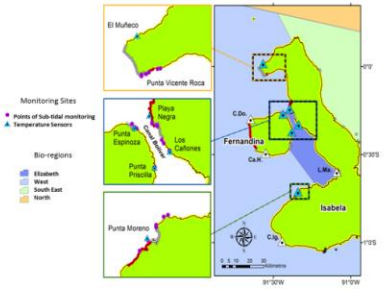
# Influence of Sea Surface Temperature in rocky sub-tidal communities in the Galapagos Marine Reserve: Bioindicators for identifying Climate Change?

Jose L. Santos, Ph.D. (jlsantosespol.edu.ec). Escuela Superior Politecnica del Litoral, Ecuador.
Angela M. Kuhn. Charles Darwin Research Station, Galapagos, Ecuador.

With the use of multivariate techniques we analyzed the relationship between in situ sea temperature and differences in abundance of mobile macro-invertebrates, fish and sessile coverage. Biotic records were taken during the cold and warm seasons (2004 – 2005) in sites of the west region of the Galapagos Islands. Sea Temperature at different levels (between 10 and 20 mts) was recorded with the use of 34 HOBO sensors during the period 1996-2005 (Figure 1)




Data Analysis was carried on with the PRIMERv6 software, methods include Principal Component Analysis (PCA), Multidimensional Scaling (MDS), Analysis of Similarities (ANOSIM), and Similarity Percentages (SIMPER), the process is summarized in figure 2

When trying to infer a relationship between Climate Variability and changes in biotic distribution, two things are necessary: the existence of a proper gradient and a relationship with the physiologic tolerance of the species. Sea Temperature presents both conditions in the study area, and the results suggest that there are differences in the composition of sub tidal communities between cold and warm periods, however physical and ecological characteristics make the biotic response specific of each site.

Two thermal boundaries were identified: one vertical, related to the latitudinal gradient of temperature and observed in the northern site of study; and one horizontal, corresponding to the thermocline.

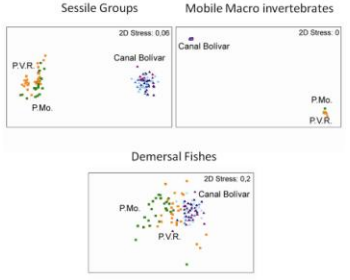



Figure 3. Differences between sites. Bio- regions West and ELIZABETH

**Punta Vicente Roca (north) Differences between cold and warm peiods**

**Punta Moreno (south) Differences between depths**

ANOSIM : $p<0,005$ significance

| | Dates | | | | Depth | | | |
|---|---|---|---|---|---|---|---|---|
| | P. Vicente Roca | | P. Moreno | | P. Vicente Roca | | P. Moreno | |
| | R | p | R | p | R | p | R | p |
| Sessile | 0,01 | 0,396 | 0,04 | 0,728 | 0,04 | 0,773 | 0,42 | 0,001 |
| Macro-invertebrates | 0,19 | 0,007 | 0,00 | 0,423 | 0,10 | 0,049 | 0,43 | 0,001 |
| Fishes | 0,33 | 0,001 | 0,13 | 0,026 | 0,11 | 0,034 | 0,42 | 0,001 |

MDS suggests a biotic differentiation for functional groups (sesiles, mobile maco invertebrates) and a gradient differentiation for demersal fishes in the west region (P. Vicente Roca, PVR, and P. Moreno, PMo) and the Elizabeth Region (Bolivar Canal), see Figure 3

There were also differences in the relationship parameter for each type of organism. Sessile and macro-invertebrates were associated to minimum and average temperature 30 days previous to the monitoring and the abundance of fishes was explained by the variable of temperature ratio between 30 and 60 days. Details of the species with clearest patterns and their replications in time are presented and related empirically to seasonal and inter-annual thermal fluctuations observed in remote-sensed records for the region. Figure 4 and Table 1 .

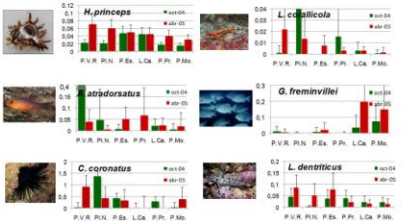



Figure 4. Analysis of Similarities Percentages for pattern differentiation between species (y axis: relative abundance (ind/m²)

The results suggest the possibility of identifying bioindicators that can be used to asses the impact of Sea Surface Temperature changes due to Climate Change and El Niño Southern Oscillation ENSO– like events.