

Underwater noise measurements of a 1/7th scale wave energy converter

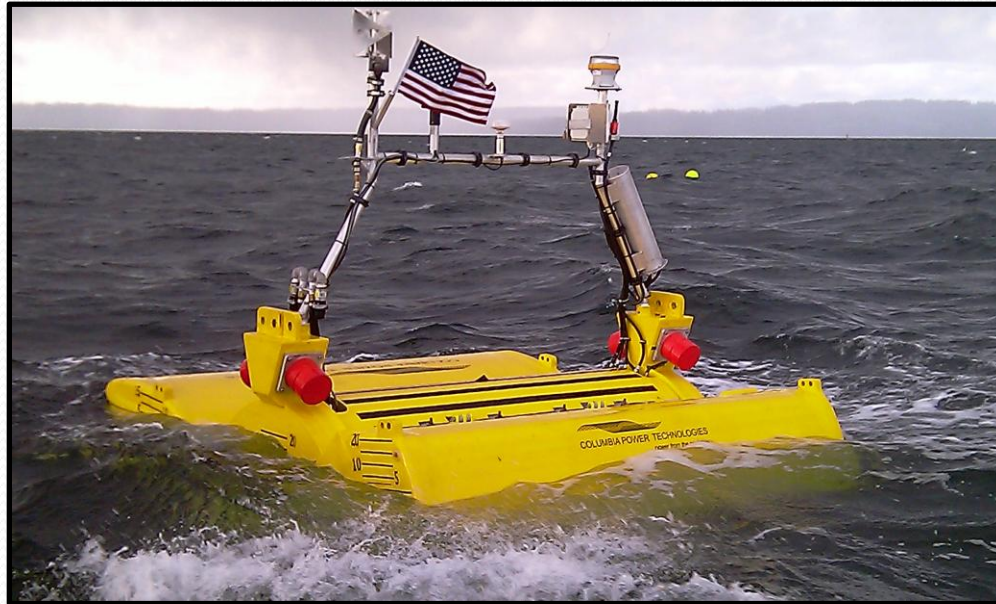
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DOE MHK Environmental Webinar Series
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Wave Energy Converter



<http://www.columbiapwr.com/technology.asp>

Columbia Power Technologies – SeaRay

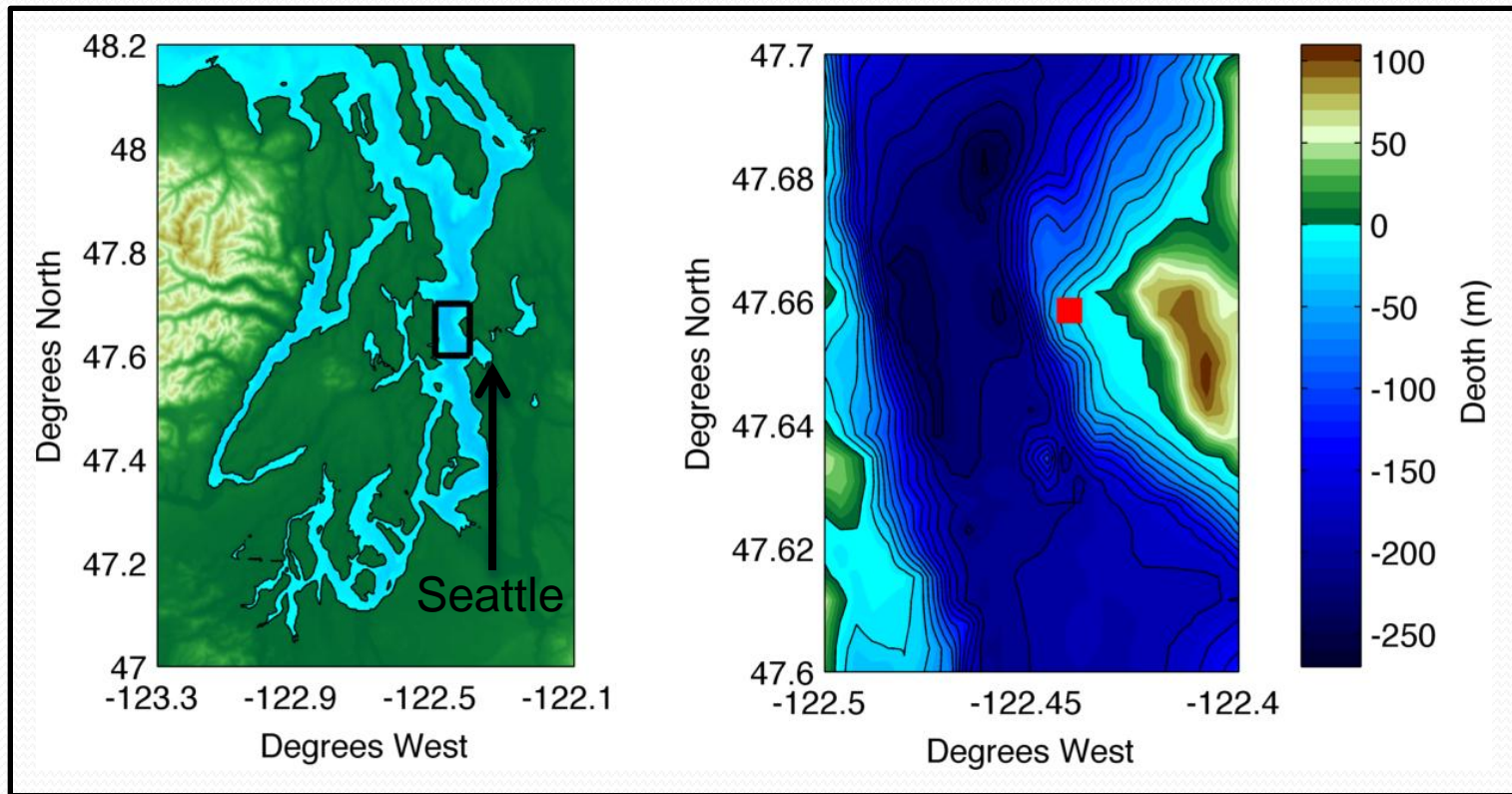
- 1/7th scale prototype
- Heave and surge point absorber
- 5 kW permanent magnet generators (x2)
- Mechanical yaw
- 3 pt. mooring

Site Information

Study performed on March 30, 2011 between 10:00 and 14:00 (PDT)

Site: West Point, Puget Sound, WA

- ~ 20 meters deep



Drifter - SWIFT



SWIFT – Surface Wave Instrument Float with Tracking
(Thomson, in review)

- GPS for tracking (post-processing)
- Anemometer
- Garmin Astro for real time tracking
- GoPro Hero high definition video camera
- QStarz BT-Q1000eX accelerometer sampling at 5 Hz
- Loggerhead DSG for acoustic measurements

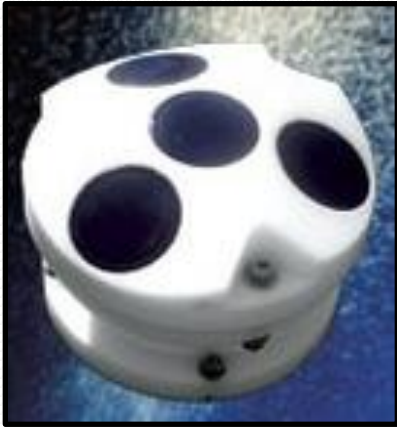
Loggerhead DSG

- Recorded 60 seconds every other minute



Parameter	Value
Sample Rate	80 kHz
Storage	32 GB (Flash)
Effective Sensitivity	-166 dB re 1V/ μ Pa
Linear Response	20 Hz – 30 kHz

Ancillary Data from SeaRay



Wave and current

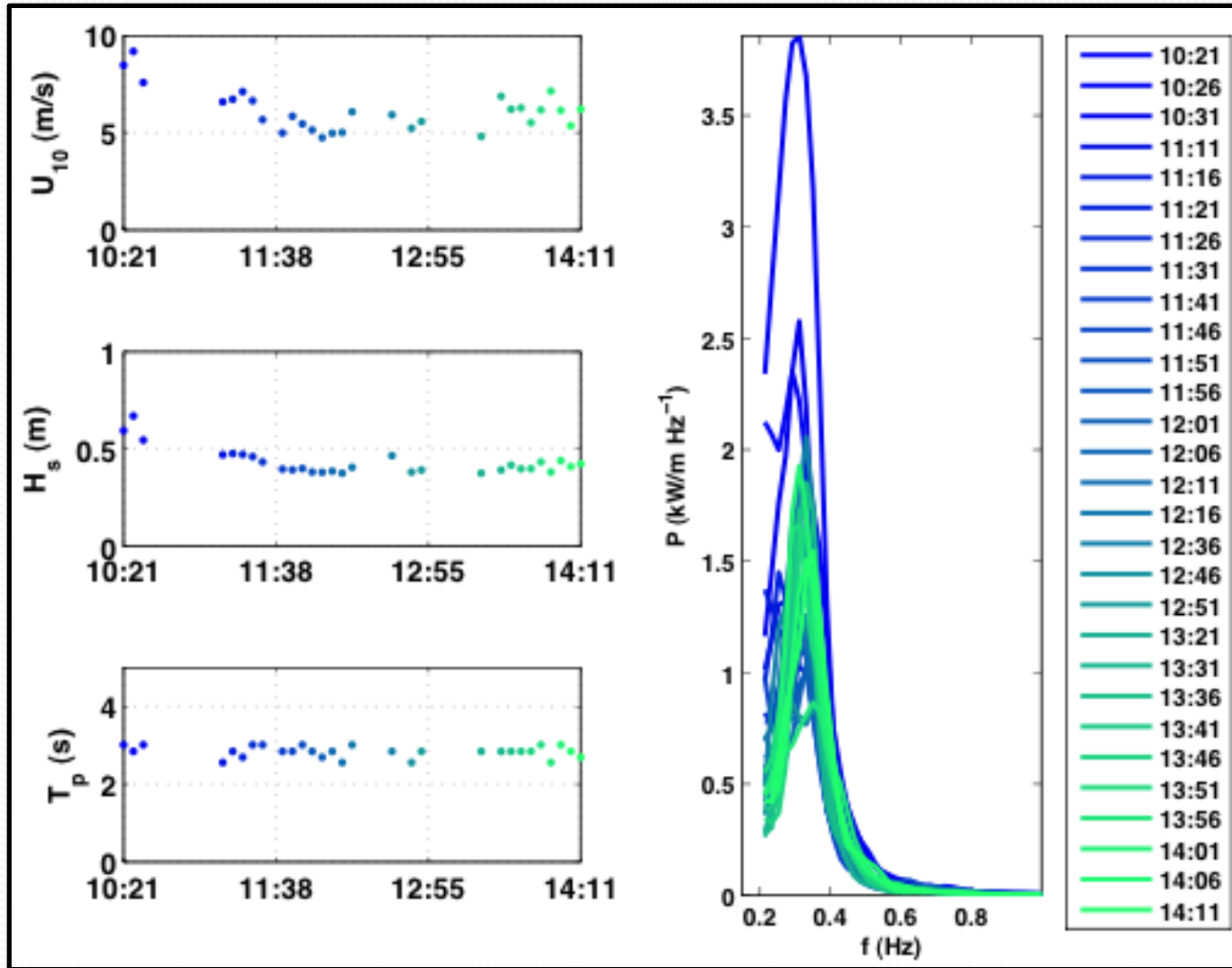
- Nortek Acoustic Wave and Current meter (AWAC)

<http://www.nortekusa.com/en/products/wave-systems>

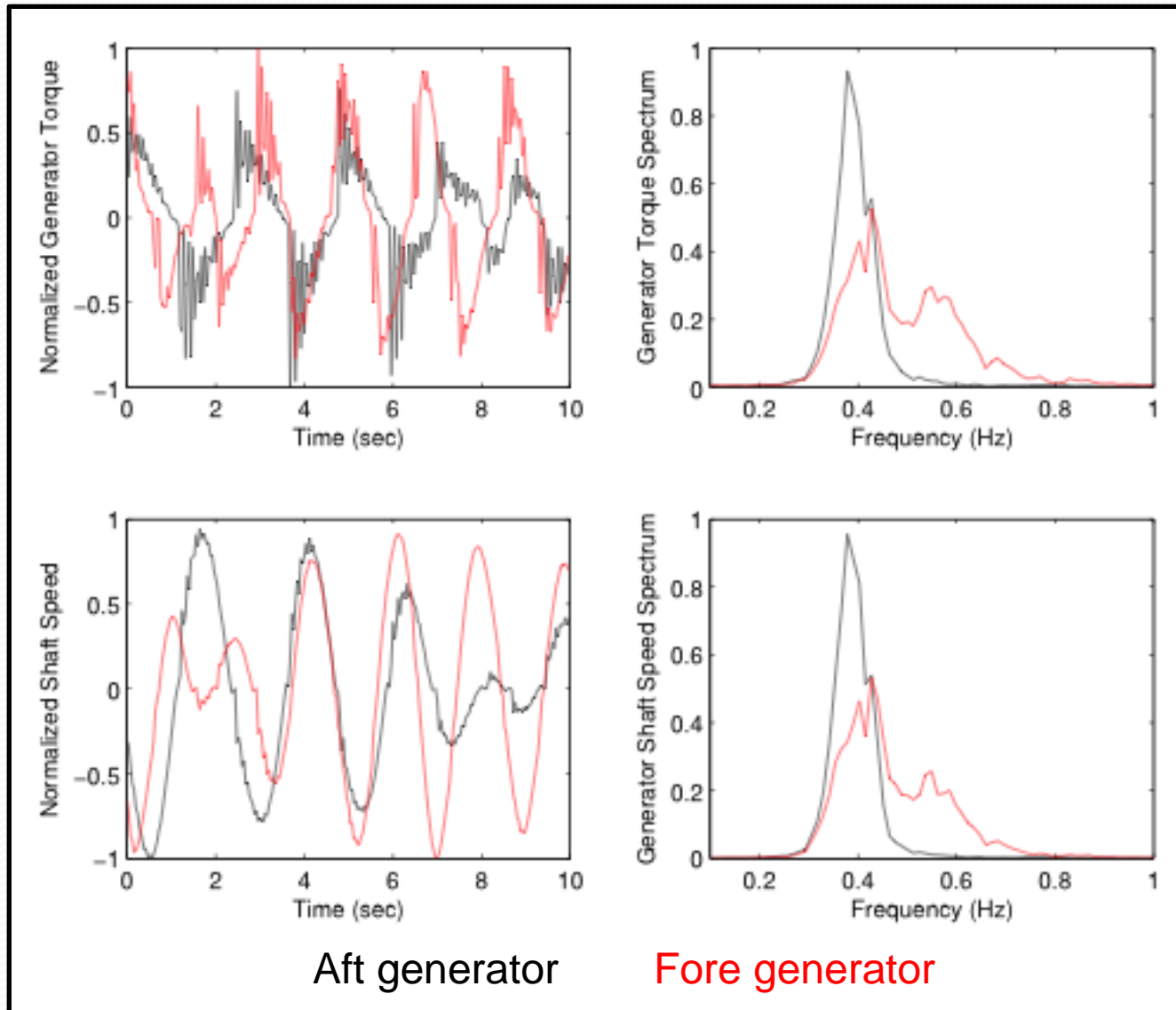
Generator performance

- Shaft speed (fore and aft)
- Generator torque (fore and aft)

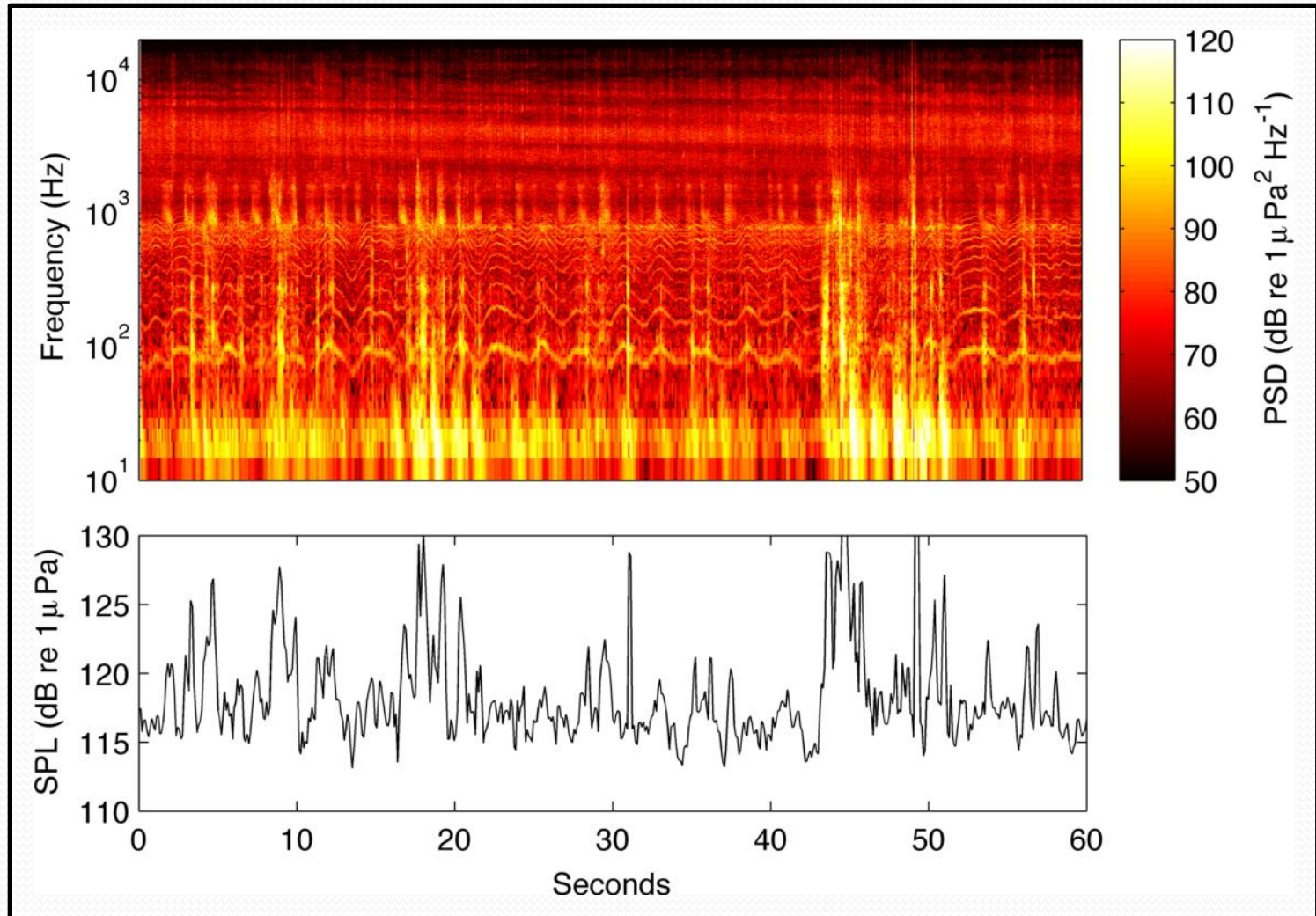
Wave Measurements from SWIFT



Generator Speed and Torque

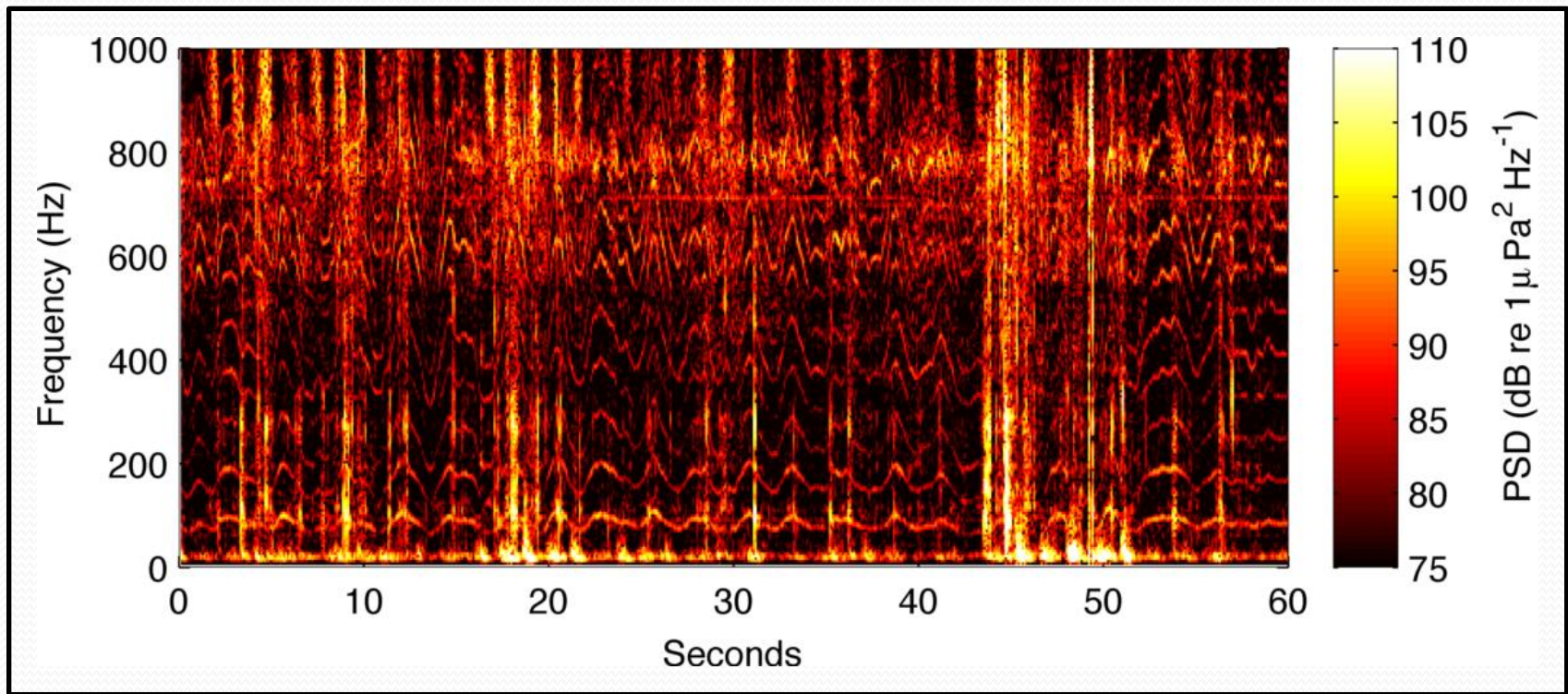


Acoustic Signature



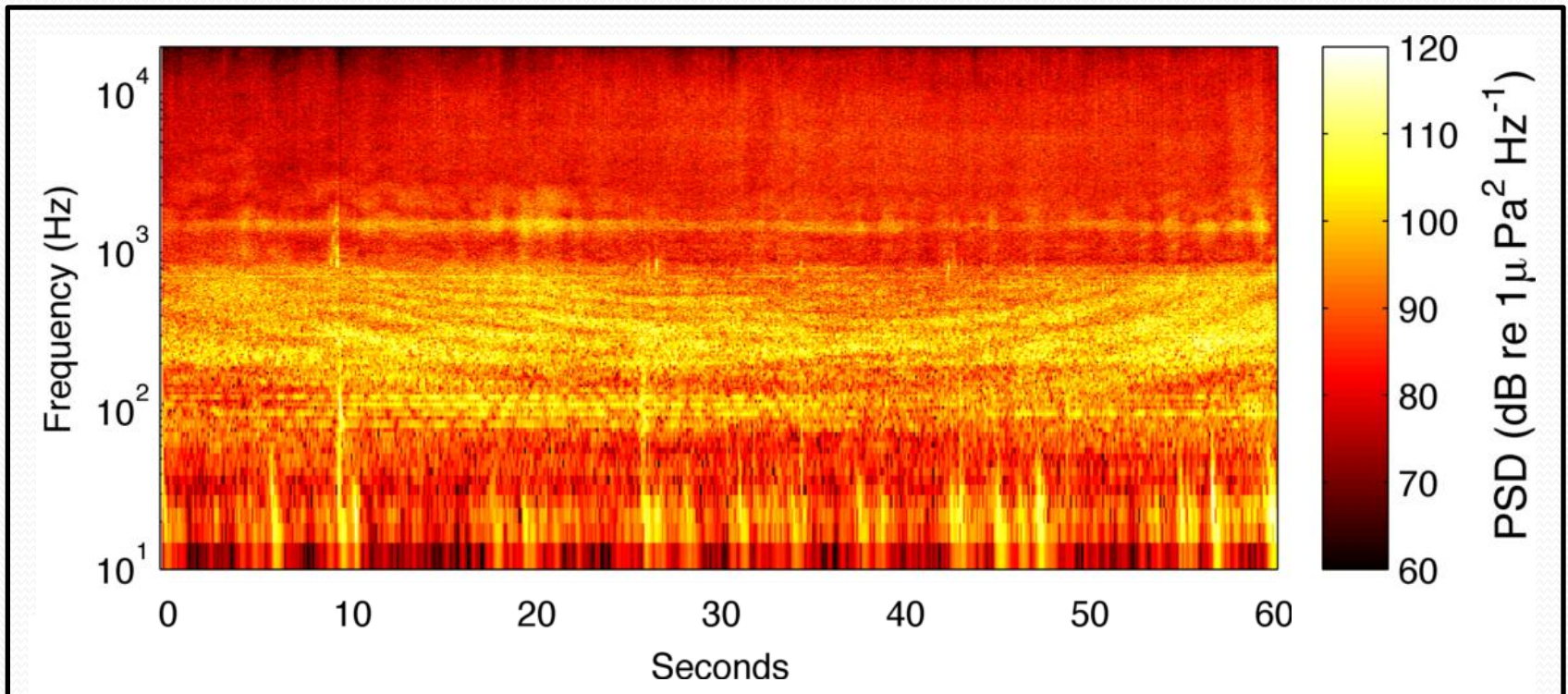
Acoustic Signature

- ~ 10 identifiable harmonics that oscillate with dominate wave period
- Additional broadband slaps that occur twice per wave period



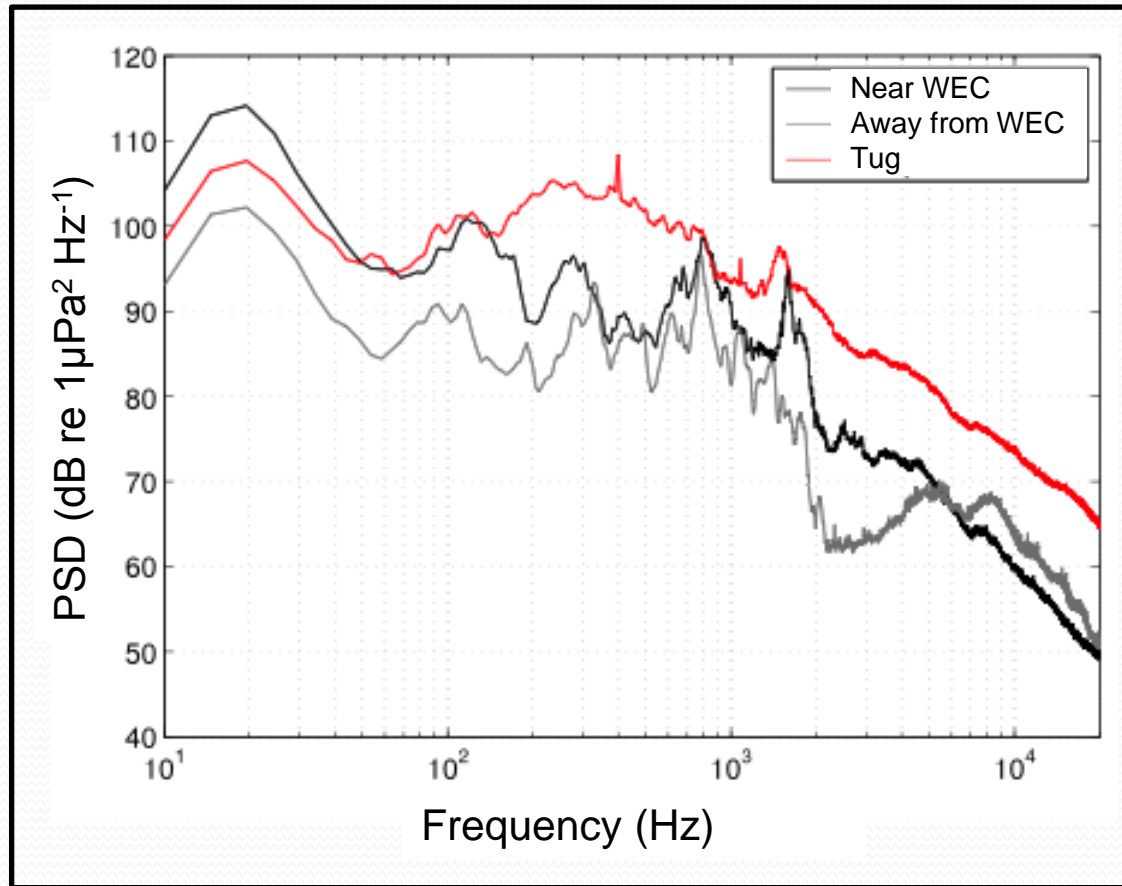
Masking by Vessel Noise

- Tug passing (< 1km) hydrophone.
- Hydrophone ~ 500 m from SeaRay



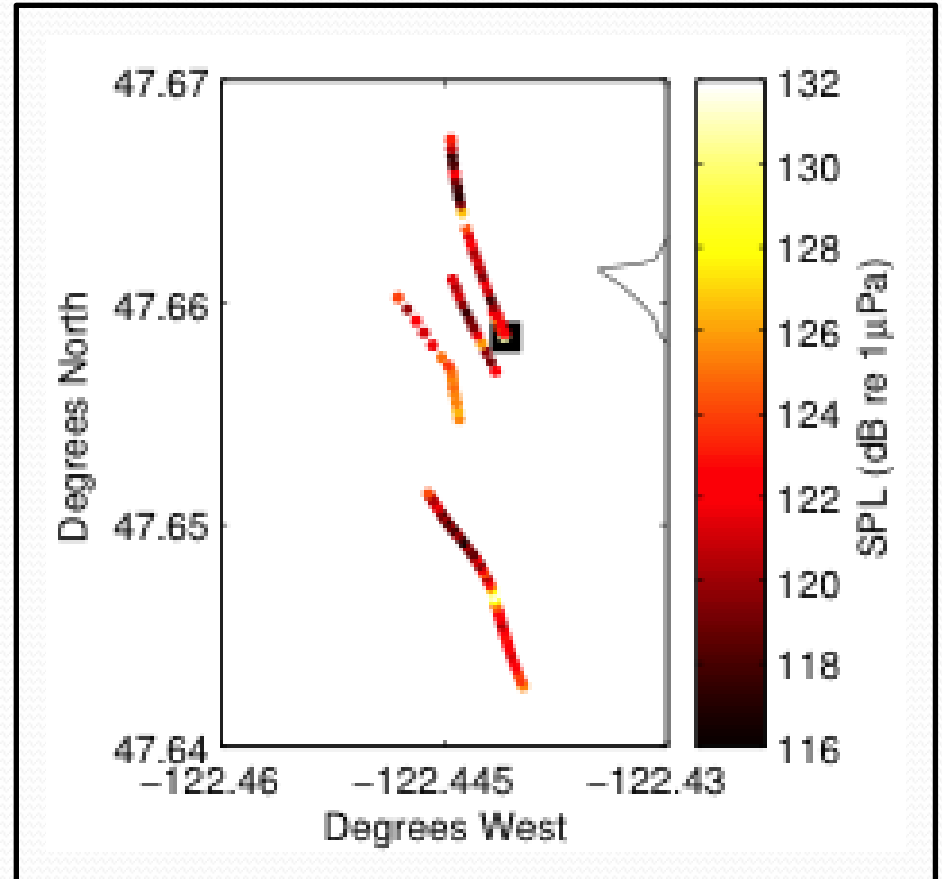
Acoustic Spectra

- Acoustic spectra produced from 60 second averages
- Averaged spectra do not adequately describe the time-frequency dependence of noise produced by the SeaRay

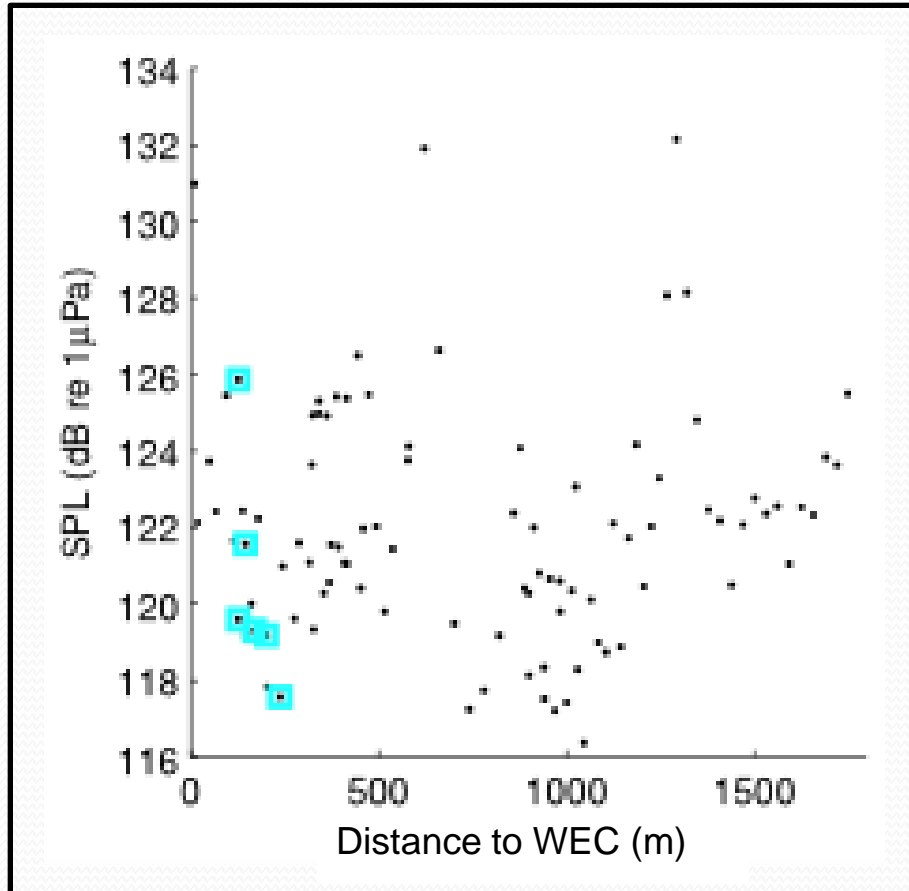


Received Level Map

- The four drift surveys plotted with received SPLs (60 Hz to 30 kHz)
- High levels of ambient noise due to vessel traffic are typical in the region (Bassett et al., in prep.)
- Received levels are a combination of noise from the SeaRay and vessel traffic



Source Level Estimation



- Vessel traffic results in regular masking of acoustic signature
- High ambient noise levels made quantifying the source level difficult

Conclusion

- Averaged spectra of acoustic noise provide an incomplete description of noise produced by the device. The inherent periodicity of wave energy requires a detailed time-frequency analysis along side operating parameters.
- Noise from the device is neither continuous nor impulsive.
- The loudest recorded SPLs are attributed to vessel traffic although numerous recordings were taken less than 100 meters from the SeaRay.
- Given the proximity to vessel traffic, the noise from this pilot project is not likely to significantly alter ambient noise levels.

References

- J. Thomson, “Observations of wave breaking dissipation from a SWIFT drifter,” J. Atmos. Ocean. Tech., in review.
- C. Bassett, B. Polagye, and J. Thomson, “A vessel noise budget for Admiralty Inlet, Puget Sound, WA (USA)” (in preparation).

Thank You



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