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Flying fishes, marine birds, and elasmobranches as integrated biological indicators of LMEs' boundaries and their spatial and temporal changes

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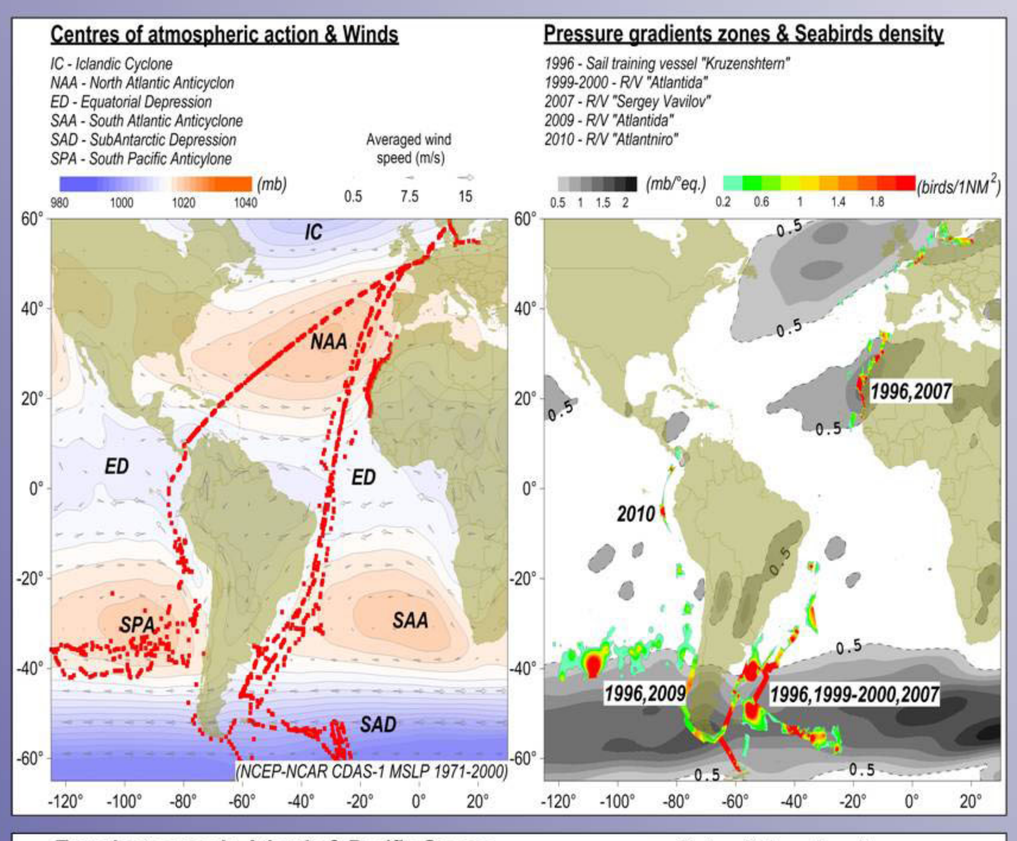
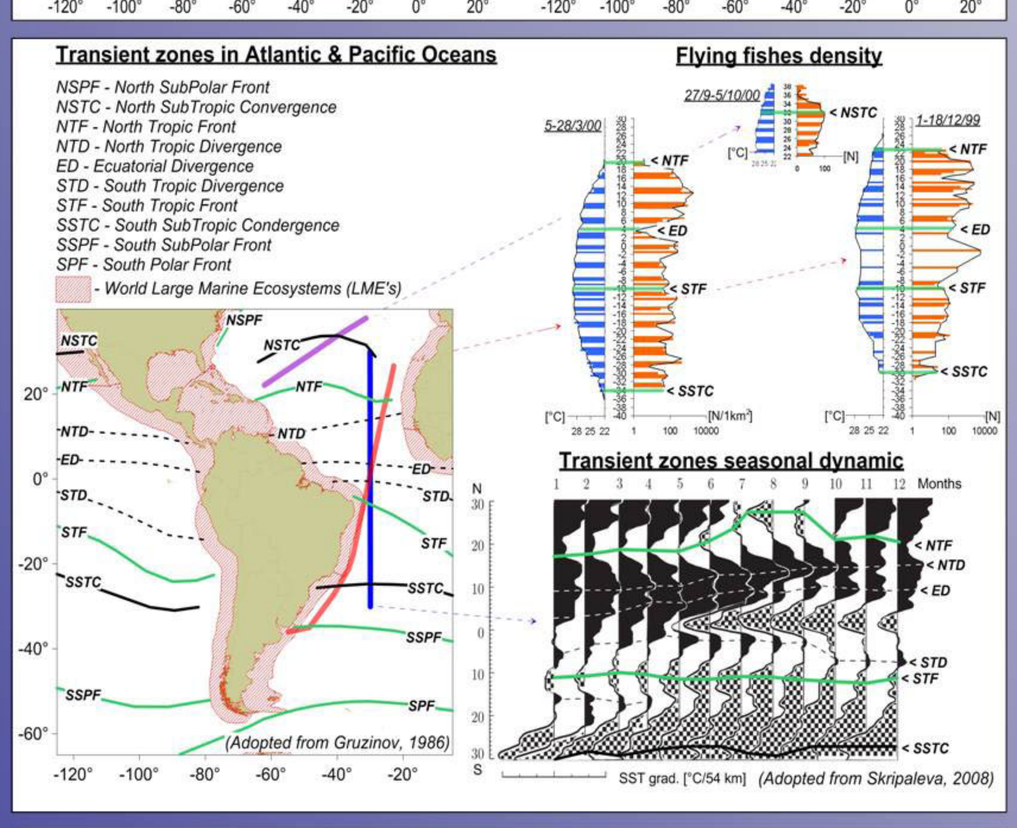
Assessment of Large Marine Ecosystems (LMEs) and integrated ocean management require determination of boundaries positions and their seasonal, interannual and longperiod changes.
The data on significant shifts in position of Sea Fronts, water masses, currents etc. serve as important signal of possible changes in states of LMEs. As the first step to reveal such shifts may serve observations of integrated indicators, living organisms.



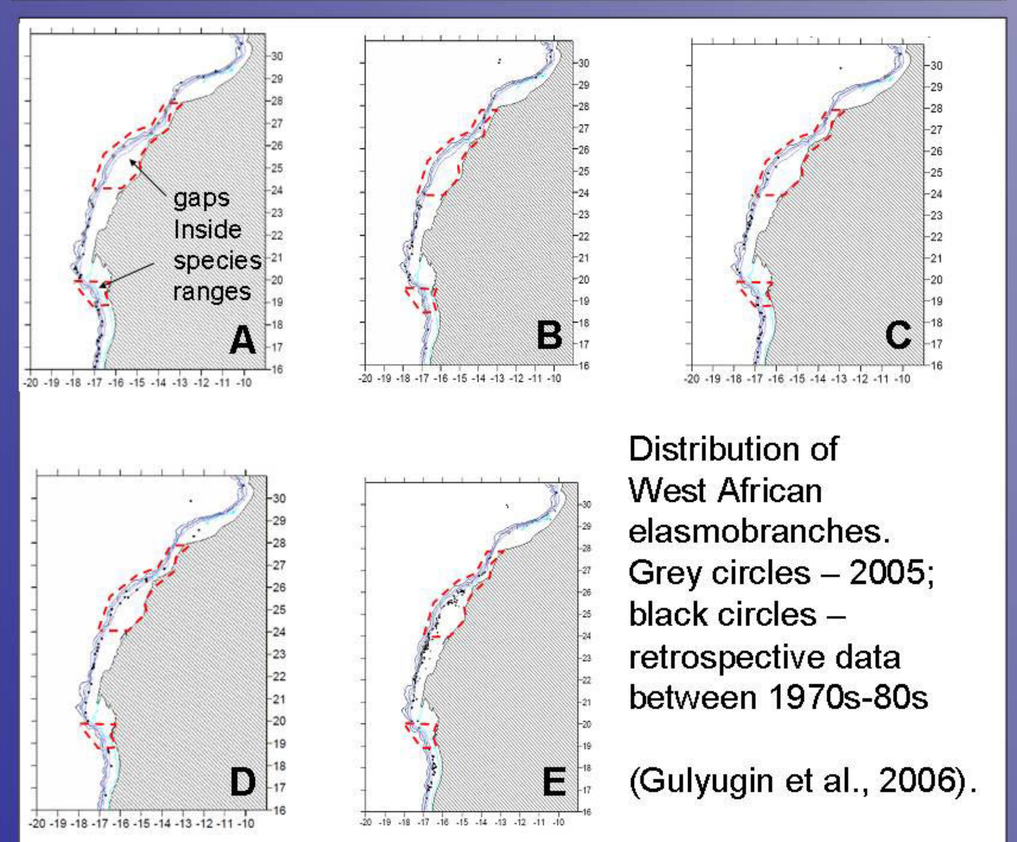
Marine birds..

Despite of their highly increased ability to move, seabirds strictly observe certain boundaries in the ocean, determined by oceanographic features. Thus, the highest density of seabirds in the *Southeast Pacific* in spring season 2009 corresponded to the seasonal position of the Subtropical Southeastern Pacific Frontal zone between 33-37°S and lay on the northern border of the atmosphere pressure gradient zone between 40-60°N. Similar situations were observed in other region: *Southwest Atlantic* in 1999-2003 and *Central Eastern Atlantic* in 2007.



Flying fishes..

The most pronounced shifts in LMEs boundaries are observed at extreme species/communities ranges' boundaries, positions of highest abundance and gaps inside species and higher taxa ranges. E.g., trans-equatorial transects North-South and S-N in 1999 December – 2000 March revealed seasonal shifts of extreme fishes' range boundaries to south more than 3 degrees of latitude. In 2010 September the northernmost boundary was observed at 38°N (against 22°N in 1999 December and 19°N in 2000 March).



Distribution of West African elasmobranches. Grey circles – 2005; black circles – retrospective data between 1970s-80s

(Gulyugin et al., 2006).

D.calcea (A), D.profundorum (B), E.spinax (C), O.centrina (D), R.naevus (E)

Elasmobranches..

The gaps inside species ranges were observed in number of *West African* elasmobranches species at:

- 32-34°N; - 24-28°N; - 19-20°N; - 8°N

Such gaps, existing for a long time may cause emergence of isolated fish stock units, and, in the extreme case, twin species. Coincidence of such gaps in several species of different ecology suggests existence of boundaries between communities and ecosystems which are not recognized yet.

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