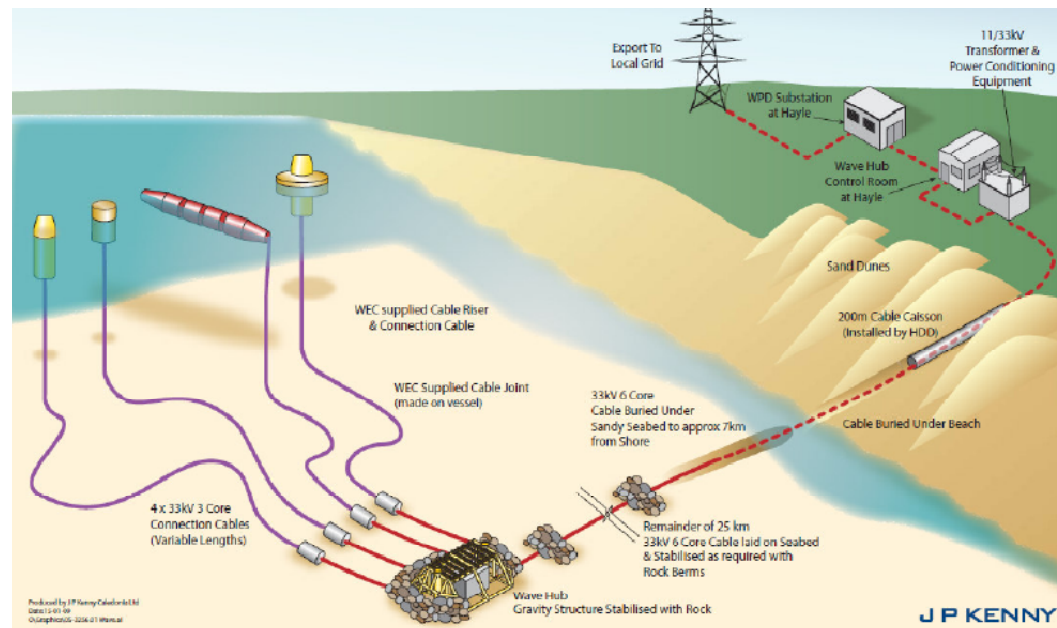


Effective Monitoring Strategies

The Wave Hub Example

Daniel Conley

SMSE, University of Plymouth



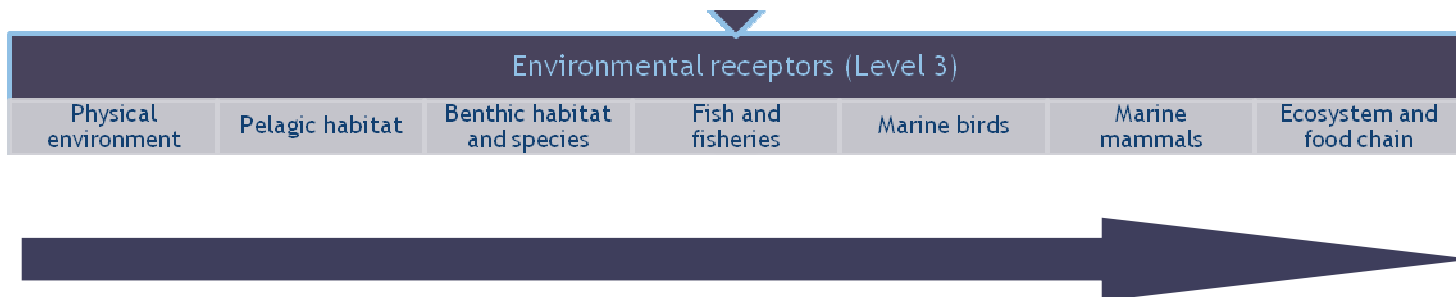
Principles of Monitoring



- Determine Relevant Indicators
- Effective Monitoring
 - * Specific enough to detect expected impacts
 - * Broad enough to detect large unexpected impacts
 - * Design for appropriate controls
- Achievable
 - * Economic & Resource Considerations
- Appropriate Analysis
- Dissemination of Results

Methodology

Physical Impacts

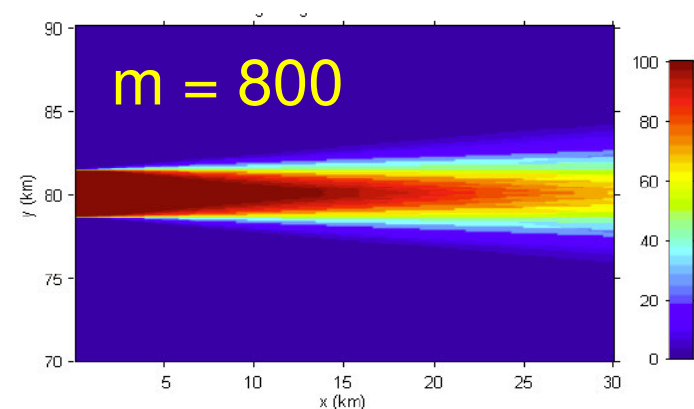
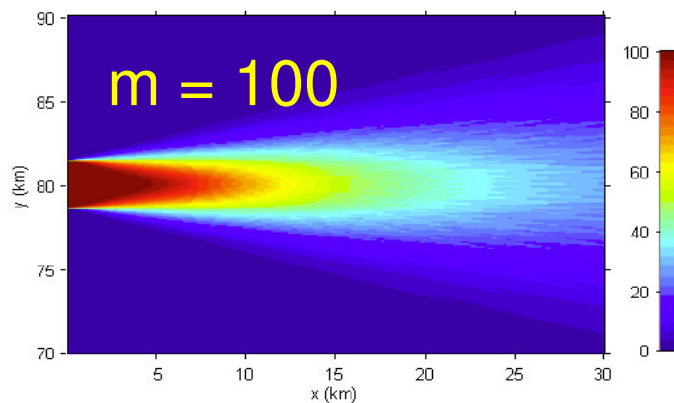
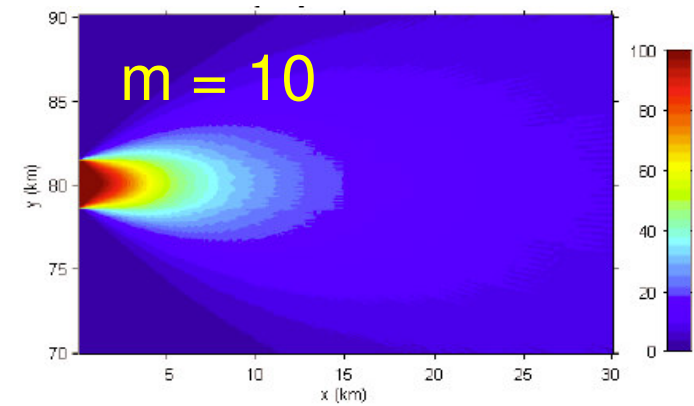
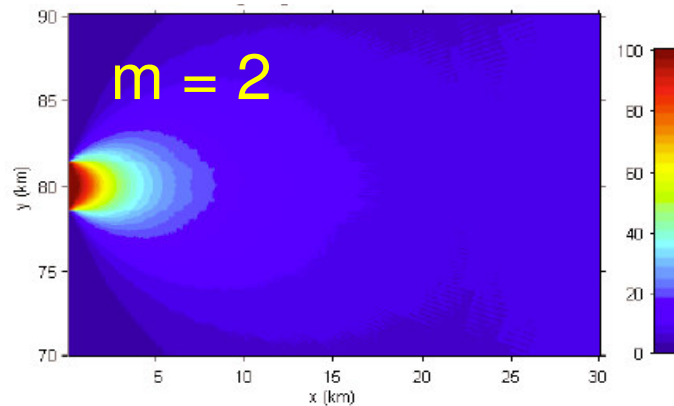


Pressing Monitoring Questions

Device Presence

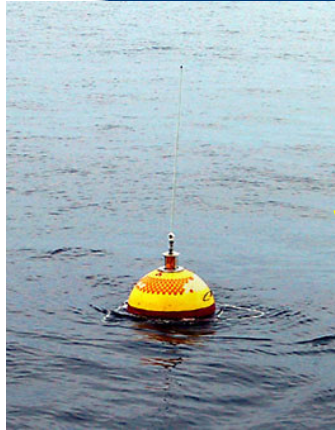
Receptor	Effects	Duration	Monitoring methods
Physical Environment Affected by Device Presence	Alteration in water circulation patterns	Long term	Repeat hydrographic surveys, In-situ moorings, ADCPs, remote sensing (ocean color, surface currents)
	Modification of wave climate	Long term	Use of in-situ wave measurements upstream and downstream of the project before and after project instalation (pressure sensors, ADCP's, Wave buoys) Use of remote sensing techniques that can be applied to the area (Sea Surface Height)
	Increased mixing of the water column	Long term	Vertical CTD profiling of the water column downstream from the project Turbulence characterization
	Alteration in sediment dynamics (erosion and accretion pattern change - implication to coastal defense and management)	Short term/long term	Definition of grain size , organic content and mineral content of sediments. Characterization of current direction and sediment transport through ADCP. Monitoring of the bathymetry in the projects vicinity. Remote sensing to determine shoreline changes.

Numerical Simulations & Directional Spread

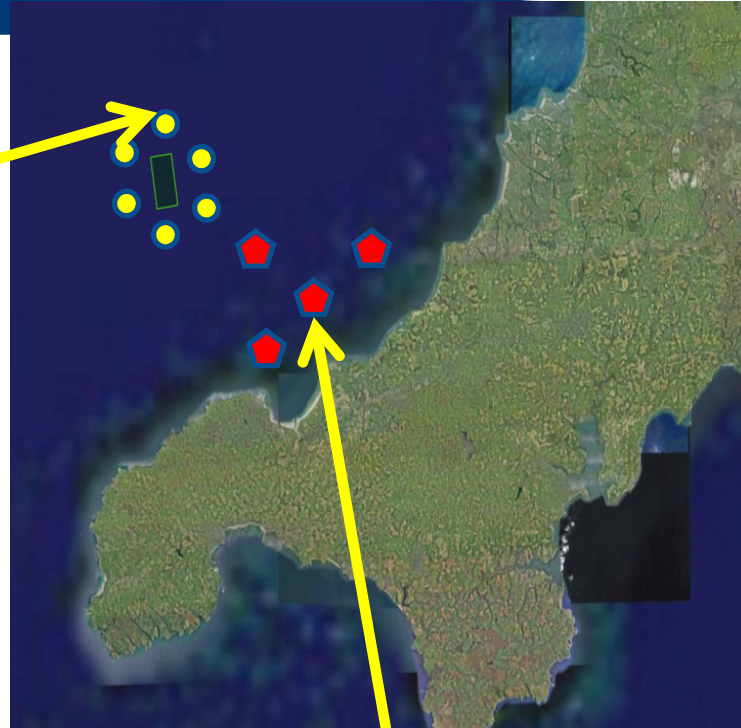


- $m=2$; DSPR=31.5 messy swell (essentially the Millar et al. case of DSPR=30).
- $m=10$, DSPR=17.1 reasonable surfing swell
- $m=100$; DSPR=5.7 very clean swell approaching monochromatic
- $m=800$; DSPR=2.0 exceptional swell, essentially monochromatic

In-Situ Measurements



Wave buoy



- Provides wave spectra (direction & frequency), current profiles.
- Provides calibration and validation for wave and circulation models as well as HF Radar.
- Project designed to provide *at least* 1 years baseline data



ADCP



TRAWL
RESISTA

HF Radar Installation

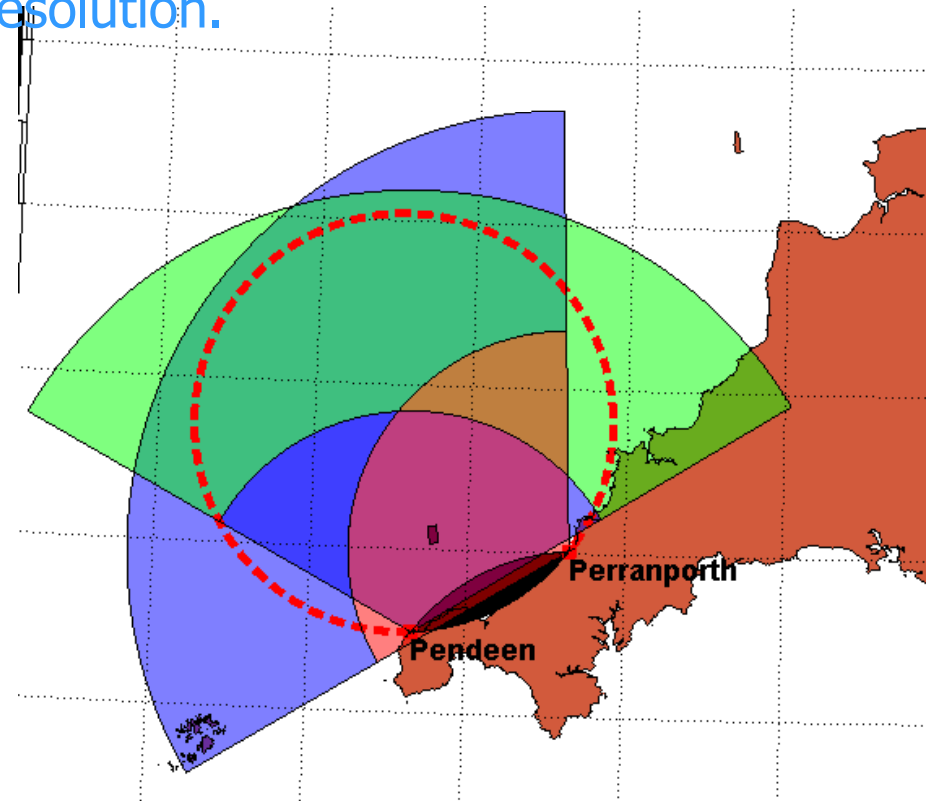
Deployed at 2 sites with each site requiring Tx and Rx array and electronics package. Installation is non-permanent.

Transmit Array
(4 element
10 x 5 m)



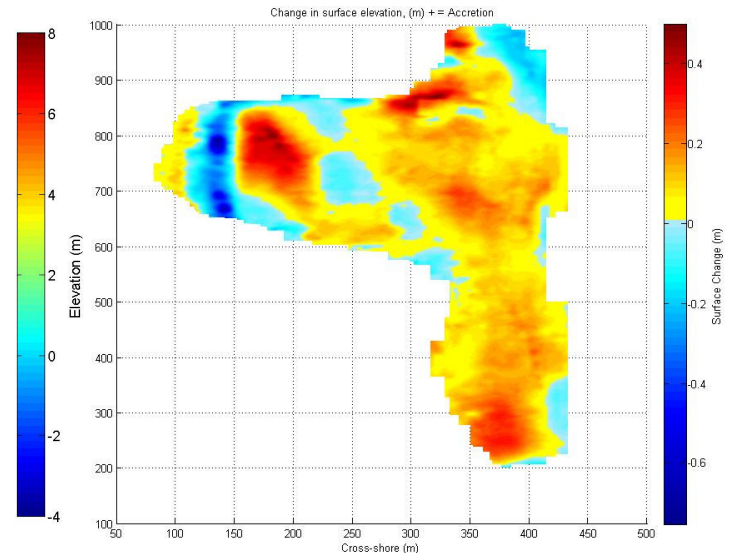
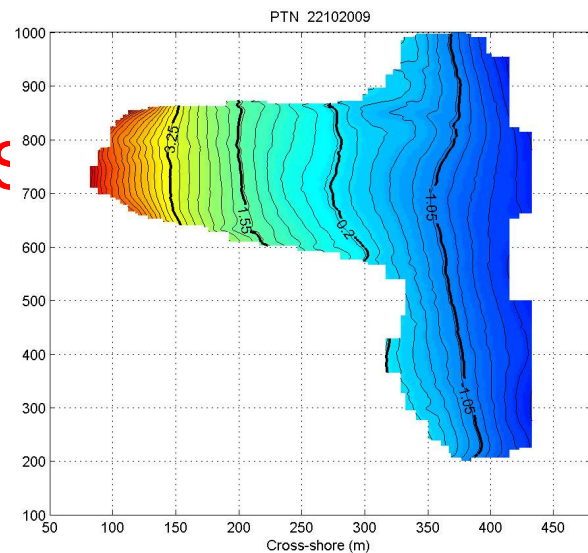
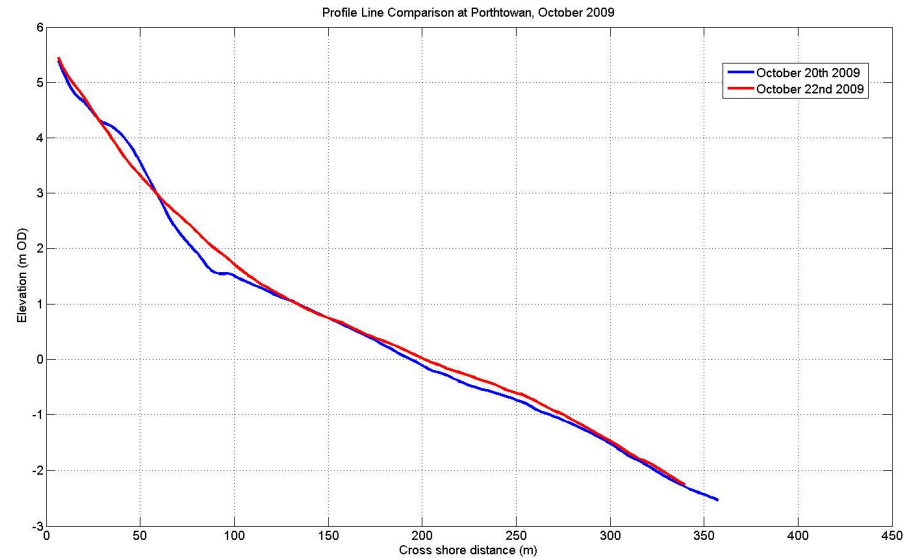
Receive Array (16 element, 150 m)

Mean expected data coverage. Directional estimates exist for intersections of colors. Wave coverage half of current coverage. Provides map of independent estimates at 2 km resolution.



Shoreline Change

Monthly surveys of complete subaerial beach topography at 4 beaches (Godrevy, Portreath, Porthtowan and Perranporth) since April 2007.

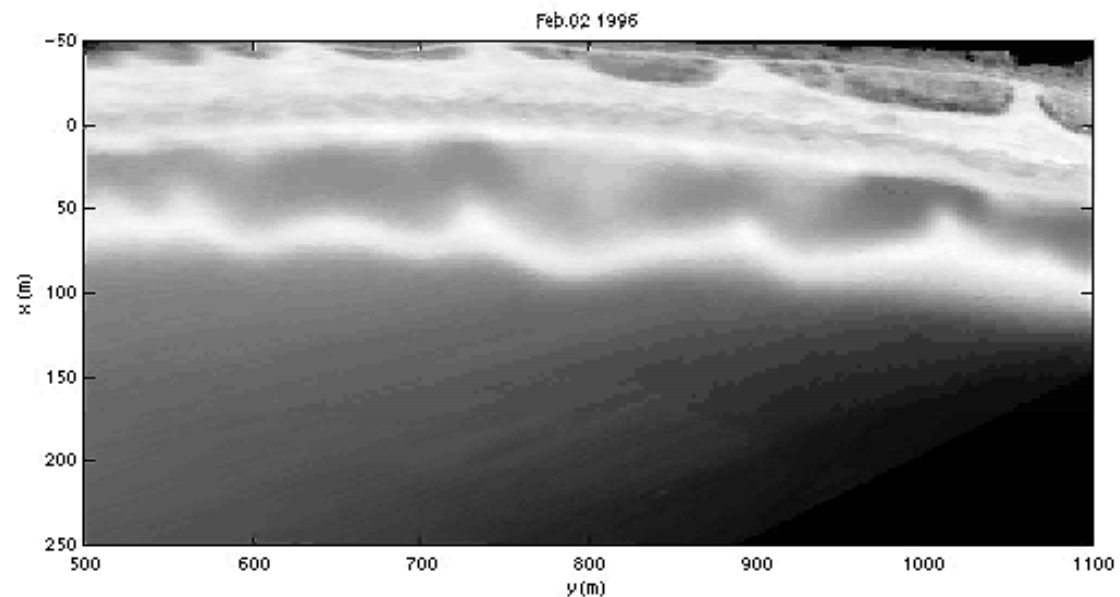


Surf Zone Behaviour

Argus video



Continuous coverage of full surf zone at 2 beaches from from Argus stations. Characterizes longshore bar and troughs and identifies circulation features such as rip currents.



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Pressing Monitoring Questions

Electromagnetic Fields

Receptors	Effects	Duration	Monitoring methods
Benthos	Effects of electrical fields on benthic species	Long term	Species tagging Mesocosm experiments
Fish	Electrical fields: interference with prey location, orientation and reproduction	Long term	Video monitoring of site (towed/fixed) Laboratory testing for species sensitivity
	Magnetic fields: interference with migrations	Long term	Population change of commercially viable species can be monitored through port landings and enquiring fishermen
Marine mammals	Interference with orientation and migration	Long term	Standard scientific trawls
Sea turtles	Interference with orientation and migration	Long term	

Pressing Monitoring Questions

Acoustics



Receptors	Effects	Duration	Monitoring methods
Marine Mammals	Physical – Auditory (permanent or temporal damages on hearing) or non-auditory (another tissues)	Short term /Long	
	Behavioural (e.g. interference with mother-calf interaction, avoidance of the area)	Short term /Long	
	Perceptual (communication, vocalization adaptation, prey/predator detection)	Short term /Long	
	Chronic/Stress (sensitivity, diseases vulnerability)	Long term	
Fish	Avoidance, displacement, mortality or behavioural changes	Short term /Long	
Sea turtles	Avoidance, displacement or behavioural changes	Long term	
Crustaceans	Avoidance, displacement	Long term	
Humans	Aerial noise disturbance of onshore devices (eg. OWC devices)	Long term	

Pressing Monitoring Questions

Sea Birds

Stressors & Receptors	Effects	Duration	Monitoring methods
Marine Birds Affected by Device Presence	Collision	Long term	<p>Background information can be obtained through a literature review and resorting to data obtained from previous government run projects in the area</p> <p>Local surveys aimed at determining abundance and use of area by species (methodology and techniques suggested by Camphuysen et al., 2004).</p> <p>Telemetry and tagging studies; visual observations (by boat, land and aircraft)</p> <p>Monitoring attraction of sensitive species to the devices and cross this information with distribution and abundance studies in the area.</p>
	Entanglement	Long term	
	Interference with migration routes	Long term	
	Disturbance/disorientation of birds due to lighting at night	Long term	
	Disturbance during operations	Short term	
	Habitat change: roost, nest and feeding sites	Long term	
Marine Birds Affected by Chemical Contamination	Species disturbance / mortality due to oil spills	Short term / Long term	<p>List the chemical potential for leak and dispersion</p> <p>Identify toxicity</p> <p>Pre & post operational soil & water column surveys</p> <p>Monitor bioaccumulation (how)</p>

Pressing Monitoring Questions



Collisions & Strike Effects

Stressors & Receptors	Effects	Duration	Monitoring methods
Benthos, fish, diving birds, marine mammals, sea turtles	Strike	Long term	The risk of rotor strike from angle unit can be readily estimated for an organism in the zone of influence from information; laboratory studies on the probability and effects of strike associated; collection of data on animals from underwater video and ph
	Cavitation	Long term	Blade performance predictions

Other Monitoring Questions



- Omitted Techniques?
- Problems with Principles?
- Suggestions Regarding Costs, Resources?
- Insights Into Dissemination?
- Other?