

Relating Incident Wave and Current Characteristics to the Morphology of the Kelp *Laminaria digitata*

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Work Stream 10: Ecological Consequences of Tidal and Wave Energy Conversion

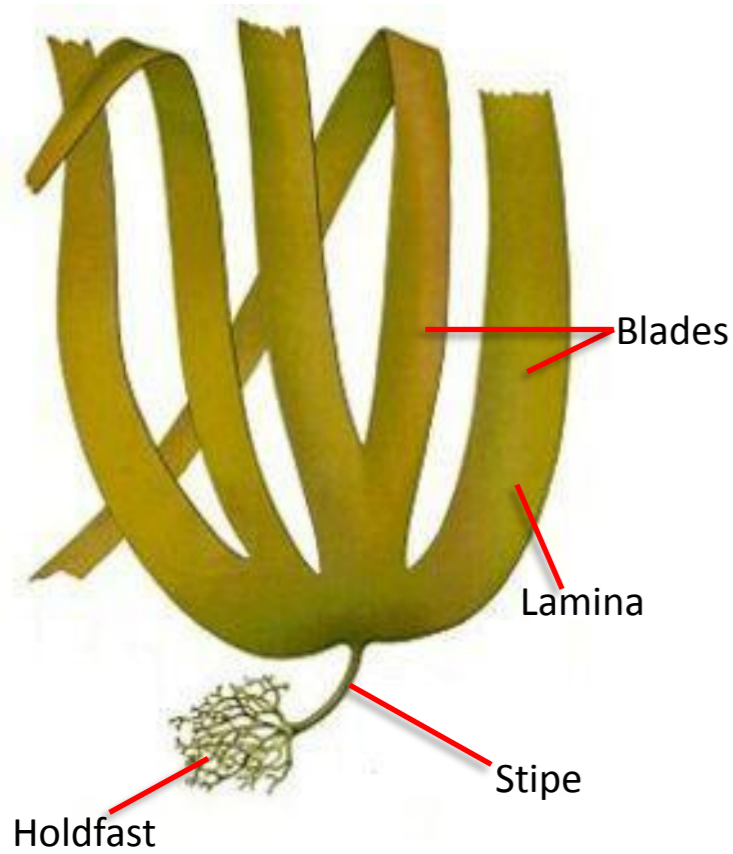


Fig.1 *Laminaria digitata*

Introduction

Inshore Marine Energy Converters (MECs) have the potential to alter the incident wave and current characteristics impacting the coastline. For regulatory purposes, it is necessary to understand the impact of the installation of inshore MECs on the ecology of the shore. *Laminaria digitata* (Fig. 1) is the dominant kelp of the upper sublittoral zone on rocky shores around the UK and has been shown to exhibit morphological plasticity in relation to its hydrodynamic environment [1]. Acoustic Doppler current profilers (ADCPs) now allow the relationships between plant growth dynamics and specific hydrodynamic parameters to be resolved.

Methods

Six sampling sites have been selected to exhibit a variety of wave and current characteristics (Fig. 2). Ten adult specimens of *L. digitata* are collected on a monthly basis from each site and a suite of morphological measurements and tensile tests made on each individual. Incident current velocity profiles and wave spectra are determined using ADCPs.

Results

The average width of the blades of *L. digitata* (Fig 3) is found to decrease with increasing total wave and current energy. This may be attributed to the impact of breaking waves and increasing shear stress at higher current speeds. Higher current speeds may also be expected to impose greater bending moments on the stipes of *L. digitata*. It may therefore be expected that an increase in the cross sectional area of the bottom of the stipe will be associated with increasing current speed. In order to allow for differences in plant size, the ratio of mid to basal stipe cross sectional areas is plotted in Fig. 4. The data shows a decrease in this ratio with increasing current speeds. This may be interpreted as showing that kelp plants impacted by higher current speeds possess thicker stipes near the holdfast thus allowing them to tolerate the addition of increasing bending moments.

Further Work

Further ADCP deployments are planned to allow determination of the wave and current characteristics at the three remaining sites. The data obtained from the ADCP will be partitioned into wave and current energies and the respective energies correlated to specific morphological characteristics of *L. digitata*. With the assistance of Queen's university materials testing lab both pull-to-break tensile tests and tear tests are being undertaken on the blades of *L. digitata*. Preliminary results indicate that there may be a relationship between both tensile properties and tear strength and the incident energy environment.

References

Mann, K. H. 2000. Ecology of coastal waters: With implications for management. pp192, Blackwell Press; 2. Sundene, O. (1964). The ecology of *Laminaria digitata* in Norway in view of transplant experiments. *Nytt Magasin for Botanikk* 11: 83-107.

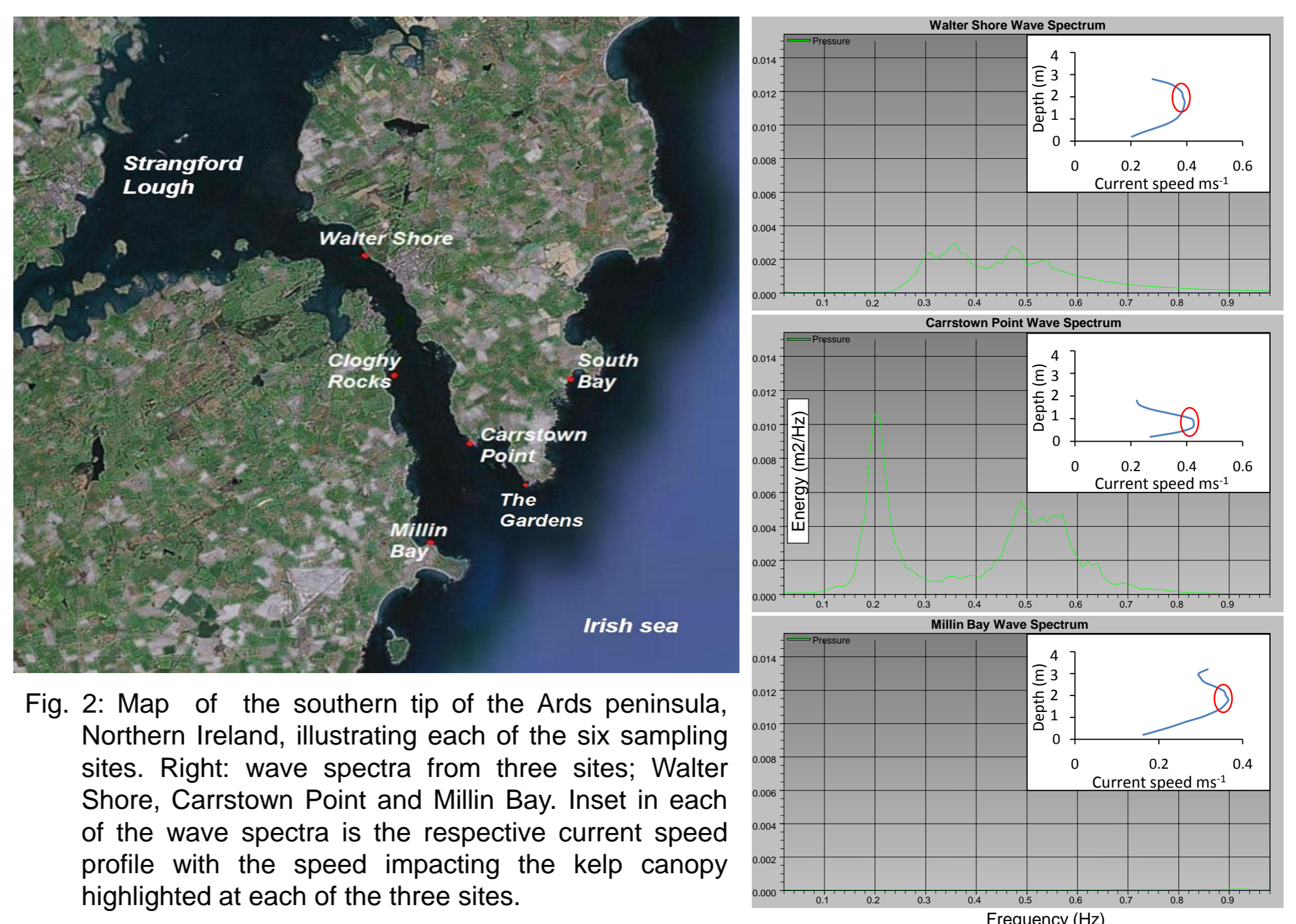


Fig. 2: Map of the southern tip of the Ards peninsula, Northern Ireland, illustrating each of the six sampling sites. Right: wave spectra from three sites; Walter Shore, Carrstown Point and Millin Bay. Inset in each of the wave spectra is the respective current speed profile with the speed impacting the kelp canopy highlighted at each of the three sites.

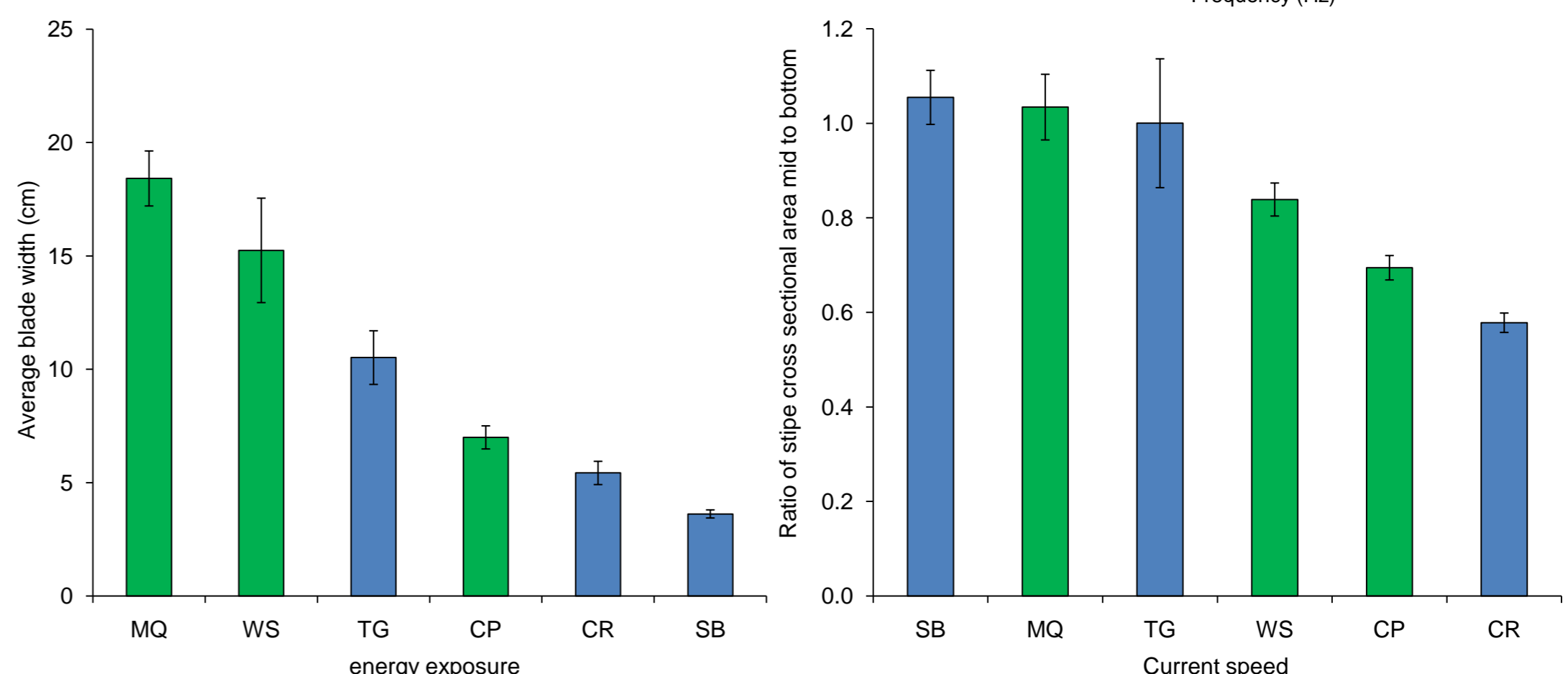


Fig. 3: The average width of the blades on the laminae of *L. digitata* +/- SE along a partially subjective energy exposure scale. The green data points correspond to the sites where wave spectra and current profiles are available.

Fig. 4: The ratio of the cross sectional areas of the stipes of *L. digitata*, mid to bottom, +/- SE along a partially subjective current speed scale. The green data points correspond to the sites where current speed profiles are available.