

# EVIDENCE OF LONG-TERM CHANGES IN THE DISTRIBUTION OF KEY INTERTIDAL SPECIES

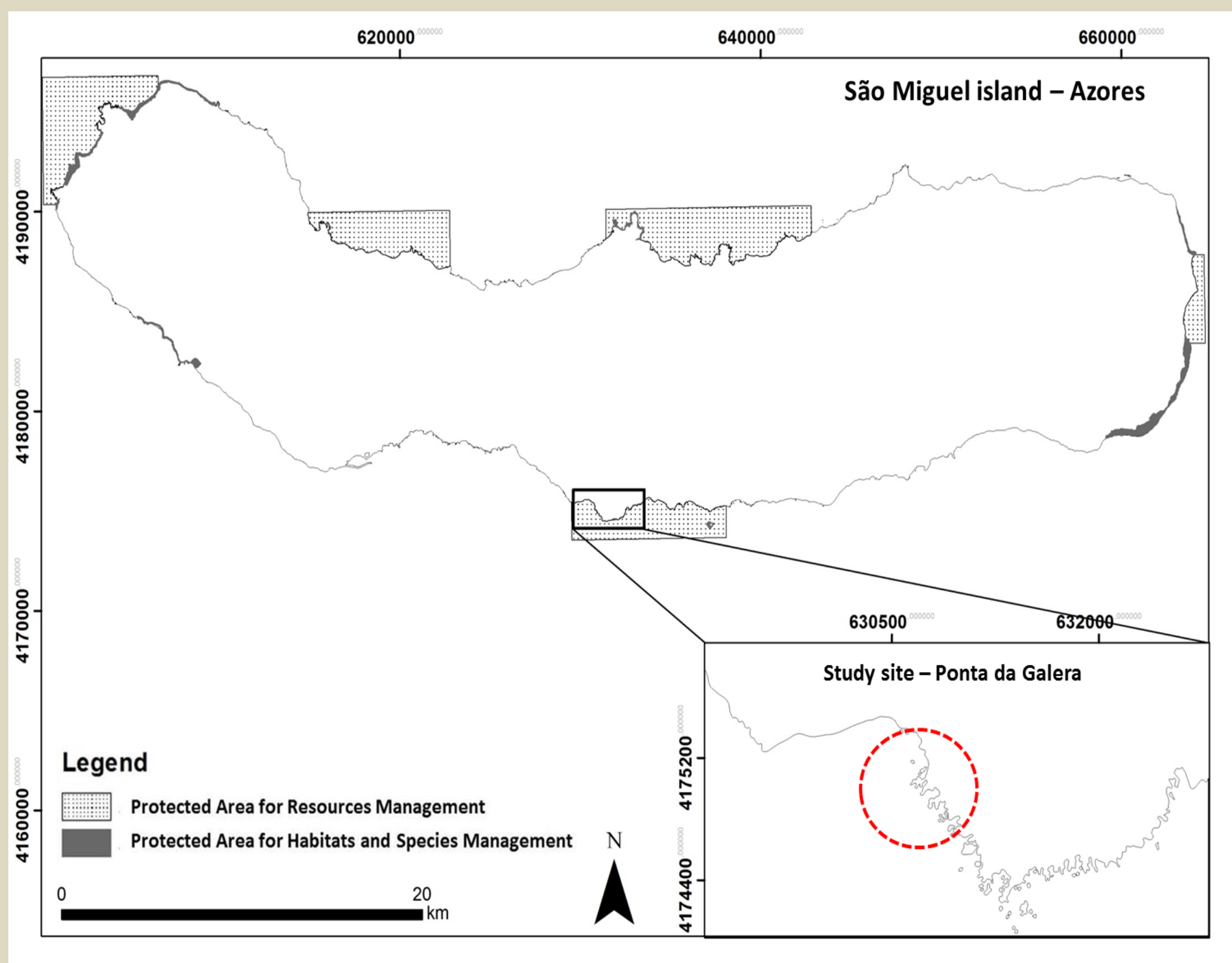
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**ABSTRACT** Globally, changes are occurring in the biogeochemistry and ecology of the oceans, which may influence the physiology, phenology, and species distribution. Biological communities are reacting to climate change through changes in the abundance and phenology of the organisms and through the poleward shift in species distribution. Rocky shores are relatively simple ecosystems, which makes them an excellent model system for the understanding of the consequences of climate change. This study aims to examine the evidence of long-term changes on the distribution of key intertidal species in the Azores. Grey literature and unpublished data collected in the late 1980's by Stephen J. Hawkins and his colleagues in the island of São Miguel (Azores) was compared to data collected in 2012. Whilst most taxa sampled in 1988 were still present during 2012, there were changes in species distribution. In general, there was an overall decrease in the abundance of organisms that was more pronounced on the sheltered area. In addition, there was generally a shift upwards of the vertical distribution of taxa that was more pronounced on the exposed area. These changes are tentatively interpreted as a consequence of increased temperatures and wave action (both predicted by climate change scenarios). This study also suggests that there may be interactive effects between environmental processes affecting species distributions. In addition, there was evidence that processes operating at large temporal scales may indirectly influence the distribution of species via changes in the abundance of their competitors.

## METHODS

- Re-surveyed exact area sampled by SJ Hawkins, Al Neto and colleagues in 1988 – Ponta da Galera (São Miguel island, Azores).
- 3 distinct areas differing in exposure to wave action – Exposed, Moderately exposed and Sheltered.
- Vertical distribution and abundance of organisms were estimated at several levels on the shore.
- Organisms were grouped to match the categories used by Hawkins *et al.* (1990).
- Mean abundance of each taxa in 1988 and 2012 were plotted against shore height for the 3 transects surveyed.
- Wilcoxon matched-pairs signed-rank test was used to test changes in taxa abundance over time.

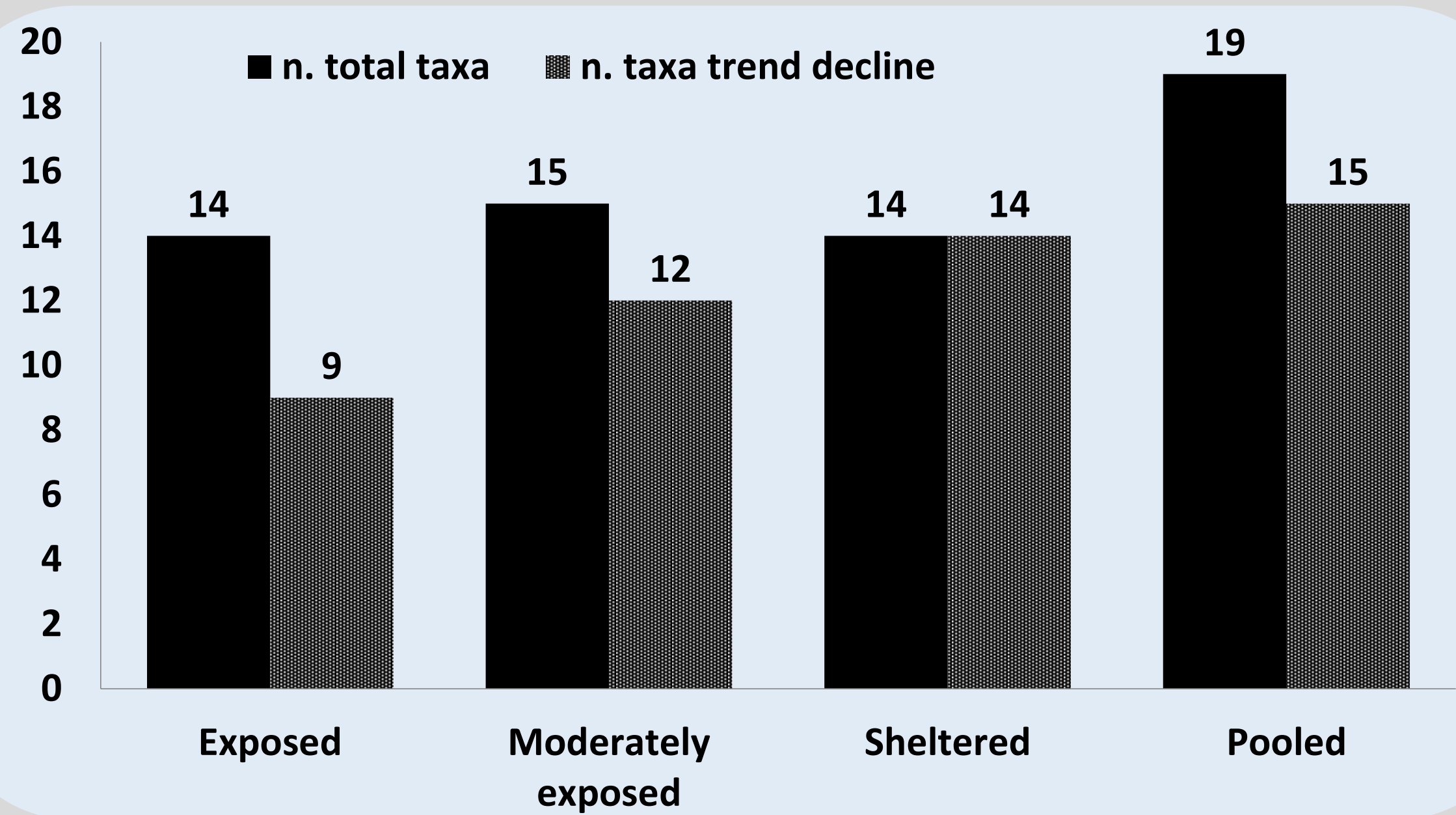


## RESULTS

### I. Compositional changes (1988/2012)

- Same specific composition.
- Few changes in assemblage composition - same general pattern of zonation.

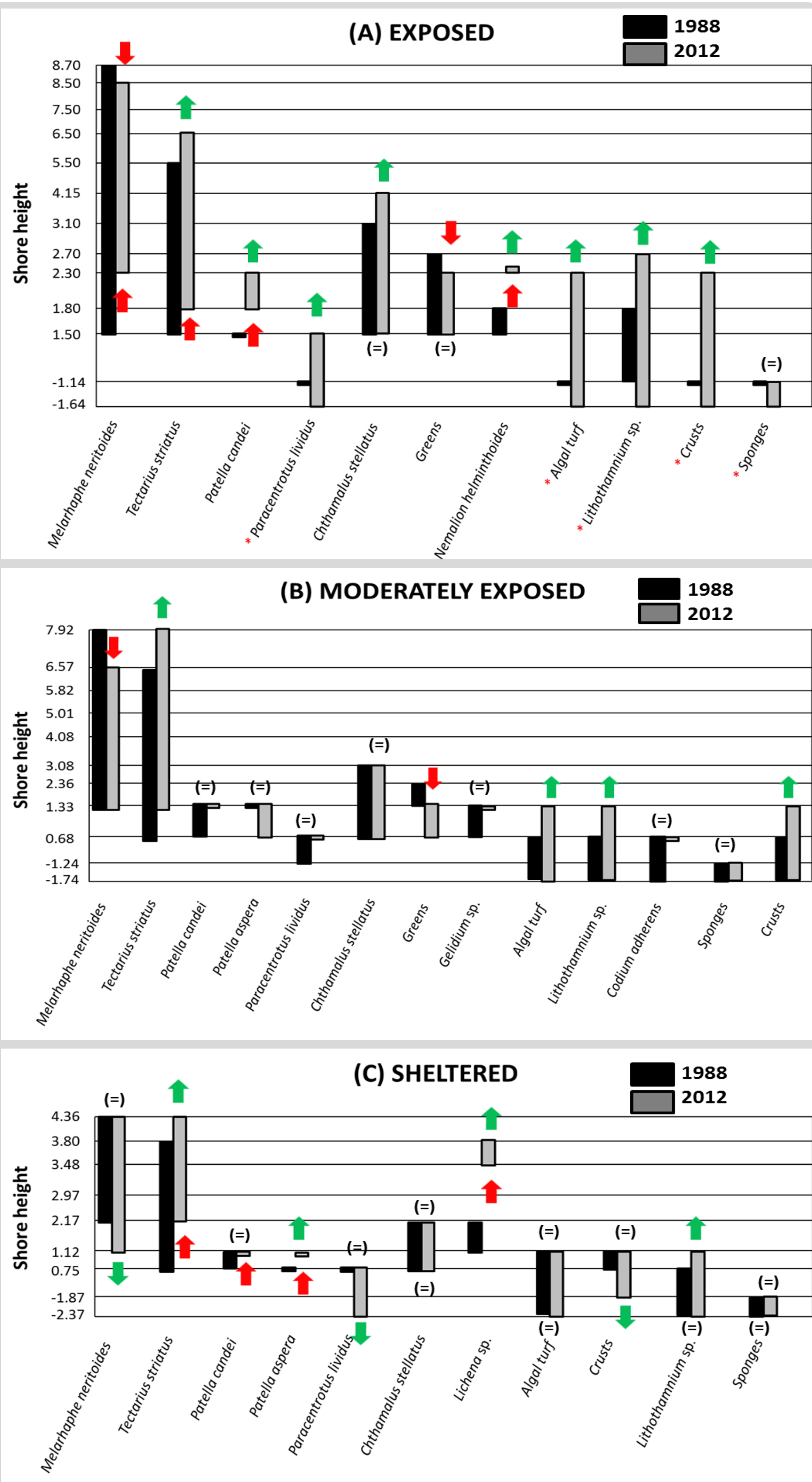
### II. Changes in abundance (1988/2012)



- Exposed:** *Melarhapha neritoides* - significant reduction in abundance.
- Moderately exposed:** *M.neritoides* and *Tectarius striatus* - significant reductions in abundance.
- Sheltered:** *M.neritoides* and *T.striatus* - significant reductions in abundance.
- Pooled:** *M.neritoides*, *T.striatus*, *Chtamallus stellatus*, greens (algae), *Lithothamnium* sp. and sponges - significant reductions in abundance.

### III. Changes in vertical patterns of distribution (1988/2012)

		Taxa		%
Exposed	Upper	Expand	8	
	Lower	Retreat	2	15
		Equal	1	
Moderately Exposed	Upper	Expand	-	-
	Lower	Retreat	4	31
		Equal	2	15
Sheltered	Upper	Expand	4	31
	Lower	Retreat	2	15
		Equal	7	54
	Upper	Expand	2	15
	Lower	Retreat	5	39
		Equal	6	46
	Upper	Expand	4	33
	Lower	Retreat	0	0
		Equal	7	58
	Upper	Expand	3	25
	Lower	Retreat	4	33
		Equal	4	33



- Recorded changes in distribution and abundance of key intertidal species over a period of 24 years have been tentatively interpreted as a response to increased temperatures and wave action. An increase in wave exposure is likely to mitigate the effects of increasing temperatures on the more exposed areas.
- Present study:
  - Wave exposure may have the largest influence on rocky intertidal community structure as exposed shores are the dominant feature.
  - Wave action (stormier seas) has probably increased between 1988 and 2012 (further studies).
  - Northern species are extremely vulnerable since they have little space to retreat.



correlates with seasonal changes in temperature, humidity and water availability. This presentation summarizes some 20 years of research on resistance to desiccation and heat in *ca.* 25% of the Israeli land snail fauna. In general, resistance to heat and aridity is correlated with distribution patterns and with abiotic environmental variation. The study comprised of intra-generic and intra-specific comparisons and micro-habitat and phylogeny-related differences. We also tested the effects of body size, ontogeny and the physiological set-points of the water regulatory mechanisms. Lately, we study the cellular mechanisms functioning under stress conditions and reflected in the pattern of expression of heat shock proteins (HSPs).

#### T10.P1

### THE FUNCTIONAL TRAIT-BASED APPROACH TO INVESTIGATE LIFE HISTORY TRAITS IN MARINE INVERTEBRATES TO PREDICT EFFECTS OF GLOBAL CLIMATE CHANGE ON ECOSYSTEMS

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Due to the actions of Man, biodiversity is constantly shrinking in every known ecosystem worldwide. The loss begins with modifications of functional traits at the individual level, proximately involving an alteration in the amount of energy available for metabolism by individual organisms: with insufficient energy, metabolic machinery does not work efficiently and organisms are unable to reach their maximal fitness throughout their life span. Here, we present a simple conceptual framework recently developed in our Lab in collaboration with many world-wide Universities inside a network studying the effect of climate changes on marine ecosystems, which is based on functional trait-based bioenergetic principles. Through some case studies, we show that the importance of the amount of available energy at the individual level is able to explain how emergent and classical anthropogenic factors may drive biodiversity loss starting from the individual reproductive failure. Flows of energy and matter through habitats and organisms are indeed subject to the laws of energy conservation and this allows us to mechanistically trace them through individuals and from individuals to populations and communities. The combination of lab and field experimental procedures with a robust mechanistic theory helps us to predict how each species operates under different sets of conditions (and when it does not). We are eager to investigate and possibly predict effects of both local (chemical [e.g., pollution], physical [e.g., thermal or boating noise]) and global (increasing temperature and CO<sub>2</sub>) disturbance, from benthic sessile to mobile pelagic organisms and from shallower intertidal to deeper subtidal habitats. Lab people, from undergraduate students to post-docs, like to face similar issues with quantitative rigor and innovation.

#### T10.P2

### EVIDENCE OF LONG-TERM CHANGES IN THE DISTRIBUTION OF KEY INTERTIDAL SPECIES

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Globally, changes are occurring in the biogeochemistry and ecology of the oceans, which may influence the physiology, phenology, and species distribution. Biological communities are reacting to climate change through changes in the abundance and phenology of the organisms and through the poleward shift in species distribution. Rocky shores are relatively simple ecosystems, which makes them an excellent model system for the understanding of the consequences of climate change. This study aims to examine the evidence of long-term changes on the distribution of key intertidal species in the Azores. Grey literature and unpublished data collected in the late 1980's by Stephen J. Hawkins and his colleagues in the island of São Miguel (Azores) was compared to data collected in 2012. Whilst most taxa sampled in 1988 were still present during 2012, there were changes in species composition. In general, there was an overall decrease in the abundance of organisms that was more pronounced in the sheltered studied area. In addition, there was generally a shift upwards of the vertical distribution of many taxa, which was more pronounced in the exposed area. These changes are tentatively interpreted as a consequence of increased temperatures and wave action (both predicted by climate change scenarios). This study suggests that the consequences of processes responsible for long-term changes recorded in species distribution can be mediated by wave action. In addition, there was evidence that processes operating at large temporal scales may indirectly influence the distribution of species via changes in the abundance of their competitors.

#### T10.P3

### SYNERGISTIC EFFECTS OF OCEAN ACIDIFICATION AND WARMIN IN SQUID EARLY ONTOGENY: EVIDENCE FOR SEVERE BIOLOGICAL IMPAIRMENTS

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We investigated a set of biological responses to climate-change related variables during early ontogeny of the squid *Loligo vulgaris*. Embryo's survival rates ranged from 92%-



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