheries in the world are over-exploitation and the effects of climate change.
- Multi-method approach to investigate thermal sensitivities of growth (dendrochronology), recruitment (larval thermal tolerance), metabolism (respirometry) and distribution (physiological based modelling).
- Comparing fish from one of the oldest marine protected areas in Africa (Tsitsikamma MPA) and a nearby exploited population (Noordhoek) in order to determine the effects of exploitation on the species sensitivity to climate change



Study sites

- TNP vs Noordhoek (PE)
- MPA vs Exploited area

Theoretically, hook and line exploitation removes the fittest, fastest growing individuals with the broadest thermal tolerance as they are most likely to take the bait.
Based on this, we hypothesised that individuals in an MPA will have a physiological advantage over others and therefore, MPA's should protect those individuals that have inherent resilience to environmental change

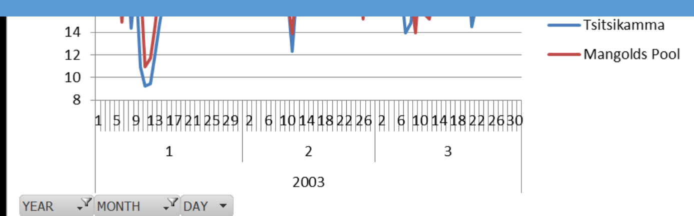


Figure 3: in situ UTR Daily SST (dep. Oceans and Coasts)

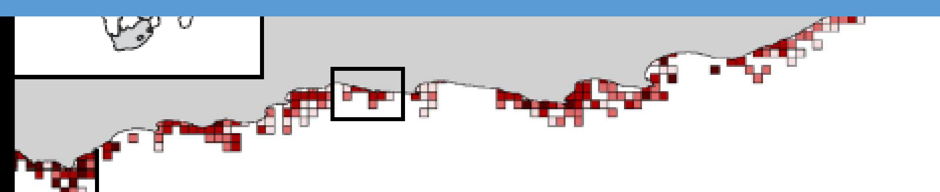
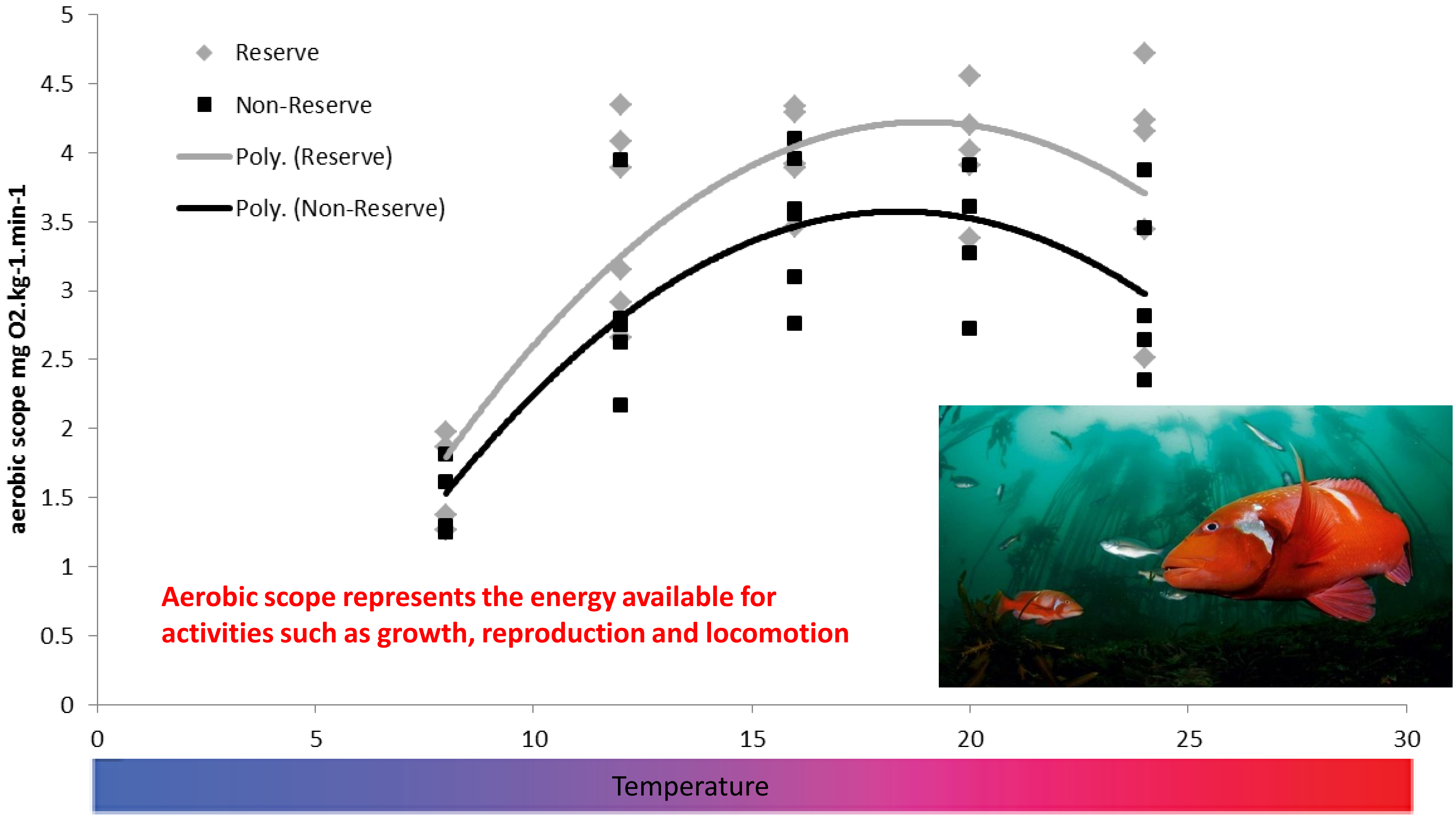


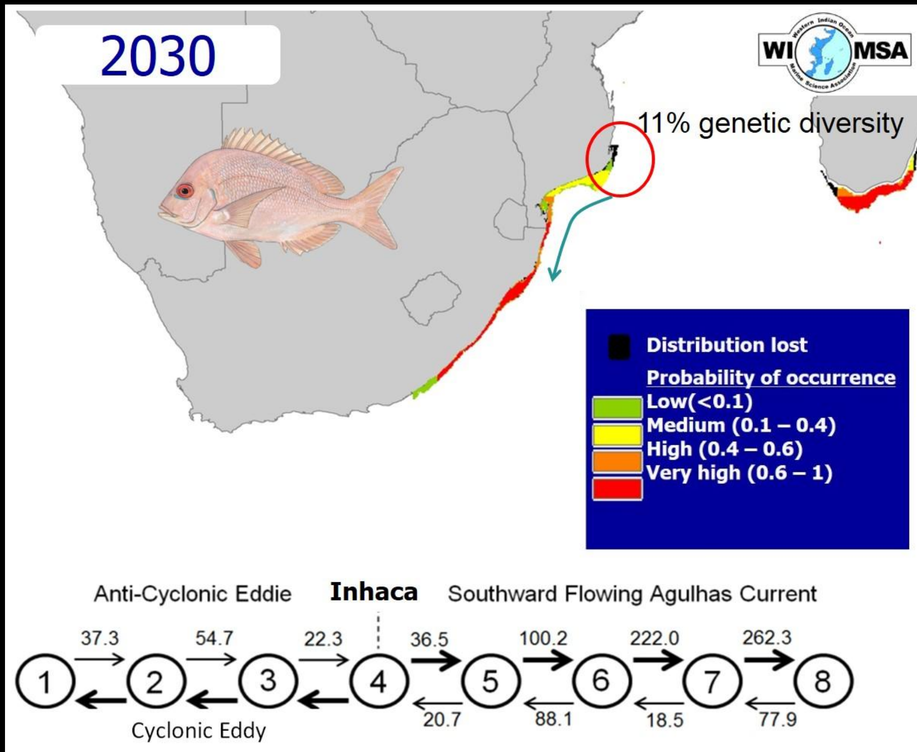
Figure 4: Red Roman spatial CPUE (Kerwath et al. 2013)



First information showing that fish in MPAs are more resilient to the impacts of climate change

PREDICTION - ECOLOGICAL NICHE MODELLING

Chrysoblephus puniceus (slinger)



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ELSEVIER

Grey mullet (Mugilidae) as possible indicators of global warming in South African estuaries and coastal waters

CrossMark

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[b] Marine and Fisheries Division, Department of Agriculture, Environment and Rural Affairs, Northern Ireland, 17 Antrim Road, Lisburn BT28 3AL, United Kingdom