Posidonia oceanica meadow architecture and landscape characteristics: relationship with the hydrodynamic setting

UNIVERSITY OF MALTA
L-Università ta' Malta

*Matthew Pace[1], Joseph A. Borg[1], Charles Galdies[2]
[1]Department of Biology, University of Malta, MSD2080, Msida, Malta
[2]Environmental Management and Planning Division, Institute of Earth Systems, University of Malta, MSD2080, Msida, Malta
*Corresponding author: matthew.e.pace@gmail.com

Introduction

The ecologically important endemic Mediterranean seagrass *Posidonia oceanica* forms dynamic landscapes that range from discrete patches to continuous meadows[1]. Understanding the natural dynamism in seagrass meadow landscape configuration and architecture is of great importance, given the potential implications for stress tolerance of the habitat and the influence on the associated flora and fauna.

However, despite the importance of water movement on seagrass ecosystems at various spatial scales from leaves to entire landscapes, the relationship has been poorly studied for *Posidonia oceanica* meadows, particularly those present in relatively deep water (>6m).

Hypothesis statement

Exposure to hydrodynamic forces significantly influences landscape spatial configuration and architectural complexity of *Posidonia oceanica* meadows.

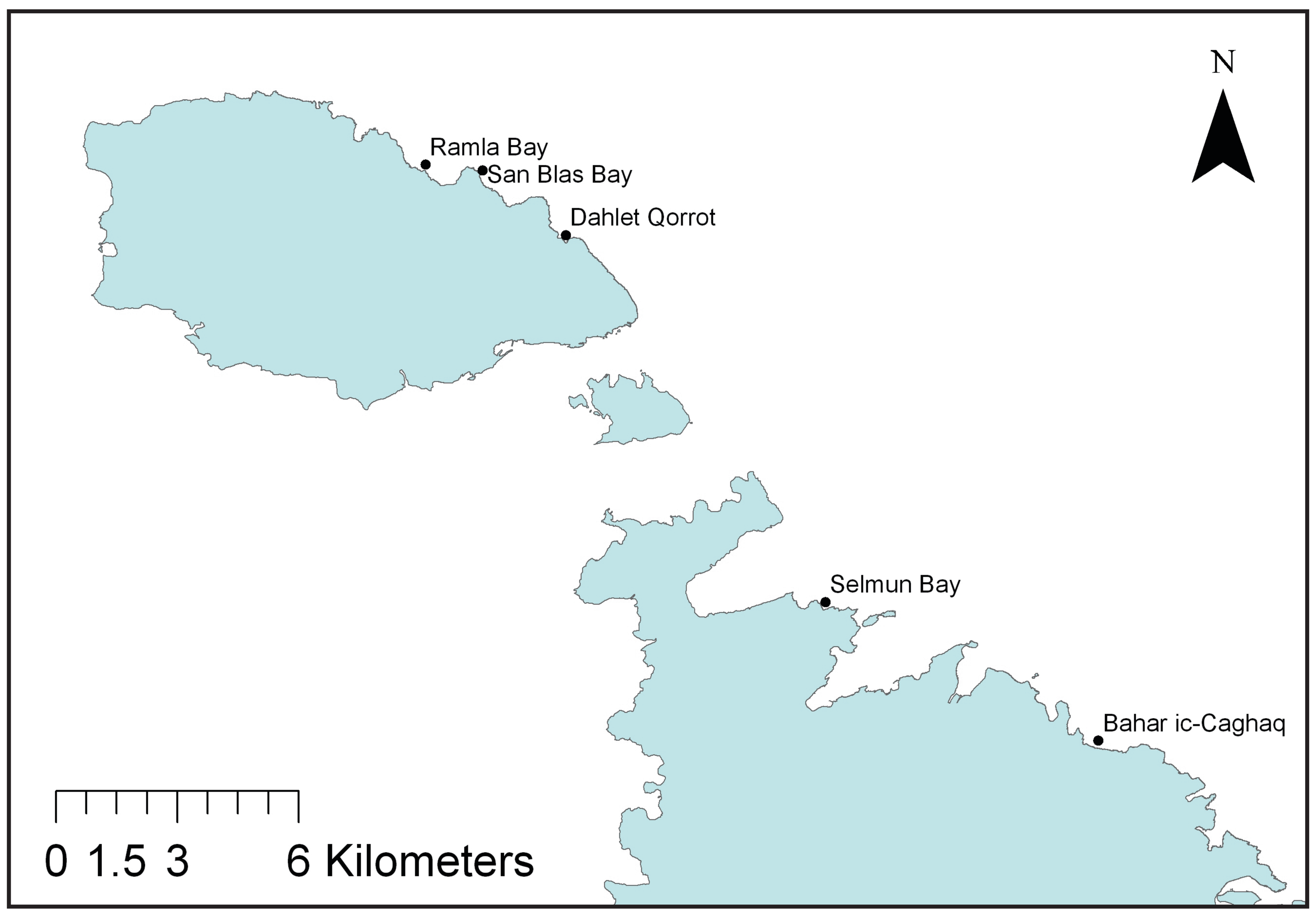


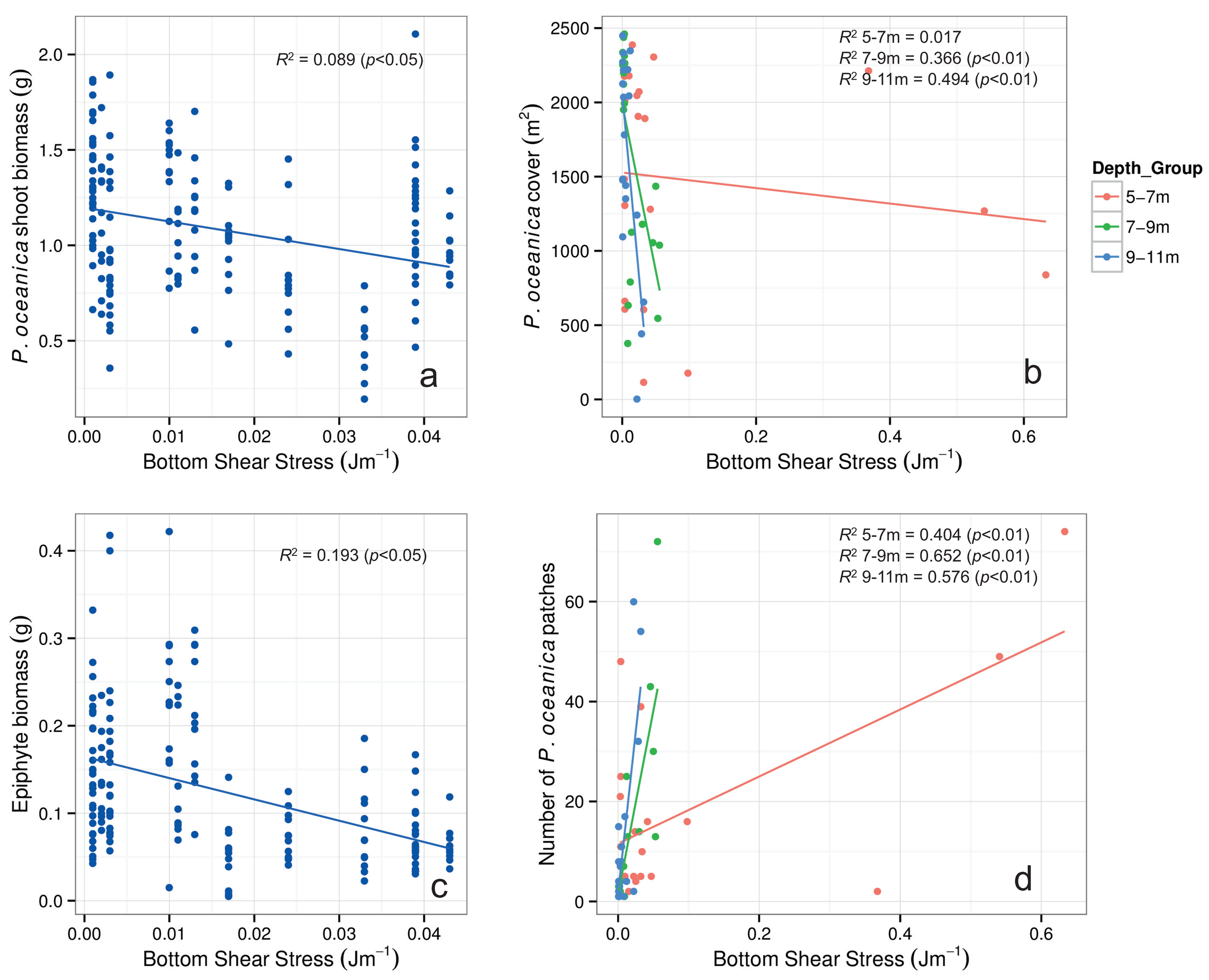
Figure 1: Map indicating the five study sites located along the north-eastern coast of the Maltese Islands

Material and Methods

Five coastal sites (Figure 1) on the northeastern coast of the Maltese Islands, each supporting three different bed types of *Posidonia oceanica*: patchy, reticulate and continuous, were mapped to a depth of circa 15m using a combination of colour vertical aerial photographs and SCUBA diving surveys. Indices describing different aspects of landscape configuration were calculated for replicate 2500m^2 subsamples extracted from the seagrass habitat maps. *In situ* shoot density counts were made and 12 shoots collected from a station located on each of the three bed types at each site for subsequent analysis of meadow architectural attributes.

A hydrodynamic model, WEMo (Wave Exposure Model)[2], was used to model estimates of wind-generated wave energy at the sea surface (Representative Wave Energy) and the depth-attenuated energy at the seabed (Bottom Shear Stress) using hourly wind speed and direction data for the years 2009-2011.

Figure 2a-d: Variation of landscape and architecture attributes in *Posidonia oceanica* meadows exposed to a gradient of depth-attenuated energy. Scatter plots show linear regression lines and associated *p*-values and coefficients of determination (R^2) for the relationships between bottom shear stress (J.m^{-1}) and: a) shoot biomass, b) *P. oceanica* cover per unit area, c) epiphyte biomass, and d) number of *P. oceanica* patches per unit area.



Results

- *Posidonia oceanica* cover and patchiness were significantly correlated with Bottom Shear Stress and this relationship was modified by water depth (Figure 2b,d).
- Shoot and epiphyte biomass were significantly lower at high energy sites compared to low energy sites.
- However, the proportion of variability within data for seagrass architectural attribute that could be accounted for by the relationship with Bottom Shear Stress was low (Figure 2a,c).

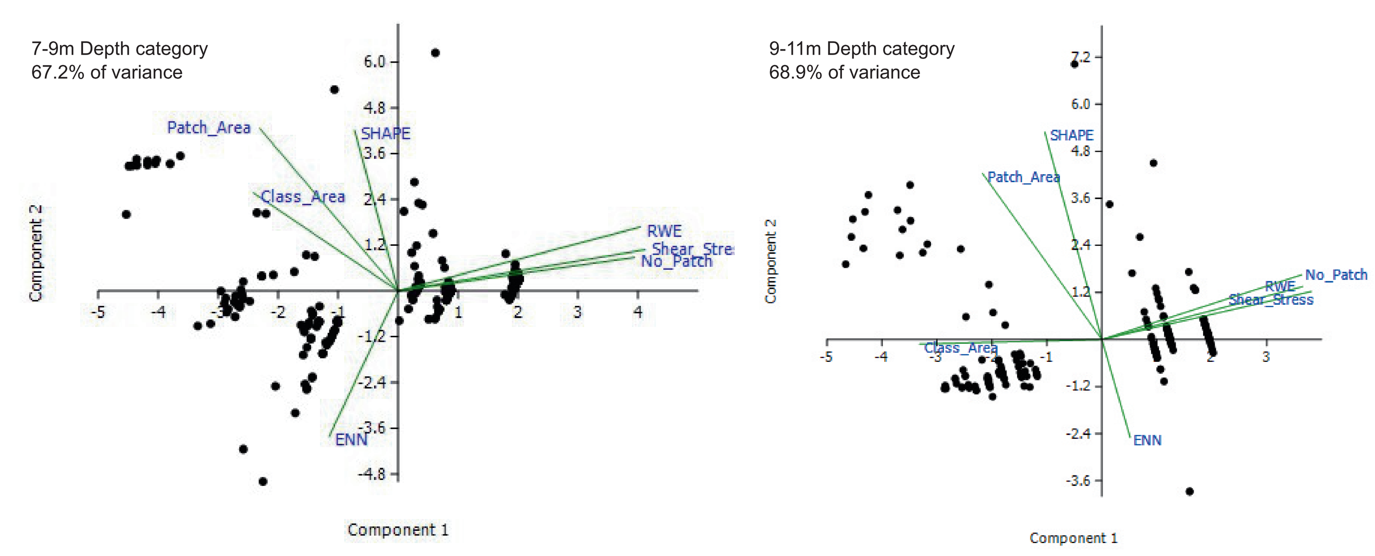


Figure 3: Biplot of the first and second components extracted via principal components analysis (PCA) of seagrass landscape variables and modelled hydrodynamic forces.

Conclusions

Exposure to hydrodynamic forces significantly influences seagrass landscape and meadow architecture of *Posidonia oceanica* located in relatively deep water (>6m). This results in: (i) patchier meadow landscapes, hence lower cover compared to seagrass habitat in less exposed sites; and (ii) lower intra-patch architectural complexity along a low to high energy wave exposure gradient, which is expected to influence the assemblage composition and structure of associated biota [3].

Acknowledgements

The authors would like to thank Dr Mark Fonseca and Mr Amit Malhotra for their help and advice on the application of WEMo to the Maltese Islands and landscape-scale analysis of seagrass meadows. We are also grateful to the Malta Meteorological Office and the Hydrographic Office within Transport Malta for the provision of wind data and bathymetric data respectively.

References

[1] Borg, J. A., Micallef, M. A., & Schembri, P. J. (2006). Spatio-temporal variation in the structure of a deep water *Posidonia oceanica* meadow assessed using non-destructive techniques. *Marine Ecology, 27*(4), 320–327.
[2] Fonseca, M.S., & Malhotra, A. (2010). *WEMo: Wave exposure model for use in ecological forecasting* (p. 74). Beaufort, North Carolina.
[3]Boström, C., Jackson, E. L., & Simenstad, C. (2006). Seagrass landscapes and their effects on associated fauna: a review. *Estuarine, Coastal and Shelf Science, 68*(3-4), 383–403.