# Wave transformation across a rocky reef: effects on intertidal plant survival.

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#### 1. Wave Impacts on an Intertidal Rocky Reef

Wave action is a key physical parameter influencing ecological structuring on rocky reefs.

- This influence may occur through:
  direct damage to plants by wave forces
  resuspension of sediment which can smother plants
  limitations on the setting of propagules
- control of nutrient transfe
- generation of bubbles and changes to light penetration

However defining waves in the intertidal reef area is problematic.

# The objectives of a 5-day pilot study were to:

- quantify the attenuation of wind-waves and swell by the shallow irregular reef evaluate the changes in wavefield induced by this interaction
- test the suitability and accuracy a range of wave sensors in this rugged environment develop an optimum sampling strategy
- measure the survival of *Durvillaea* propagules at both 'wave-sheltered' and 'wave-



Kaikoura study site

Sediment resuspended by wave action

gauge

## 2. Study Site

Three sites were chosen with a gradient of wave exposure and biological variation.
The dominant species were: Durvillaea antarctica at the wave

exposed site (A), and Hormosira banksia at the sheltered sites



Sheltered Site B



Wave Exposed Site A

#### Instruments used

D: Dobie - pressure sensor, salinity, temperature, optical backscatter (sediment) W. Wire wave gauge - direct surface elevation
A: ADV - water velocity at the bed
S: Sediment traps - variety of designs S. Sediment traps - variety of designs ADP: alongshore currents Waverider buoy: offshore waves Radar: map of water surface velocity





### 3. Wave Spectra

Pressure sensors provide a robust means of measuring waves but need to be validated in this environment

Pressure sensors provide an indirect measure of way height, which is dependent on an assumption of linear waves. Wire wave gauges give a direct measure but are fragile. Neither explicitly deal with bubbles.

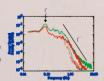
For long period swell in this shallow water, the waves become quite non-linear as shown by the steep wavefronts.

However despite this, the long wave period results in a near hydrostatic pressure balance. Thus the pressure dotted line) agrees with the directly measured surface displacement (solid line). So the physically robust pressure sensors can still be used to give a reliable measure of long period waves in this environment

The wave spectra show a dominant swell peak at f ~ 0.08 Hz (period ~12.5 sec). The non-linearity gives rise to higher frequency harmonics.

The high frequency waves from 0.8 Hz to 3 Hz, shows fall-off as f consistent with a locally generated equilibrium spectrum. In contrast, the low frequencies are severely attenuated yet still dominate.





#### 4. Wave Transformation

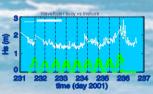
Satellites and wave buoys can provide offshore data - but how does it relate to wave amplitudes in

Wave activity over the reef (measured by significant wave height, H ) is dominated by tidally varying water depth.

Even small differences in depth at the 2 'ways

Even small differences in depth at the 2 wave-sheltered sites (8 & C) result in large differences in wave energy. At high tide the effect of depth attenuation is a minimum, with ratios of energy at the 2 sites approximately 1 (middle panel).

Offshore wave energy measured by the Waverider buoy is attenuated by a factor of 3 across the reef.





#### 5. Propagule Survival

Biological and physical parameters are ared in very different ways at very different resolutions.

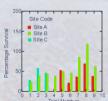
For comparison of biological and physical parameters, tidal cycles were used as

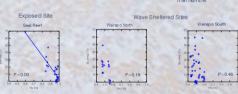
parameters, tidal cycles were used as replicates.
Waveheight was averaged across a tidal cycle.
The number of *Durvillaea* propagules before and after exposure to a tidal cycle were measured

Various substrates for settlement plates were trialled (top right); fibrelite produced the highest survival rates. The wave exposed site A (red, right) clearly

showed lower survival rates of propagules. Regression analysis (below) found a statistically significant correlation between wave height and survival at the exposed site, but not at the wave-







#### 6. Conclusions

- Swell incident upon the reef has a highly non-linear waveform, yet the long period of these waves retains a quasi-hydrostatic pressure balance.
- This allows pressure sensors to be used despite the non-linearity.
- The dobie pressure sensors were found to be most robust wave sensors for this
- In this short pilot study, a significant relationship between survival of Durvillaea propagules and wave height was found at the wave-exposed site. At the wave-exposed site. sheltered site other factors such as desiccation dominate

A longer term study is underway, now including other physical variables (sediment, light exposure, temperature, salinity)