



**Ocean Variability in the Benguela Current LME and the
Benguela Current Commission**

By

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IOC-IUCN-NOAA-UNEP Large Marine Ecosystem

9th Consultative Committee Meeting, 10-11 July 2007, Paris, France

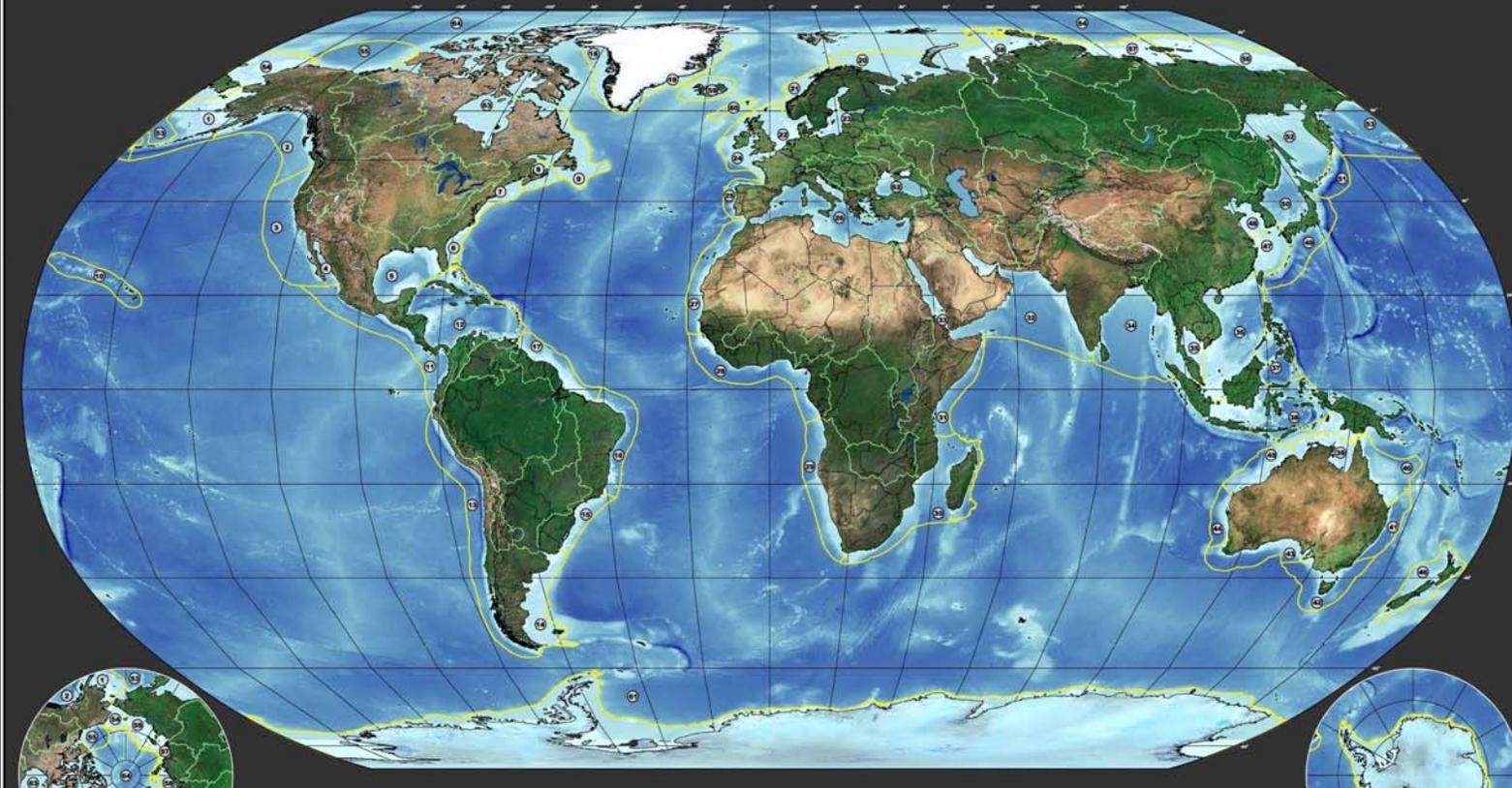
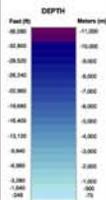
LARGE MARINE ECOSYSTEMS OF THE WORLD

Large Marine Ecosystems of the World and Linked Watersheds

MAP KEY:

- LME Numbers:**
1. East Bering Sea
 2. Gulf of Alaska
 3. Chukchi Current
 4. Gulf of Mexico
 5. Caribbean Sea
 6. Southeast U.S. Continental Shelf
 7. Northwest U.S. Continental Shelf
 8. Arctic Shelf
 9. North Pacific Ocean
 10. Inshore Pacific-Northern Shelf
 11. North Central American Coastal
 12. Caribbean Sea
 13. Northwest Current
 14. Patagonian Shelf
 15. South Brazil Shelf
 16. East Brazil Shelf
 17. North Brazil Shelf
 18. West Greenland Shelf
 19. East Greenland Shelf
 20. Barents Sea
 21. North Sea
 22. Baltic Sea
 23. Celtic Sea Shelf
 24. North Atlantic
 25. North Sea
 26. Celtic Sea Shelf
 27. North Atlantic
 28. North Atlantic
 29. North Atlantic
 30. North Atlantic
 31. North Atlantic
 32. North Atlantic
 33. North Atlantic
 34. Bay of Bengal
 35. Gulf of Thailand
 36. South China Sea
 37. East China Sea
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 62. East China Sea
 63. East China Sea
 64. Arctic Ocean

- Large Marine Ecosystem
- Watershed Boundary
- Political Boundary



LARGE MARINE ECOSYSTEMS are areas of the ocean characterized by distinct bathymetry, hydrography, productivity, and trophic interactions. They annually produce 95 percent of the world's fish catch. They are national and regional focal areas of a global effort to reduce the degradation of linked watersheds, marine resources, and coastal environments from pollution, habitat loss, and over-fishing.

For More Information Visit: www.edc.uri.edu/lme



NORTH POLAR REGION

SOUTH POLAR REGION

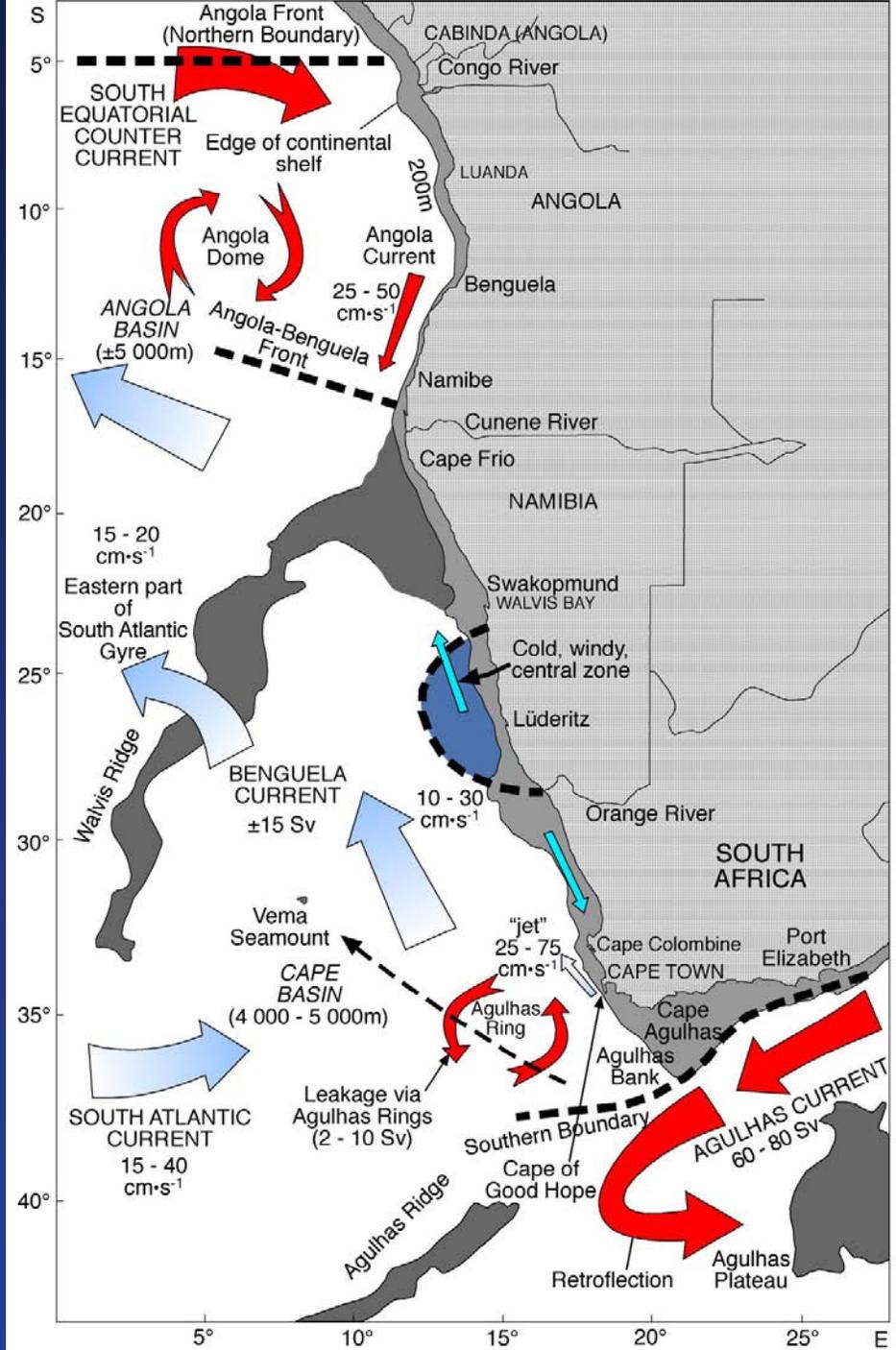


Physical Features of the BCLME

Warm Angolan Current

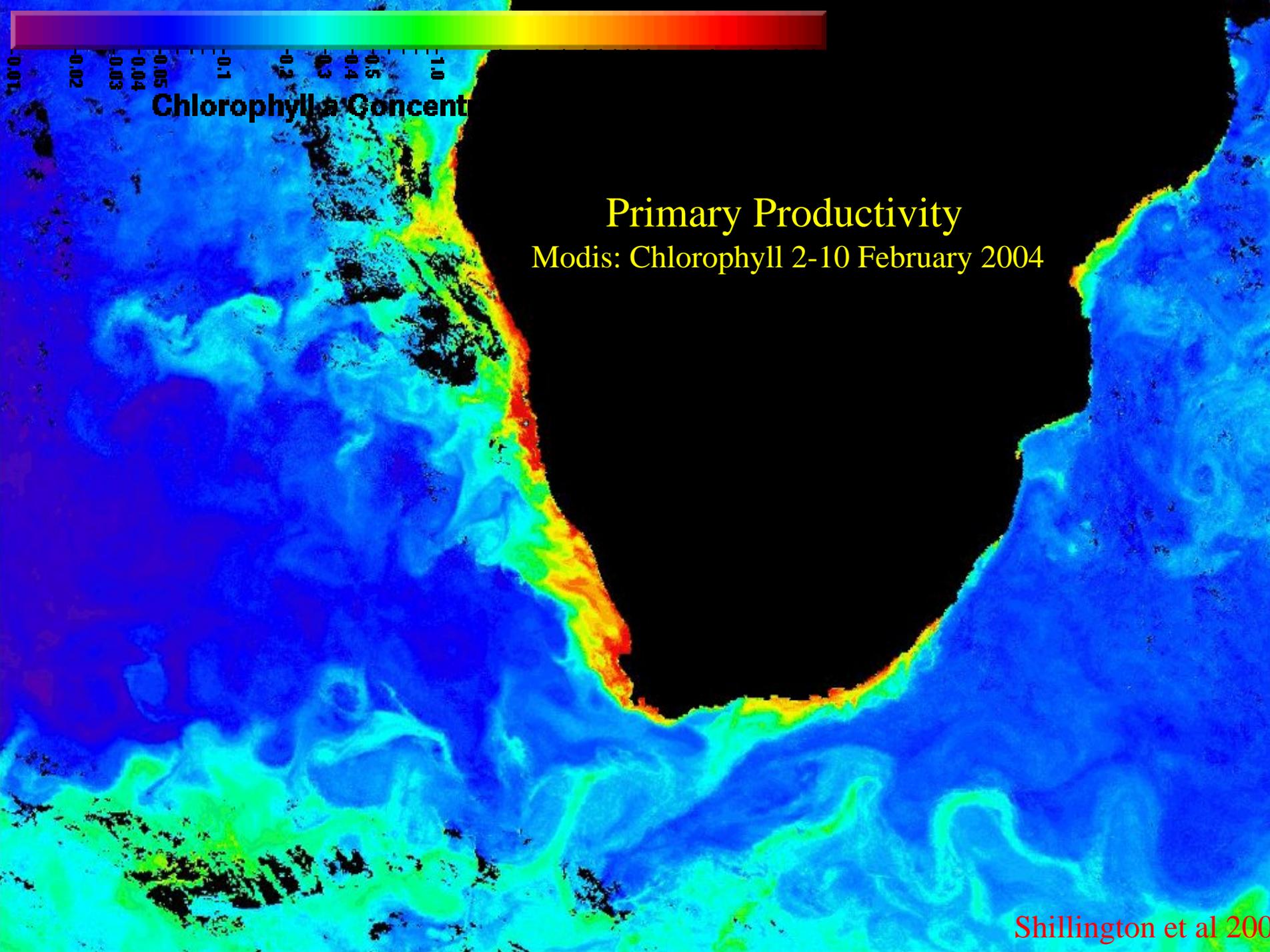
Cool Benguela Current

Warm Agulhas Current



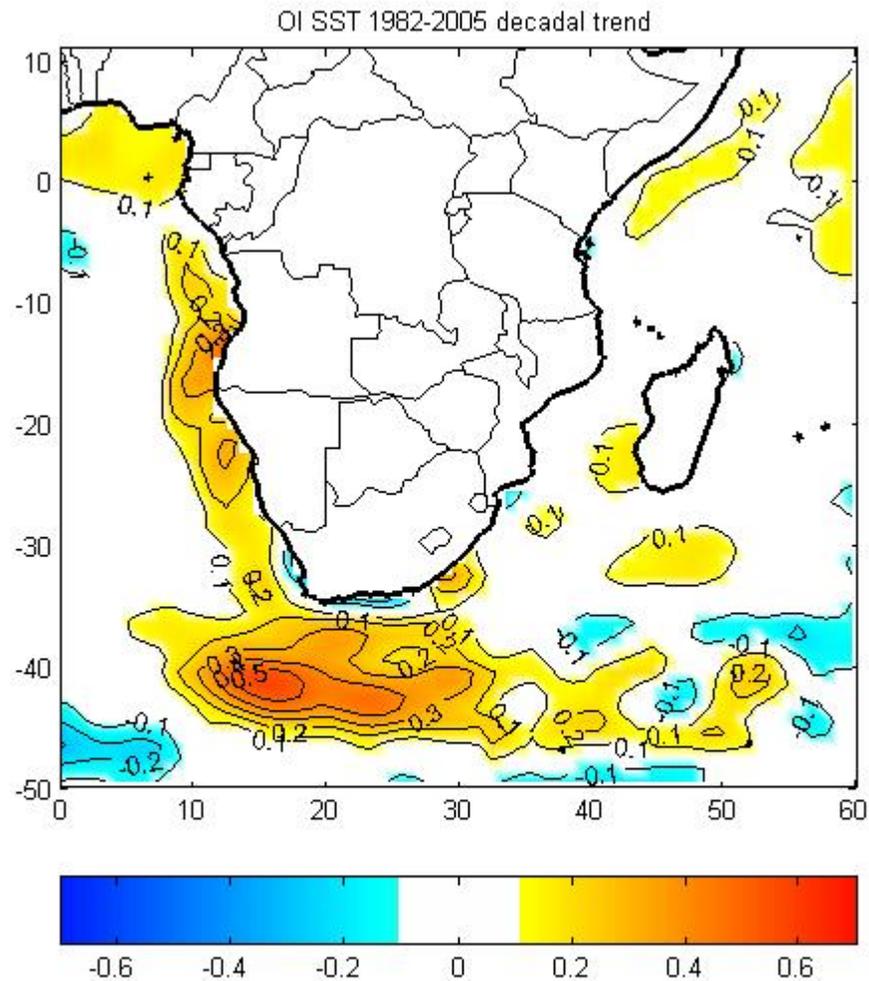
Benguela Current Large Marine Ecosystem - Variability

- **Highly productive, complex and variable**
- **Difficult to separate climate signal from noise**
- **At confluence of Atlantic, Indian and Antarctic oceans; tropical, sub-tropical, mid-lat. pressure**
- **Higher degree of variability than Humboldt, Canary and California systems**
- **Conditions in ocean basins around Southern Africa influence marine resources, weather patterns and rainfall over entire region**

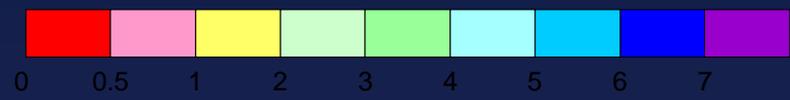


Chlorophyll a Concentration

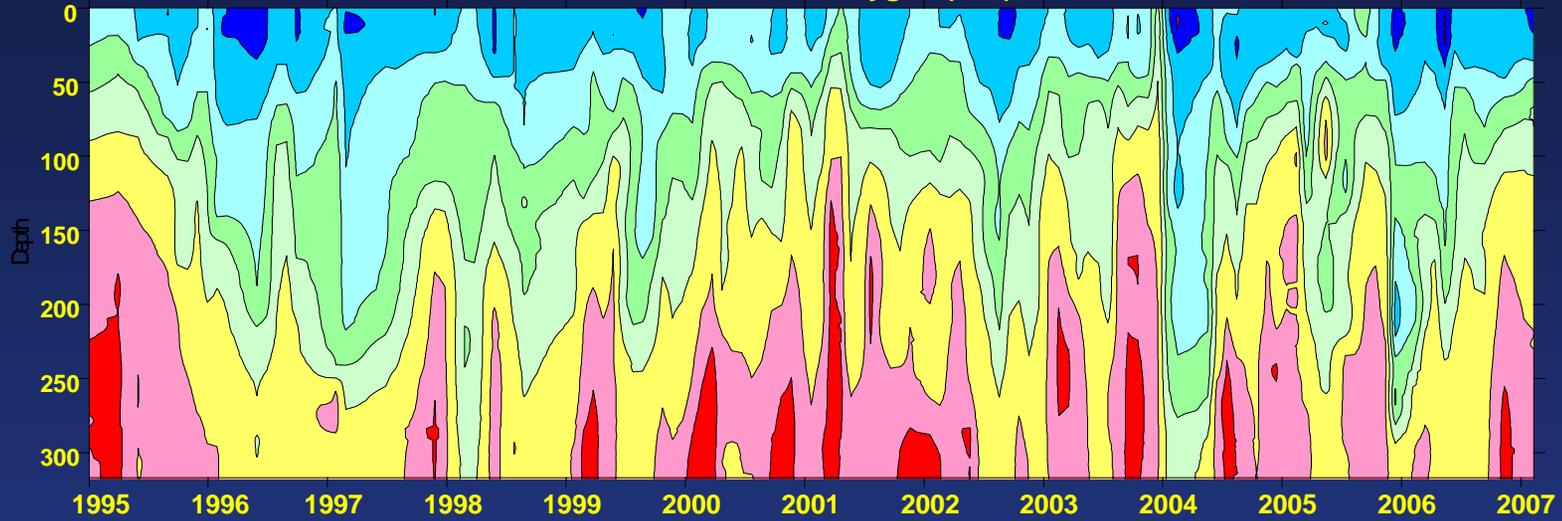
Primary Productivity
Modis: Chlorophyll 2-10 February 2004



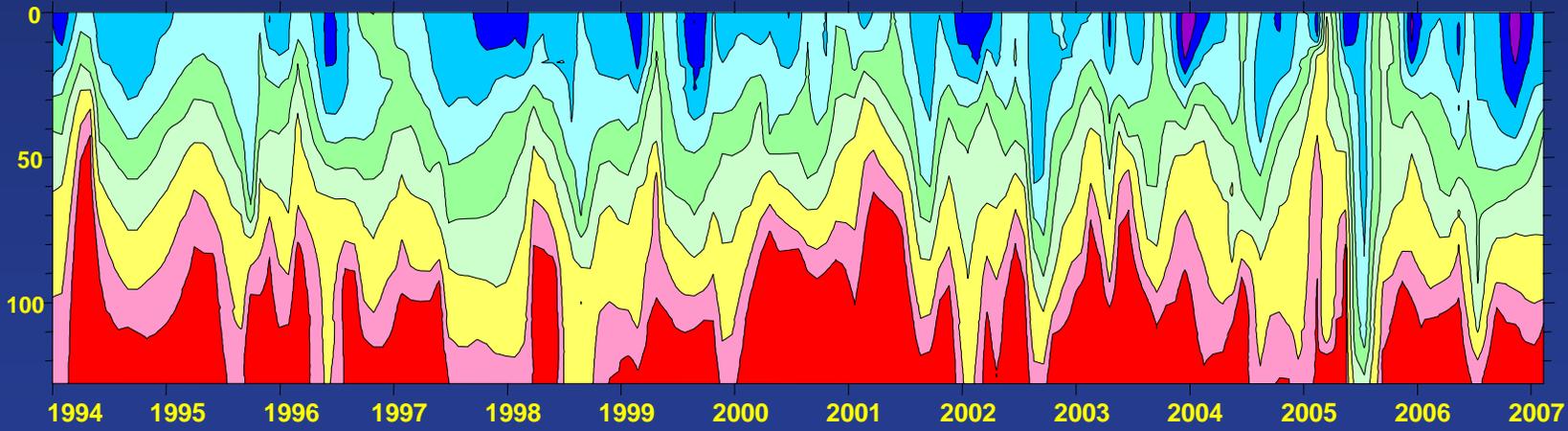
- Trend in SST since 1982 using the more reliable Reynolds SST (Combination of observations and satellite remote sensing but interpolated and 1 x 1 degree resolution).



70nm, 23S - Oxygen (ml/l)

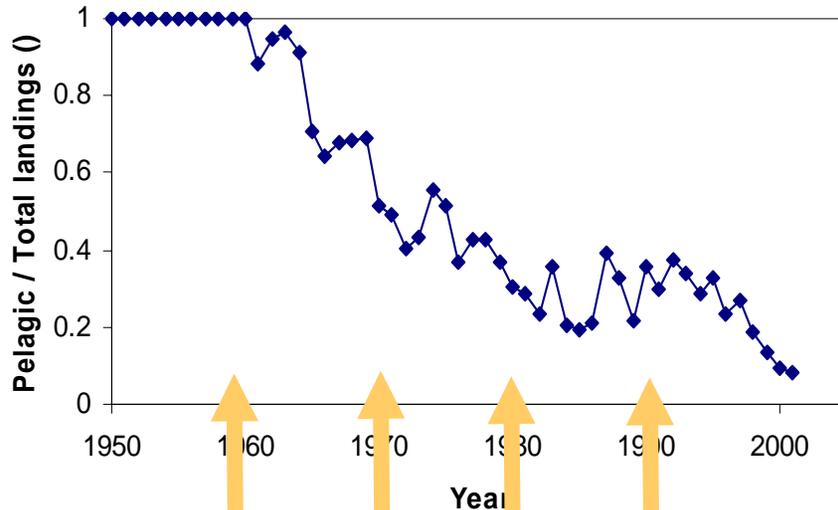


20nm, 23S - Oxygen (ml/l)



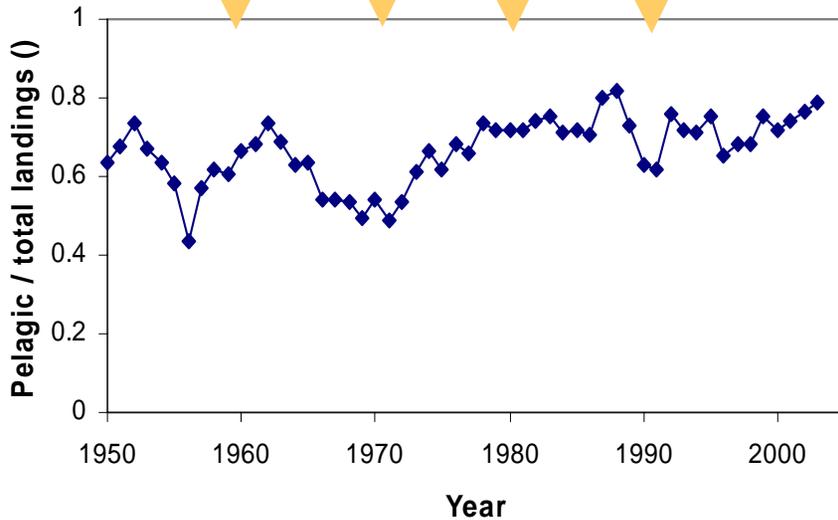
Documented change: Relative importance of pelagic landings

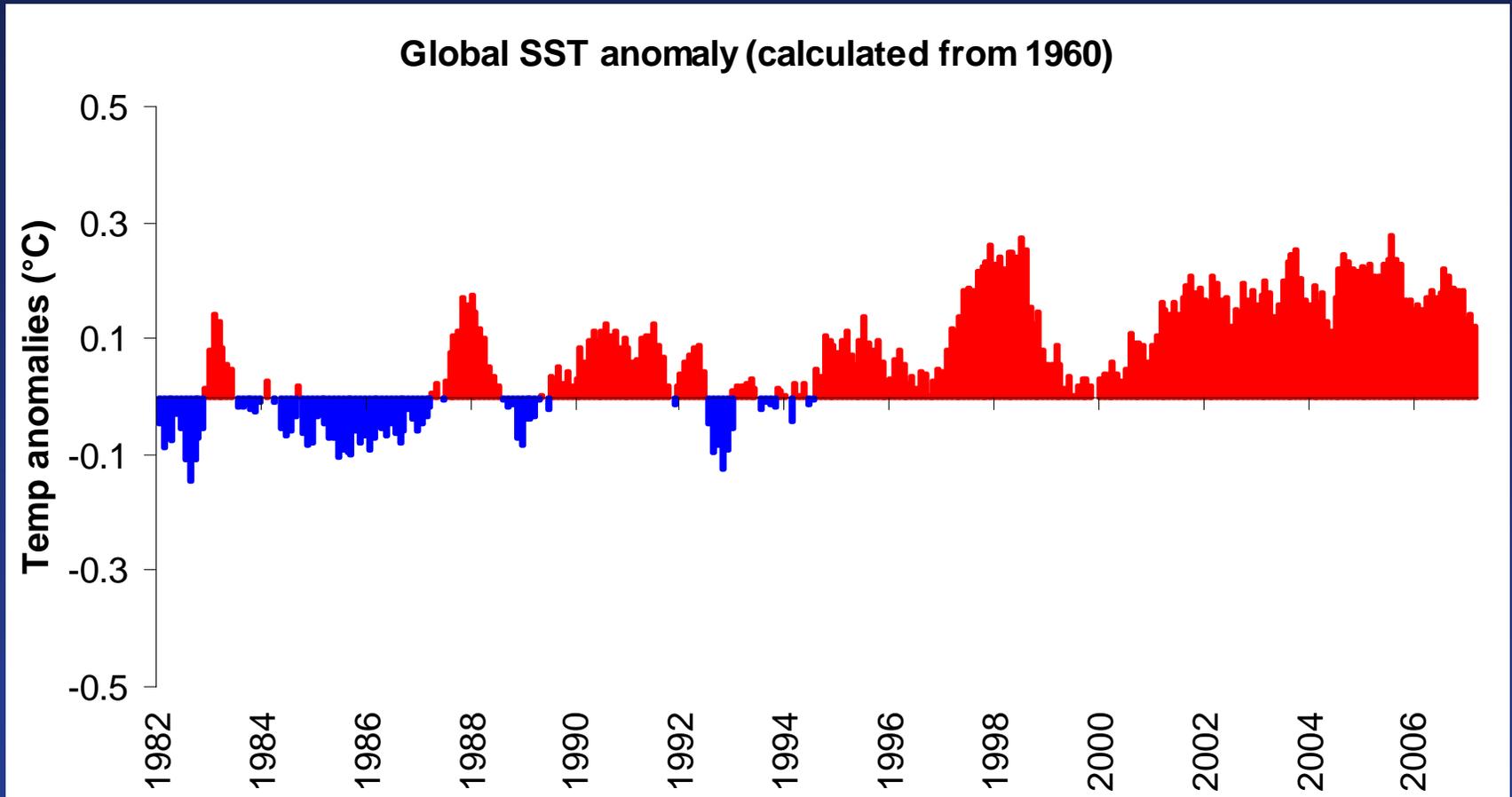
Northern Benguela



Benguela Niños

Southern Benguela





SEA SURFACE TEMPERATURE ANOMALY

Lobster Dynamics
 Sardine Eastward Shift
 Non-recovery of N-Benguela Sardine?

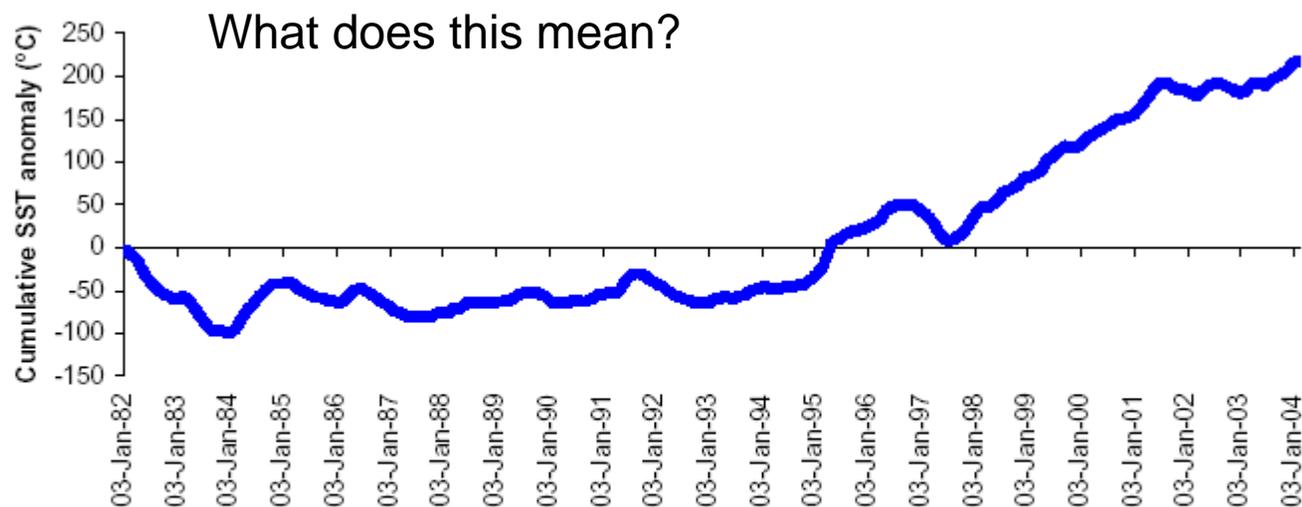
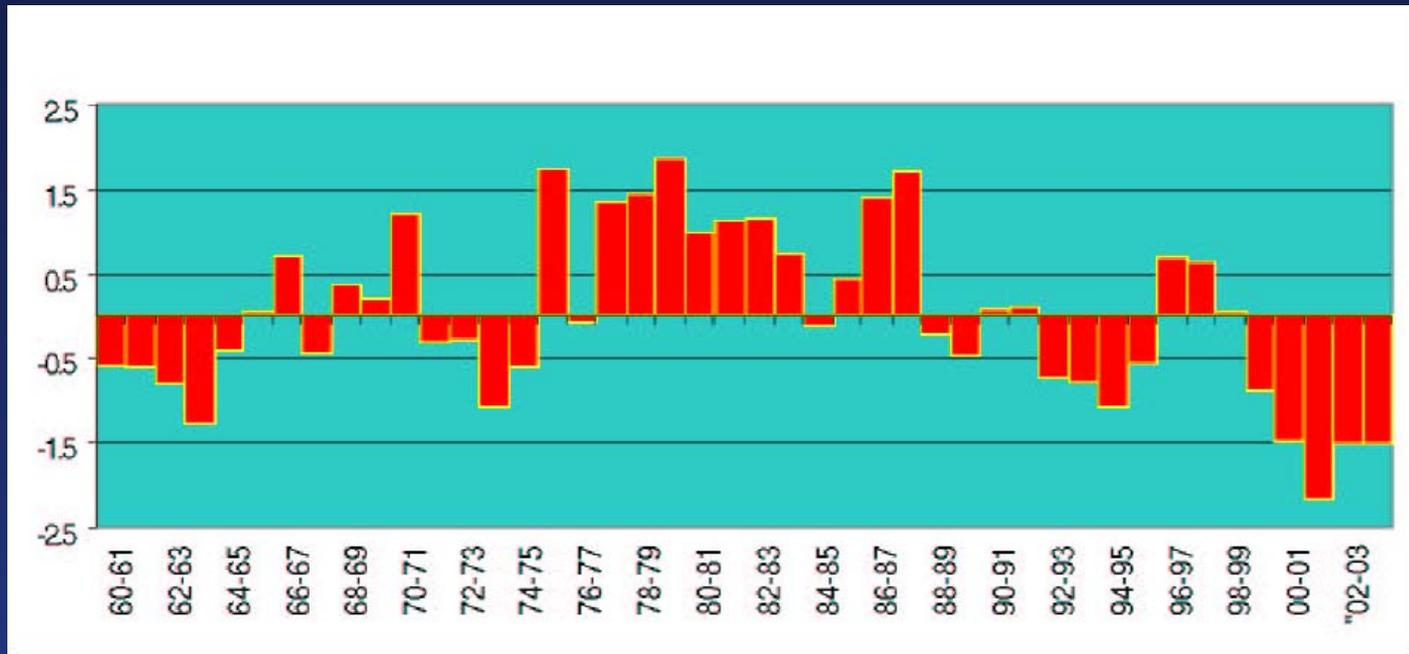


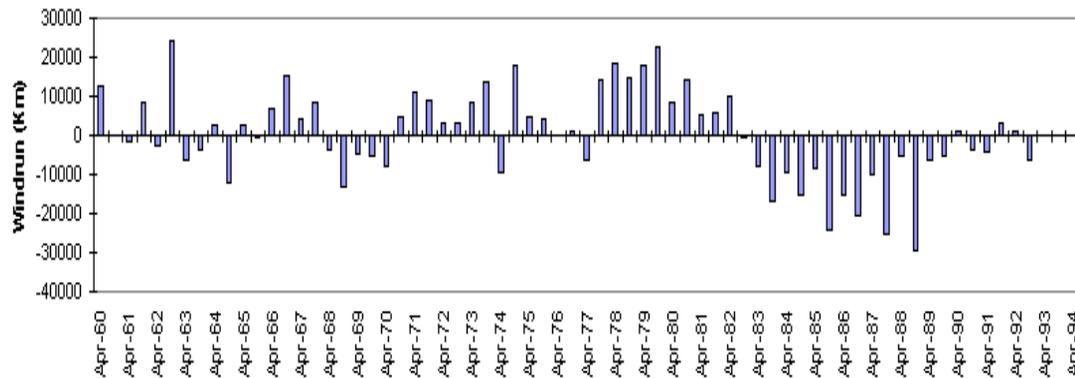
Figure 4: Cumulative SST anomaly over the Namibian shelf (satellite derived).



Upwelling Favourable Wind Anomalies at Diaz Pt. (Lüderitz)

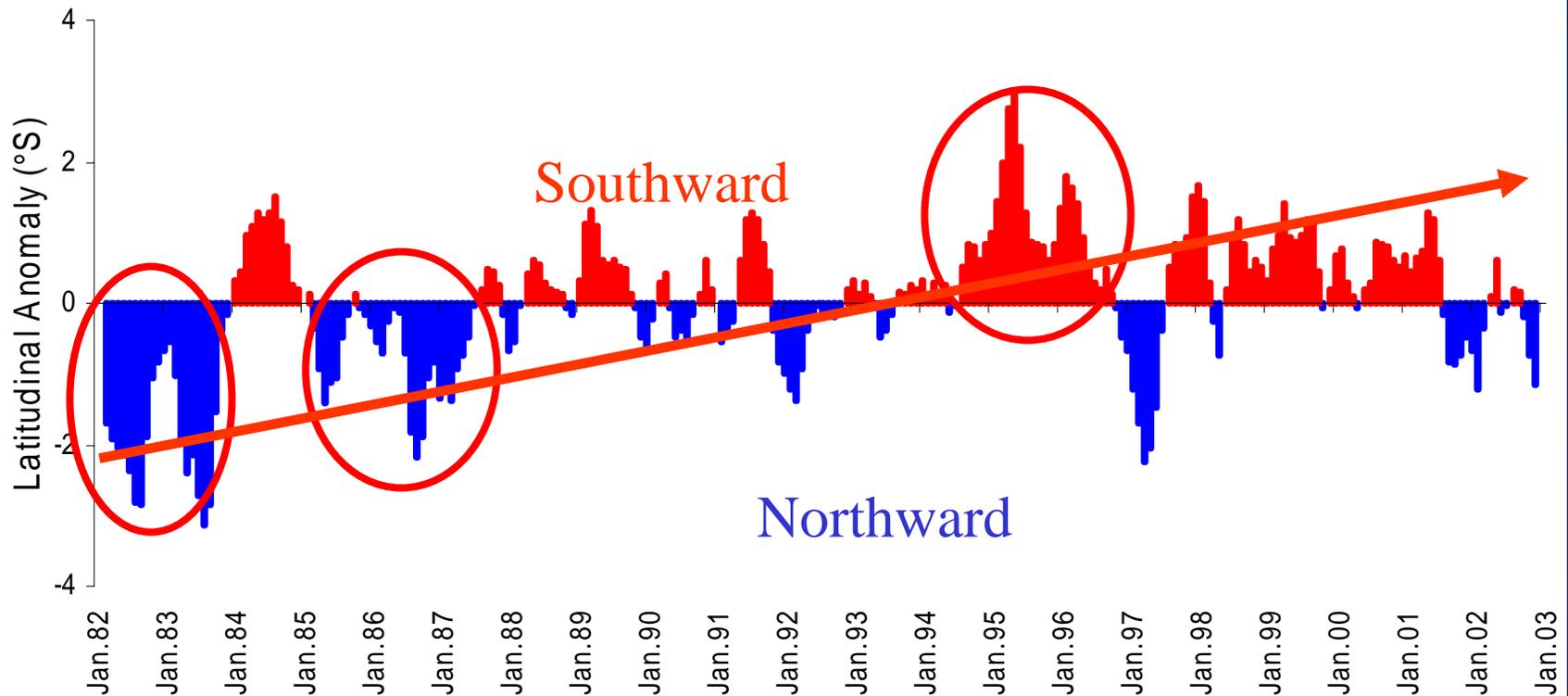


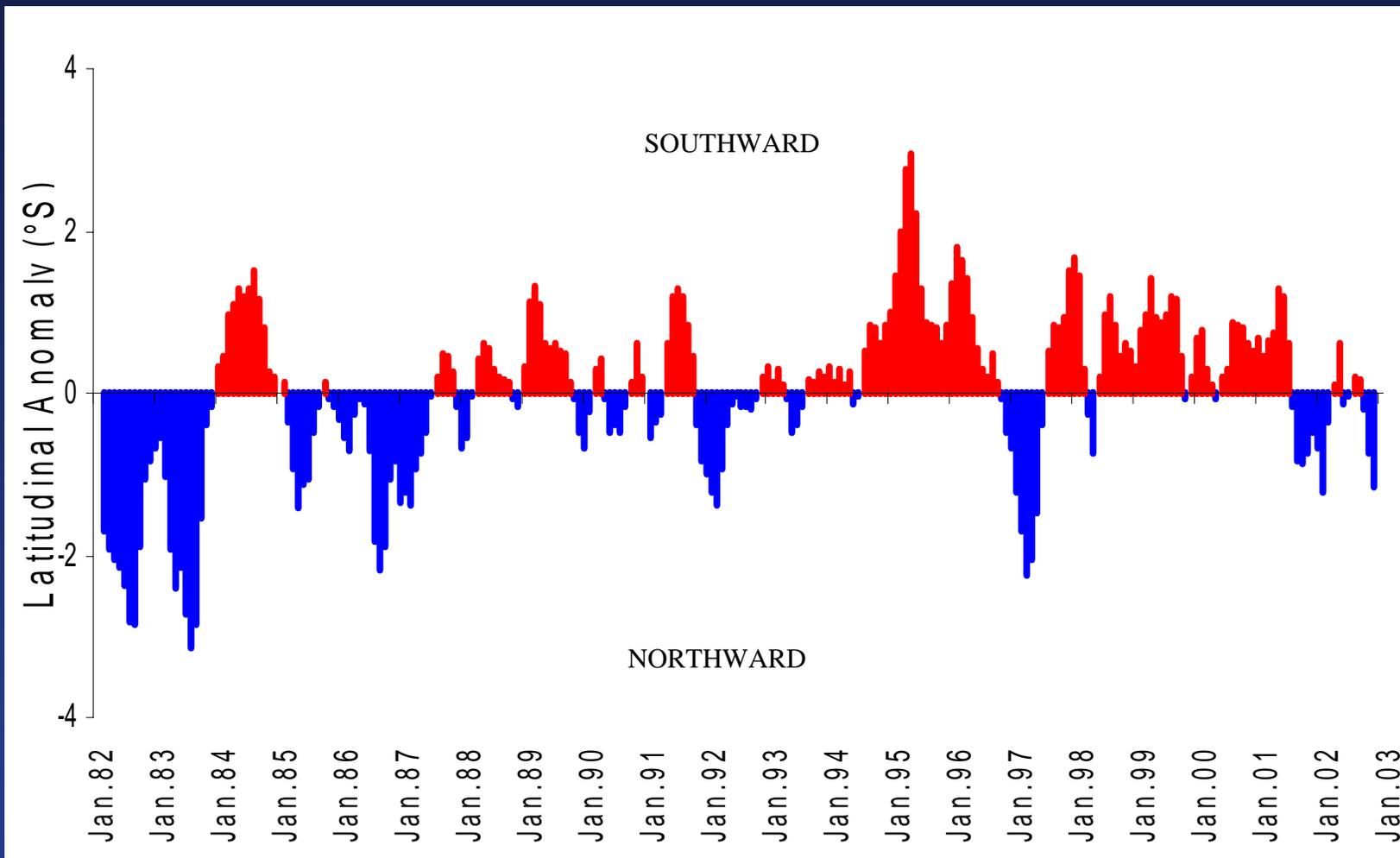
Cape Columbine summed windrun anomalies - summer & winter N/S



Angola Benguela Front Shifts

ABF – the front that separates the Angola & Benguela systems occurs between 15 and 17°S



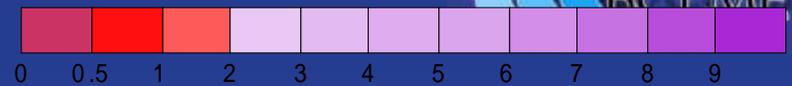
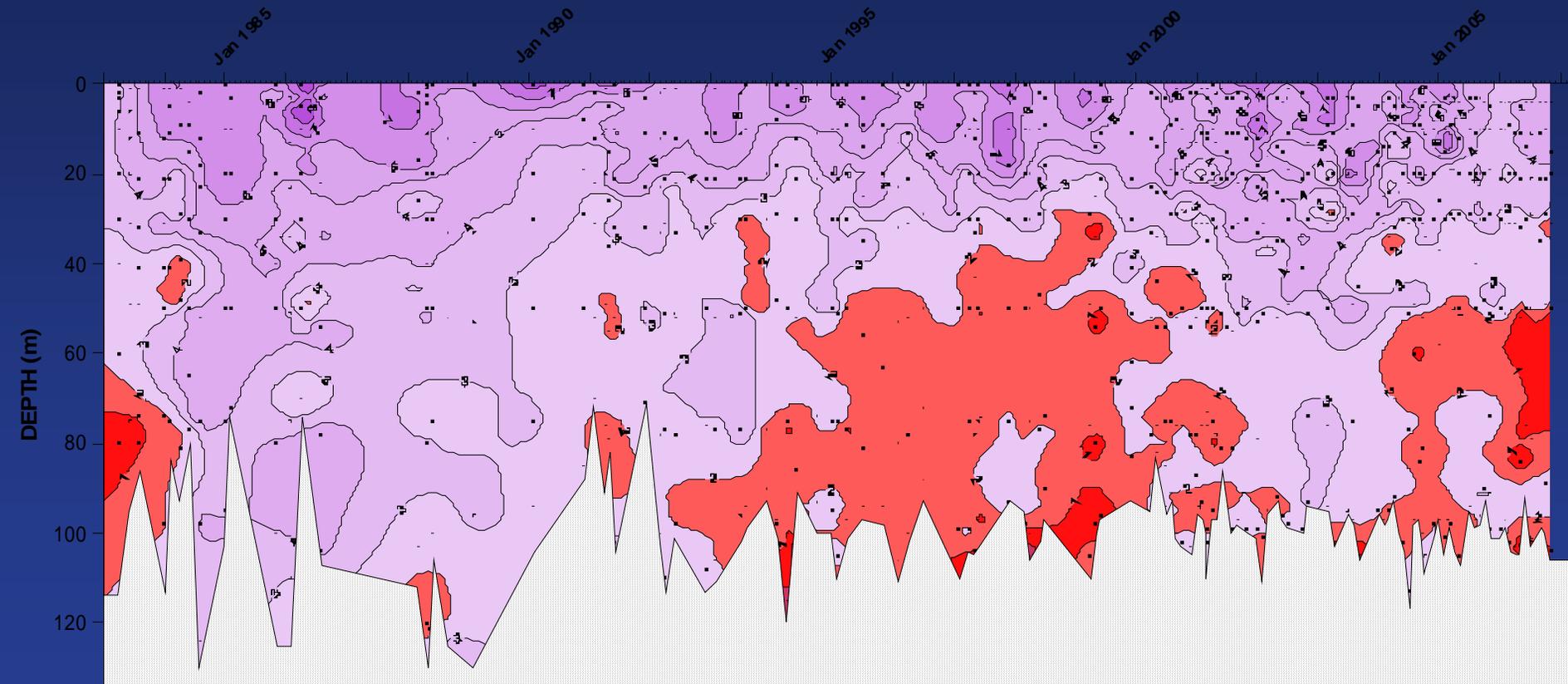


MOVEMENT OF THE ANGOLA-BENGUELA FRONT

CAPE COLUMBINE OXYGEN TIME SERIES, 100M STATION, 1982-2006

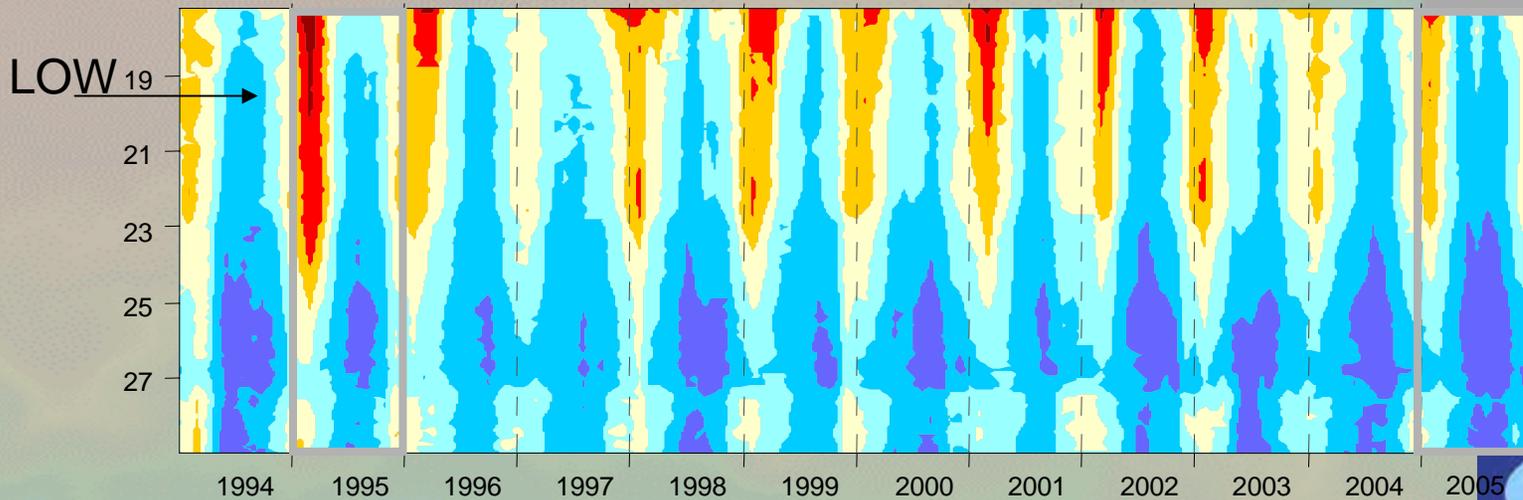
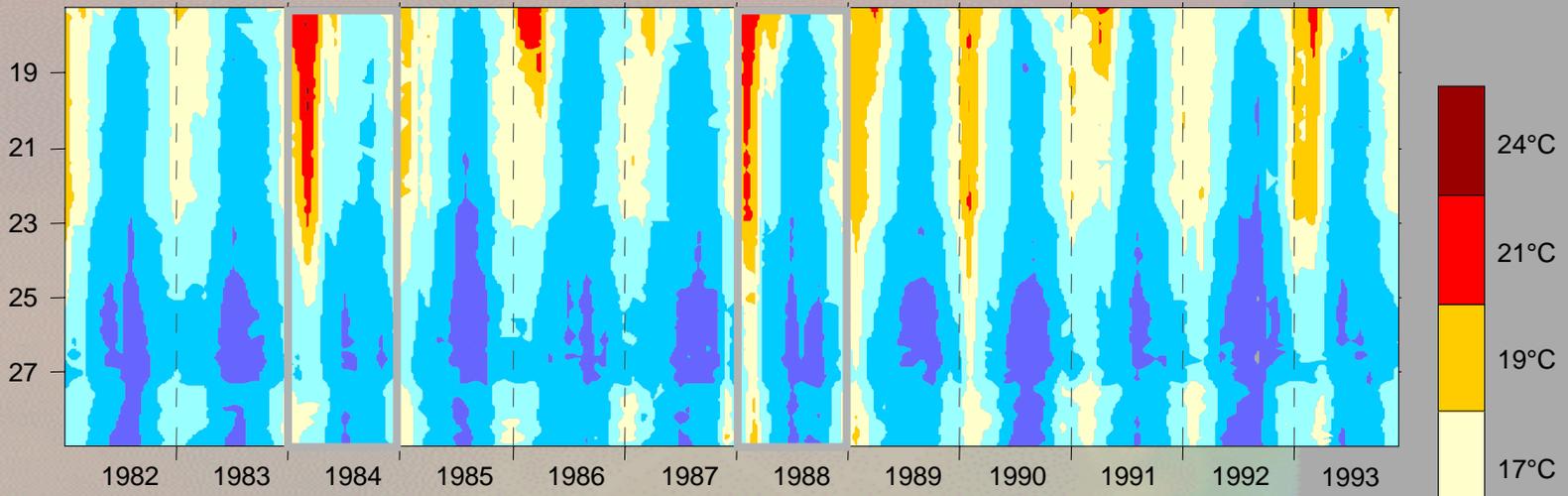
TIMESERIES
March 1983 - October 2006

OXYGEN



1994 / 1995 Benguela Nino

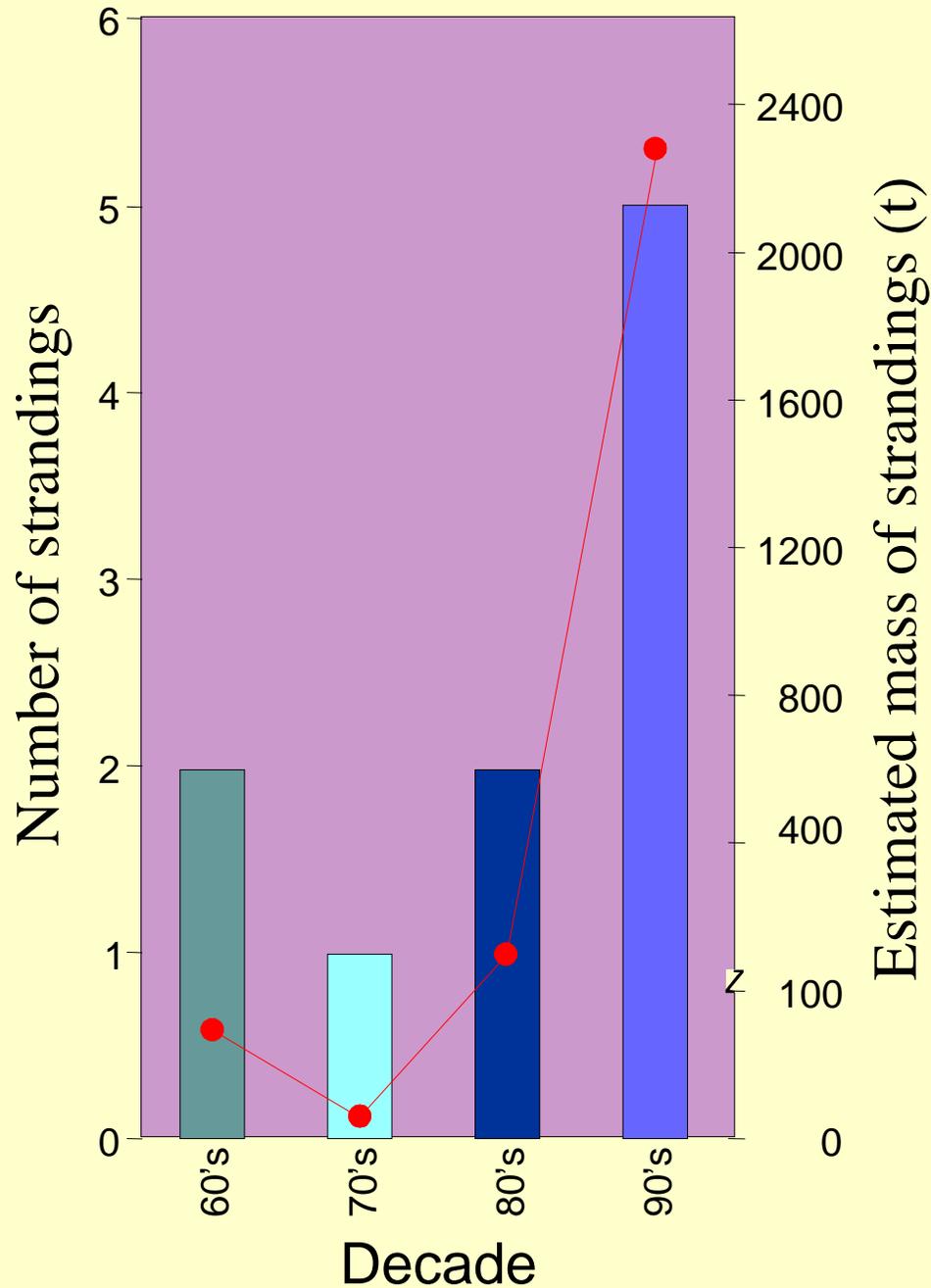
January Mean SST



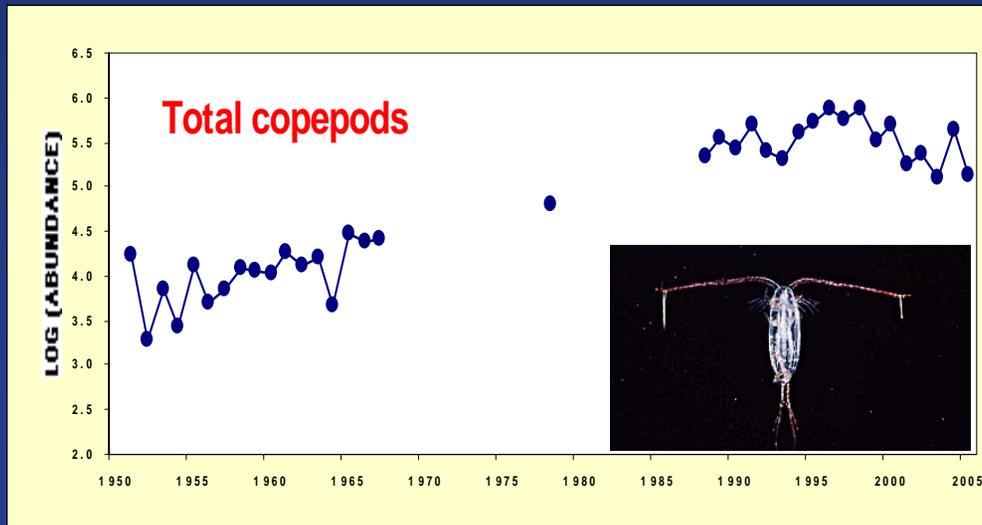
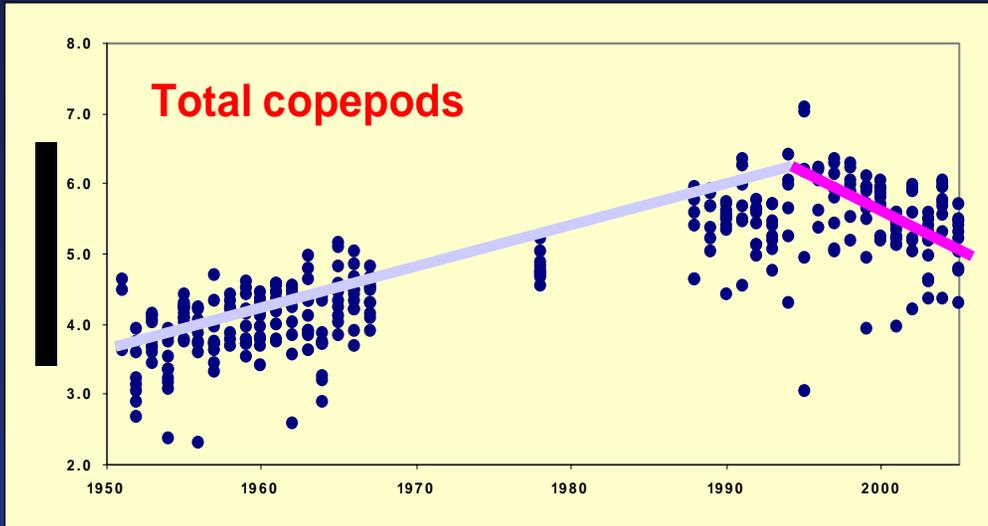


Other Indicators

“Walkouts” in Elands Bay

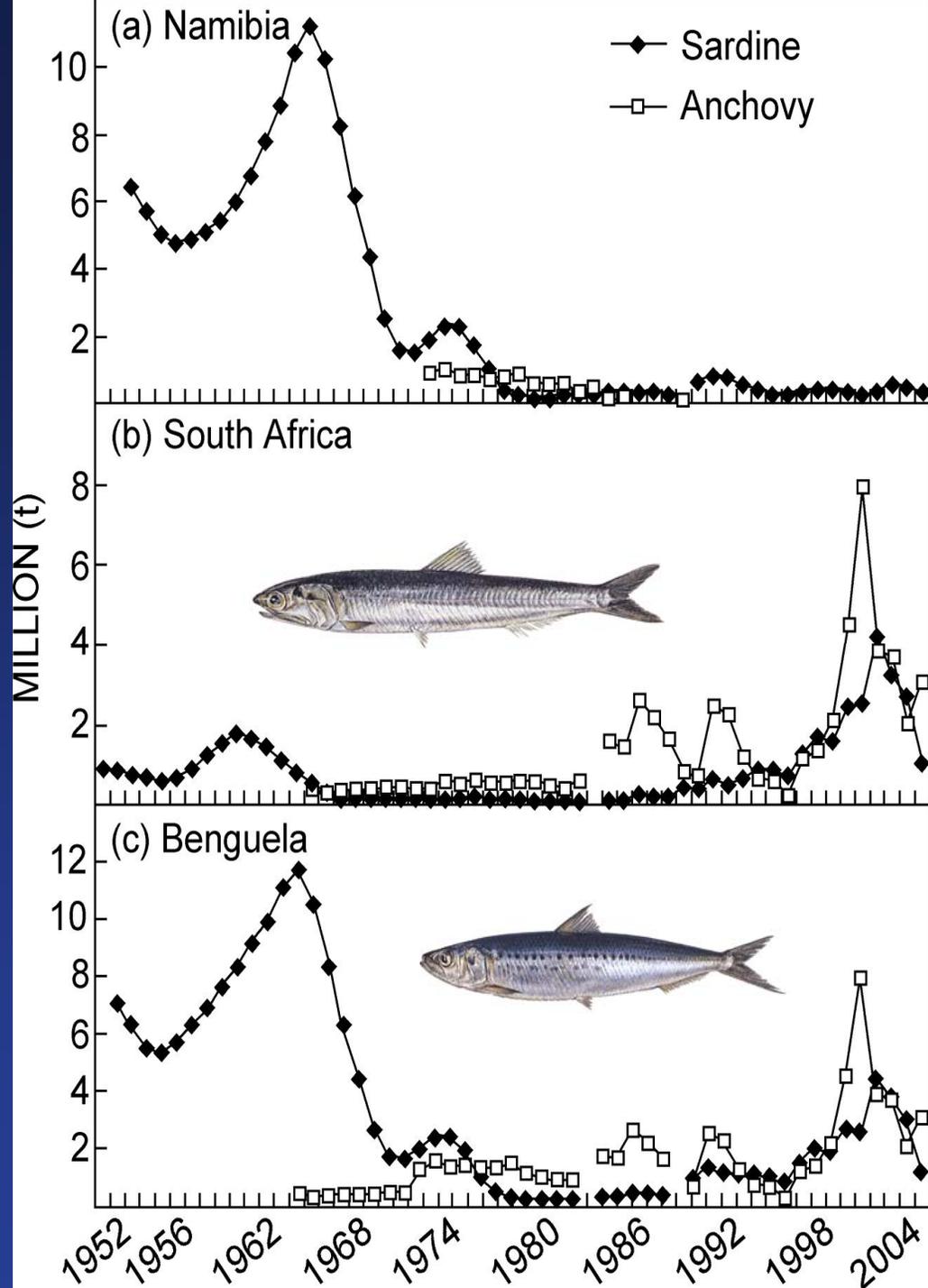


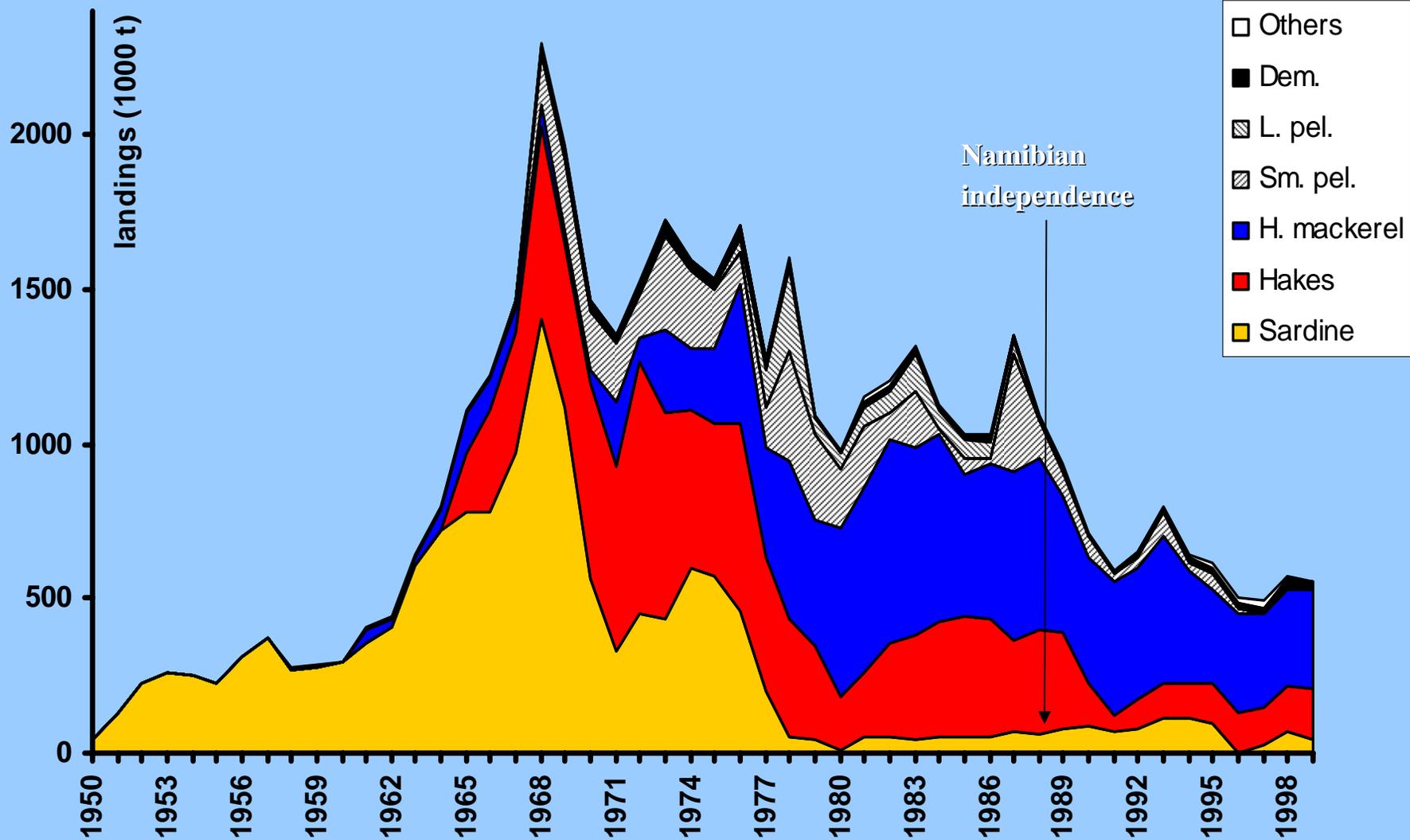
Updated zooplankton (copepods) time-series in St Helena Bay, 1951-2005



- initially, a long-term, 100-fold increase in copepod abundance from 1950s until mid-1990s;
- thereafter, reversal to downward trend.

Biomass



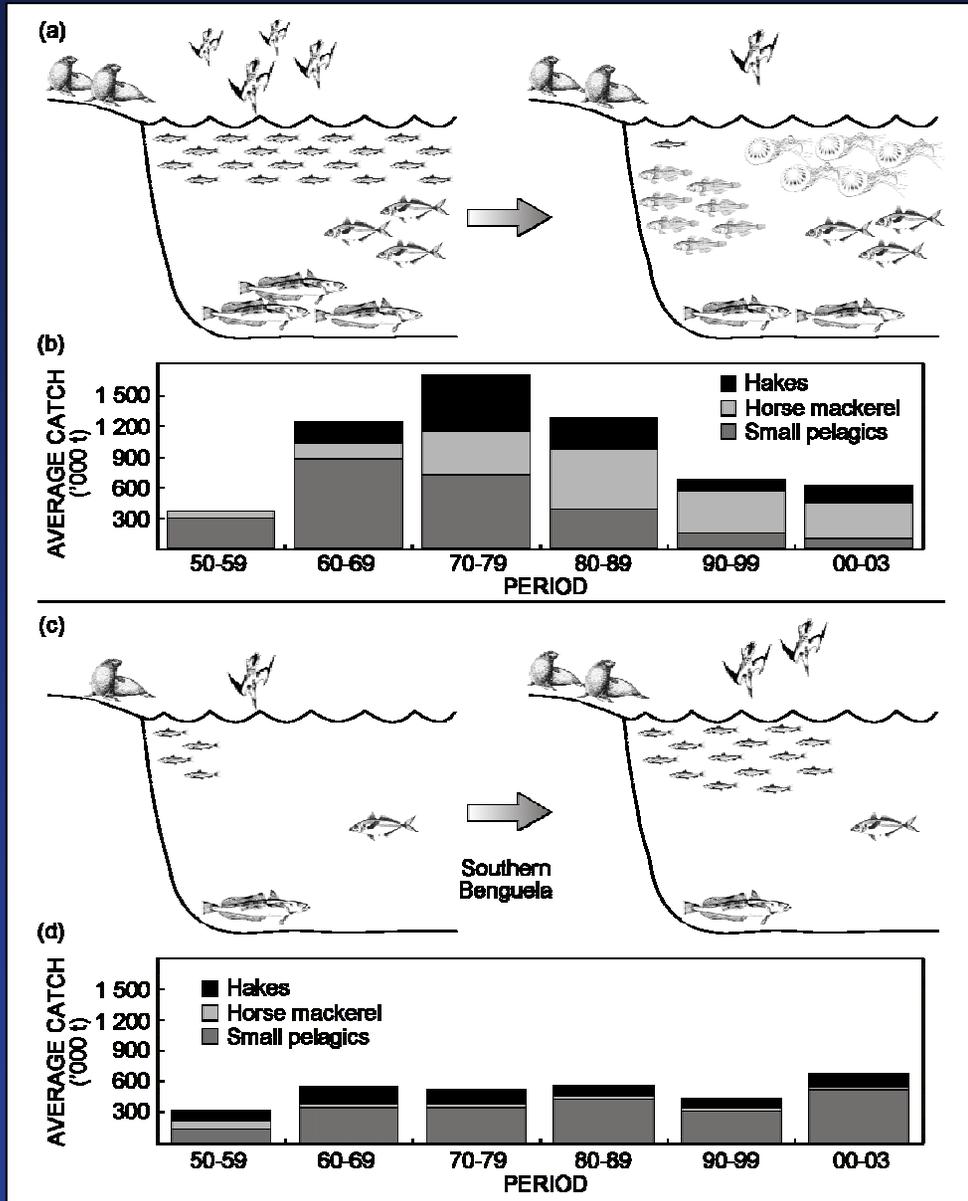


Trends in Namibian fish catches (1950 – 1999)



Ecosystem-level change has been documented in the BCLME, e.g.

Northern Benguela



Change from anchovy-sardine to goby-jelly dominance; much reduced seabirds and reduced fishery catches

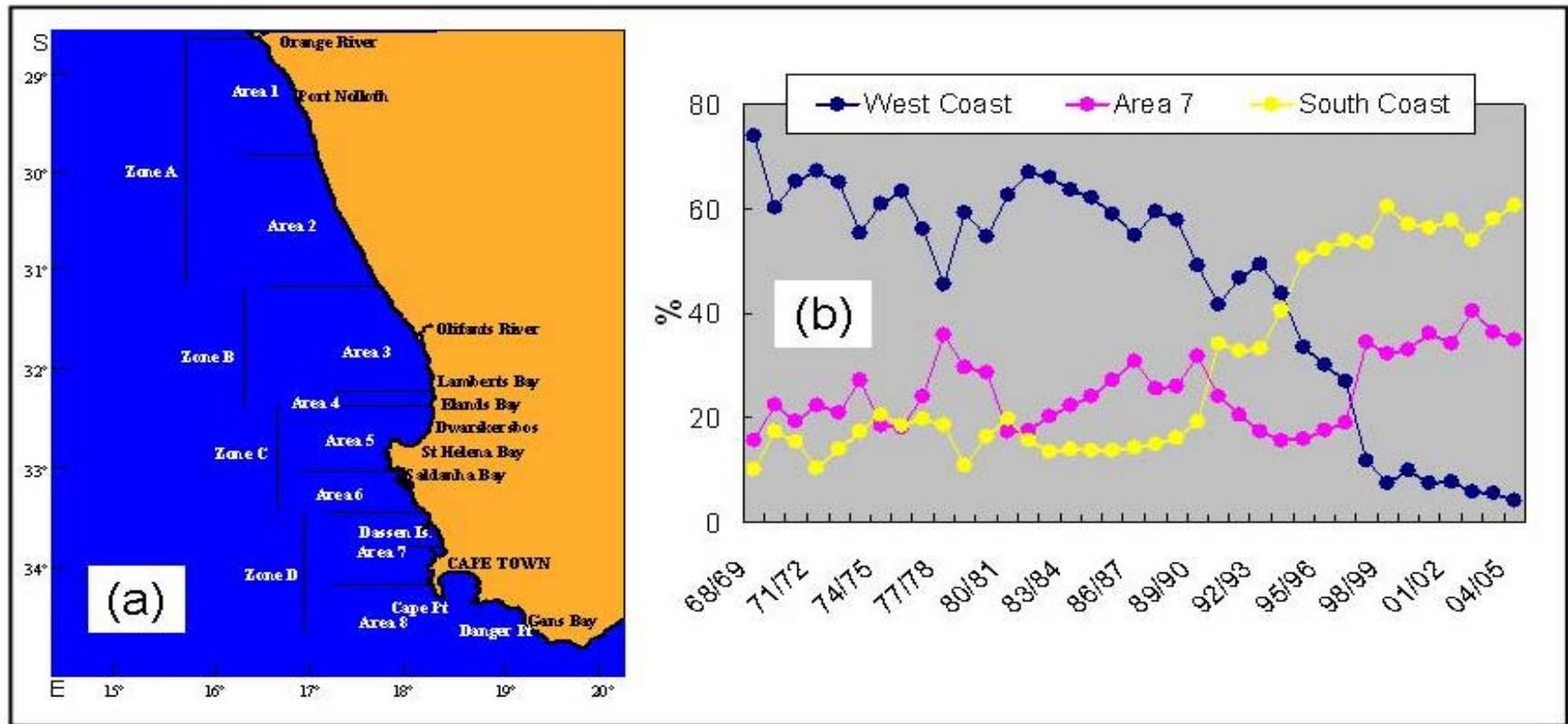
Southern Benguela

Change to abundant small pelagics, seals and seabirds.



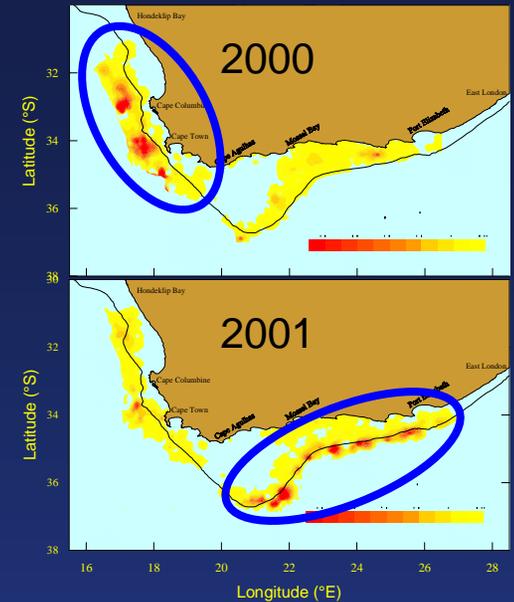
Documented change: Southern Benguela

South coast increasingly important to West Coast rock lobster from early 1990s



Variability in distribution (eggs):

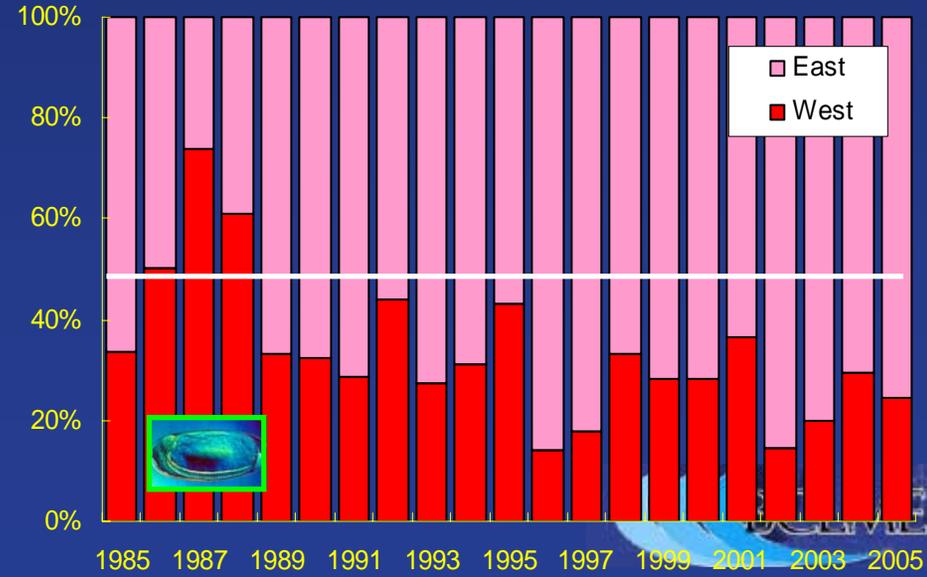
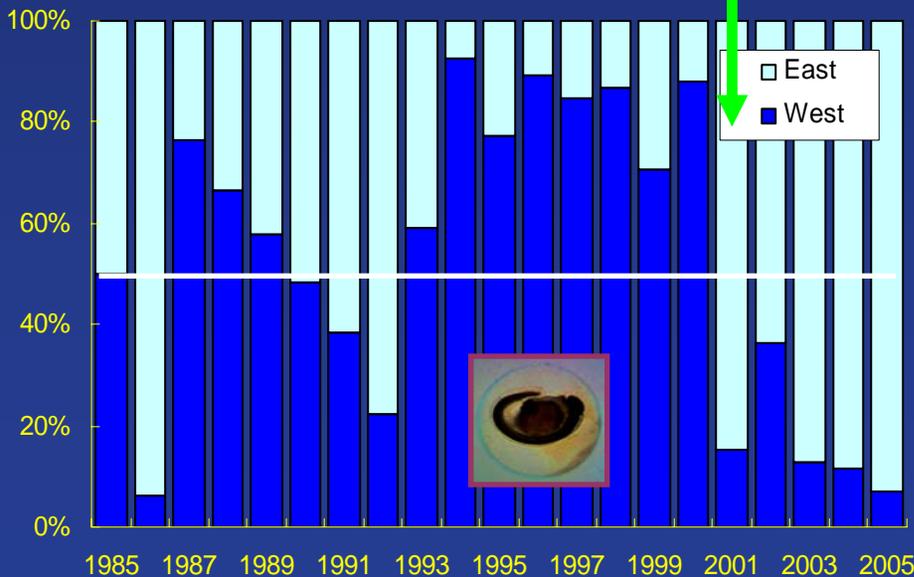
- Sub-decadal-scale changes in the relative distribution of sardine eggs with both the WC and SC being important spawning areas at different times
- Dramatic shift from WC spawning to SC spawning by sardine in 2001, and currently no spawning off the WC – decadal-scale change? (sardine spawned off the WC in the 1960s)
- Decadal-scale(?) trend to increased south coast spawning by anchovy (due to WC eggs in 1987 and 88?)

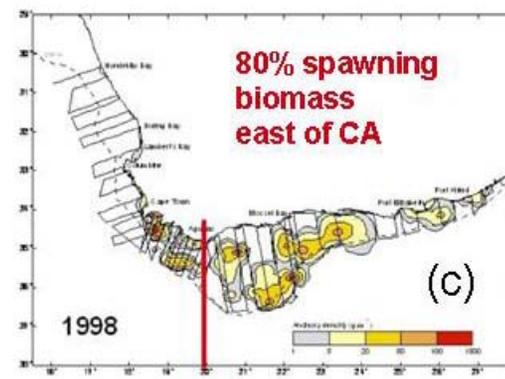
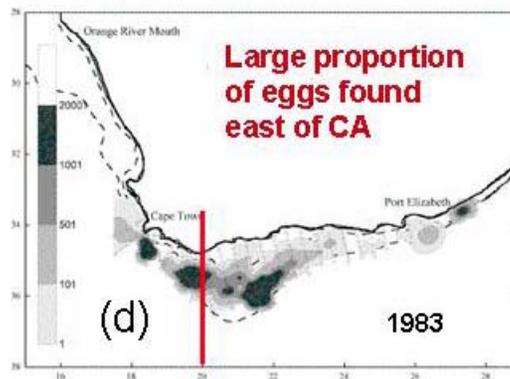
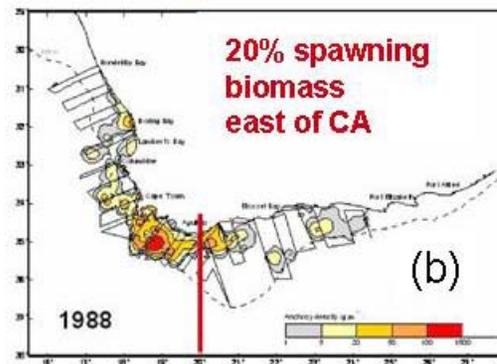
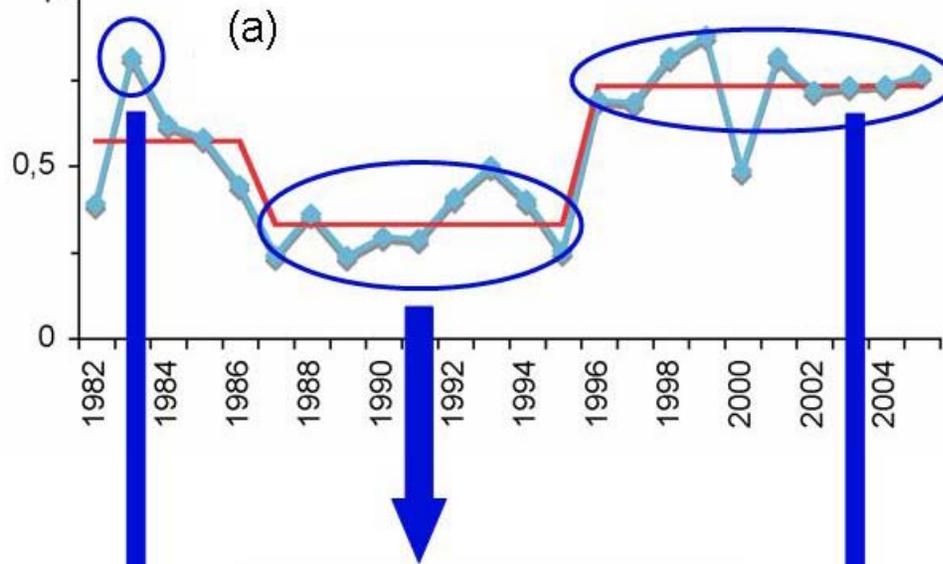


Sardine

2001

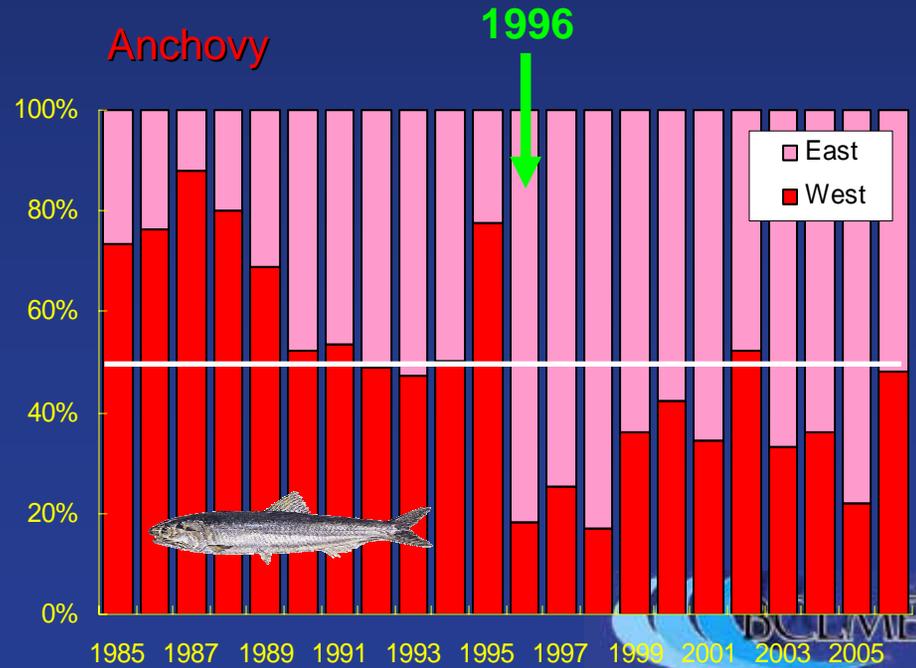
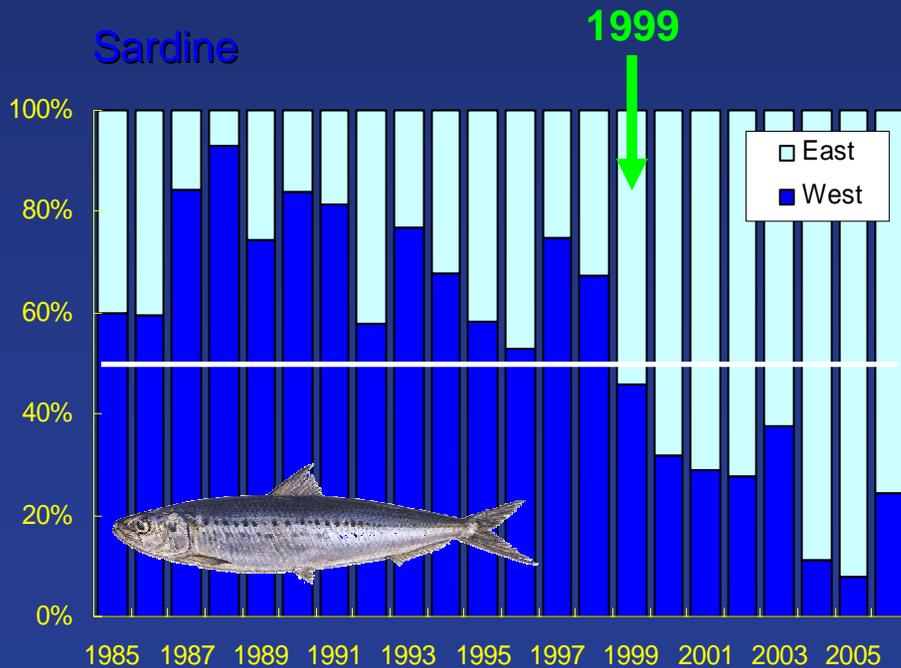
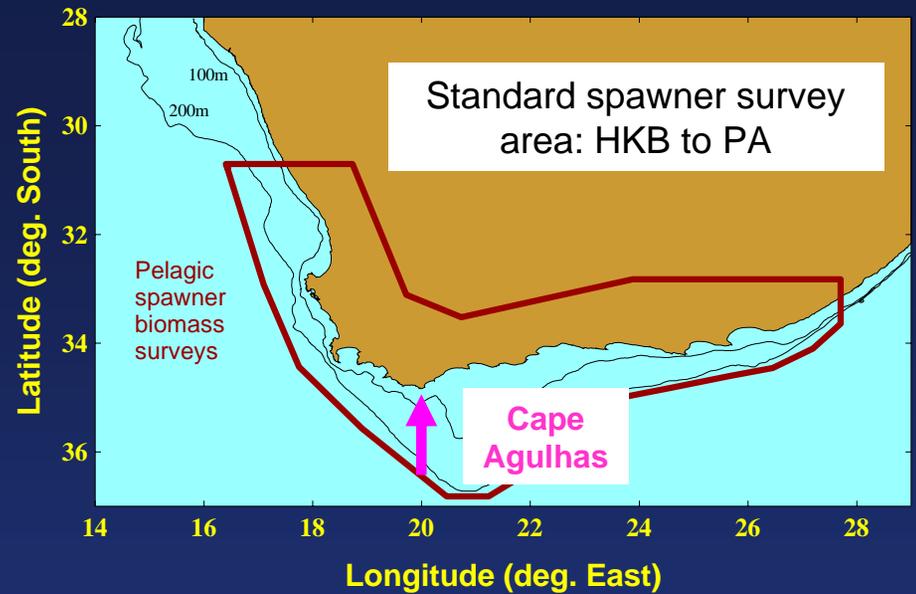
Anchovy



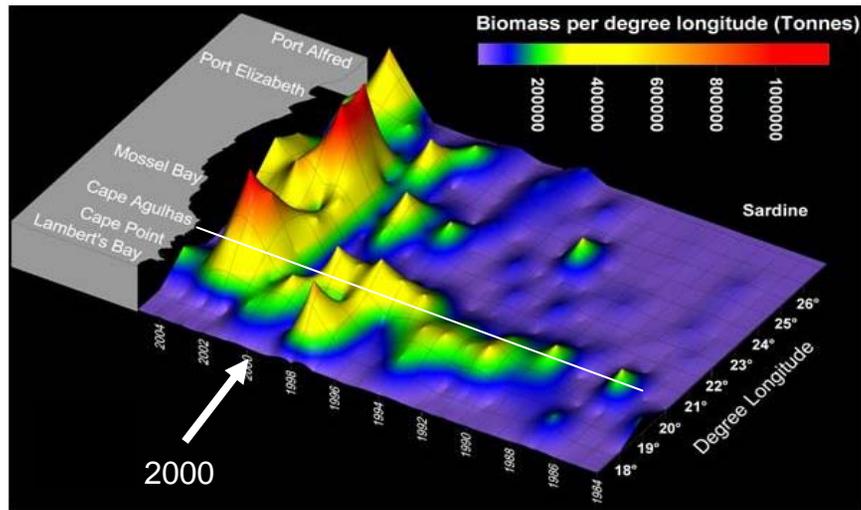


Variability in distribution (spawners):

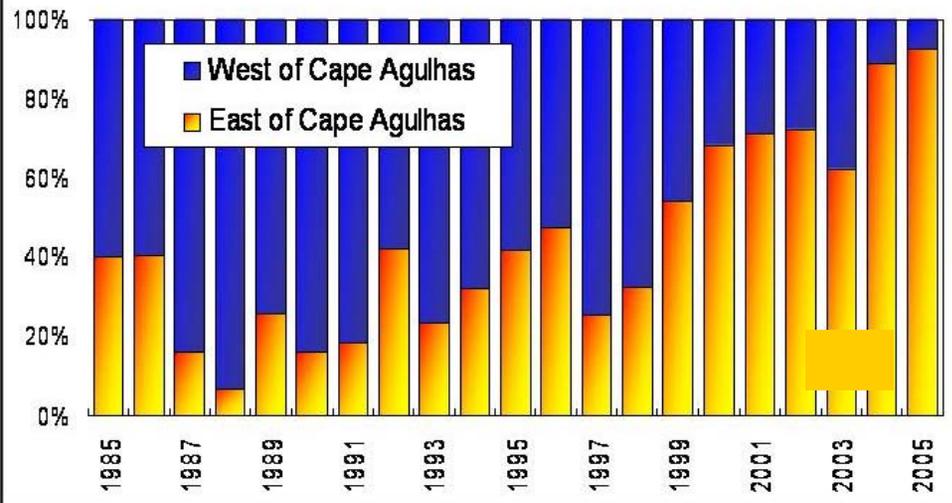
- Decadal-scale changes in the relative (% of total) distribution of sardine and anchovy, with both species showing an eastward shift in spawner distribution
- Sardine - steady change in distribution, with %B east of CA > %B west from 1999
- Anchovy - abrupt shift from W>E to E>W in 1996

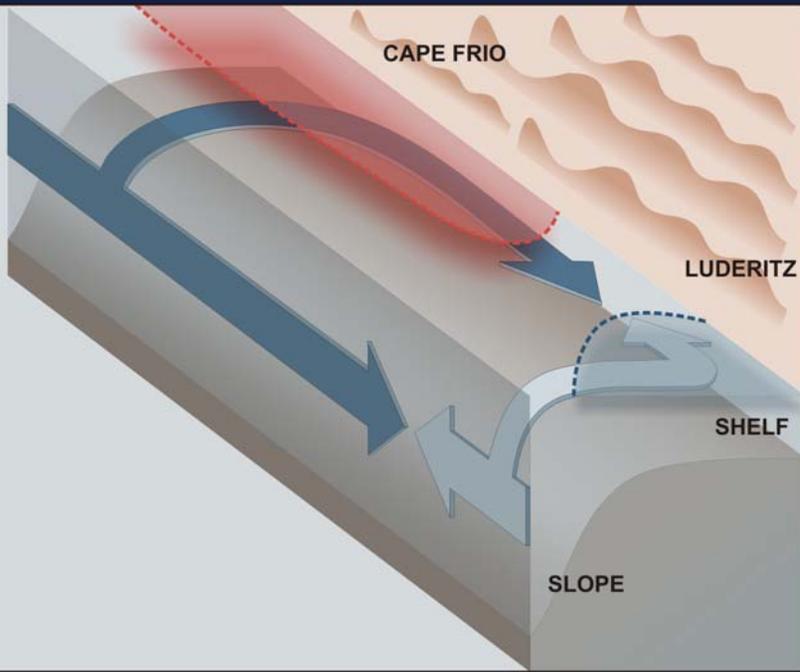


Documented change: Southern Benguela

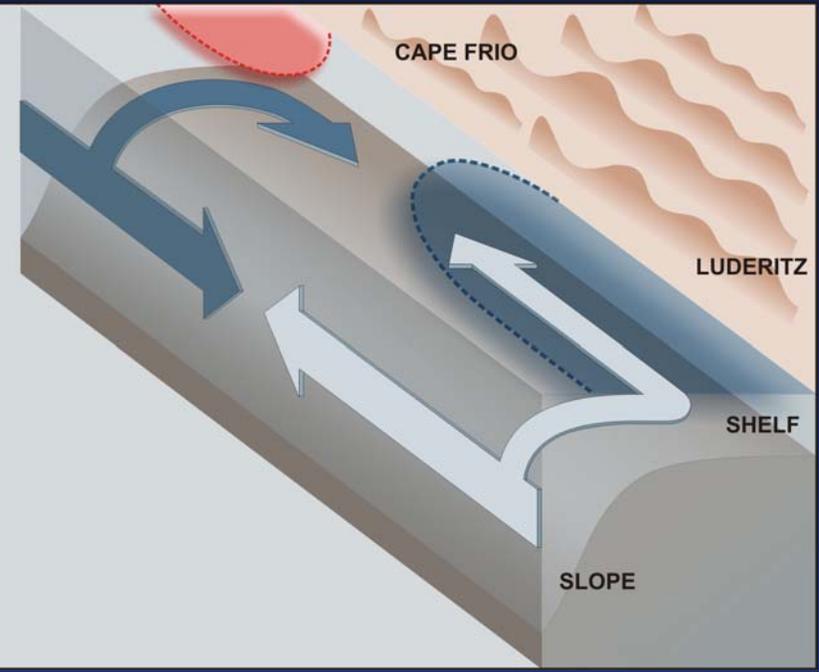


Sardine moves to south coast in the mid-1990s



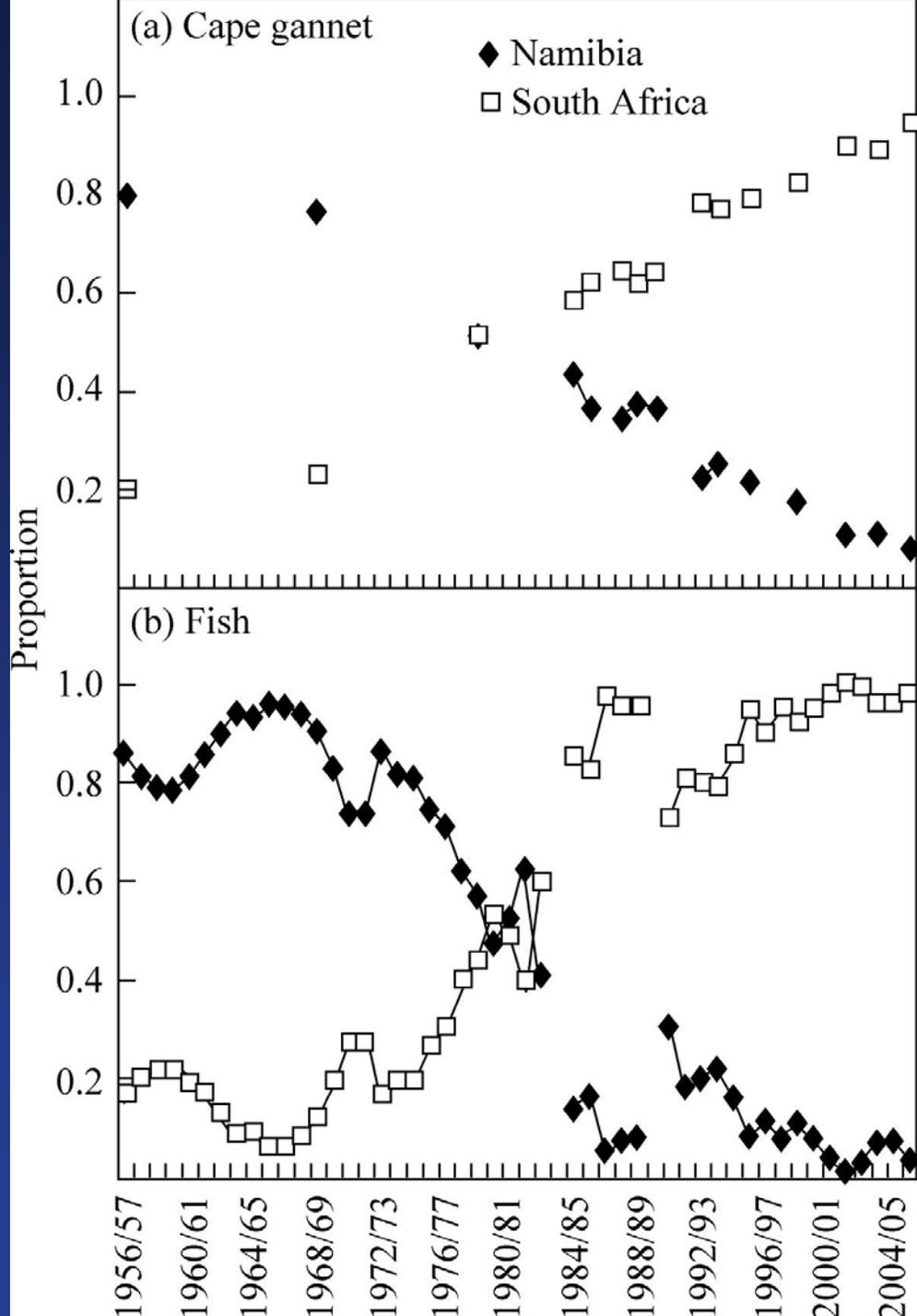
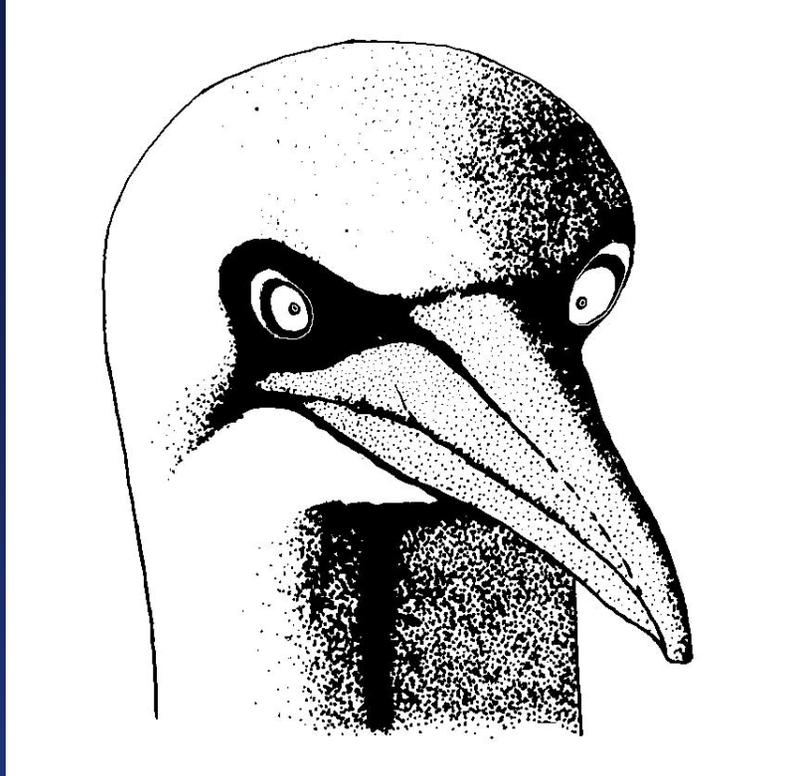


(Benguela Niño
Death Scenario)

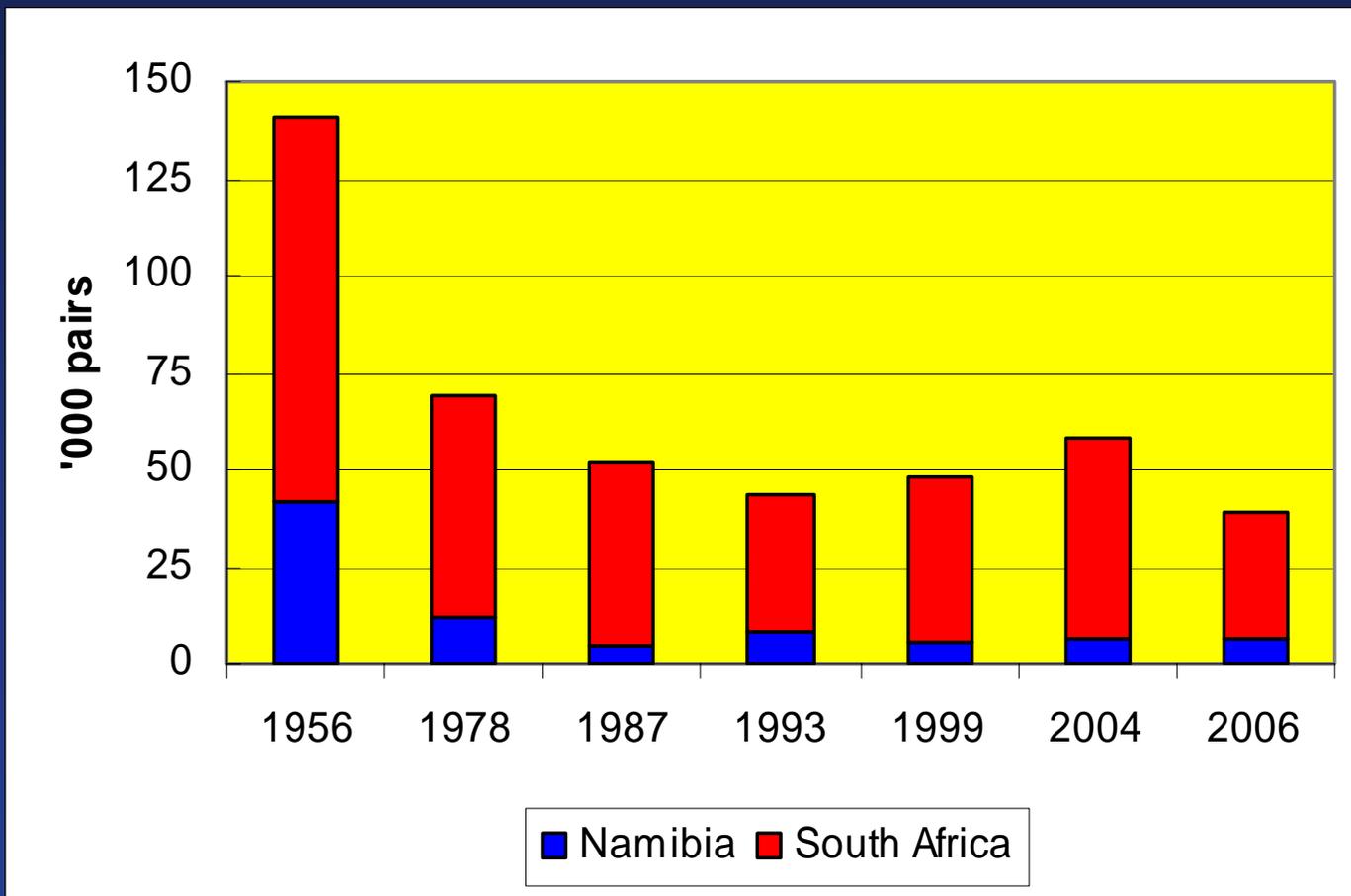


(Benguela Niña re-
animation Scenario)





African Penguin overall population





Conservation

1930s:

Eberlanz

Museum,

Lüderitz



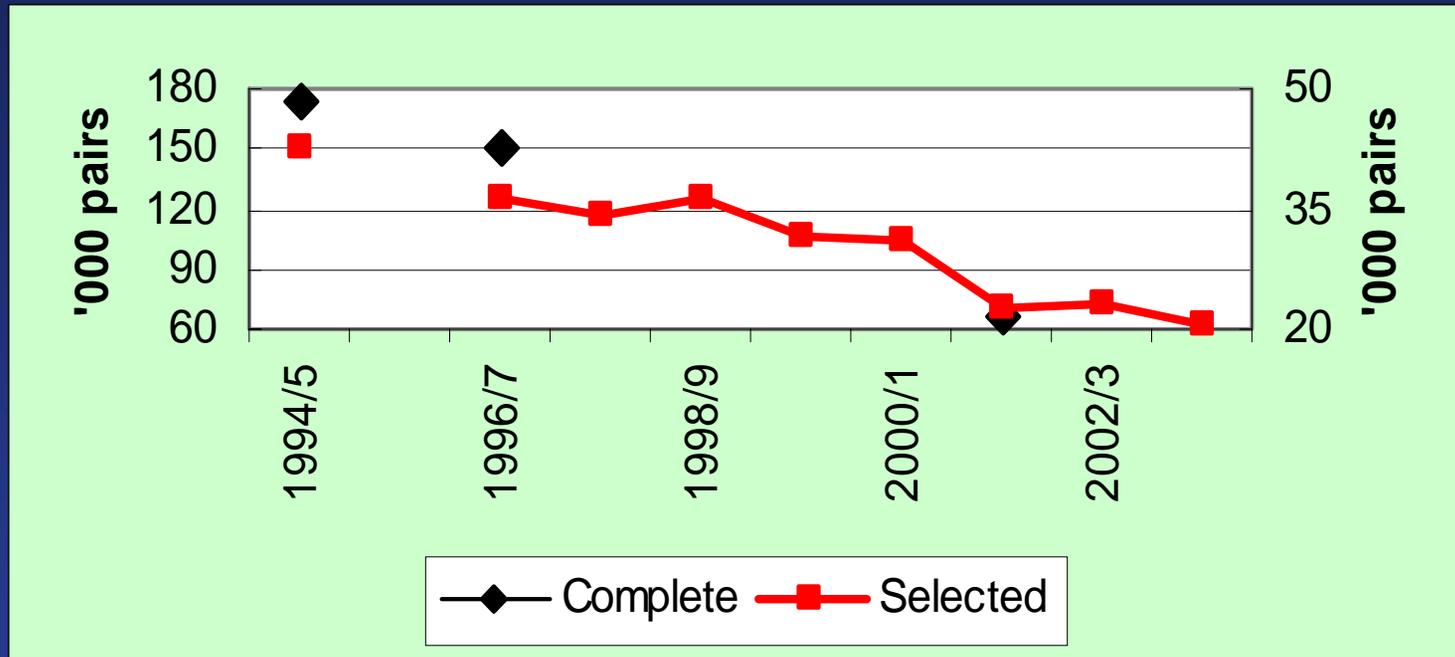
2004:

J Kemper

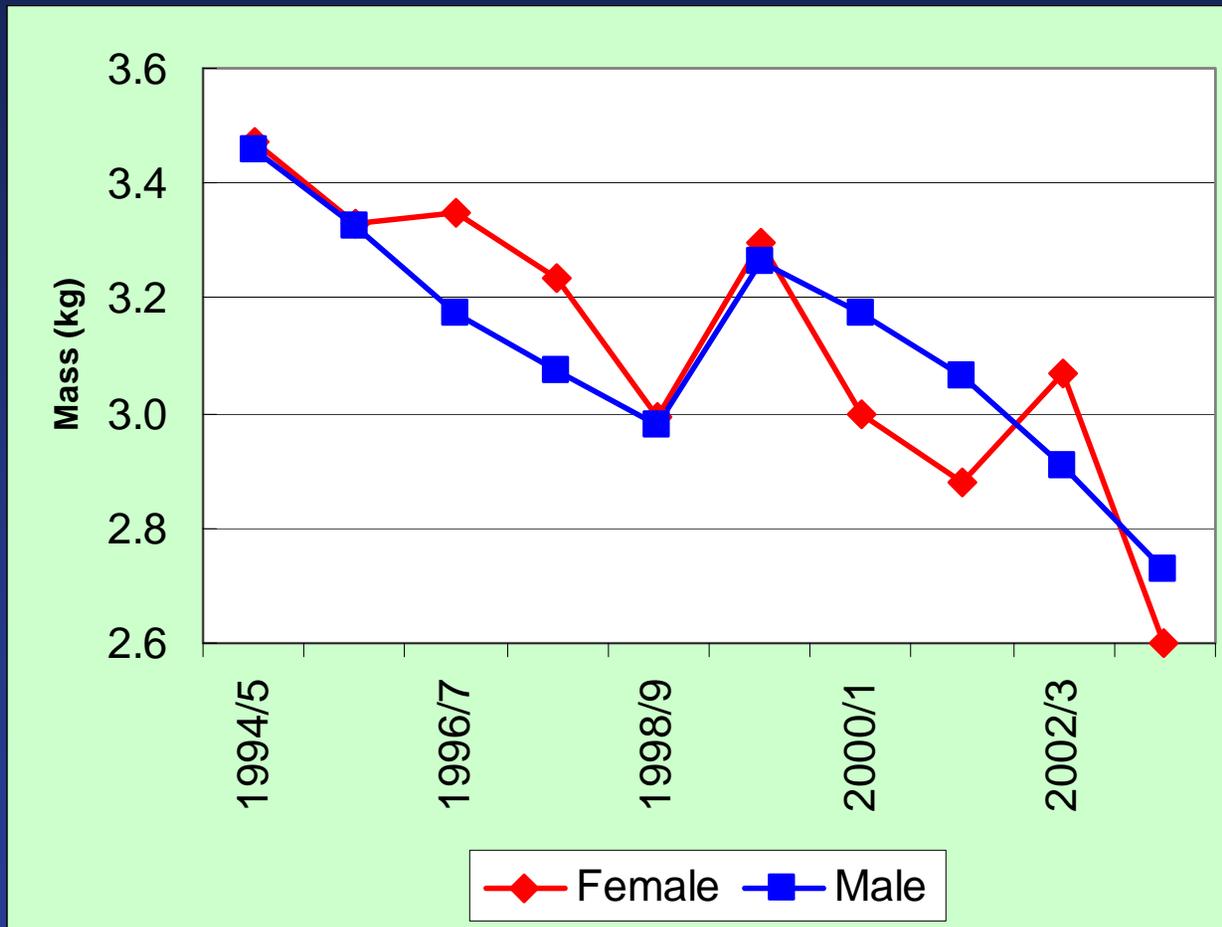
Halifax Island

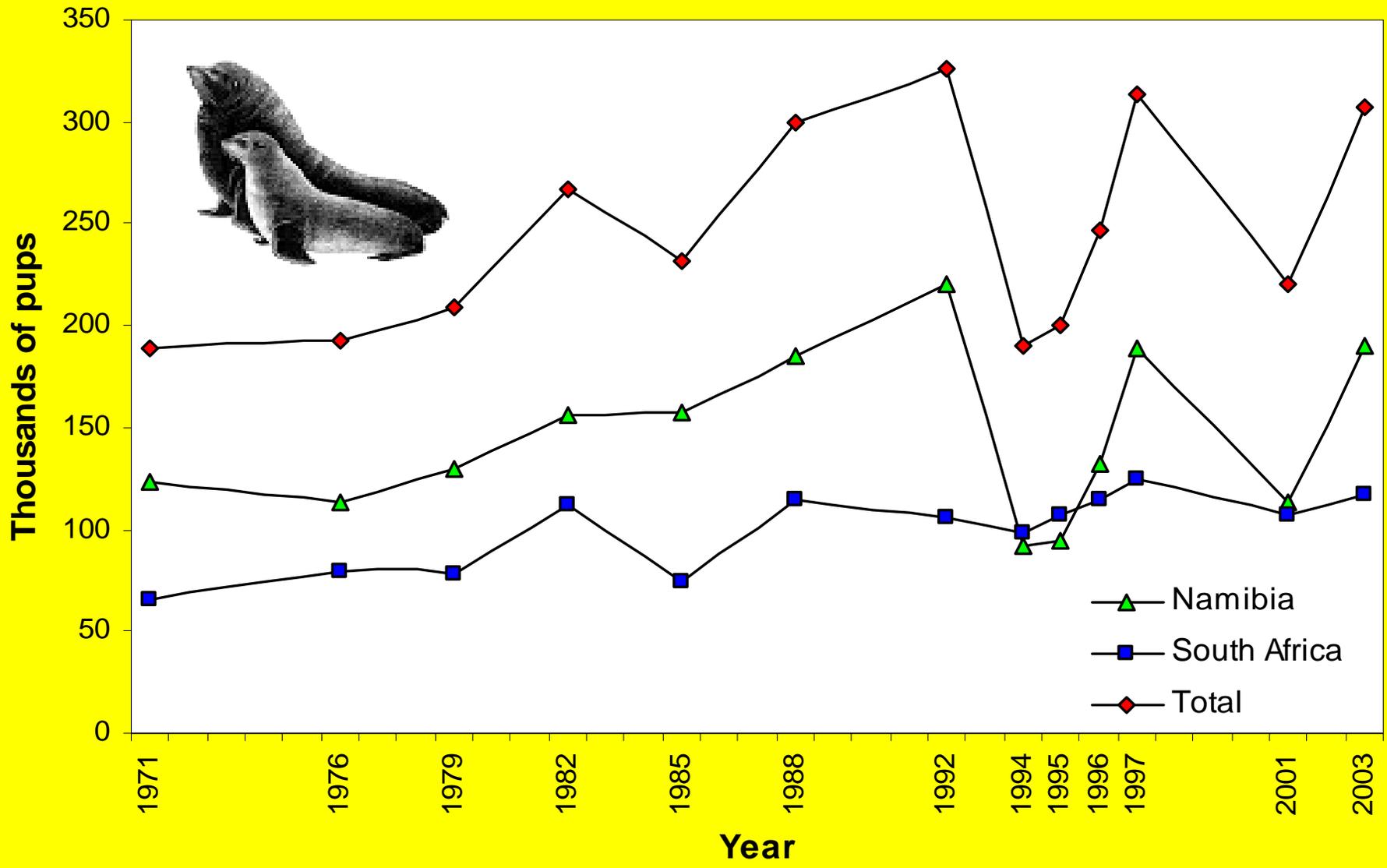


Rockhopper Penguin at Marion Island



Rockhopper Penguin mass on arrival at Marion Island



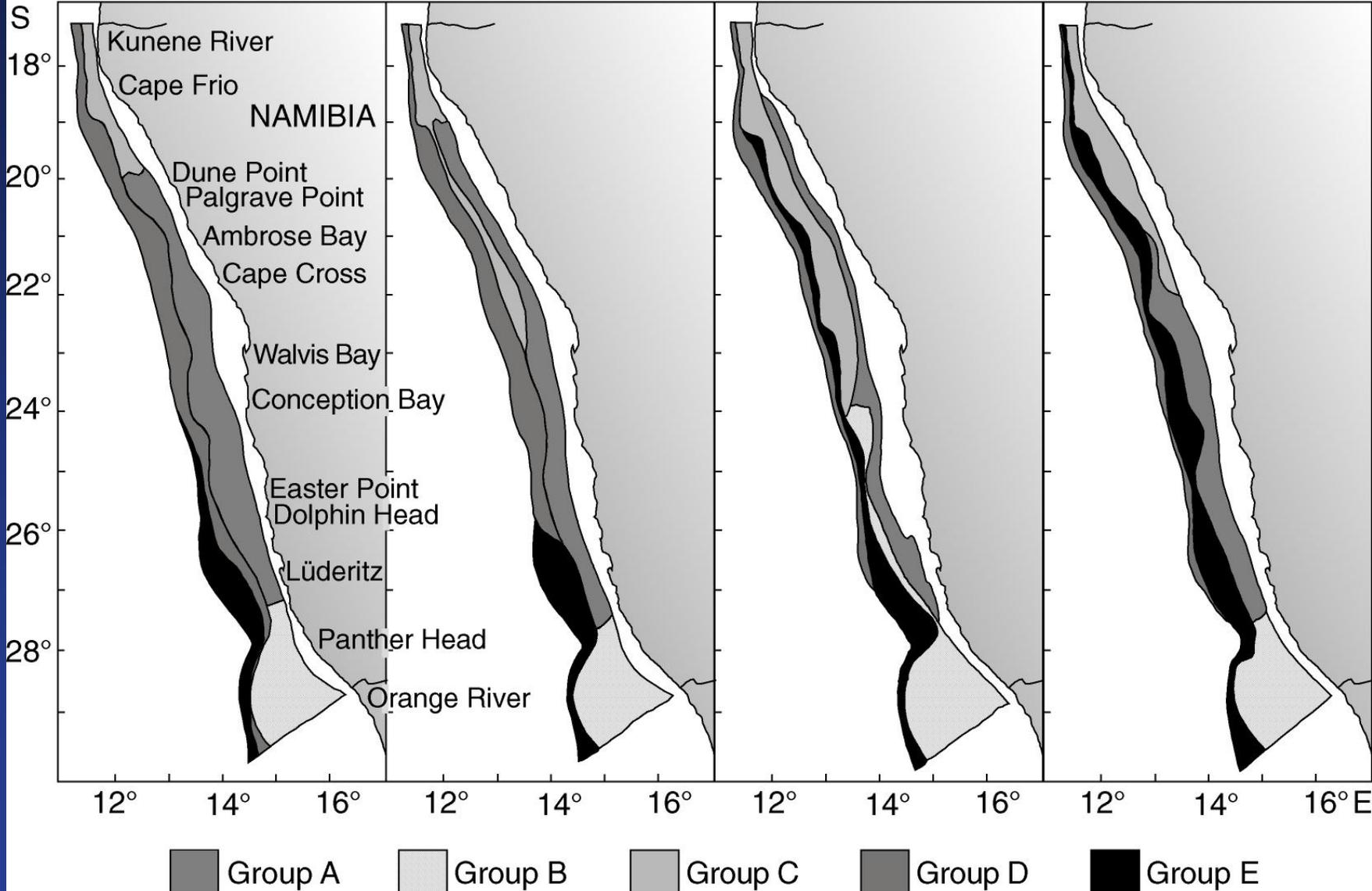


Trends in seal pup numbers in the BCLME region



a) **OCT. 1992** **JAN. 1993** **JAN. 1996** c) **OCT. 1996**

d)



Variability and Impacts of Change in the BCLME (50 years)

Physical Environment

- rise of 1°C in SST (coastal and offshore)
- 5 major Benguela Nino's warm events
- Poleward propagation of major hypoxia in northern Benguela in 1994 –ecosystem collapse
- Frequent eruption of hydrogen sulphide in coastal waters of Namibia – toxic and fish mortalities

Variability and Impacts of Change in the BCLME (50 years)

Phytoplankton and Zooplankton

- Decadal changes indicating increase in phytoplankton abundance from 1980-2000
- 100 fold increase in zooplankton abundance estimates (western Cape) from 1950 - to 1995
- Seasonal cycle of zooplankton biomass has altered
- Copepods more abundant off Namibia compared with 20 years ago
- HABs increasing in frequency in BCLME – uncertain links to climate change: negative consequences



Variability and Impacts of Change in the BCLME (50 years)

Living Marine Resources

- Large decrease in epi-pelagic fish resources in Namibia 1960-1990 (7.5 million tonnes to 0.7 million tonnes)
- Disappearance of anchovy following collapse of sardine fishery in Namibia; increase in horse mackerel, gobies and jellyfish
- Decline in penguins and gannet by 85% in Namibia
- Spectacular sardine recovery in Southern Benguela in the early 1990's
- Recent marked shifts in distribution of sardines and rock lobster around to eastern Cape

Variability and Impacts of Change in the BCLME (50 years)

Socio-economic consequences

- Collapse of sardine and rock lobster fishery in Namibia during 1960s-1970's : decimated canning industry, large job losses
- Harm done to hake resources in Namibia (hypoxic event – failure to recover despite conservative mgt.
- Economic and job losses (rock lobster mortalities and HABs)
- Eastward spread of pelagics – impacts on processing industry, jobs and fish quality
- HABs and developing mariculture industry (threats of markets, jobs and development)



THE BENGUELA CURRENT COMMISSION

INTERIM AGREEMENT

**Endorsed by South Africa and Namibia
29th August 2006, Cape Town: Angola,
31st January 2007, Luanda**



BENGUELA CURRENT COMMISSION



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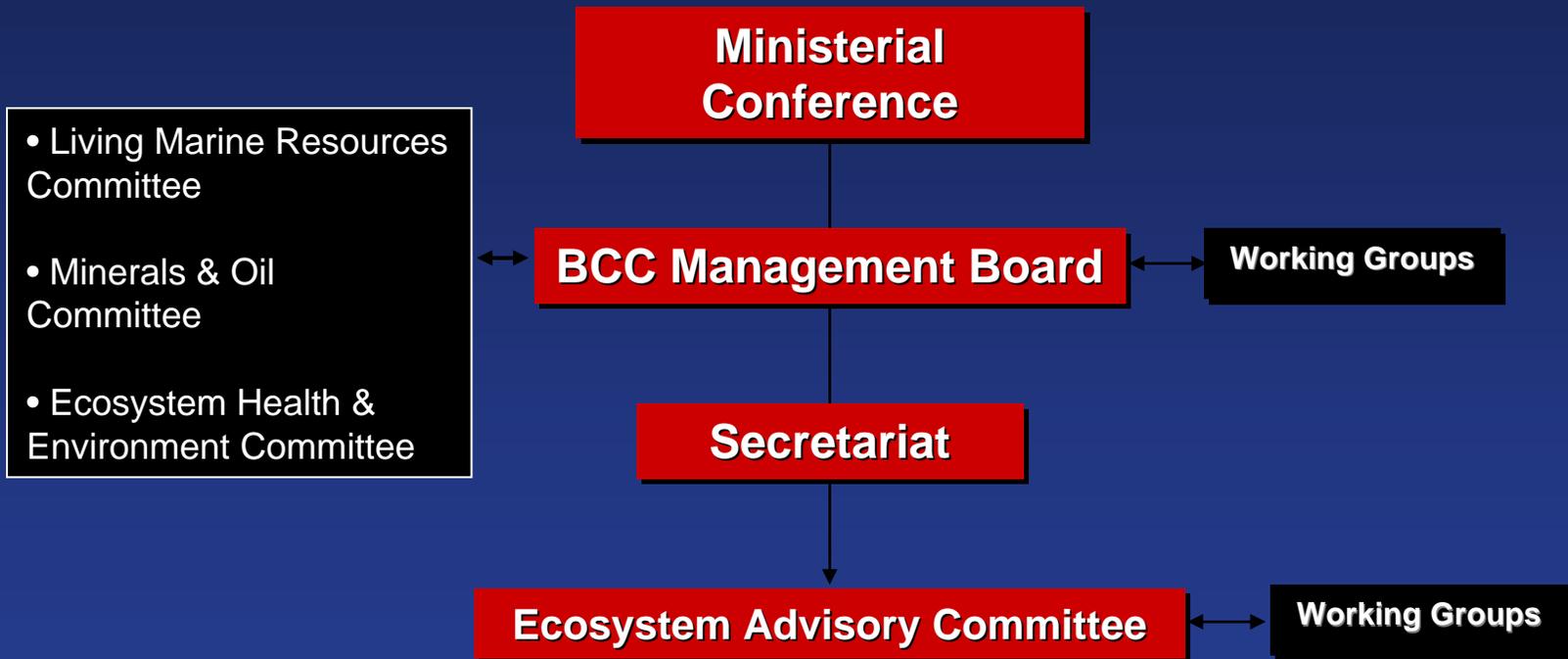


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The future of co-operative ecosystem management in the Benguela region of southern Africa

Benguela Current Commission Organogram



The future of co-operative ecosystem management in the Benguela region of southern Africa

Benguela Current Commission Mandate

Annex 1 (Article 7(9))

- MCS
- Transboundary Fish Stock Management
- Biodiversity Conservation
- CZM & ESBM – Intl. Obligations
- MPAs, Rehabilitation & Non-targeted spp. conservation
- Harmful Algal Bloom Management
- EIAs for regional items
- Industrial Impact Mitigation
- Regional contingency planning e.g. oil spills
- Implementation of regional standards and harmonization of policies e.g. water quality, pollution, sewage
- Maritime Safety
- Data and information exchange

**Ministerial
Conference**

BCC Management Board

Secretariat

Ecosystem Advisory Committee

The future of co-operative ecosystem management in the Benguela region of southern Africa

Benguela Current Commission Role & Functions

**Ministerial
Conference**

BCC Management Board

Secretariat

Ecosystem Advisory Committee

- (a) approve any changes to the Strategic Action Programme.
- b) ensure effective implementation of the Strategic Action Programme.
- (c) negotiate, ratify and implement the comprehensive legal instrument referred to in Article 10.

The future of co-operative ecosystem management in the Benguela region of southern Africa

Benguela Current Commission Role & Functions



The future of co-operative ecosystem management in the Benguela region of southern Africa

Benguela Current Commission Role & Functions

**Ministerial
Conference**

BCC Management Board

Secretariat

Ecosystem Advisory Committee

Article 8:

- Administration & facilitation of functioning of BCC subsidiary bodies e.g. WG's
- Liaison with donor agencies.
- Financial Management of BCC
- Planning and operations.
- Facilitate communication with stakeholders.

The future of co-operative ecosystem management in the Benguela region of southern Africa

Benguela Current Commission Role & Functions

**Ministerial
Conference**

BCC Management Board

Secretariat

Ecosystem Advisory Committee

Ecosystem Advisory Committee:

Scope of work :

- Scientific co-ordination and collaboration among participating institutes
- SEIS, EEWS & Data Management
- Monitoring & improving predictability – climate variability
- Regional Stock Assessment & Monitoring
- Implementation of Biodiversity Conservation Plan, Pollution Monitoring System (N BCLME), auditing & monitoring of change and threats.
- Support and monitoring of progress toward EAF
- Promotion of training and capacity building

The future of co-operative ecosystem management in the Benguela region of southern Africa



Benguela Current Commission Requirements

Staffing of BCC: (Secretariat)

- Executive Secretary (Manager)
- EAC Co-ordinator (Scientist)
- Administrative Staff x 2

Support Staff for BCC (non-Secretariat)

- 3 Country Focal Points (National Coordinators)
- Training and Capacity Building Co-ordinator
- Data & Communications Manager

Operations:

- Administration, basic ops and travel
- Meetings of subsidiary bodies & working groups
- Rent & Utilities

Scientific Activities:

- Transboundary Surveys & Monitoring
- Specialist studies
- Meetings and workshops
- Data Management
- In-service Training

The future of co-operative ecosystem management in the Benguela region of southern Africa

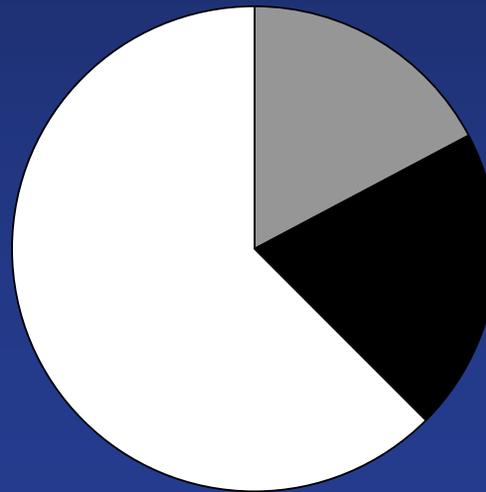


Benguela Current Commission Requirements

Annual Budget for the BCC + Support Services

- BCC staff and operation (US\$555,000.00/pa)
- BCC Support Staff and operations (US\$695,000.00/pa)
- Scientific Activities (US\$2,000,000.00/pa)

Total: US \$3,250,000.00/pa



The future of co-operative ecosystem management in the Benguela region of southern Africa



Benguela Current Commission Requirements

Funding Sources (4 years)

Funding requirement = US\$13,250,000.00

- Contracting Parties: US 2,250,000.00 + in kind co-finance
- GEF: US\$5,000,000.00
- Other donors US\$6,000,000.00 + technical support

