Underwater sound levels at a wave energy device testing facility in Falmouth Bay, UK

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Aim

To monitor and assess sound levels during:

1) a baseline period,
2) wave energy converter installation activity,
3) the device *in situ* with inactive power status, and
4) the device *in situ* with active power status.

Background

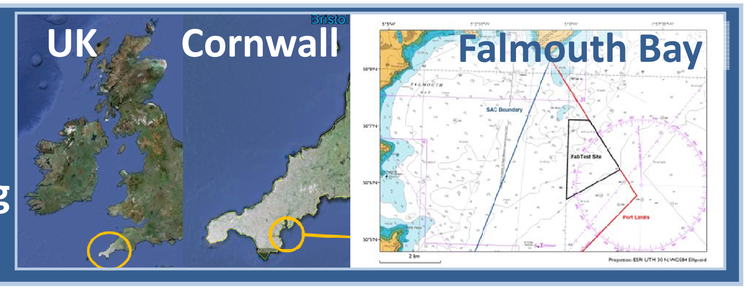
There is a lack of *in situ* sound measurements of full scale wave energy converters (WECs) during all stages of installation, operation and decommissioning. These sound measurements are needed to inform environmental impact assessments.

The WEC

The point absorber wave energy converter was deployed at FaBTest, a testing facility in Falmouth Bay in March 2012-present.

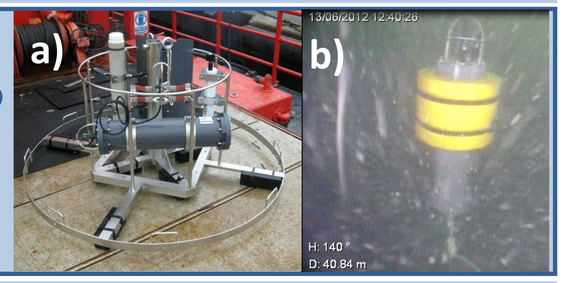
The Location

The area supports considerable commercial shipping, recreational boating and diverse marine fauna.



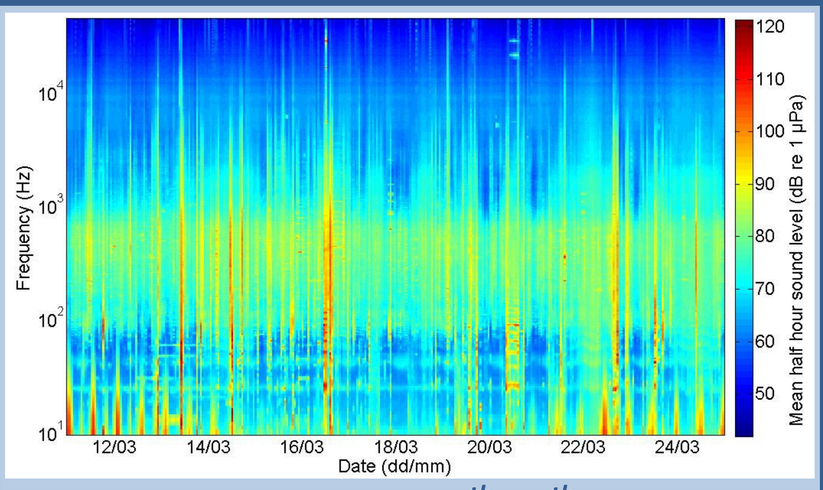
Method

Passive acoustic monitoring (PAM) devices were deployed at the device testing site since two weeks prior to installation of the WEC using a) a dome configuration on the seabed or b) a flotation collar 5 m above the seabed. The device records for the first half of every hour in the frequency range 10 Hz to 32 kHz or 48 kHz. Custom MATLAB scripts are used to process the data.



Results

Baseline

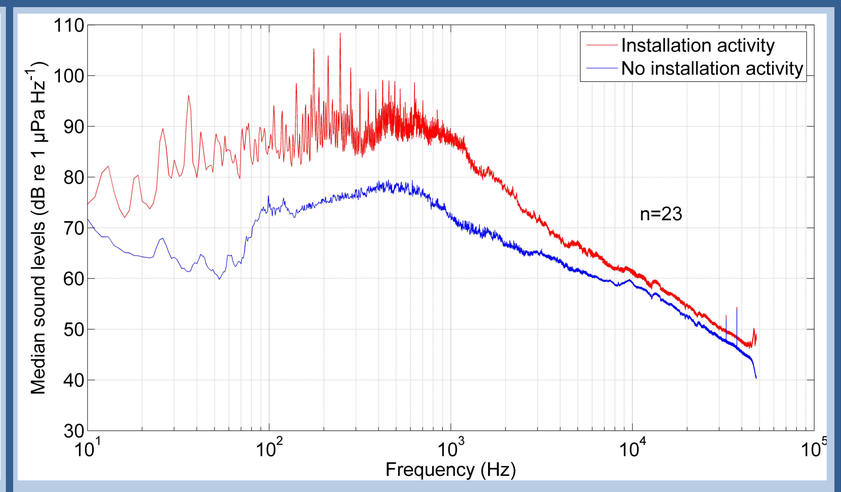


Baseline sound levels 11th-25th March 2012 (mean square pressure per half hour sound file).

The median sound level during the baseline period ranged from 60-80 dB re 1 µPa^2 (10 Hz to 10 kHz), decreasing to ~45 dB re 1 µPa^2 at 48 kHz.

The majority of the sound energy is in the range ~100 – 1000 Hz, this is in agreement with Merchant *et al*. (2012) which found sound from shipping was mostly below 1 kHz. Falmouth Bay can be seen to already experience loud sound events of 100 dB or more which are likely to be caused by local shipping or industrial activity.

Installation

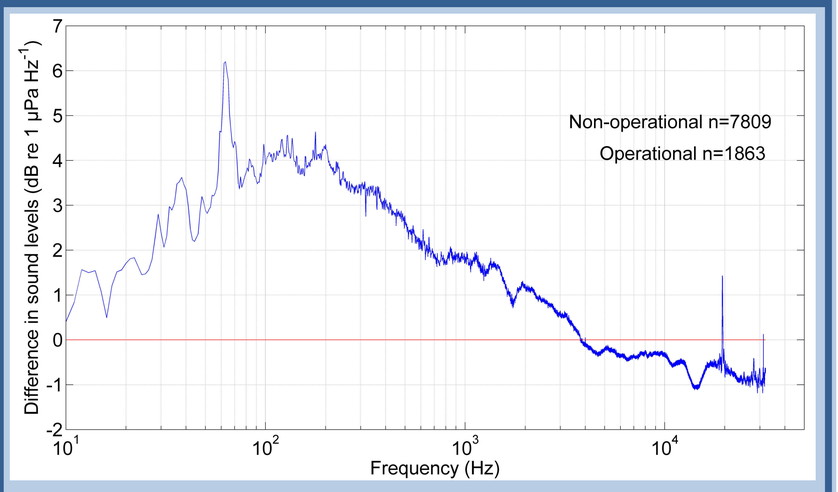


Median sound levels for installation activity compared to periods containing no installation activity, where n= number of half hour files for each activity status.

The median difference was 2.22 dB re 1 µPa^2 (10 Hz to 48 kHz). The maximum difference was 34.84 dB re 1 µPa^2 at 36 Hz.

The loudest sounds have been found to be during installation in line with expectations (Patricio *et al.* 2009). However, installation activity was only recorded in <20% of the half hour files collected in the whole installation period (26th-30th March 2012).

Operation



Median difference in the sound levels between operational and non-operational periods April 2012-August 2013, where n= number of half hour files.

A difference of >0 dB (shown by the red line) indicates that the sound levels are louder, on average, during operation compared to non-operation for that frequency. The median difference is -0.58 dB (10 Hz—32 kHz). However, there are more periods of non-operation than operation so it is possible that this affected the results.

The maximum difference is 6.20 dB at 63 Hz so the WEC may be contributing to the local sound levels at this frequency in particular.

Conclusion

- **The sound levels in Falmouth Bay are variable and affected by local shipping.**
- **The loudest sounds occurred during installation activity, this may be problematic if multiple devices are deployed.**
- **Median sound levels during periods of operational activity compared to periods of non-operational were louder at some frequencies. These are similar frequencies to those affected by shipping at the site.**

Further work

- **Continued monitoring including during decommissioning**
- **Analysis of the sound monitoring to date (March 2012-present)**
- **Analysis of peak sound levels and sound exposure levels (SELs)**
- **Analysis of data recorded at different distances from the WEC**

References

Merchant ND, Witt MJ, Blondel P, Godley BJ, Smith GH (2012) Assessing sound exposure from shipping in coastal waters using a single hydrophone and Automatic Identification System (AIS) data. Marine pollution bulletin 64 (7):1320-1329

Patrício S, Moura A, Simas T (2009) Wave energy and underwater noise: State of art and uncertainties. In, 2009. IEEE, pp 1-5

Southall BL *et al. (*2007) Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic mammals 33 (4): 1:521