Changes in the trophic structure of the southern Benguela before & after the onset of industrial fishing.

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❖Introduction:

Retrospective models can allow for forecasting of possible future systems based on potential management and exploitation scenarios (Pitcher 1998).

❖Methods:

Ecopath with Ecosim was used to construct and compare mass-balanced foodweb models of the southern Benguela ecosystem, based on fisheries records and knowledge of the system. The following eras of human influence were represented:

1: aboriginal (10 000 BP–1651)
2: pre-industrial (1652–1909)
3: industrial (1910–1974) and
4: post-industrial (1975–present).

Model's structure was based on those previously constructed by Shannon *et al* (2003) and Jarre-Teichman *et al* (1998).

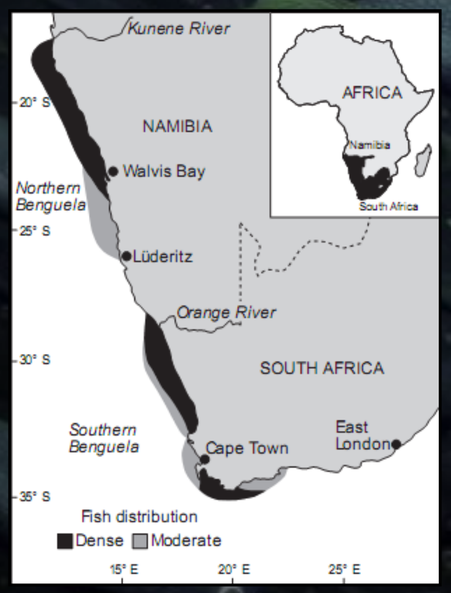

Fig.1: Map of the Benguela region, modified from Jarre-Teichmann *et al.* (1998).

❖Results & Discussion:

1) Biomass

- ❖at higher trophic levels (TLs) declined
- ❖sardine and anchovy increased in the post-industrial 2000s model

2) Trophic level

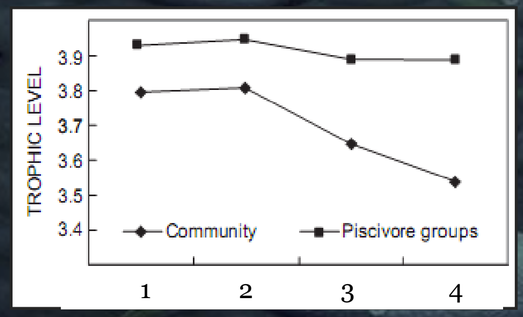

Fig.2: Mean TL of the community (excl. detritus, benthos and phytoplankton) and piscivorous groups in each era.

3) Consumption

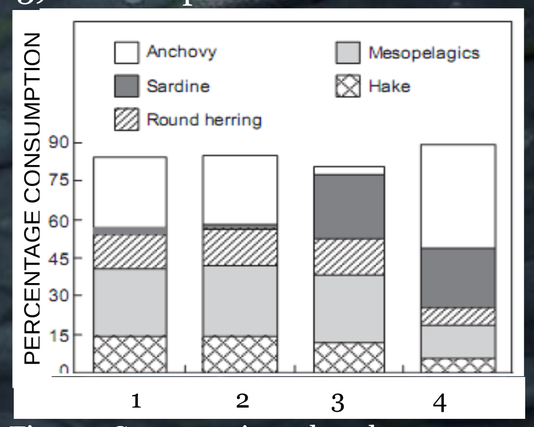

Fig.2: Consumption by key groups contributing >5% to overall consumption in each era.

4) Fishing

- ❖ increasingly important role as a consumer in the system
- ❖Mean TL of catch declined from 4.52 pre-industrial to 3.63 post-industrial

5) System indices – see Table 1

Table 1: Trends in selected indices (after Odum 1985) of ecosystem stress. SIDI = Simpson's diversity index and SHDI = Shannon's diversity index. Trend from eras 1-3 is displayed as well as that from 1-4, to show the effect of the high small pelagic biomass in the 2000s model (era 4) on overall trend.

System indices (Odum 1985)	Expected trend (stressed ecosystems)	Eras 1-2	2-3	3-4	1-3	1-4
Community respiration (*R*)	/	\	/	\	/	\
Production / respiration (*P*/*R*)	<1 or >1	>1	>1	>1	>1 (declined)	>1 (declined)
Maintenance:biomass structure (*P*/*B*)	/	/	/	\	/	\
(*R*/*B*)	/	\	\	/	\	\
Unused primary production and nutrient loss (sum of all flows to detritus)	/	/	/	\	/	\
Vertical cycling of nutrients (Finn's cycling index)	\	\	\	/	\	/
Proportion of *r*-strategists; size and lifespan of organisms (*B*/*P*)	\	\	\	/	\	/
Length of food chain (Finn's mean path length)	\	\	\	/	\	/
Species diversity (SIDI)	\	\	\	/	\	/
(SHDI)	\	\	\	/	\	/

❖Conclusions:

The effects of South African fisheries on ecosystem structure are in addition to environmental forcing that has always influenced the system.

Fishing stress at the ecosystem level and the collapse of small pelagic stocks may lead to a shift toward a bottom-up trophic control mechanism becoming the dominant driver of ecosystem dynamics, increasing the impact of environmental events (Shannon *et al.* 2008).

It is thus possible that pristine systems were not as severely affected by environmental anomalies as are modern systems

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