

Ecospace modelling of the northern Benguela

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An Ecospace model of the northern Benguela, off the coast of Namibia (15-29°S, 10-17°E) was constructed to look at the effectiveness of current MPAs and the possible placement and number of MPAs in the future. This model is based on the Ecopath with Ecosim model of the northern Benguela as described by Heymans et al. (2006). The model consists of 32 groups including 2 primary producers, 2 marine mammals, sea birds, 18 fish groups, and 8 invertebrate groups. The fisheries include the purse seine and demersal trawlers (both of whom have ports in Lüderitz and Walvis Bay), the midwater trawlers, longliners, crab trappers, lobster trappers, commercial and recreational linefishers, seal fishers and seaweed harvesters. The advection fields were calculated by using a negative coriolis force of -0.5 and sketching the prevailing south to north Benguela current. Phytoplankton and mesozooplankton were advected in this model.

Habitat information was available for some species and fisheries from the literature and these are described below. This information was used to define the habitats used in this model, which included the:

- 1) Northern surf zone (3.5% of the area),
- 2) the northern slope (200-500m, 4.3% of the area),
- 3) deep areas in the north of the Walvis Ridge (>500m, 11.7%),
- 4) Cape Cross (0.3%),
- 5) northern shelf (20-200m depth, 4%),
- 6) central shelf (20-200m, 12.5%),
- 7) southern shelf (20-200m, 16.2%),
- 8) deep waters in the south of the Walvis Ridge (>500m, 29.8%),
- 9) southern slope (200-500m, 8.5%),
- 10) the West Coast Recreational Area (4.8% of the total area)
- 11) Lüderitz harbour (0.3%), and
- 12) The surf zone to the south of Lüderitz (4.3%).

The base map used in this study is given in Figure 1, the habitats preferences of the different species are given in Table 1 and the various fisheries have been defined by area in Table 2. The results from the first run of the model are shown in Figure 2. The description of why these areas were chosen and the habitat preferences is given in the appendix below.

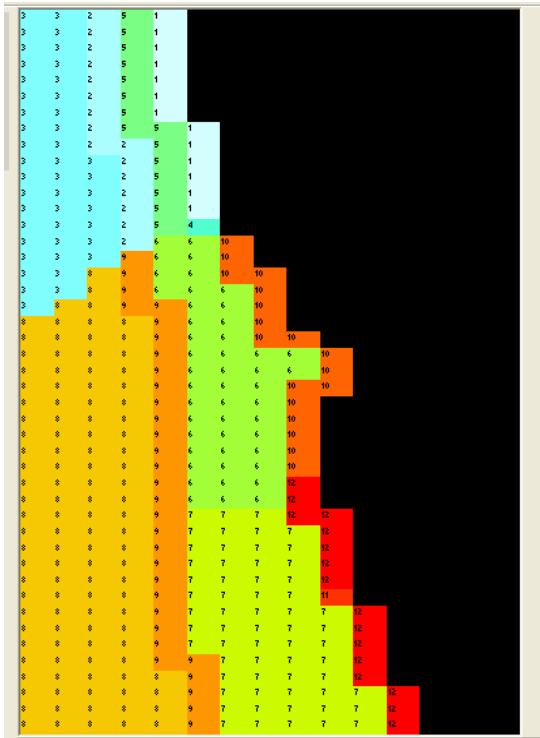


Figure 1: Base map of the northern Benguela ecosystem. See the definition of the numbers in the text.

Table 1: Preferred habitats for the various groups in the northern Benguela.

Group	All	Surf N	Slope N	Deep N	Cape Cross	Shelf N	Shelf C	Shelf S	Deep S	Slope S	WCRA	Lüderitz
Marine Mammals	+											
Seals		+			+						+	
Birds	+											
Sharks	+											
Tuna			+	+	+	+	+	+	+	+		
Snoek					+	+	+	+				
Other linefish		+			+	+	+	+			+	+
Anchovy juveniles					+		+	+			+	+
Anchovy adults					+		+	+			+	+
Sardine juveniles		+			+	+	+	+			+	+
Sardine adults		+			+	+	+	+			+	+
Gobies juveniles					+		+	+			+	+
Gobies adults					+		+	+			+	+
Other sm pelagics		+			+	+	+	+			+	+
Mesopelagics			+	+	+	+	+		+	+		
Juv. h mackerel		+			+	+	+				+	
Adult h mackerel			+		+	+	+			+		
J hake			+				+	+		+		
A hake			+	+		+	+		+	+		
Monkfish			+	+		+	+	+	+	+		

Other demersals	+															
Cephalopods	+															
Macrobenthos	+															
Crabs				+		+										
Lobster															+	+
Jellyfish juvs		+						+	+	+	+				+	+
Jellyfish adults		+						+	+	+	+				+	+
Macrozooplankton	+															
Mesozooplankton	+															
Benthic producers															+	+
Phytoplankton	+															
Detritus	+															

Table 2: Distribution of the fishery in the northern Benguela Ecospace model.

Fleet	Surf N	Slope N	Deep N	Cape Cross	Shelf N	Shelf C	Shelf S	Deep S	Slope S	WC RA	Lüderitz	Surf S	Skeleton	NNP	Sperrgebiet
Purse seine		+				+	+		+						
Midwater trawler		+	+		+	+	+	+	+						
Demersal		+	+					+	+						
Longlines		+	+		+	+	+	+	+						
Crab traps		+	+		+										
Lobster							+						+	+	
Commercial linefishery				+		+				+	+				
Recreational linefishery	+			+						+	+		+	+	
Seal fishery				+											
Other											+				

There are three marine protected areas in the northern Benguela, namely the Skeleton Coast park, in the north of the country, the Namib Naukluft Park, south of Walvis Bay, and the Diamond Sperrgebiet, south of Lüderitz. These areas are only closed to fishing from the shore, and in the surf zone, but fishing in areas deeper than 30m are allowed at present. The effect of the placement of relatively large MPAs in two different parts of the ecosystem was examined here.

1. A MPA was placed in the southern part of the ecosystem, from 30m to deep waters, and
2. A MPA was placed in the northern part of the ecosystem, from the 30m to deep waters.

The placements of the MPAs are shown in Figure 3, and the results of these MPA's on the fishing effort of in Figures 4a and 4b.

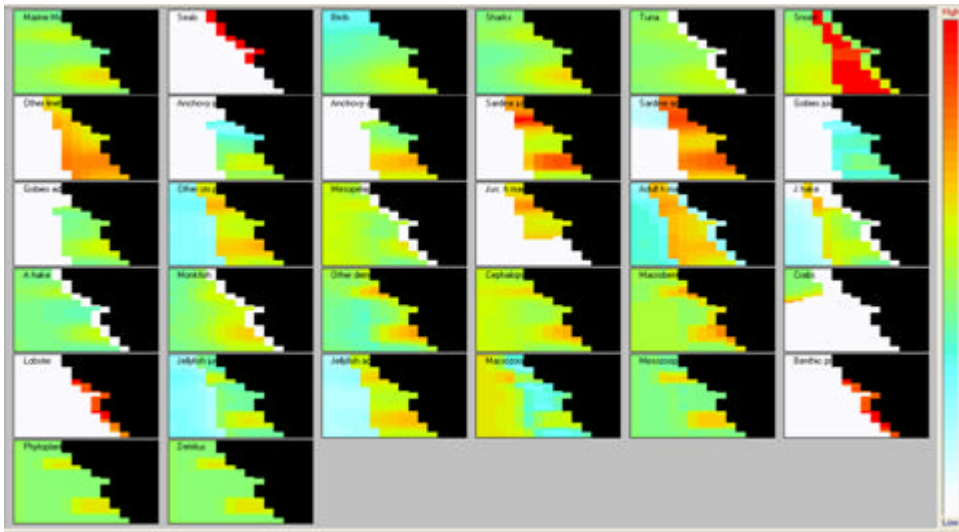


Figure 2. The result of the Ecospace run for biomass in the northern Benguela.

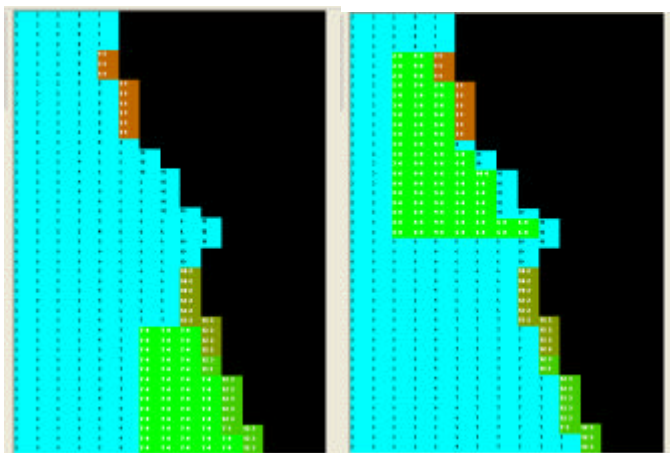


Figure 3. Map showing the placement of known MPAs and two different MPAs suggested for the testing of scenarios on the placement for fisheries enhancement.

The results of the cost and value of fishing in the base case and the two scenarios for MPA placement is shown in Figures 5a and 5b. The results of these first scenarios show that placing a large MPA in the southern part of the ecosystem would be more expensive but would increase the value of the fishery, while placing the MPA in the north would be less expensive but would not yield as much return (Figure 5). Also, the placement of a MPA in the south would be beneficial to the midwater trawl, while in the north it would be beneficial to the demersal fleet. The effects of these MPAs on the main species are shown in Figure 6, indicating that a MPA in the south would increase the sardine, while and hake but not anchovy, indicating that this might be the best placement for a MPA.

Reference:

Heymans, J. J., U. R. Sumaila, et al. (2006). Ecosystem model of the northern Benguela ecosystem, Namibia. Ecosystem values. Incofish project report, Deliverable 8.2. Integrating multiple demands on coastal zones with emphasis on aquatic ecosystems and fisheries. U. R. Sumaila, R. Chuenpagdee, P. S. Alexander et al. Vancouver, www.incofish.org: 75-130.

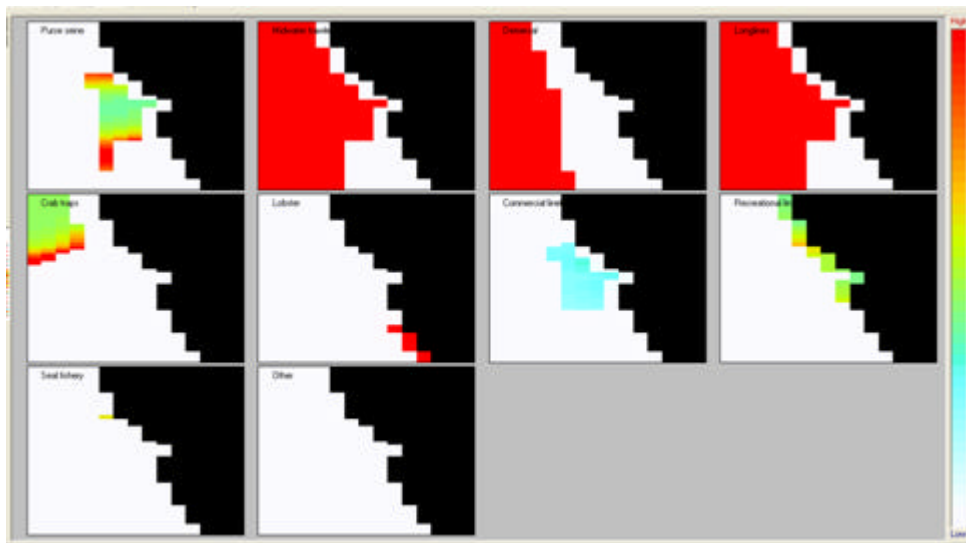


Figure 4a. Results of fishing effort by fleet at the end of the 45 year run with a MPA placed in the south.

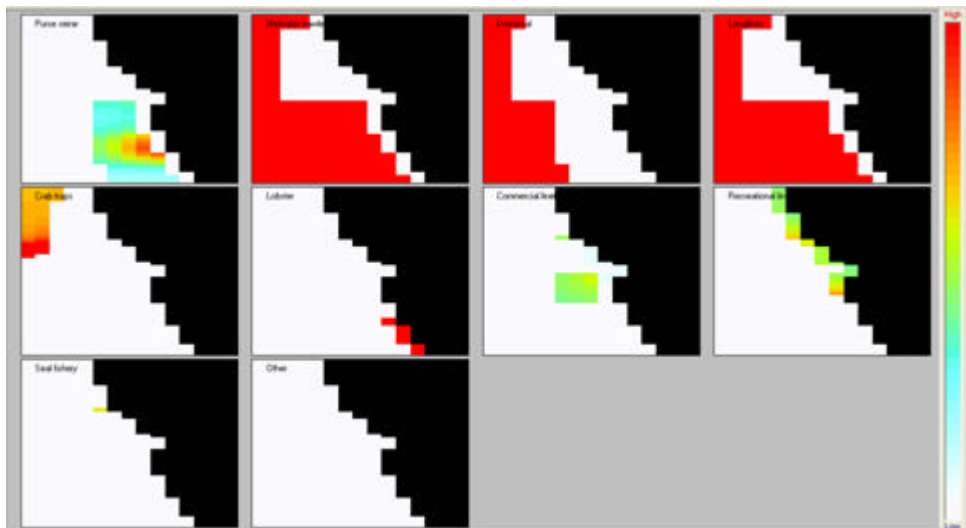


Figure 4b. Results of fishing effort by fleet at the end of the 45 year run with a MPA placed in the north.

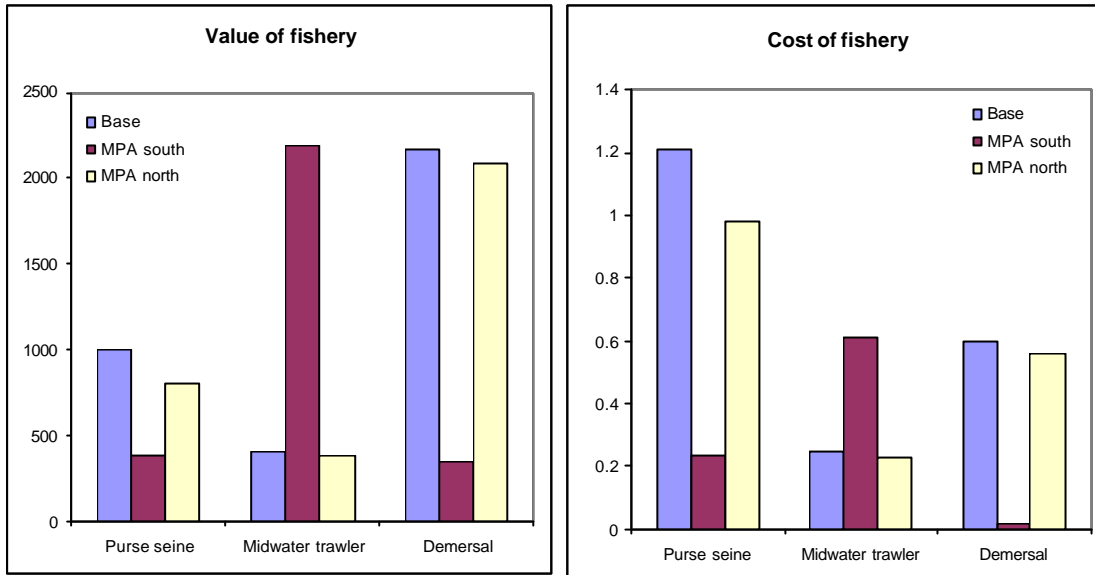


Figure 5. Changes in the value and cost of the three most important fisheries in the northern Benguela if MPAs were imposed in the north and south of the main fishery areas.

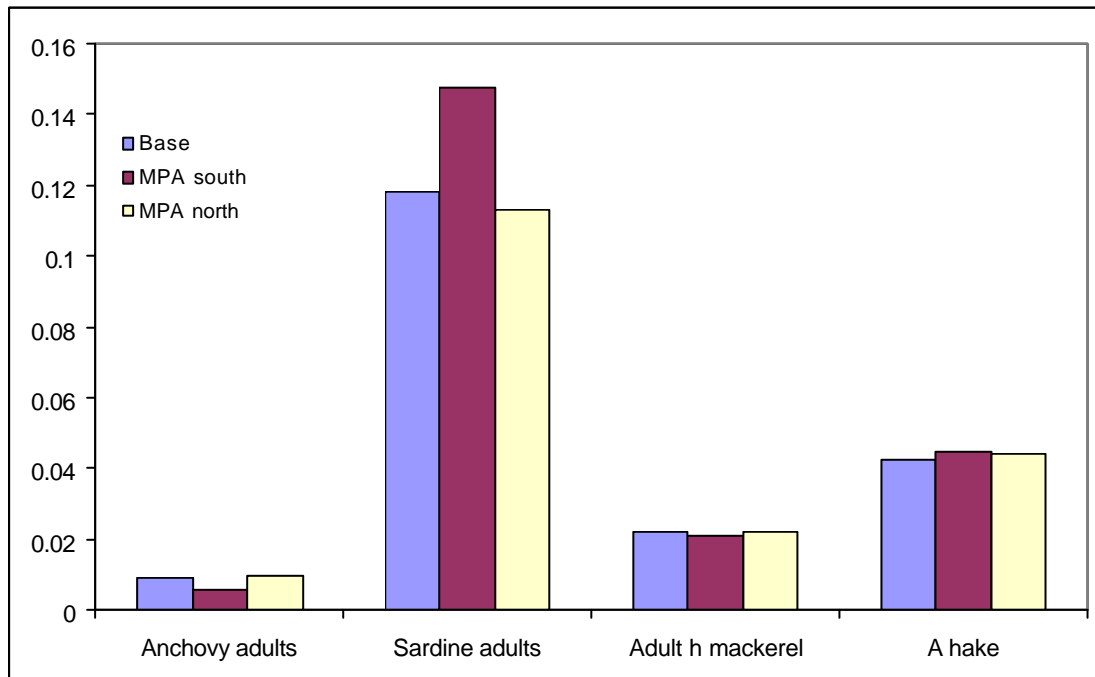


Figure 6. The effect of the placement of MPAs on the important species in the northern Benguela.