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

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Climate effects on biodiversity, abundance and distribution of marine organisms

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- Fish distribution is governed by multitude of factors that act on different life-history stages and operate at different spatial and temporal scale
  - Dispersal capacity
  - Biological interactions including spatio-temporal co-occurrence of prey species
  - Range of physiologically optimal environmental conditions

- Some of the expected of consequences of climate change:
  - Changes in demographic vital rates (growth, recruitment, survival)
  - Phenological shifts (e.g. earlier arrival of spring bloom and its cascading consequence)
  - Shifts in distribution with warming (towards higher latitudes/greater depths)

Climate change and deepening of the North Sea fish assemblage: a biotic indicator of warming seas

Nicholas K. Dul
Stephen R. Dye

Range contraction in large pelagic predators

Boris Worm[a,1] and Derek P. Tittensor[a,b,c]

Climate Change and Distribution Shifts in Marine Fishes

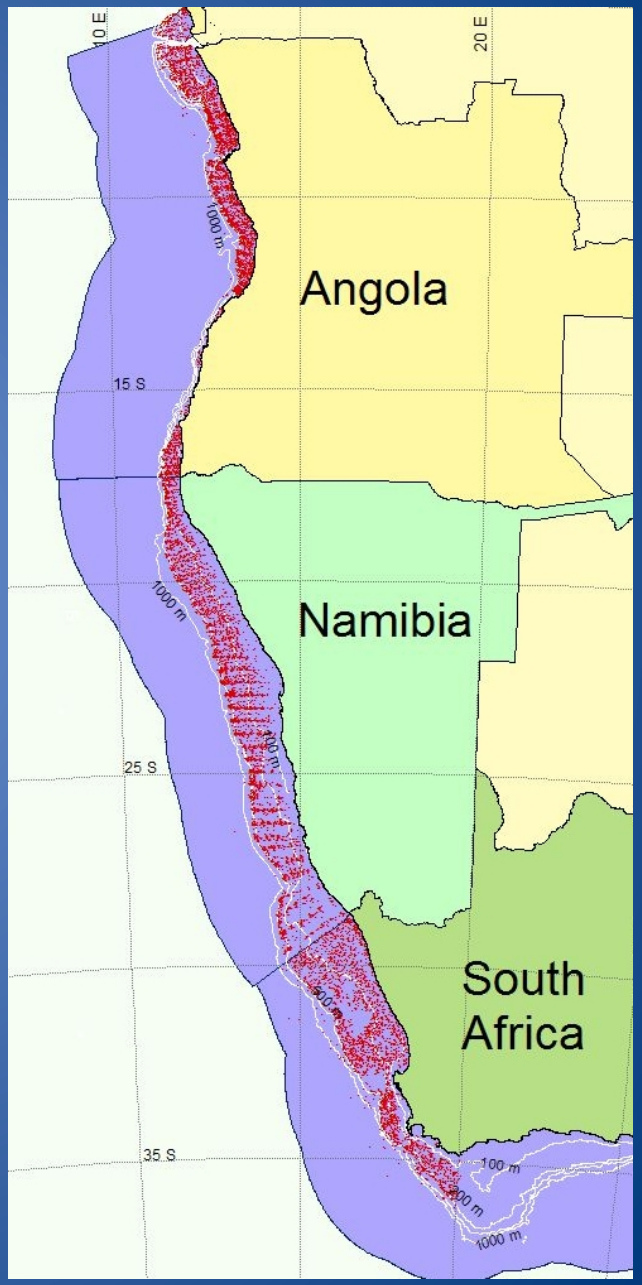
Allison L. Perry,[1*] Paula J. Low,[2†] Jim R. Ellis,[2] John D. Reynolds[1*]

- Studies have indicated environmental changes in BCLME since the 1950s (e.g. SST)
- Several studies have shown changes in distribution range size of organisms that occur or feed in pelagic waters (e.g. sardine, anchovy in southern BCLME, Cape fur seal in northern BCLME)
- Despite socio-economic importance of demersal fisheries, distributional changes of demersal species and drivers of such change have had limited attention

➢ **Aim: using appropriate indices, assess changes in distribution/range size of demersal species in BCLME countries**

- 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)



- For consistency, only summer surveys were included
- Considered demersal fish species including sharks, skates and rays, and also cephalopods

- Only species that occurred in more than 5% of all trawl stations were included
- Data for the three countries were analysed separately

  ~ differences in sampling design between countries

  ~ differing lengths of time series

- The following 4 indices of distribution/range size shift were calculated per year per country for each species considered:
  1. **mean latitude of distribution**
  2. **mean depth of distribution**

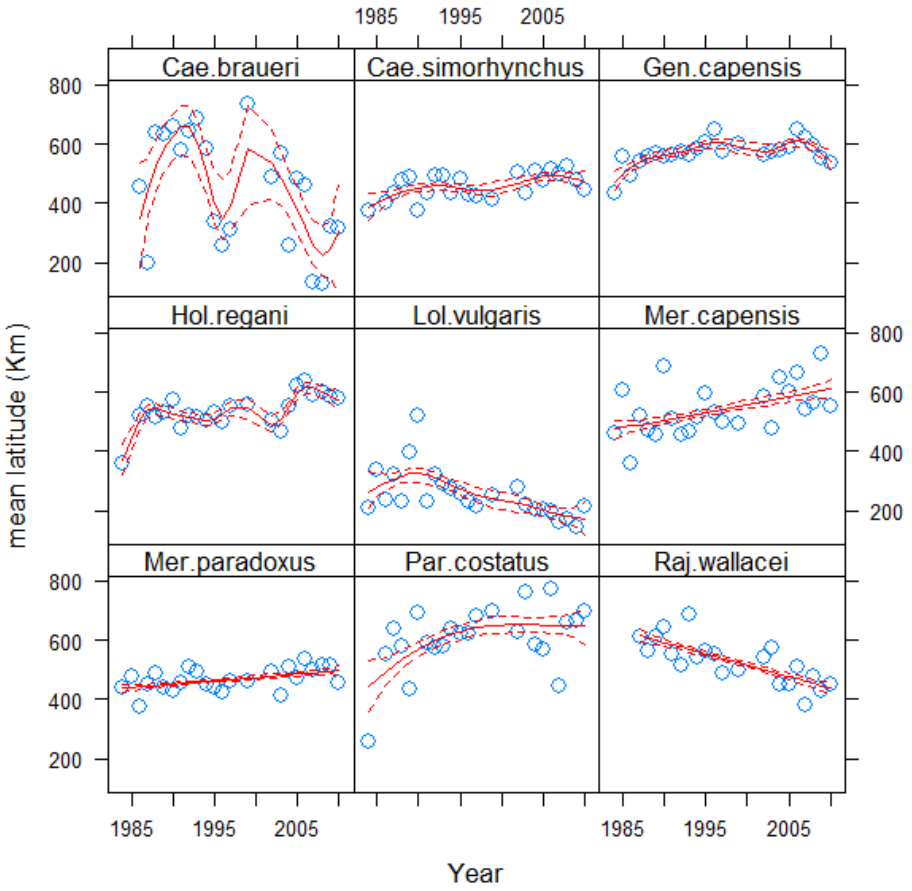
  Computed as weighted mean where the latitude/depth in which a species was observed was weighted by the corresponding log of catch rate

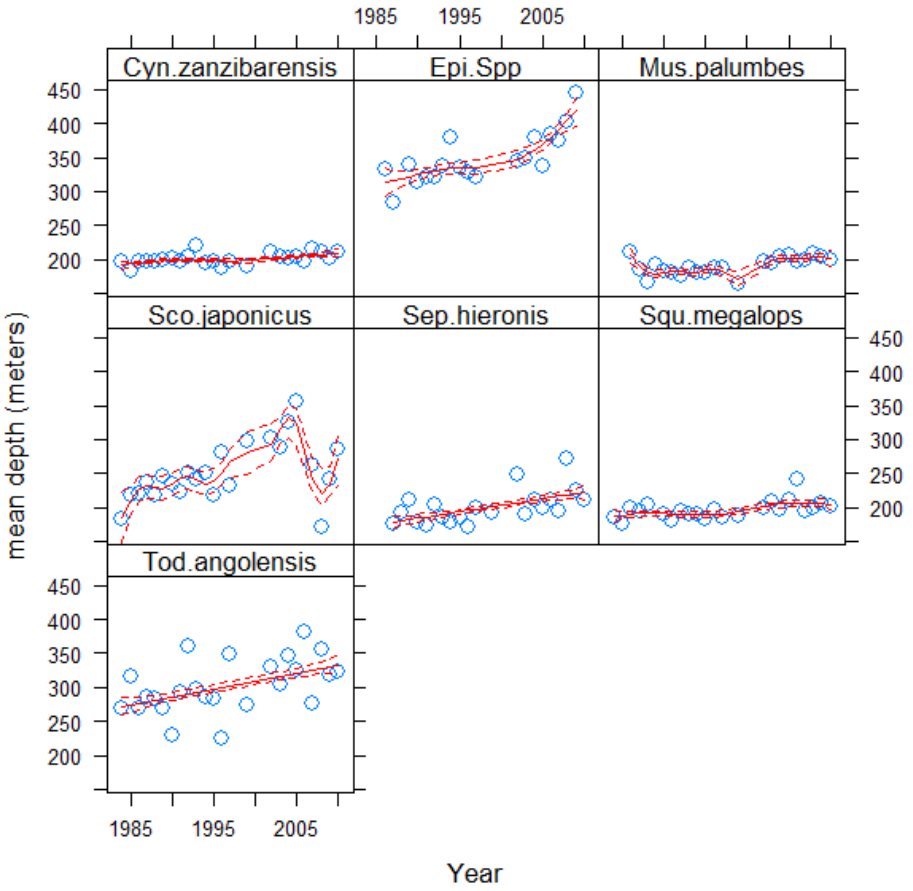
  3. **range of latitude**
  4. **range of depth**

  Calculated as the difference between the max and min lat./depth

- Temporal trend in these indicators determined by applying robust linear regression to time series' of these indices

Temporal trend (GAM function) in mean latitude and mean depth: South Africa

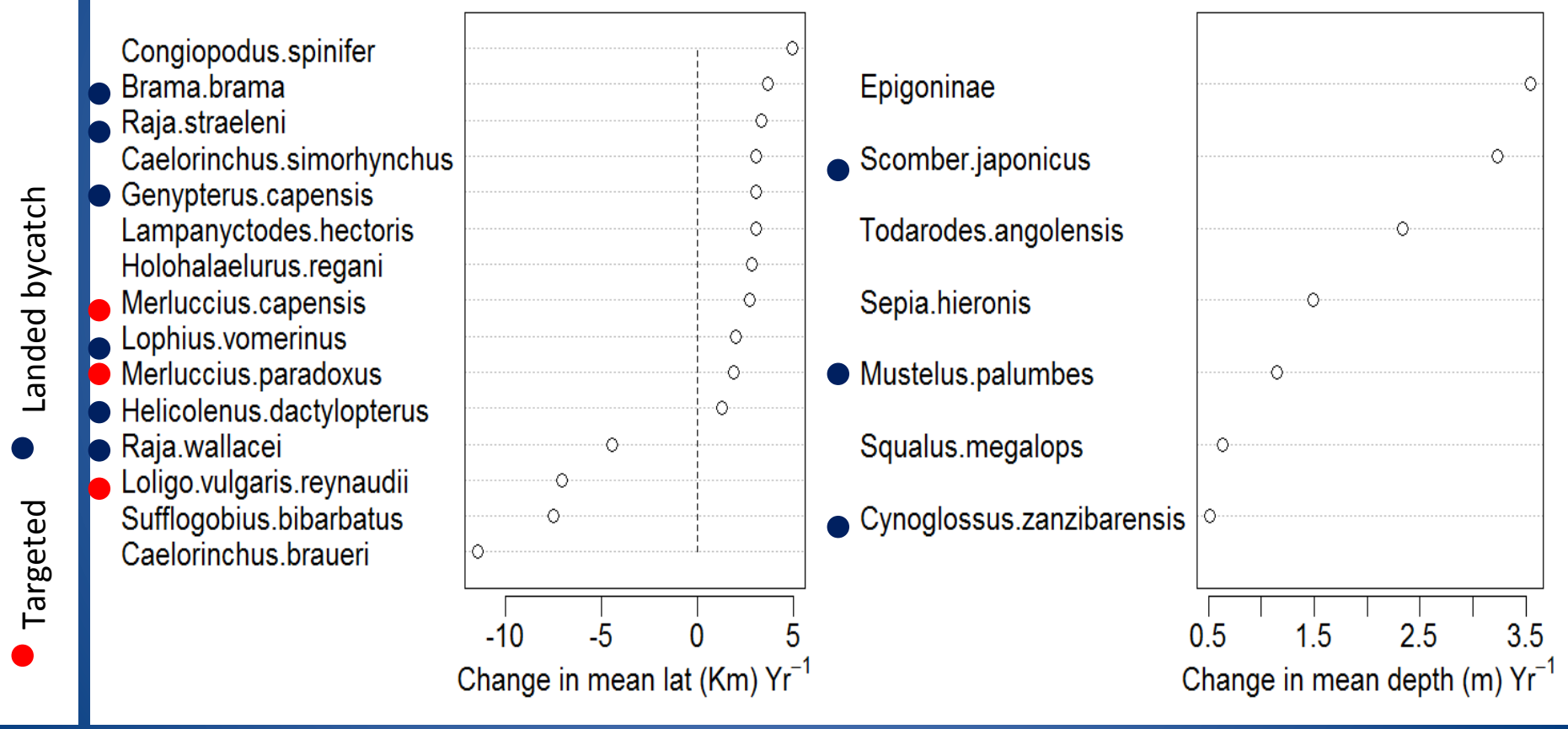




Significant changes in mean latitude

Significant changes in mean depth

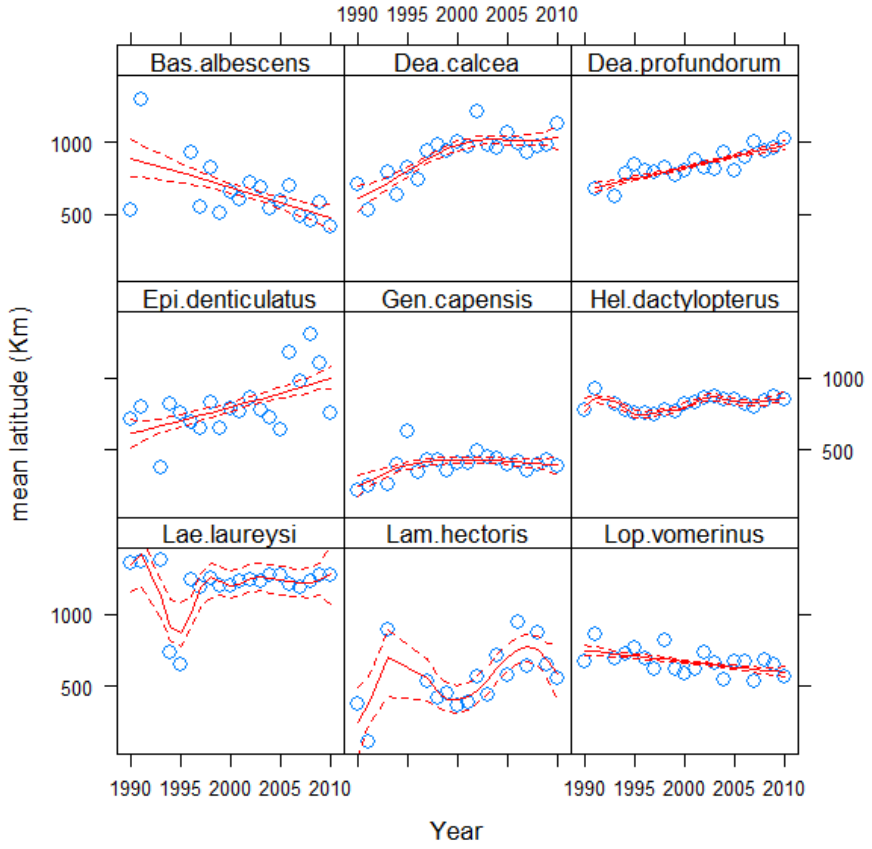
Slope of temporal trend in mean latitude and mean depth: South Africa (n=50 spp considered)

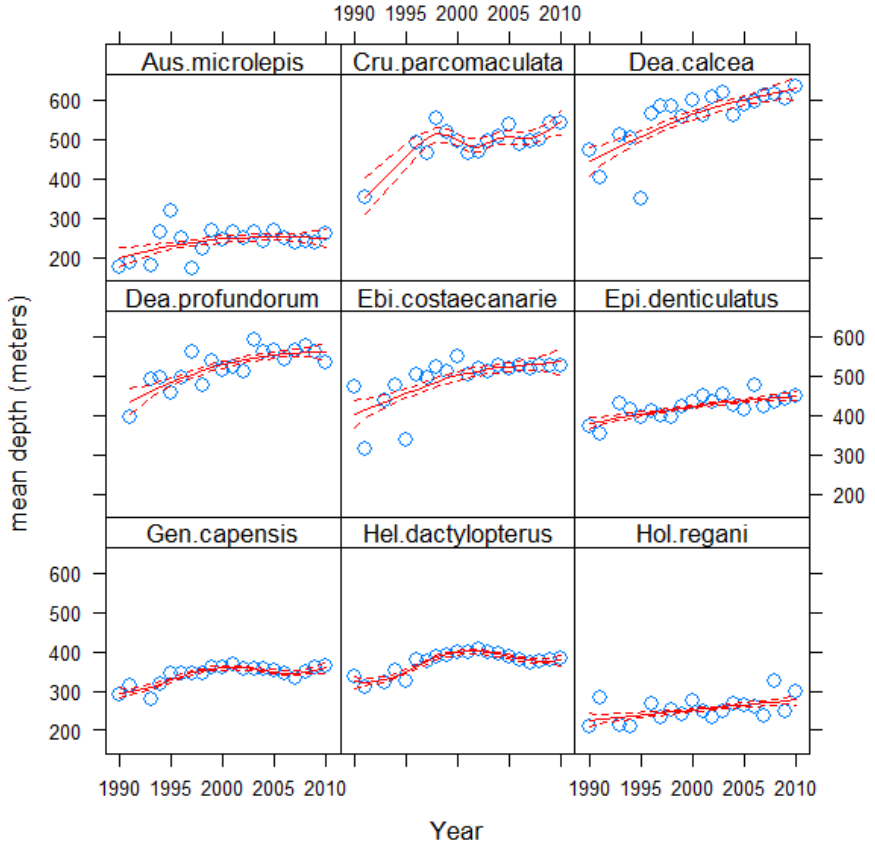


Significant change in mean latitude

Significant change in mean depth

Temporal trend (GAM function) in mean latitude and mean depth: Namibia





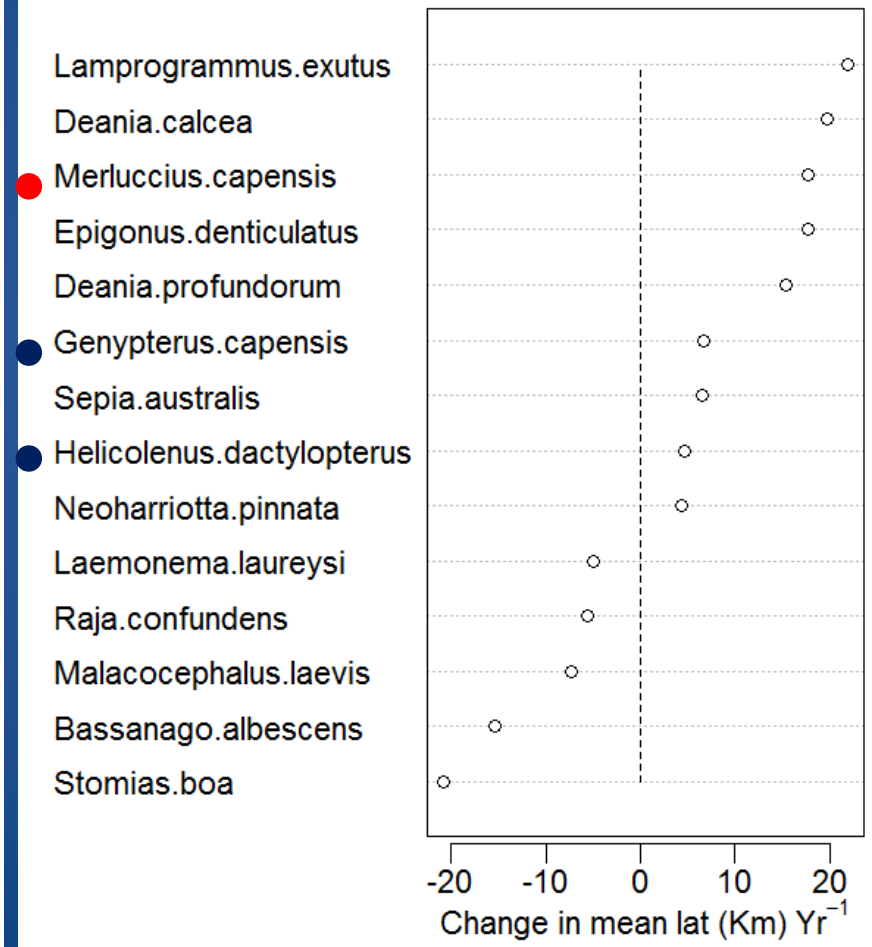
Significant change in mean latitude

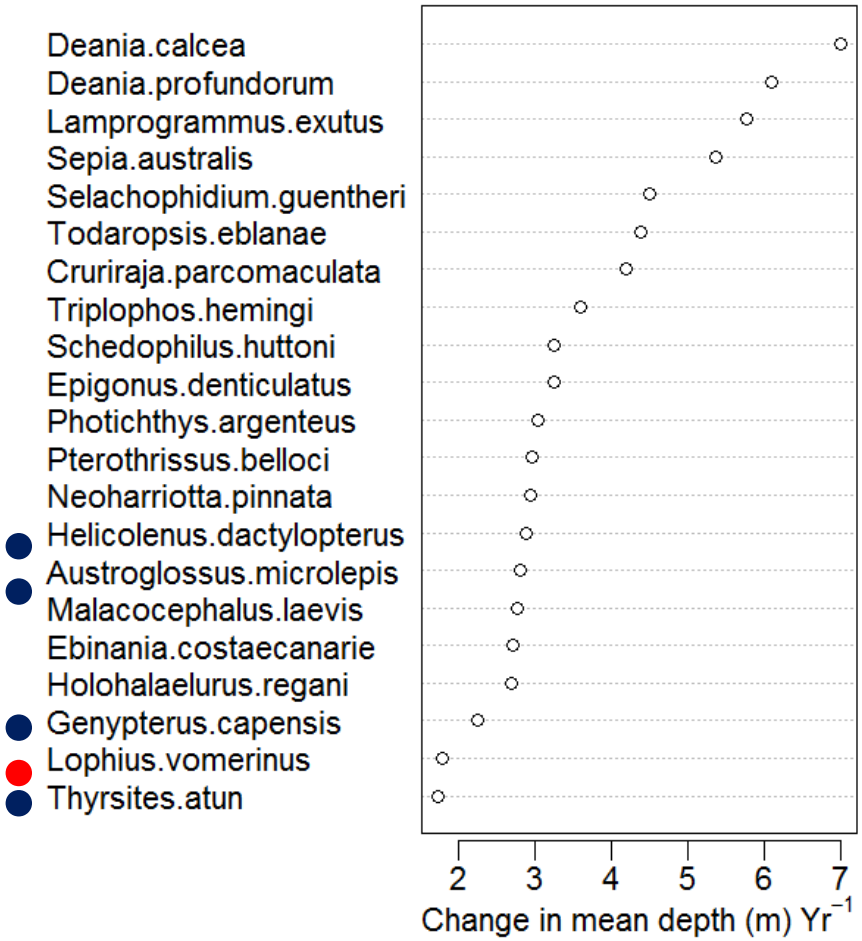
Significant change in mean depth

Slope of temporal trend in mean latitude and mean depth: Namibia (n=52 spp considered)

Landed bycatch

Targeted

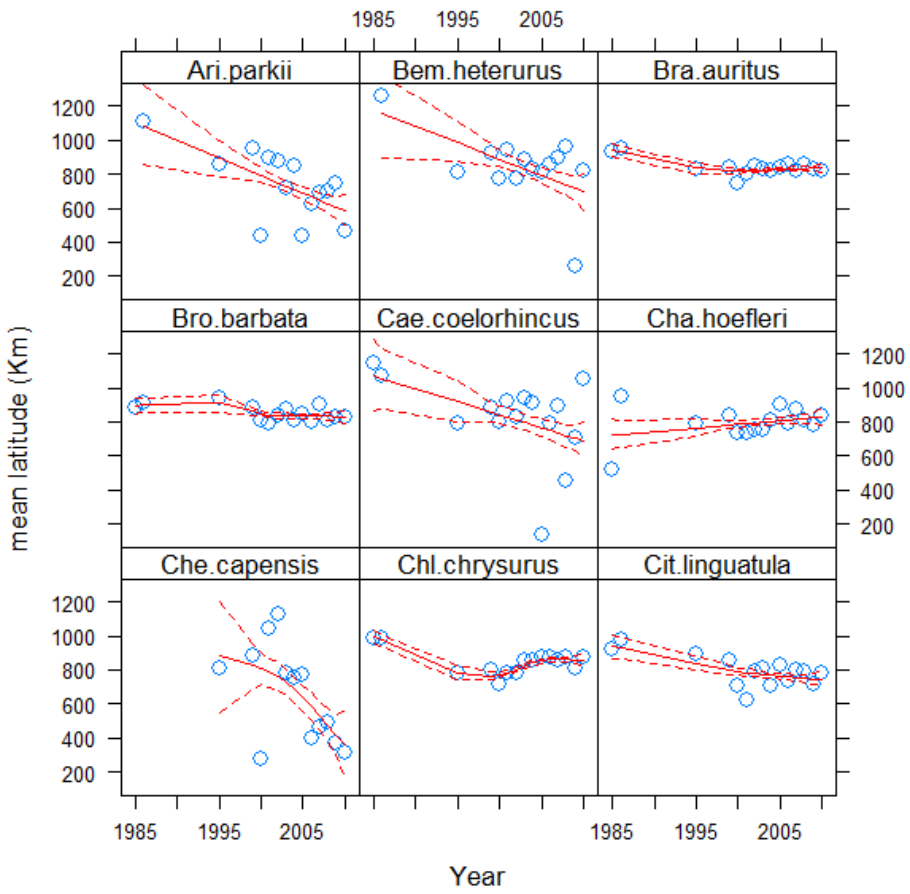


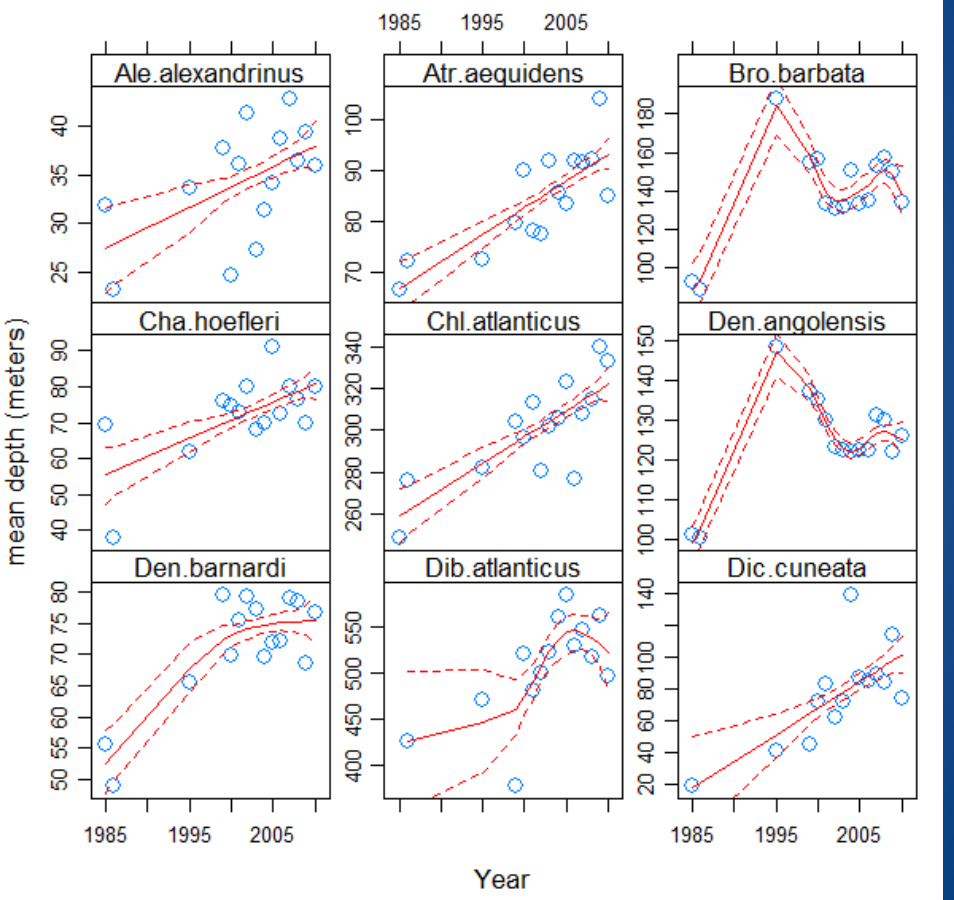


Significant change in mean latitude

Significant change in mean depth

Temporal trend (GAM function) in mean latitude and mean depth: Angola





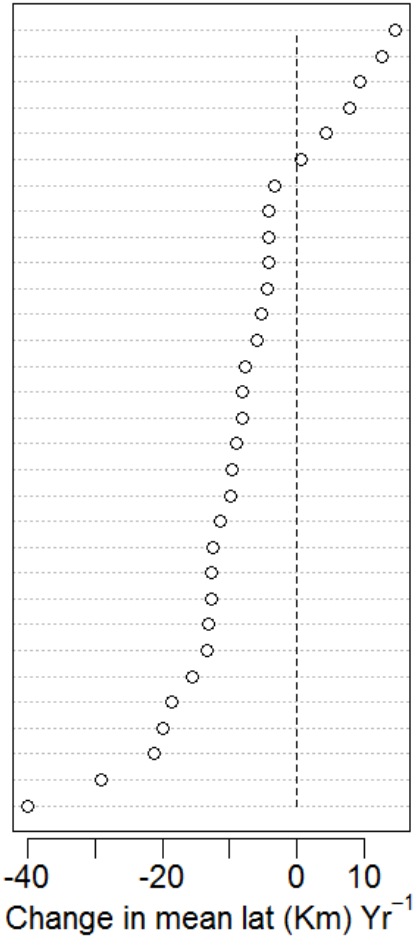
Significant change in mean latitude

Significant change in mean depth

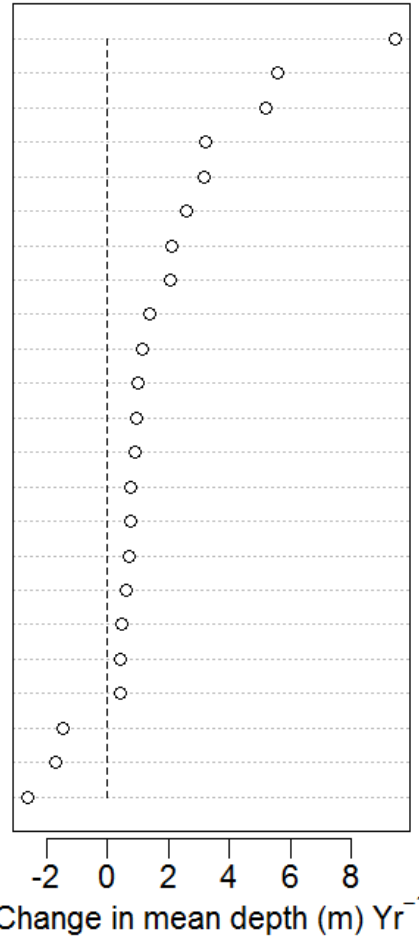
Slope of temporal trend in mean latitude and mean depth: Angola (n=89 spp considered)

Landed bycatch
Targeted

Zenopsis.conchifer
Spicara.alta
Chaetodon.hoefleri
Chloroscombrus.chrysurus
Umbrina.canariensis
Merluccius.capensis
Brotula.barbata
Lamprogrammus.exutus
Brachydeuterus.auritus
Galeoides.decadactylus
Fistularia.petimba
Raja.miraletus
Dentex.barnardi
Torpedo.torpedo
Peristedion.cataphractum
Citharus.linguatula
Hoplostethus.atlanticus
Zeus.faber
Ilisha.africana
Pomadasys.jubelini
Illex.coindetii
Pseudotolithus.senegalensis
Caelorinchus.coelorhincus
Pterothrissus.belloci
Bembrops.heterurus
Gadela.imberbis
Sepia.orbignyana
Malacocephalus.laevis
Arius.parkii
Dicologoglosa.cuneata
Chelidonichthys.capensis

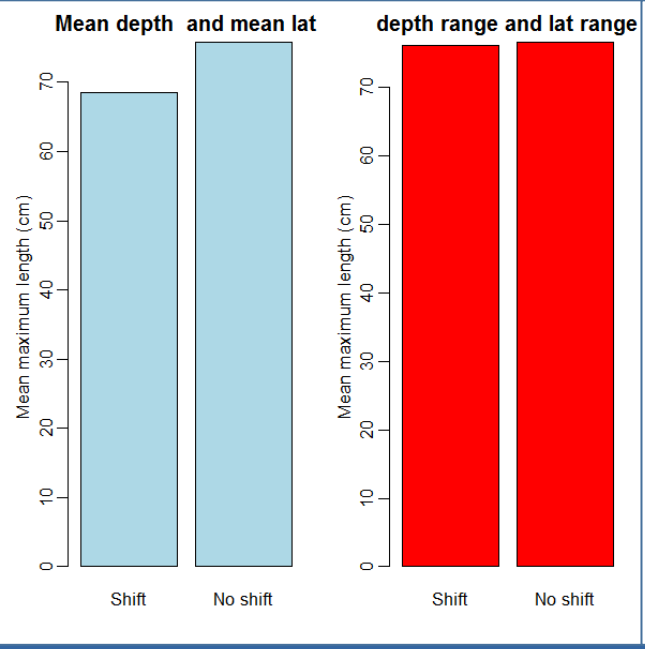


Nemichthys.scolopaceus
Halosaurus.ovenii
Dibranchus.atlanticus
Dicologoglosa.cuneata
Merluccius.polli
Chlorophthalmus.atlanticus
Brotula.barbata
Lagocephalus.laevigatus
Saurida.brasiliensis
Pomadasys.jubelini
Atractoscion.aequidens
Dentex.barnardi
Dentex.angolensis
Umbrina.canariensis
Pseudupeneus.prayensis
Chaetodon.hoefleri
Pseudotolithus.typus
Pomadasys.incisus
Galeoides.decadactylus
Alectis.alexandrinus
Pseudotolithus.senegalensis
Raja.miraletus
Sepia.officinalis

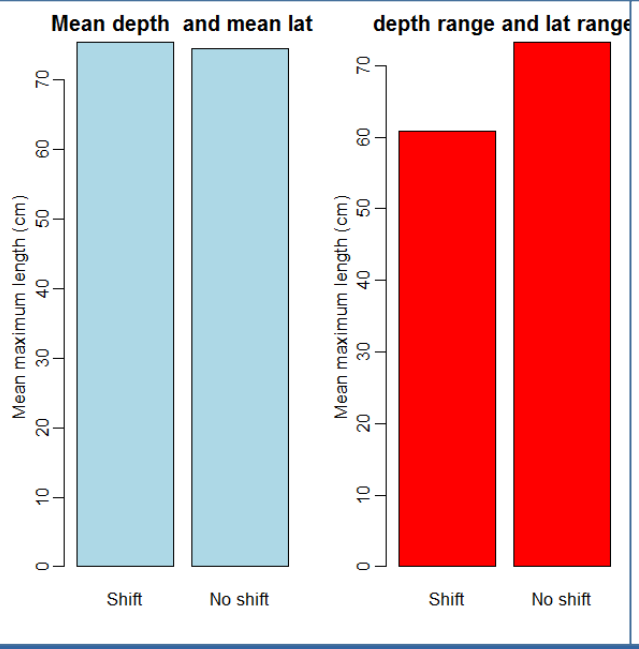


Significant change in mean latitude

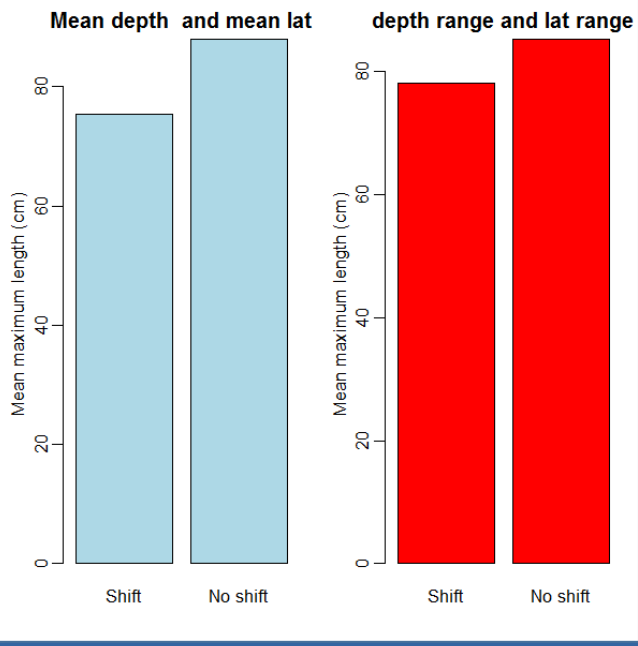
Significant change in mean depth



Angola



Namibia



South Africa

Do the observed distributional changes reflect life history traits?

Blue bars: mean max. size of species that shifted significantly in terms of mean depth or mean latitude vs those that did not

Red bars: mean max. size of species that showed significant changes in latitudinal or depth range, vs those that did not

- Observed changes in distribution, in terms of magnitude and directionality, varied between the systems of the three countries
- Latitudinal shifts that were most consistent with expectations under warming occurred off Angola (southwards), shifts off Namibia and South Africa were in both directions but mainly towards lower latitudes
- More consistency with regard to shifts in depth, mainly to deeper waters in all countries (but slower rate in South Africa)

- 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

ACKNOWLEDGEMENTS

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