

NansClim



Climate effects on biodiversity,
abundance and distribution of
marine organisms

A PROJECT FUNDED BY NORAD

NansClim PROJECT STATUS

by

E.K. Stenevik and Å. Bjordal

**Regional Inception Workshop on Building Resilience in Benguela Fisheries and
Aquaculture**

Cape Town, 3-5 July 2013





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abundance and distribution of
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A PROJECT FUNDED BY NORAD

Harald Loeng, Erling Kåre Stenevik, Marek Ostrowski, Bjørn Erik Axelsen, Espen Johnsen
(Norway)

Pedro Tchipalanga, Quilanda Fidel, Bomba Bazika Sangolay, Sylvi N'siangango, Kumbi
Kilongo, Virgilio Estevao (Angola)

Paul Kainge, Chris Bartholomae , Anja van der Plas , Anja Kreiner, Beau Tjizoo, Johannes
Iitembu, Sam Mafwila, John Kathena, Rudi Cloete (Namibia)

Hans Verheye, Larry Hutchings, Steve Kirkman, Dawit Yemane, Astrid Jarre, Toufiek
Samaai, Larvika Singh, Nandipha Mhlongo, Janet Coetzee (South Africa)

Objective

- **Identify and describe possible trends in ocean climate and corresponding changes in marine biodiversity and fisheries in the Benguela current system.**



Goals

- a better understanding of the effects of climate change and **variability** on the marine ecosystem in the Benguela region
- future scenarios of climate effects on marine resources
- strengthened regional cooperation
- **regional competence building** on ecosystem effects of climate change
- increased public awareness of climate change in relation to fisheries and marine environment
- possible implications of climate change on fisheries and other marine activities



Structure

- Module 1. Coordination of the Nansen data-base and other data (Marek Ostrowski)
- Module 2. Climate variability and climate impact on the marine ecosystem (Erling Kåre Stenevik)
- Module 3. Gaps of knowledge and research needs (Harald Loeng)
- Module 4. Project management (Harald Loeng)



Structure

Module 2

- Task 2.1 Climate variability and change
 - Leader: Pedro Tchivalanga (Angola)

- Task 2.2: Responses of pelagic ecosystem to climate change
 - Leader: Hans Verheye (South Africa)

- Task 2.3: Climate effects on the biodiversity of the demersal community
 - Leader: Paul Kainge (Namibia)



Structure

Project management committee

- Angola
 - Pedro Tchipalanga, Nkosi Luyeye (Filomena Vaz Velho)
- Namibia
 - Anja Kreiner, Paul Kainge
- South Africa
 - Hans Verheye, Larry Hutchings
- Norway
 - Harald Loeng (project leader), Erling Kåre Stenevik





**NansClim kick off meeting
14-15 september 2009**



**NansClim mid term meeting
14-16 mars 2011**



Writing workshops



- Two writing workshops in 2012
 - River Crossing Lodge in Mars
 - Okahandja Lodge in October
- 15-20 participants
- Work on writing publications

NansClim day at BCC annual forum, October 2012



NansClim publications

- Six published papers so far
- Supplement in Fisheries Oceanography
 - Nine manuscripts submitted and in review
- Synthesis in 2013



Published papers so far

- Kreiner, A., Yemane, D., Stenevik, E.K. and Moroff, N.E. 2011. The selection of spawning location of sardine (*Sardinops sagax*) in the northern Benguela after changes in stock structure and environmental conditions. *Fisheries Oceanography*, 20(6): 560-569.
- Yemane, D., Kirkman, S., Katena, J., Nsiangango, S.E., Axelsen, B. and Samaai, T. 2012. Assessing changes in the distribution and range size of demersal fish populations in the Benguela Current Large Marine Ecosystem. Submitted to *Reviews in Fish Biology and Fisheries*.
- Hutchings L, Jarre A, Lamont T, van den Berg M and Kirkman SP. 2012. - St Helena Bay then and now: muted climate signals, large human impact. *African Journal of Marine Science* 34(4) : 559-583.
- Jarre A, Ragaller S, Hutchings L. 2012 – Long-term changes in the southern Benguela pelagic social-ecological system: combining natural and human drivers. *Ecology and Society* (submitted for inclusion in the proceedings of a theme session at the World Economic History Congress, July 2012, Stellenbosch, South Africa)
- LK Blamey, JAE Howard, J Agenbag and A Jarre 2012 – Regime-shifts in the southern Benguela shelf and inshore region. *Progress in Oceanography* XX: xxx-xxx.
<http://dx.doi.org/10.1016/j.pocean.2012.07.001>
- Kirkman et al. Identifying and characterizing of demersal fish biodiversity hotspots in the BCLME: Relevance in the light of global changes (in press– *ICES J. mar.sci.*)



FOG supplement submitted papers

Spawning and nursery areas and longitudinal and cross-shelf migrations of the *Merluccius capensis* stock in the northern Benguela. Margit R. Wilhelm ^{*}, Astrid Jarre, Coleen L. Moloney

Oxygen-depleted bottom waters along the west coast of South Africa, 1950-2011. JARRE, A.1,^{*} HUTCHINGS L.1,2, CRICHTON, M.1, WIELAND, K.3, LAMONT, T.2,5 BLAMEY, L.K.1, ILLERT, C.2, HILL, E

Regime shifts in demersal assemblages of the Benguela Current Large Marine Ecosystem: a comparative assessment . STEPHEN P. KIRKMAN^{1,2*}, DAWIT YEMANE^{3,4}, LARA J. ATKINSON^{5, 4}, JOHN KATHENA^{6,7}, SILVI E. NSIANGANGO⁸, LARVIKA SINGH³, TOUFIEK SAMAAI^{1,4}

The dynamics of the suboxia tolerant bearded goby in the Northern Benguela - climate variation, oxygen availability and predation pressure . Anne Gro V. Salvanes^{1*}, Chris Bartholomae², Dawit Yemane³, Mark J. Gibbons⁴, Paul Kainge², Jens-Otto Krakstad⁵, Mathieu Rouault^{6,7}, Arved Staby^{1,5} and Svein Sundby⁵

Spawning habitats of Cape horse mackerel (*Trachurus capensis*) in the Northern Benguela upwelling region. ANJA KREINER^{1,*}, DAWIT YEMANE^{2,4} AND ERLING KÅRE STENEVIK³

FOG supplement submitted papers

Spatio-temporal trends in diversity of demersal fish species in the Benguela Current Large Marine Ecosystem (BCLME) region. SAMUEL K. MAFWILA*¹, DAWIT YEMANE^{2,7}, JOHN KATHENA³, SILVI E. NSIANGANGO⁴, STEVE P. KIRKMAN^{5,6}

Have the spawning habitat preferences of anchovy (*Engraulis encrasicolus*) and sardine (*Sardinops sagax*) in the southern Benguela changed in recent years? NANDIPHA MHLONGO, ^{1,*} DAWIT YEMANE, ^{1, 2} MARC HENDRICKS, ¹ and CARL D. VAN DER LINGEN^{1, 2}

Identification of potential demersal indicator species of climate related variability in the BCLME region – a new methodological approach. PAULUS KAINGE^{1*}, DAWIT YEMANE^{2,7}, VIRGILIO ESTEVAO³, JOHANNES IITEMBU¹, BJØRN ERIK AXELSEN⁴, JOHANNES KATHENA¹, LARVIKA SINGH², STEVE P. KIRKMAN^{5,6}

Review of the sampling methodology of the demersal trawl surveys in the BCLME region in the period 1985-2010. Bjørn Axelsen et al

Synthesis

Synthesis editorial group

- **South Africa**

- Larry Hutchings (leader), Toufiek Samaai, Dawit Yemane, Steve Kirkman, Astrid Jarre

- **Namibia**

- Paul Kainge, Anja Kreiner, Chris Bartholomae, Anja van der Plas

- **Angola**

- Pedro Tchipalanga, Filomena Vaz Vehlo, Kumbi Kilongo

- **Norway**

- Bjørn Erik Axelsen, Erling Kåre Stenevik, Harald Loeng, Marek Ostrowski



Synthesis

First meeting, Mont Fleur, Stellenbosch, South 15-19 May
2013

- A first draft of the synthesis was written and are now being compiled and will soon be circulated by the leader of the editorial group
- Next meeting will be held in Namibia 22-26 July to finish the synthesis



NansClim synthesis

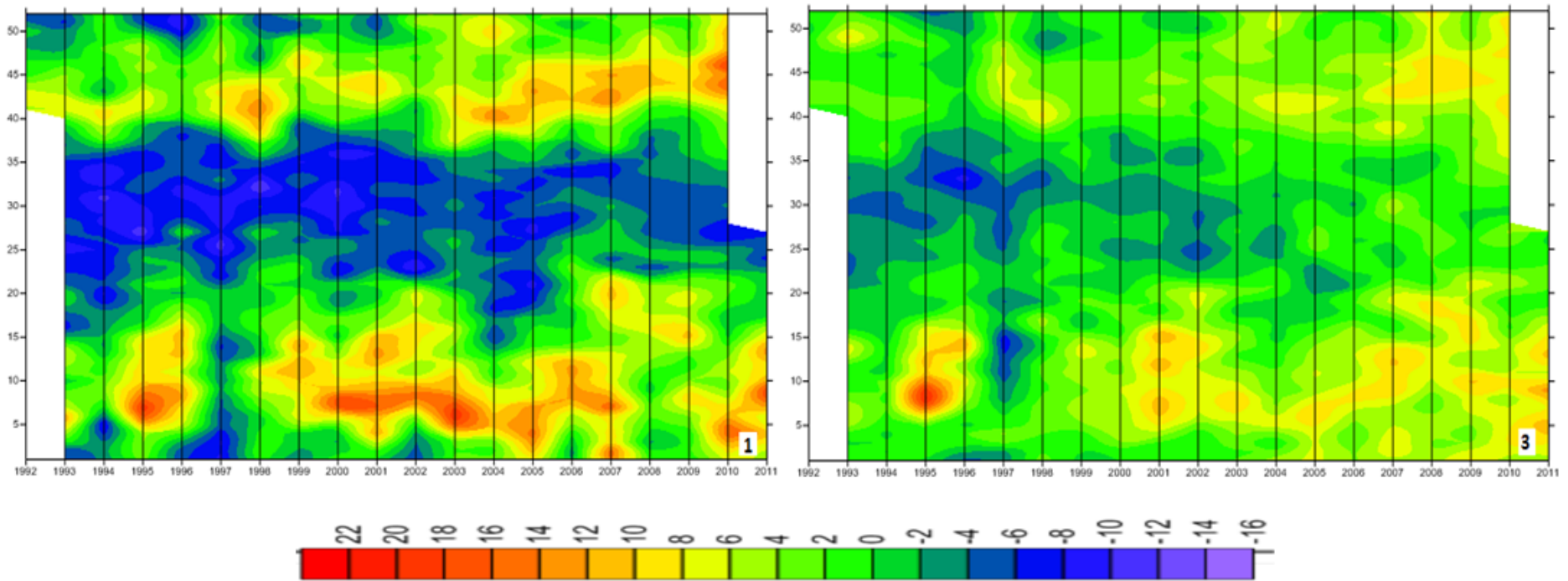
will synthesize main findings from the project and put them in context of the general literature

- **Structure of synthesis**
- 1. Introduction
- 2. Changes in oceanography
- 3. Changes in pressures on ecosystem structure and functioning other than climate
- 4. Changes in the pelagic subsystem
- 5. Changes in the demersal subsystem
- 6. Cutting across task group research: changes across habitats and communities in the Benguela system
- 7. Possible effects of management strategies to reduce pressures on the Benguela subsystems
- 8. Discussion
- 9. Acknowledgements
- 10. References

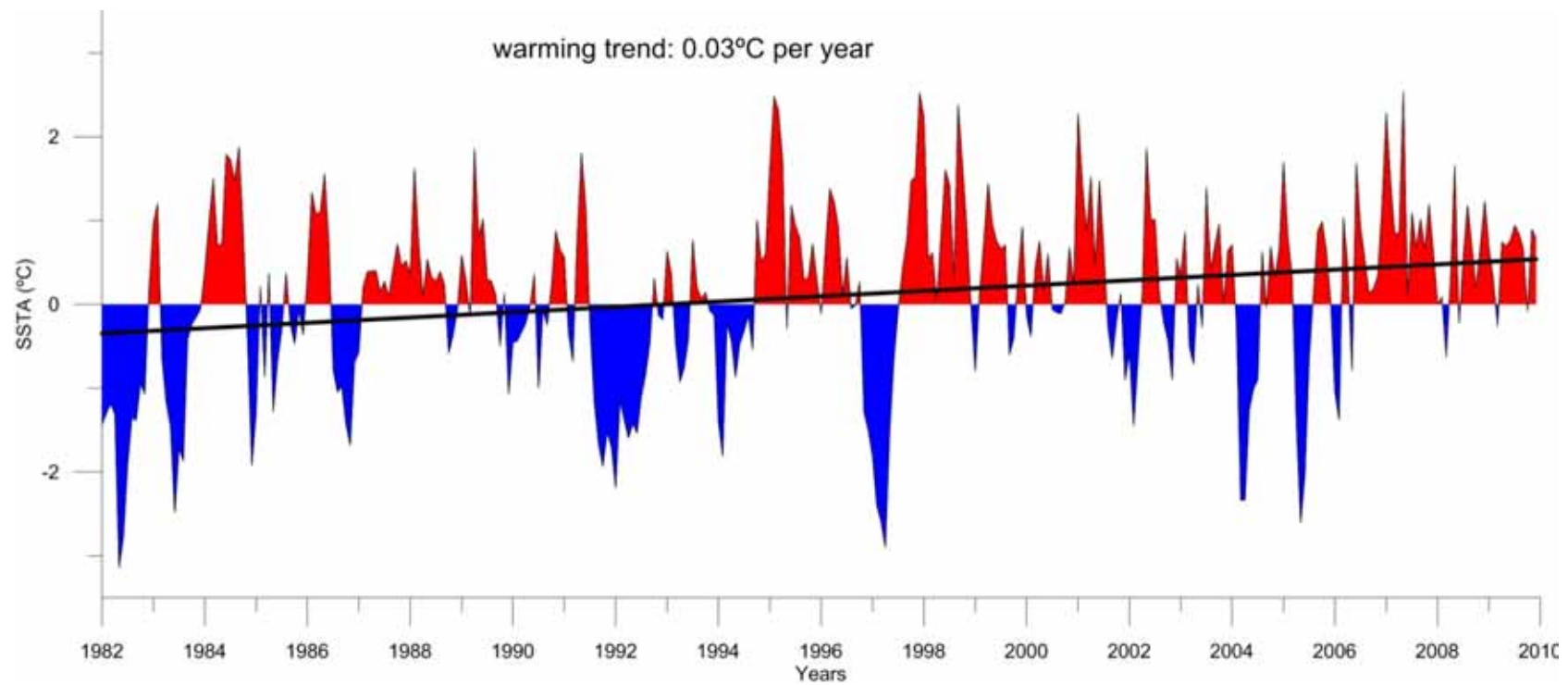


Oceanographic variability

- Angola SST (Tchipalanga et al.)



- Clear warming trend



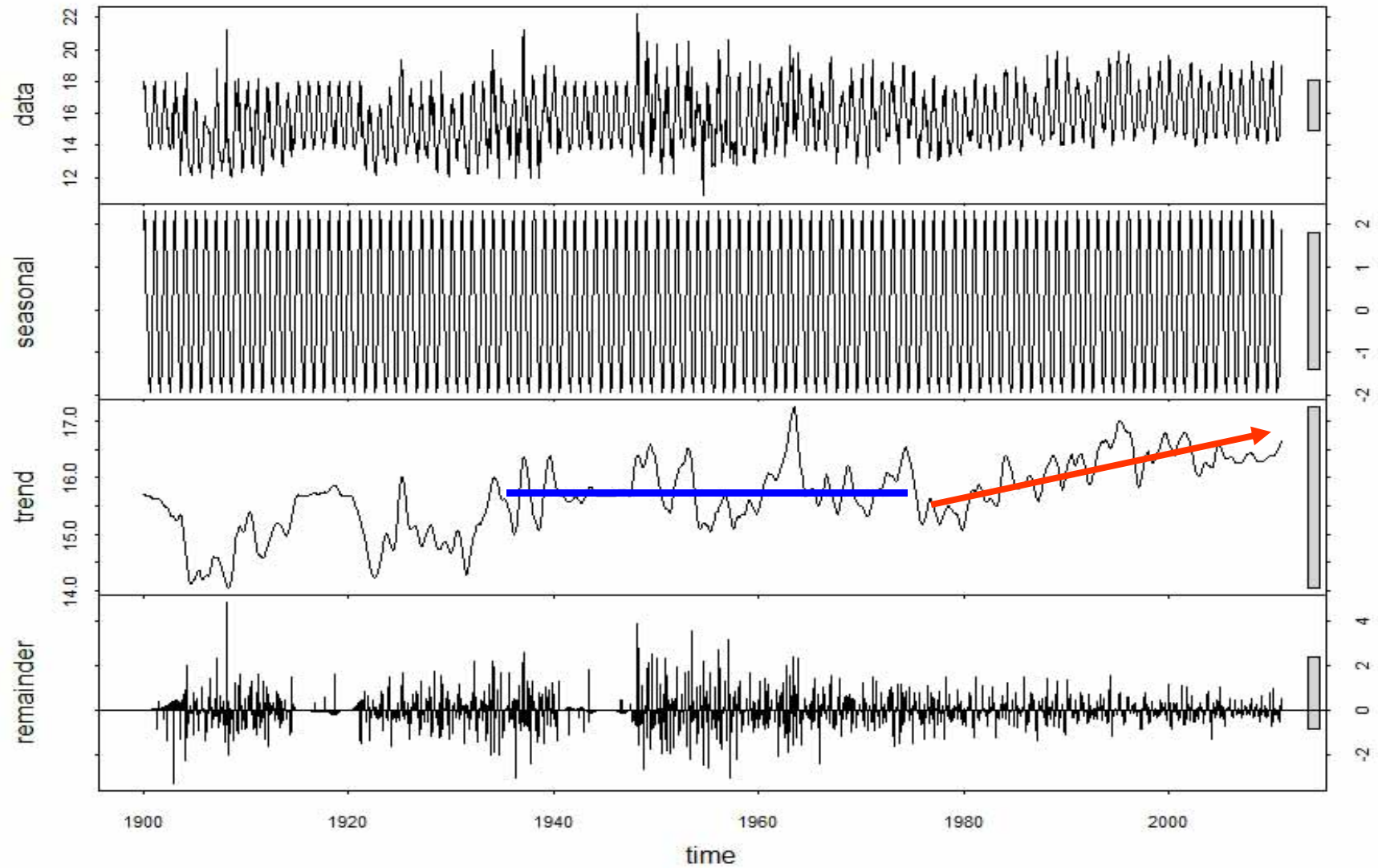
Oceanography Namibia

Spatial and temporal environmental
variability over the northern Benguela

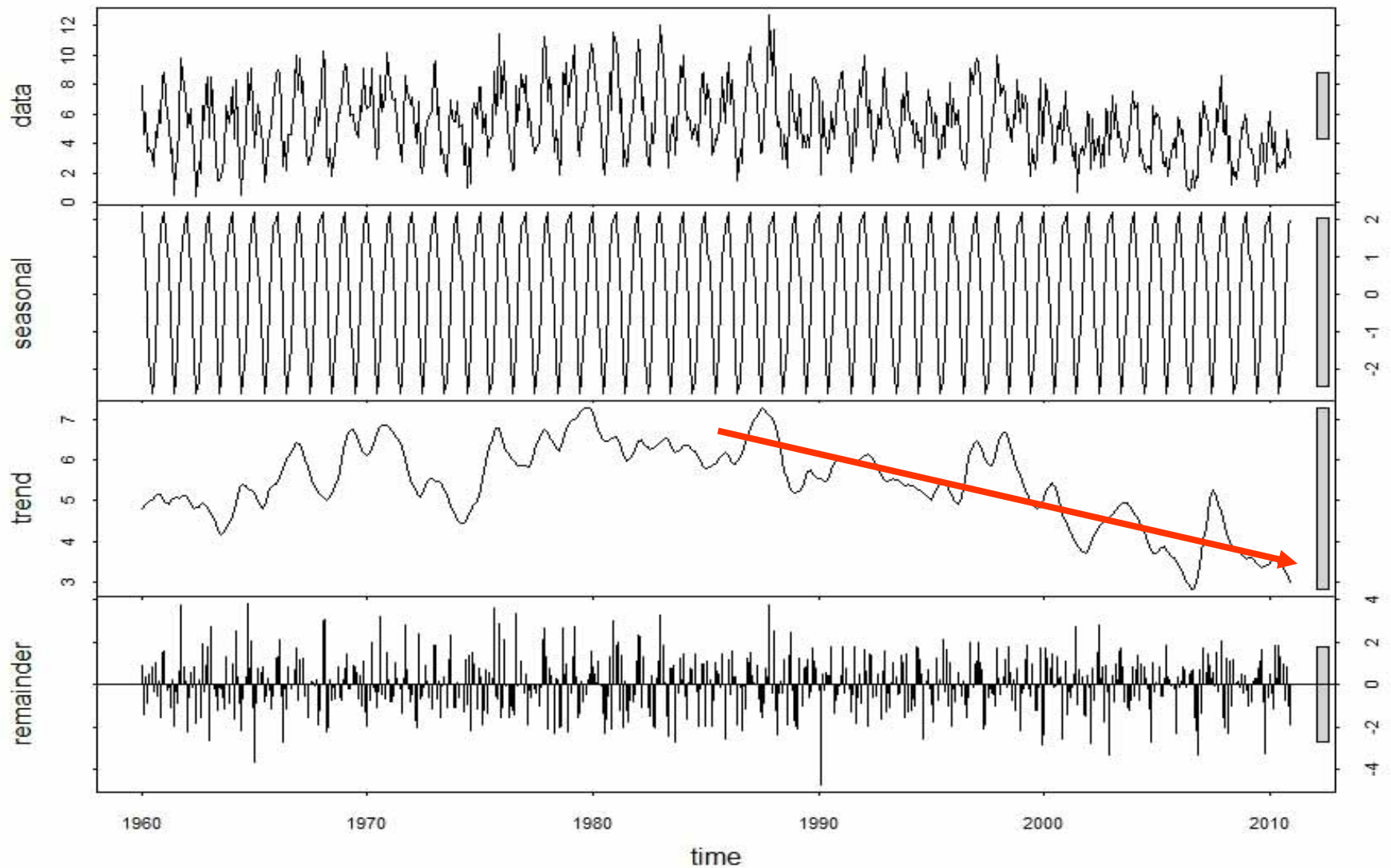
C Bartholomae & A van der Plas



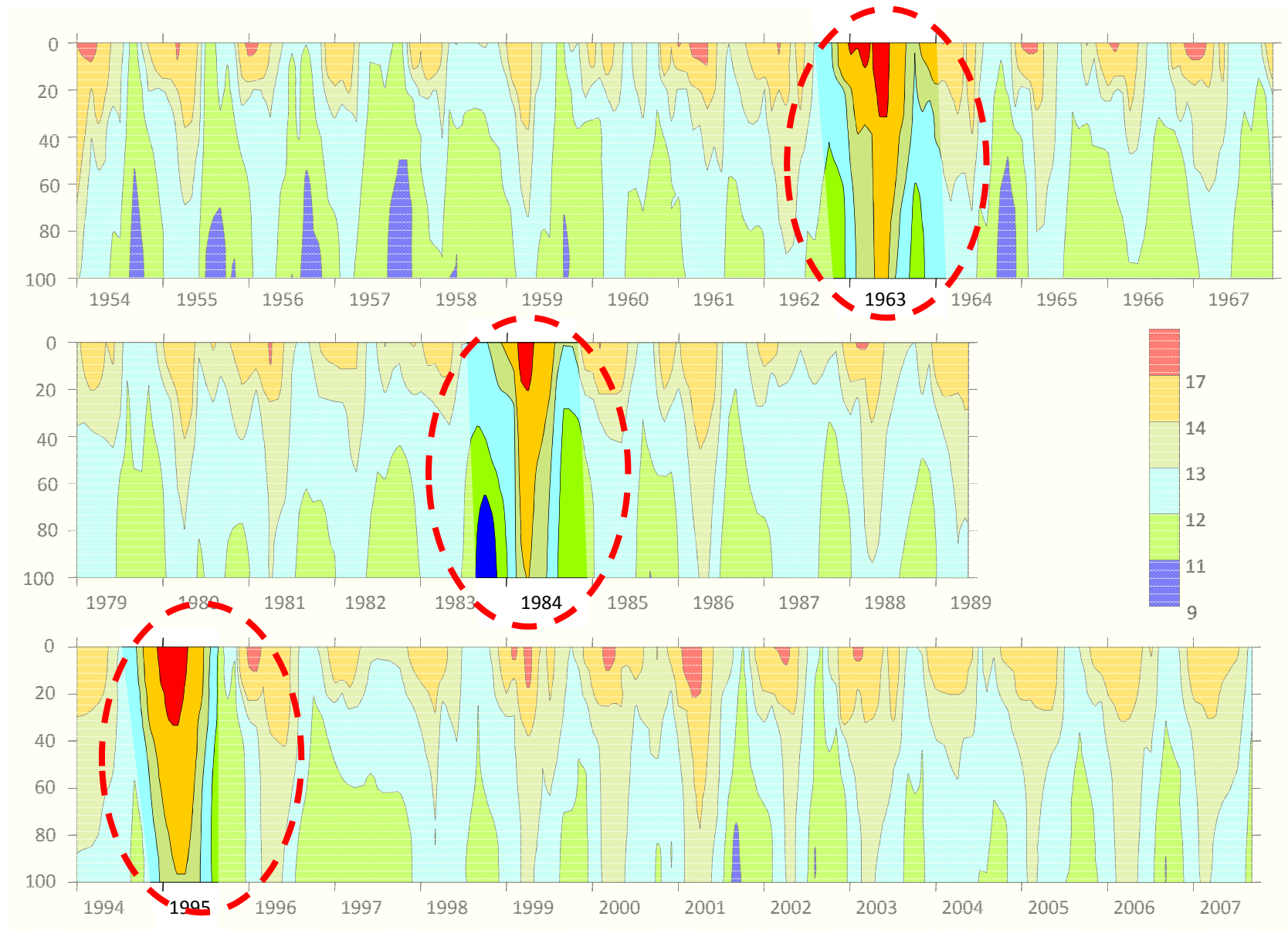
STL analysis of SST time series (22S)



STL analysis of Wind at Luderitz



In situ temperature 10nm off Walvis Bay



Oceanography South Africa

St Helena Bay (southern Benguela) then
and now: muted climate signals, large
human impact

Hutchings et al



- St Helena Bay

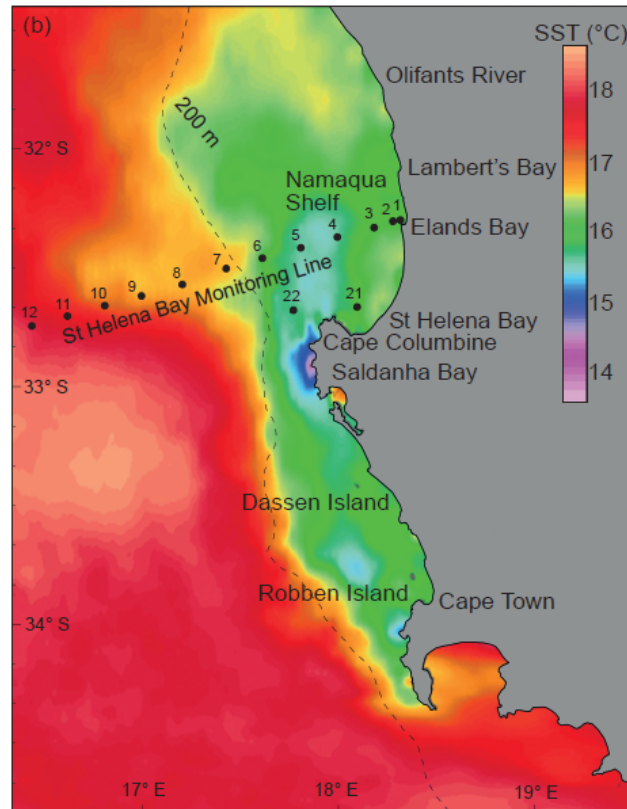


Figure 1: (a) Station sampling positions and depths in fathoms, 1950–1954 (Buys 1957) and (b) the St Helena Bay Monitoring Line, 2000–2010, superimposed on a monthly averaged thermal image of the South-West Cape shelf during active upwelling



• St Helena Bay

- Decadal variability in wind and "upwelling"
- No clear trends

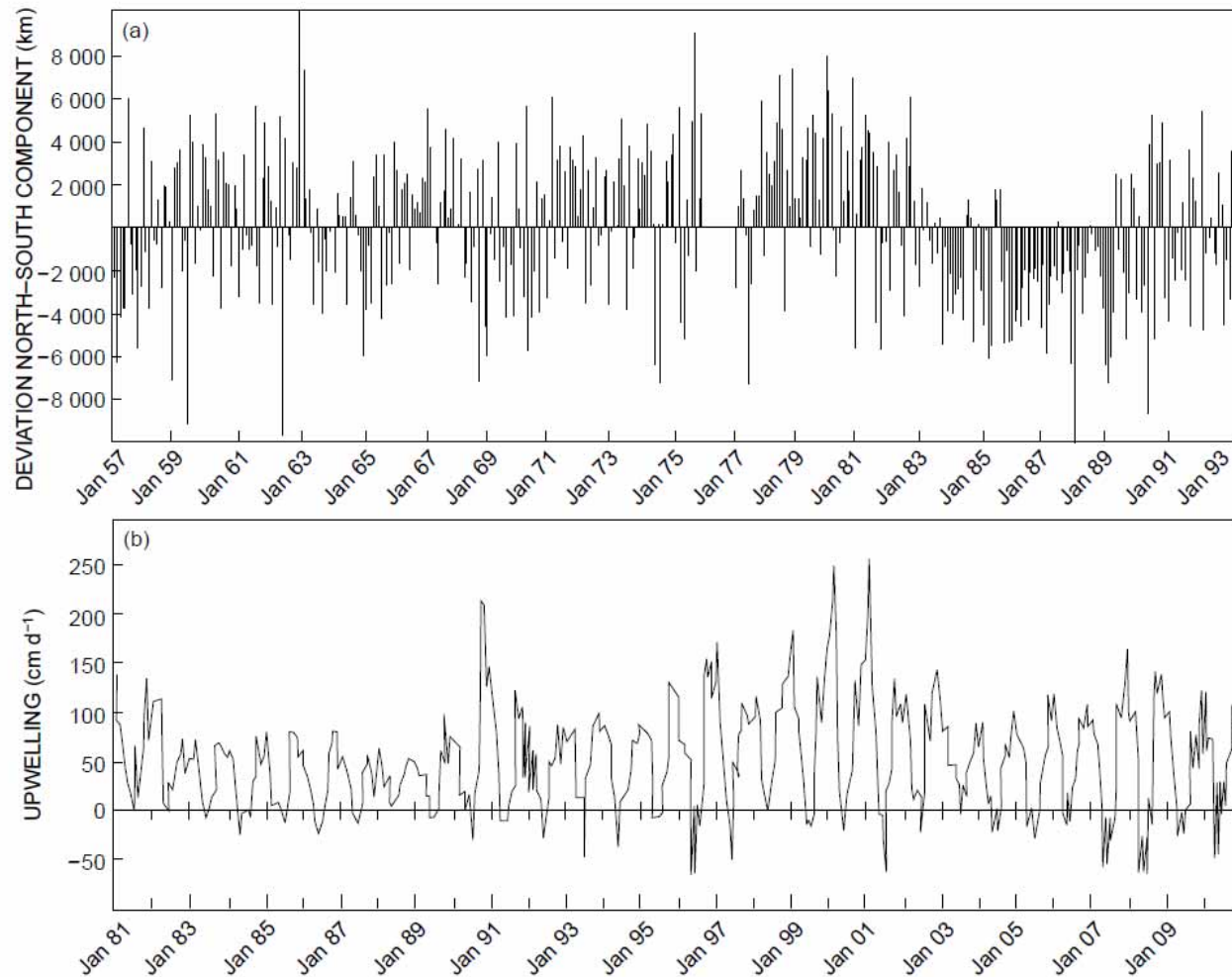


Figure 2: Wind characteristics for Cape Columbine 1957–2010: (a) monthly north–south wind anomalies, 1957–1993 (updated from Shannon et al. 1992; note no data for 1976); (b) mean monthly Ekman upwelling, 1981–2010, based on sea level pressure differences and calculated geostrophic winds during that period (DEA 2011). Note low southerly winds between 1982 and 1989/1990 and low upwelling



- St Helena Bay

- No trends but some decadal variability in SST

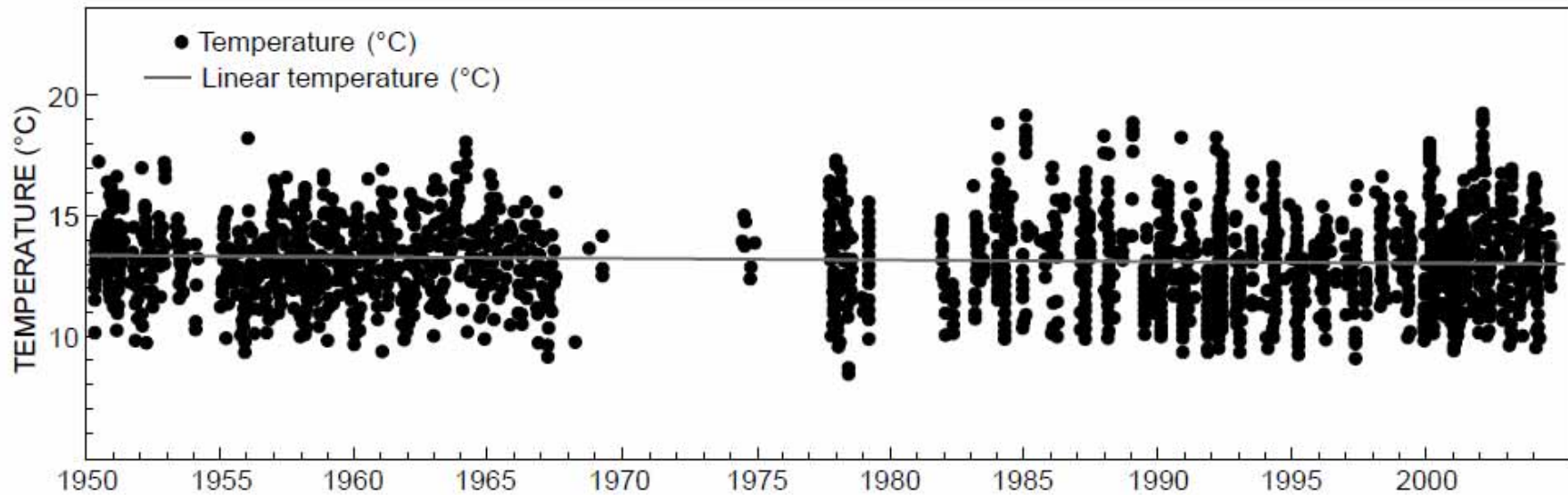


Figure 3: Temperatures in the upper 20 m within the confines of St Helena Bay, 1950–2005, extracted from the South African Data Centre for Oceanography and the Oceanographic Data System of Oceans and Coasts, Department of Environment Affairs). The trend line indicates no significant warming or cooling over 55 years but decadal-scale variability



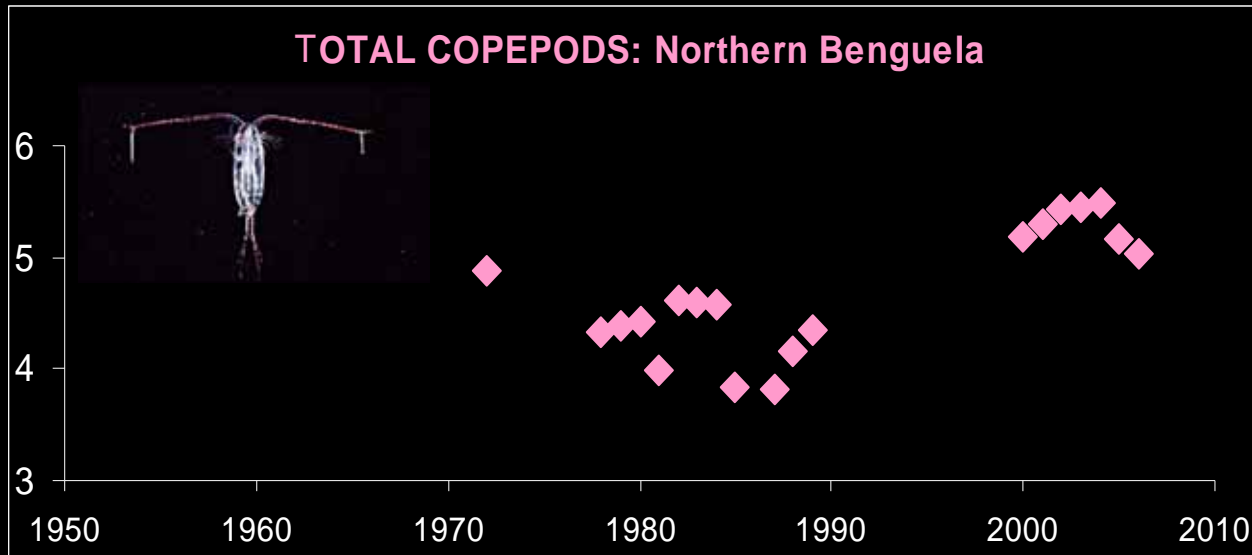
CHANGES IN THE PELAGIC SUBSYSTEM

Long-term variability of zooplankton in the
Benguela Current system: a comparison
between the northern and southern sub-
systems

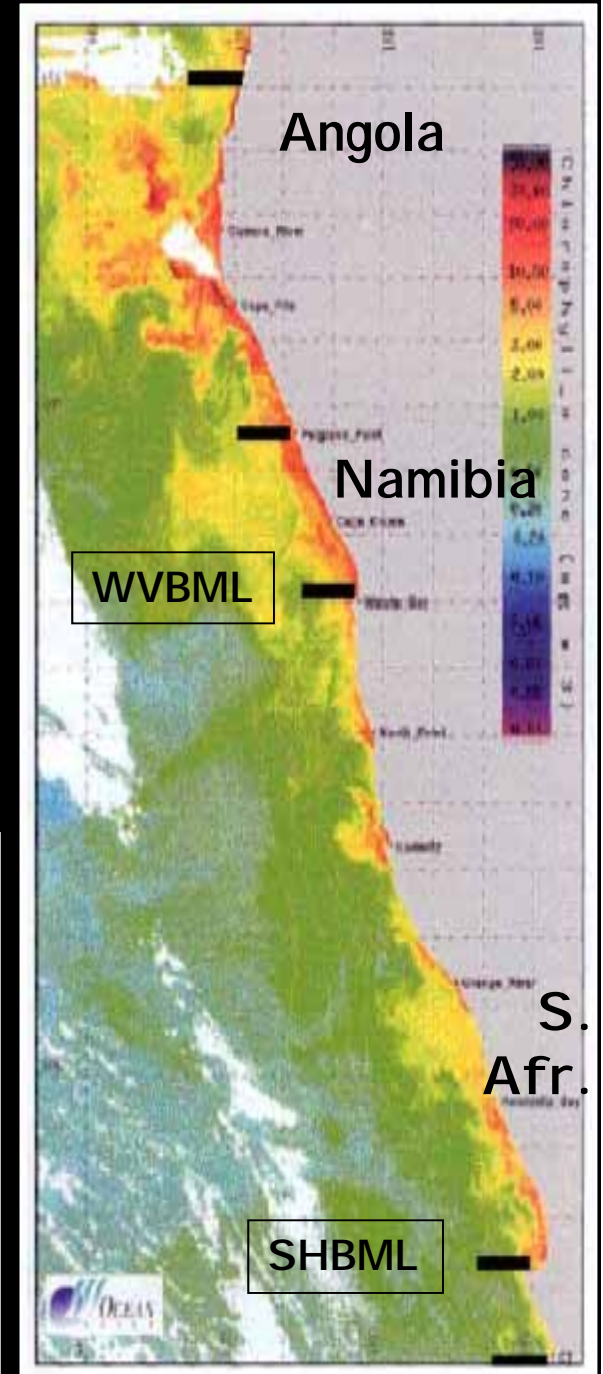
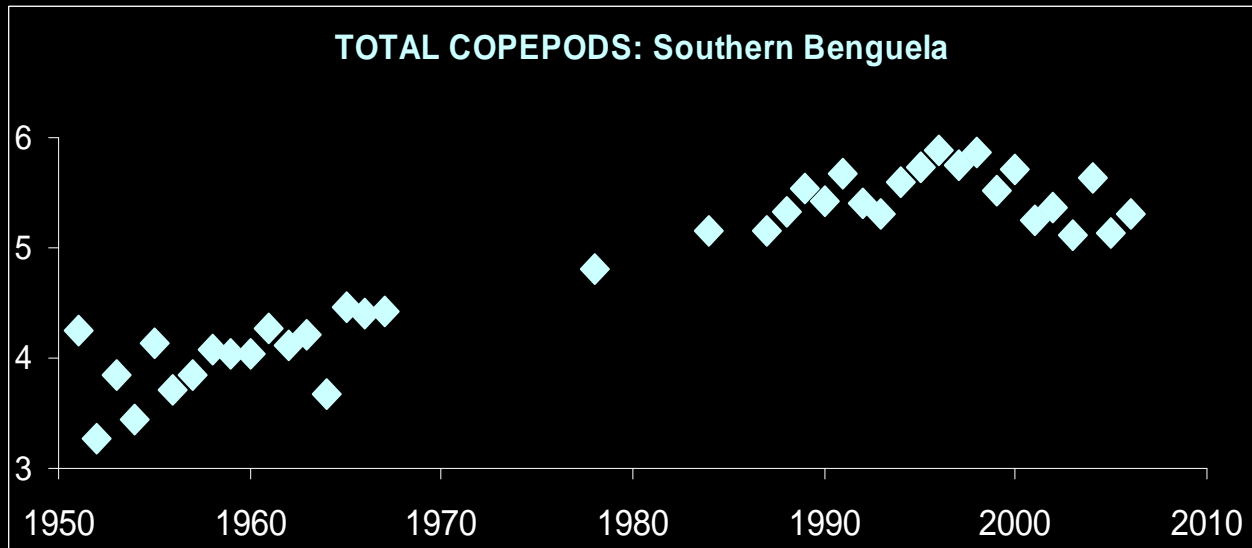
Verheye et al.



northern – southern Benguela comparison:
 total copepod abundance $\{\text{Log}_{10}[(\text{No.m}^{-2})+1]\}$
 Verheye et al

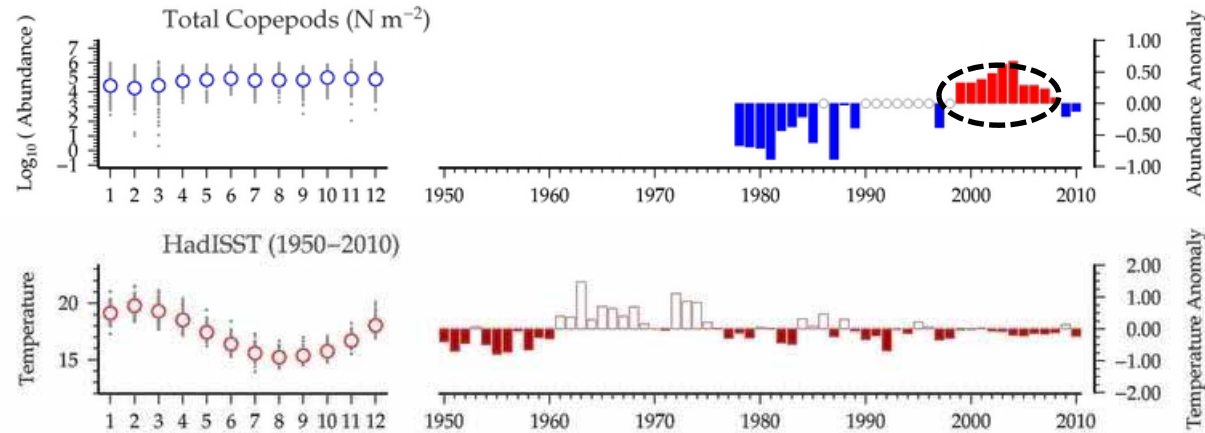


(Verheye & Kreiner 2009)

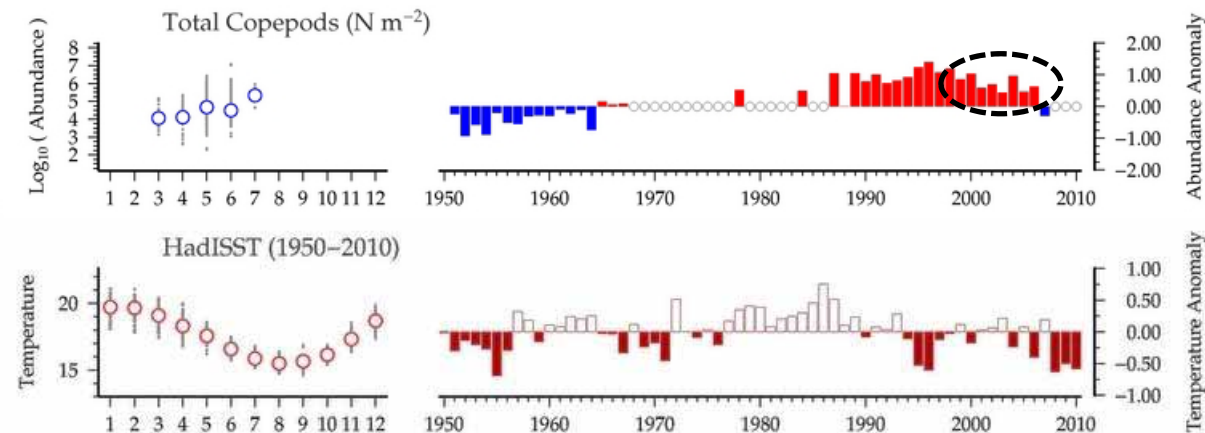


Benguela copepods vs SST: North vs South

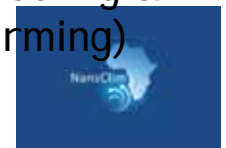
Northern
Benguela:
Walvis Bay
(23°S)



Southern
Benguela:
St Helena Bay
(32.5°S)



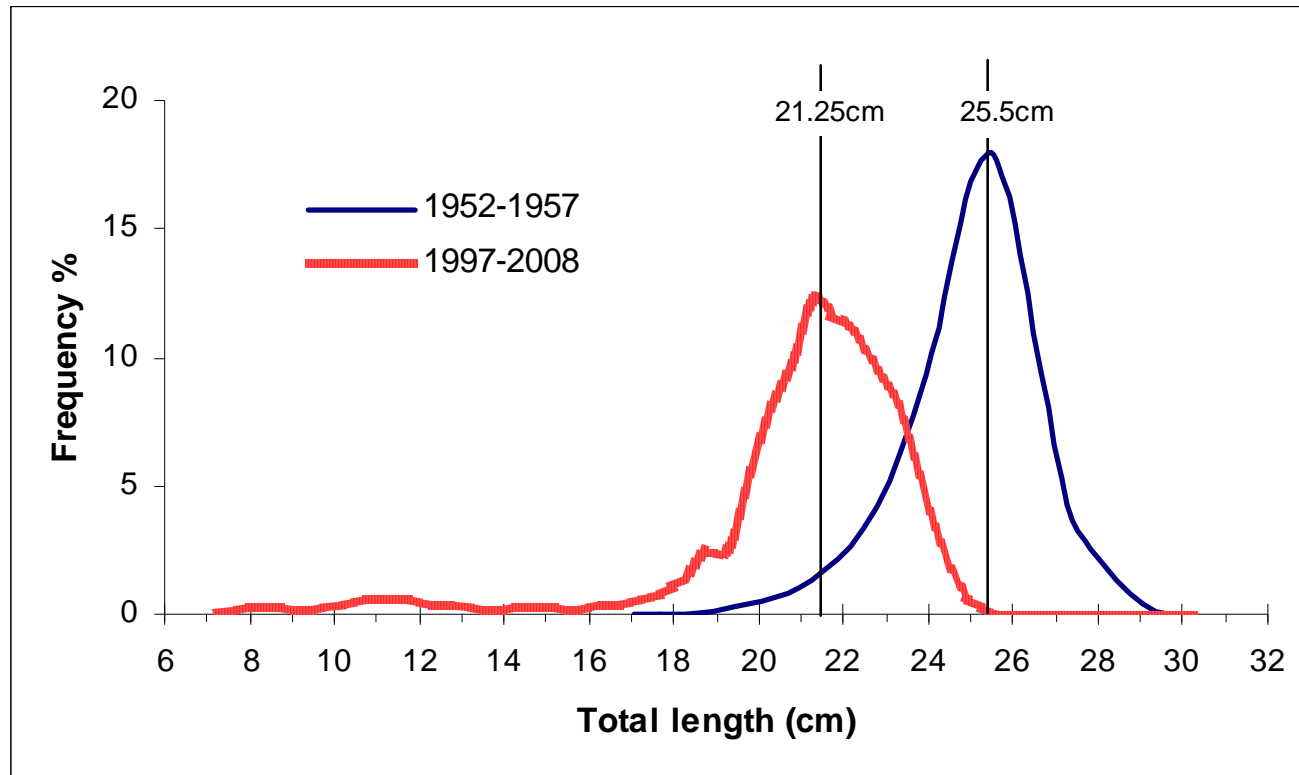
- long-term increase in copepod abundance in both sub-systems, **without clear synchrony**
- both show positive abundance anomalies for at least the late 90s – mid 2000s (~cooling & incr. upwelling ?), yet declining (as observed on the Agulhas Bank in response to warming)



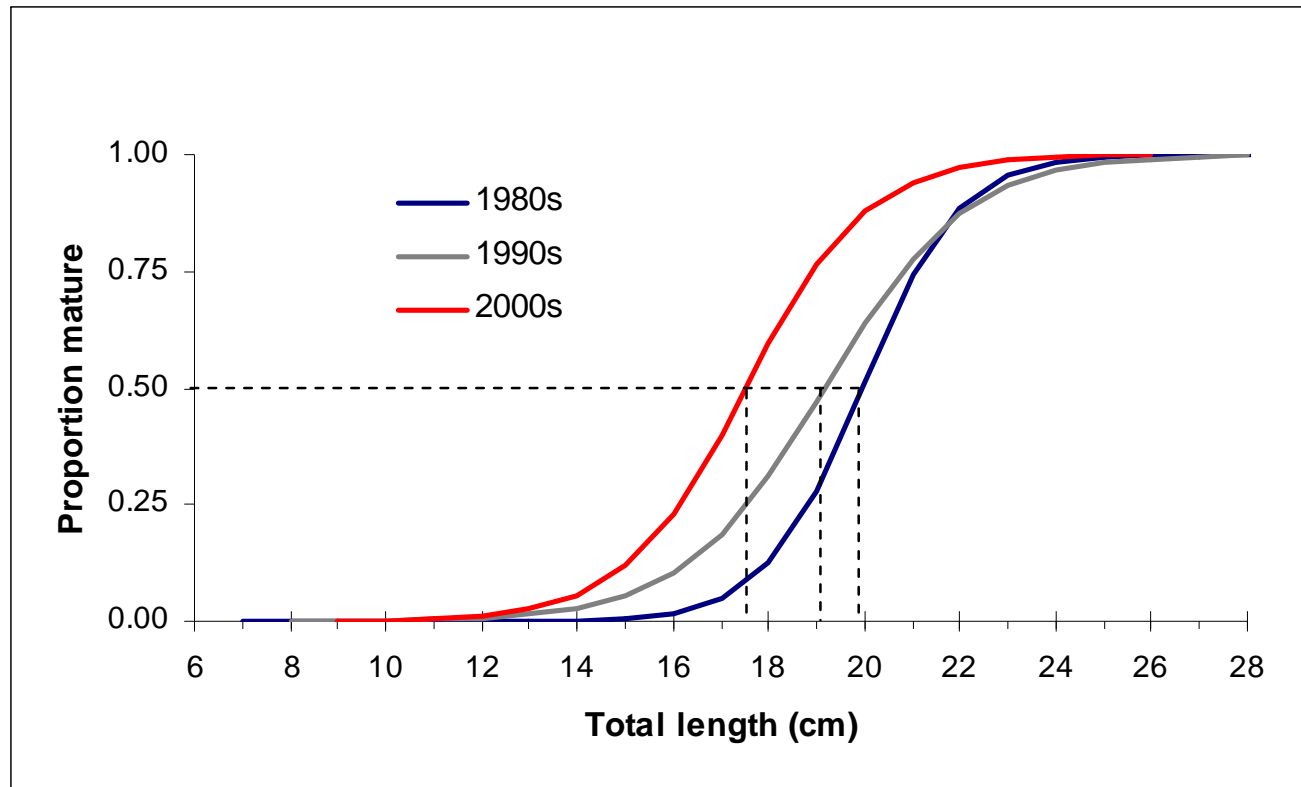
The selection of spawning location of sardine (*Sardinops sagax*) in the northern Benguela after changes in stock structure and environmental conditions

Kreiner et al. (2011)

Length frequencies

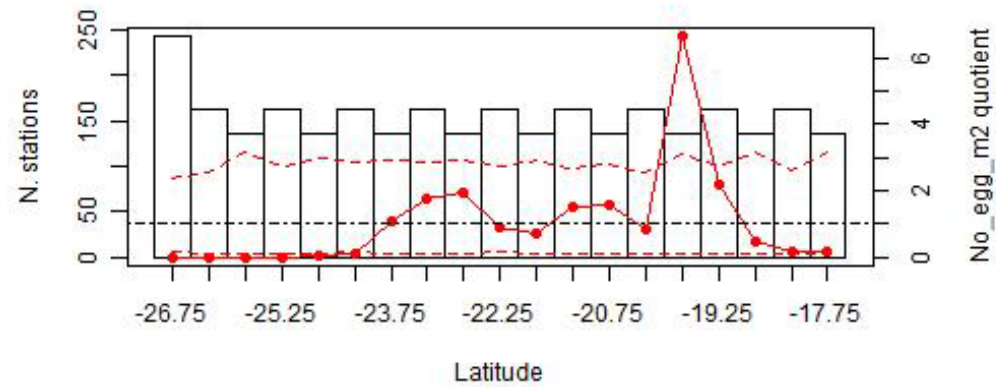


Maturity ogive

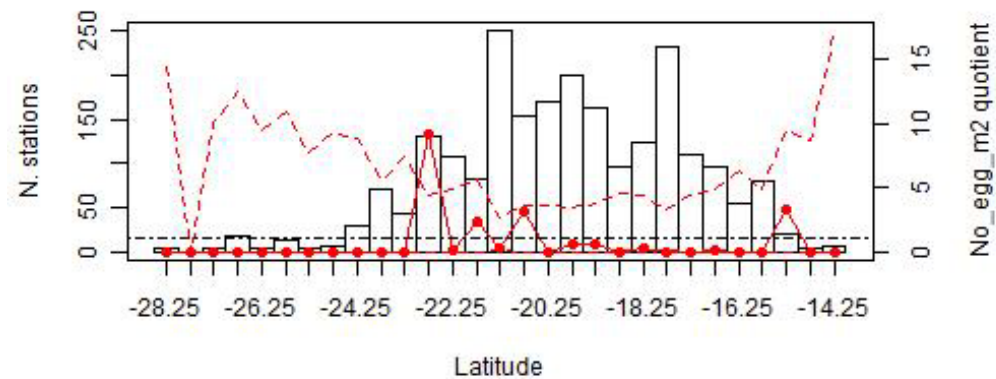


Preferred spawning locations (latitude)

1980s



2000s



Conclusions

- Our results confirm that central Namibian coast is still an important spawning area during at least some periods of the spawning season (January to March), despite the very low abundance and altered stock structure of the sardine spawning stock in Namibian waters.
- A shift in spawning away from the favourable Walvis Bay area is therefore not the reason for the reversal of the environment-fish relationship area as hypothesised by Daskalov *et al.* (2003) or the failure of the sardine stock to recover
- A reduced reproductive output due to changes in the stock structure as well as altered environmental conditions at the spawning locations, rather than the selection of spawning locations away from the favourable southern areas are the likely reasons for the failure of the sardine stock to recover in the northern Benguela.

CHANGES IN THE DEMERSAL SUBSYSTEM

Several studies related to the demersal subsystem were carried out under NansClim, focusing specifically on

- (1) Potential effects of gear shifts on the analysis and interpretation of demersal survey data (Axelsen and Johnsen in review)
- (2) Spatio-temporal trends in diversity of demersal fish species (Mafwila *et al.* in review)
- (3) Identification and characterization of demersal biodiversity hotspots (Kirkman *et al.* in press)
- (4) Regime shifts in demersal assemblages and populations (Kirkman *et al.* in review)
- (5) Identification of potential demersal indicator species of climate variability (Kainge *et al.* in review)
- (6) Shifts in distributions of demersal fish species (Yemane *et al.* in review)

Review of the sampling methodology of the demersal trawl surveys in the BCLME region in the period 1985-2010

Axelsen et al



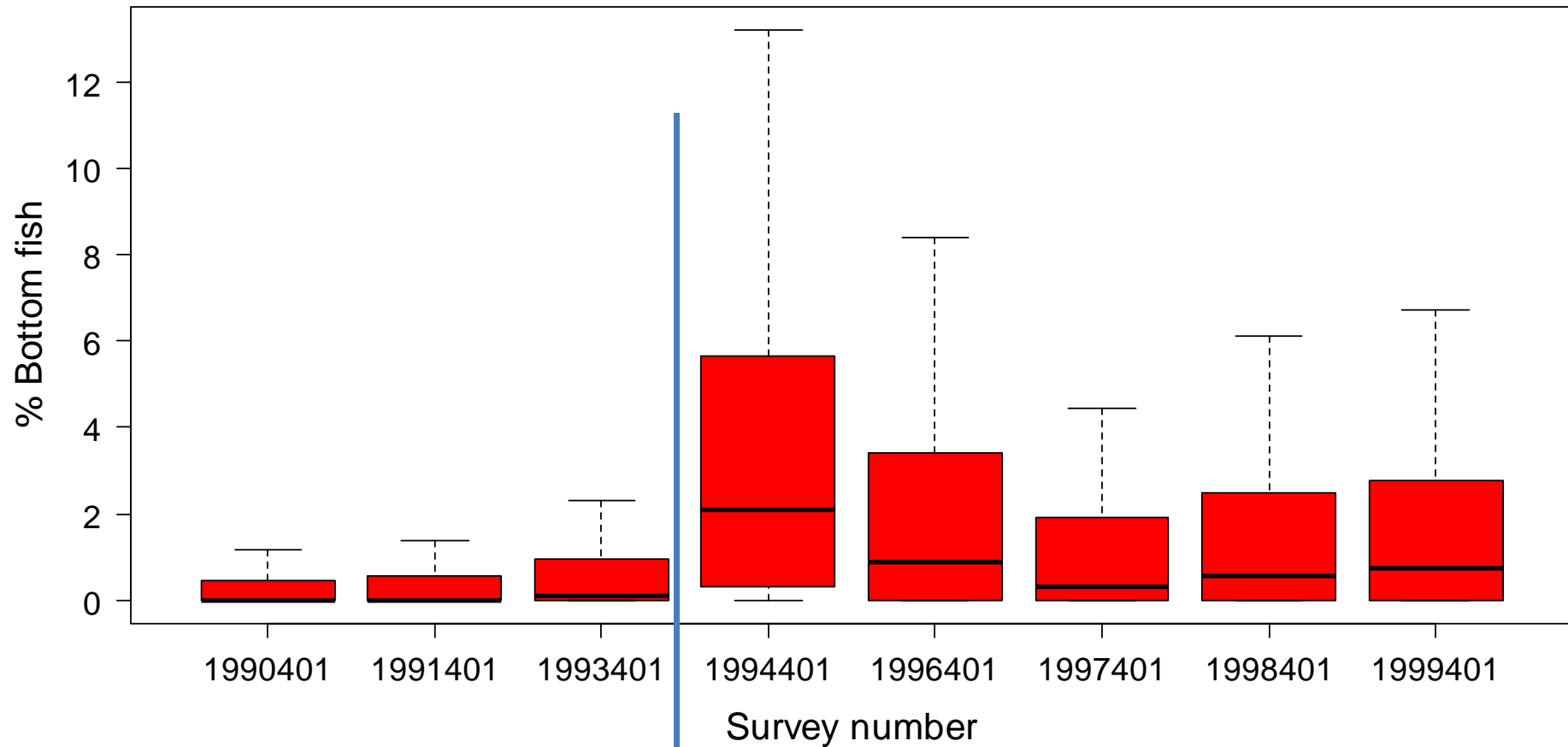
Gear changes and potential impacts – a critical look

Some factors that can affect catch rates:

- Seasonality (availability)
- Trawl doors (bottom contact, geometry, herding)
- Ground gear (escapement)
- Rigging (tickler chain and constraint rope)



Relative catch rates of bottom dwellers (Monk, Sole) in Namibia (old vs new Nansen)

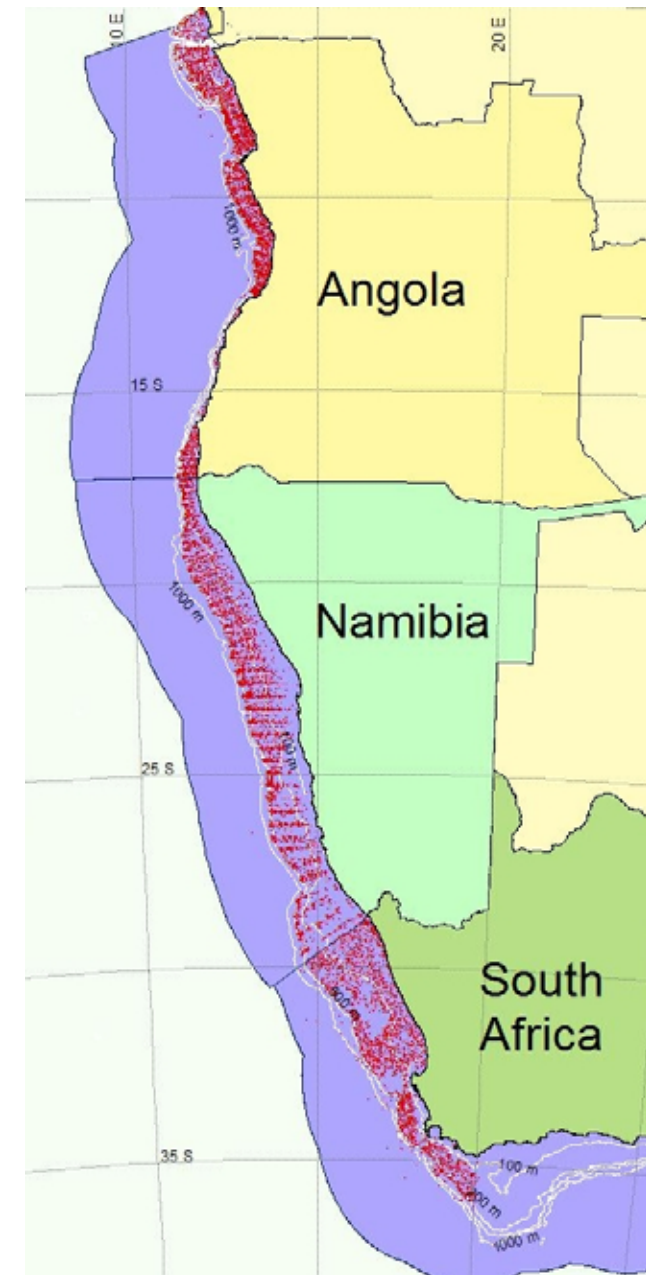


Assessing changes in distribution and range size of demersal fish species in the BCLME in relation to long-term change in the environment

Yemane et al.



- Data were obtained from the routine annual demersal biomass assessment survey off the three countries (Angola, Namibia, and South Africa) in the BCLME
- Red dots indicate distribution of trawl stations over study period in Angola (1985-2010), Namibia (1990-2010 and South Africa (1984-2010)



- The fact that both targeted and non-targeted (landed or discarded bycatch) were characterised by distributional shifts indicate that fishing alone unlikely to be accountable
- Generally smaller bodied fish (suggesting more rapid life cycles) tended to be more responsive
- Results of the study highlight the complex nature of the response of fish populations to climate or other changes



- A sustained increase in depth of fish populations in BCLME will have ecological (via trophic interactions) and economic consequences (increased fishing cost to the fishing industry)
- Currently , lack of complete policy document to address socio-economic, conservation and biodiversity consequences of climate-related changes in BCLME and consequences for supported fisheries
- Vulnerability of various components of ecosystem (and supported economic sectors) to climate change and related phenomena need to be assessed, potential adaptation strategies need to be formalised



List of indicator species Kainge et al

this is just a small part of the list

Species	Behaviour ¹	Habitat/ availability	Gear change effects ²	Indicator strength ³	Exploitation class ⁴	Range shift ⁵				Regime shift ⁶	
						DSlope	LSlope	RDSlope	RLSlope	STARS	Change point
<i>Alectis alexandrinus</i>		Pelagic-neritic	N	Poor indicator	B	0.4					
<i>Alloteuthis africana</i>	DVM	Water column	N	Poor indicator	B			8.2	21.9		+
<i>Ariomma bondi</i>		Demersal	N	Poor indicator	B				15.5		
<i>Arius parkii</i>		Demersal	N	Highly sensitive	B		-21.4				
<i>Atractoscion aequidens</i>		Benthopelagic	N	Poor indicator	T	1.0		2.7			
<i>Bathyrcongery vicinus</i>	Solitary	Benthopelagic	N	Highly sensitive	B			30.3	47.9		
<i>Bembrops heterurus</i>		Demersal	N	Poor indicator	B		-13.4	11.9	-13.3		
<i>Benthodesmus tenuis</i>		Benthopelagic	N	Poor indicator	B				54.1		
<i>Boops boops</i>		Demersal	N	Poor indicator							