JASCO APPLIED SCIENCES

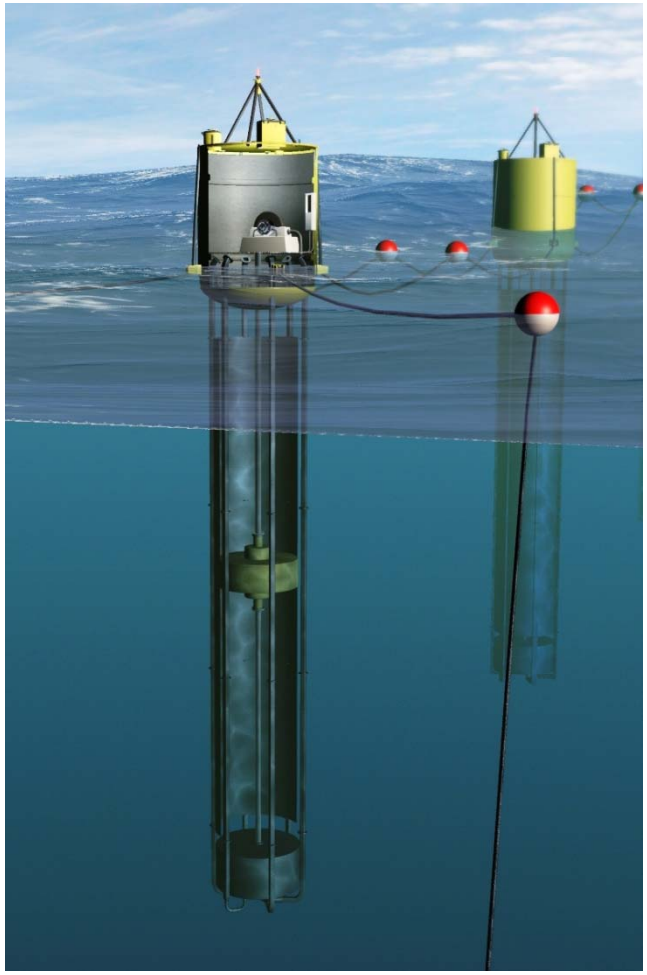
Forecasting the acoustic footprint from renewable ocean energy projects

Scott Carr
Roberto Racca

Renewable Ocean Energy & the Marine Environment – Palm Beach Gardens FL, 4-Nov-2010

Importance of pre-development planning of potential noise impact

- Renewable Ocean Energy projects usually involve large offshore structures requiring complex installation and mooring procedures.
- Underwater noise footprint from systems deployment and operation must be estimated for assessment of impacts and planning of mitigations.



Source – Path - Receiver Model

RL = SL - TL

Source (SL)

Frequency

Amplitude

Duration

Directivity

Path (TL)

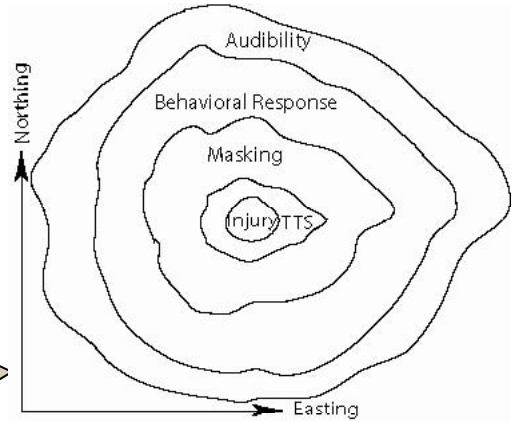
Attenuation

Absorption

Refraction

Reflection

Scattering

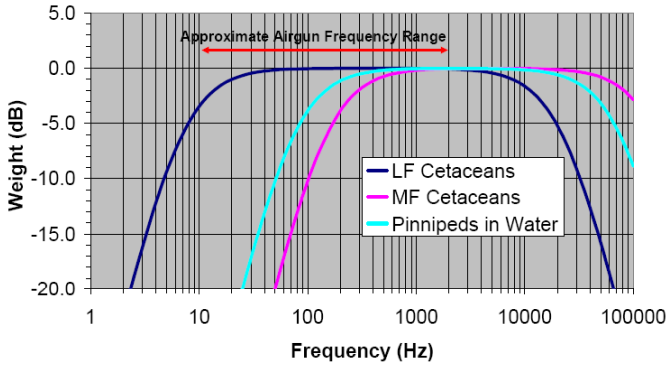


Receiver (RL)

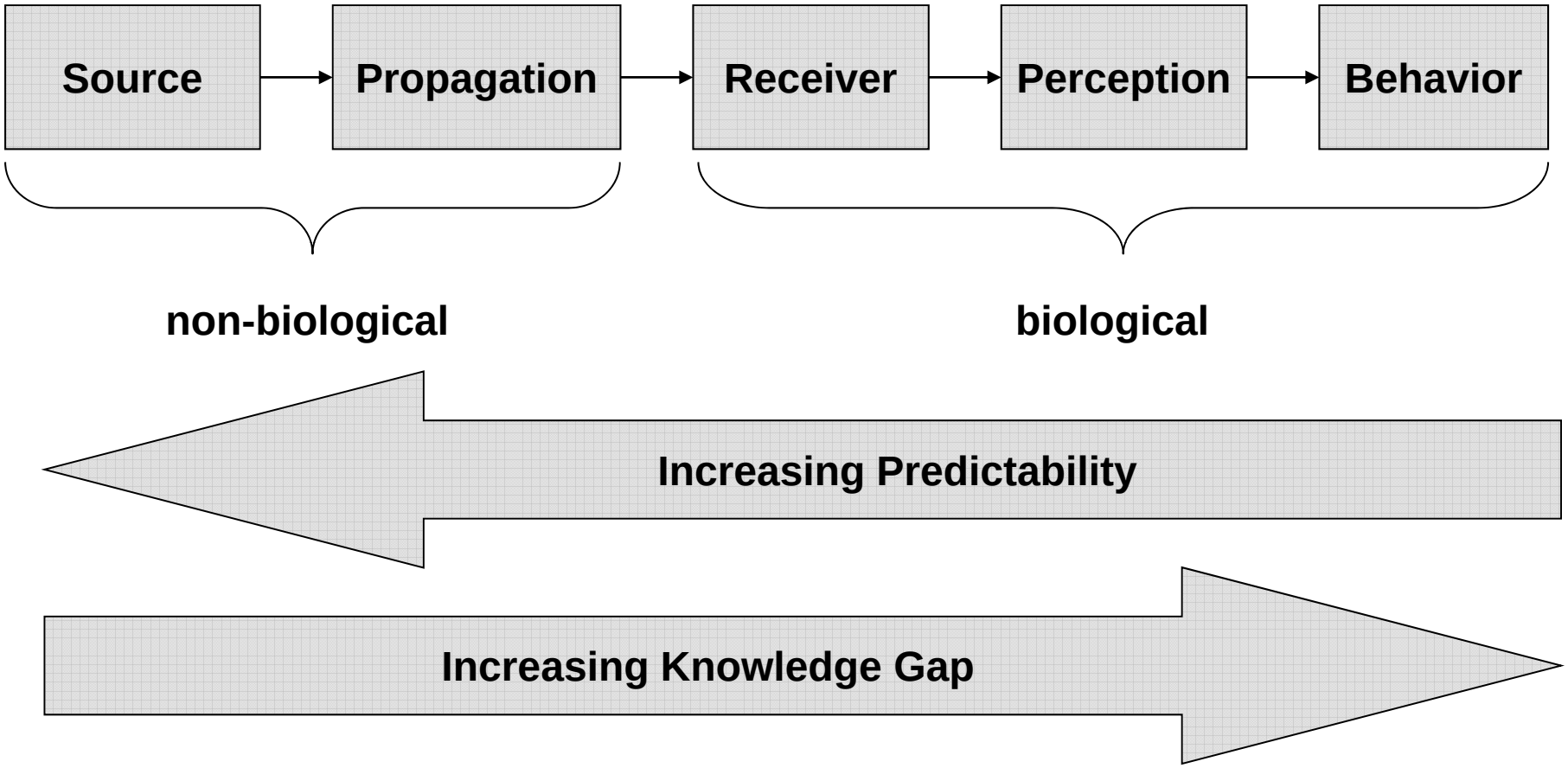
Frequency Response

Detection Ability

Distance from Source



Modeling Components:



(From Ocean Noise and Marine Mammals, 2003)

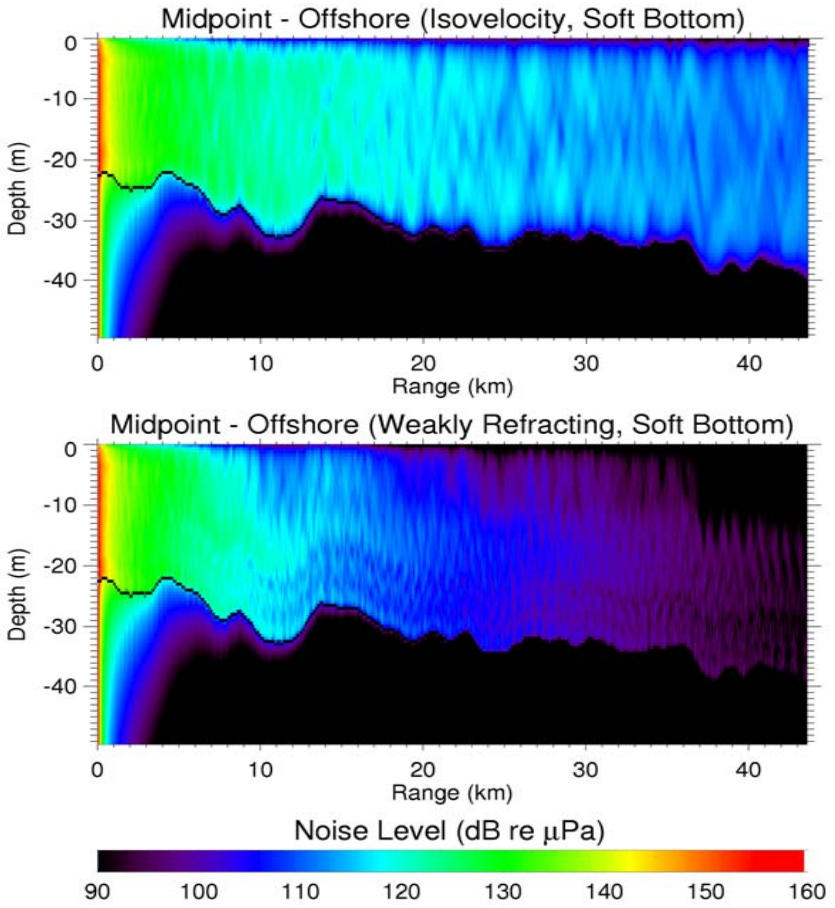
Need for accurate, standardized acoustic estimation techniques

JASCO APPLIED SCIENCES

- Planning for large scale renewable ocean energy development calls for the definition of standardized methods for the assessment of potential effects from industrial activity on the ecosystem.
- Regulators and developers require a consistent set of guidelines for impact assessment requirements.
- Pre-development estimation of noise effects should be based on advanced numerical modelling capable of accounting for influence of local environment on propagation of specific frequencies.

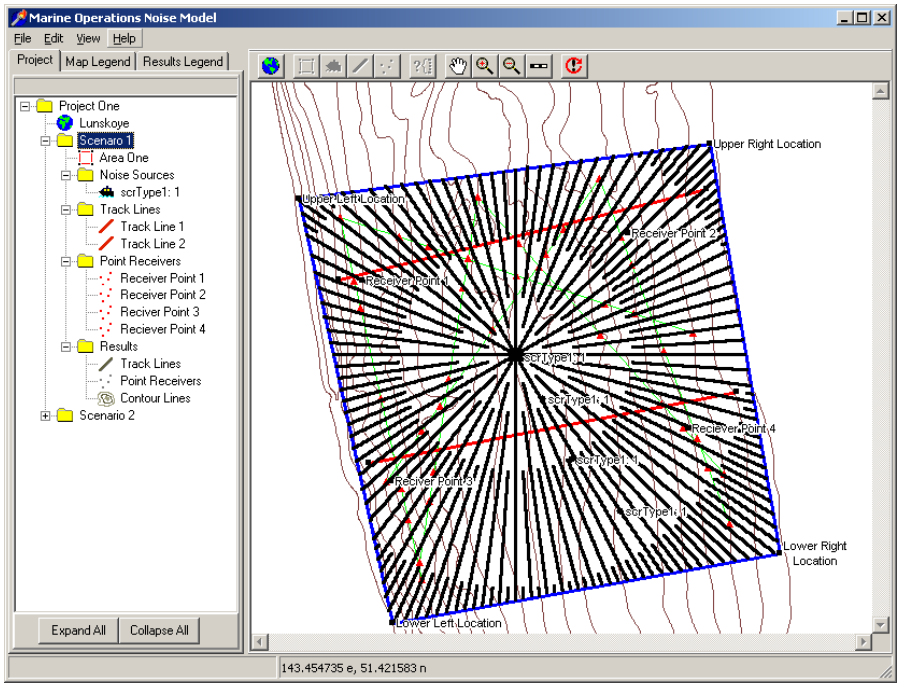
Estimation of acoustic footprint by Parabolic Equation modelling

- Source spectral levels: based on measurements or estimation from similar installations elsewhere.
- Propagation modelling: frequency dependent sound attenuation using Complex Density Parabolic Equation algorithm, which accounts for bathymetry and properties of water column and sea floor.



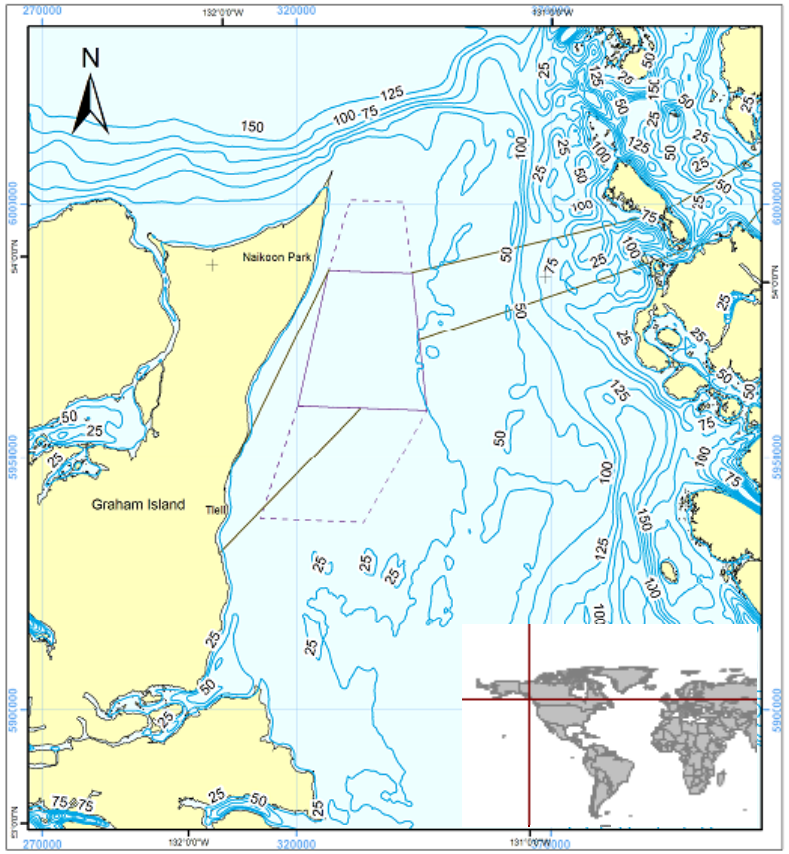
Marine Operations Noise Model with efficient radial gridding

- Adaptive method for optimal radial coverage of the area improves modelling efficiency.
- Acoustic RL footprint of each source is computed using CDPE propagation runs on a unique set of radial lines.
- Gridded levels from all sources in an operation are combined to generate RL contours from which impacts are assessed.



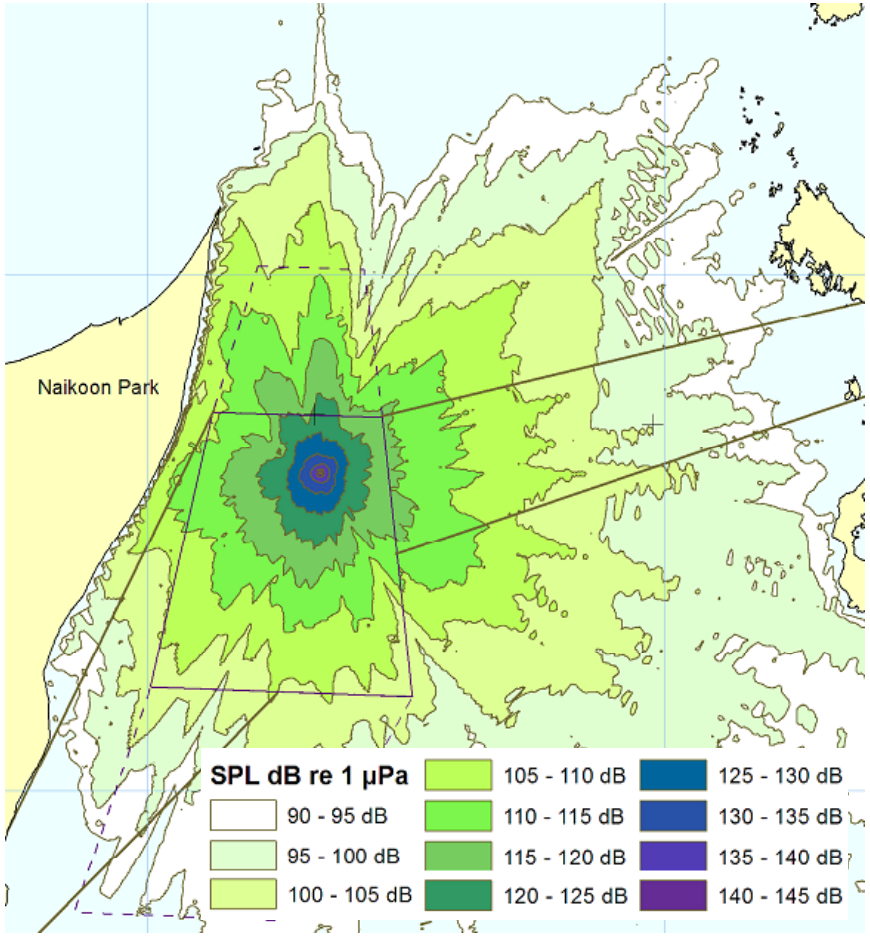
Example of noise forecasting for the NaiKun offshore wind farm

- Large planned renewable energy project in Hecate Strait off northern Haida Gwaii; one hundred-plus 3.6 MW wind turbines.
- Construction operations that were modeled include positioning, pile driving, cable laying, landfall conditioning and more



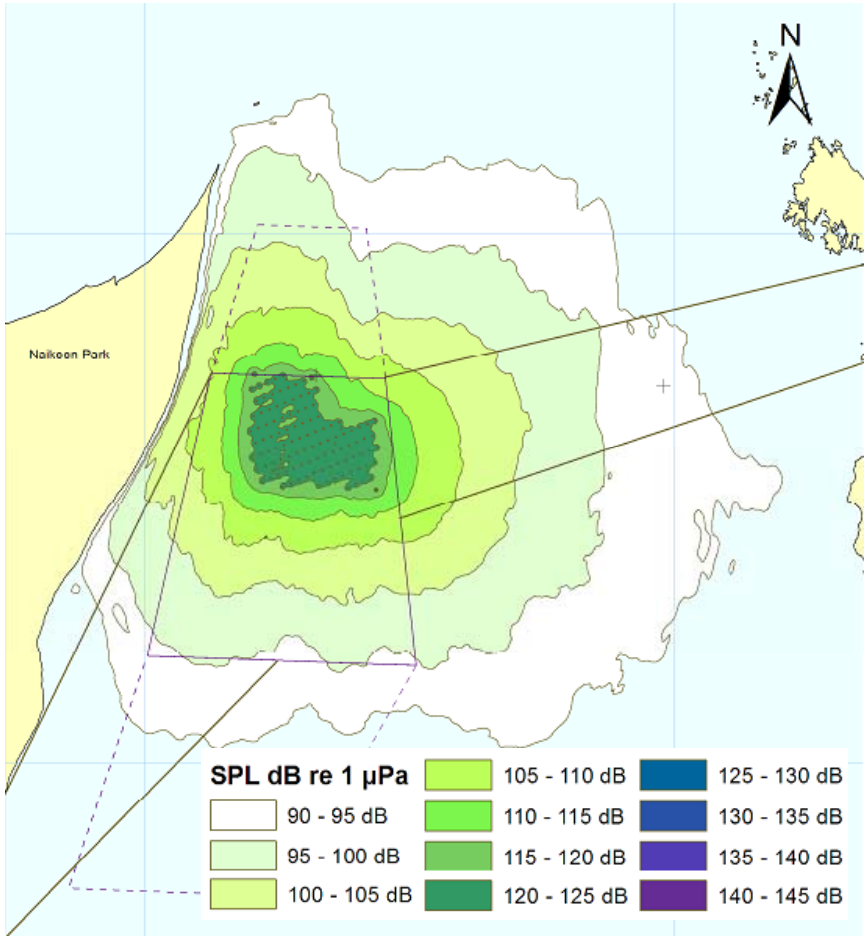
Modeled subsea noise footprint for installation phase of a WTG

- Installation of a Wind Turbine Generator and associated substructures by means of a heavy lift transport vessel (does not include pile driving).
- Representative of noise scenario for deployment of large hydrokinetic ocean energy devices.



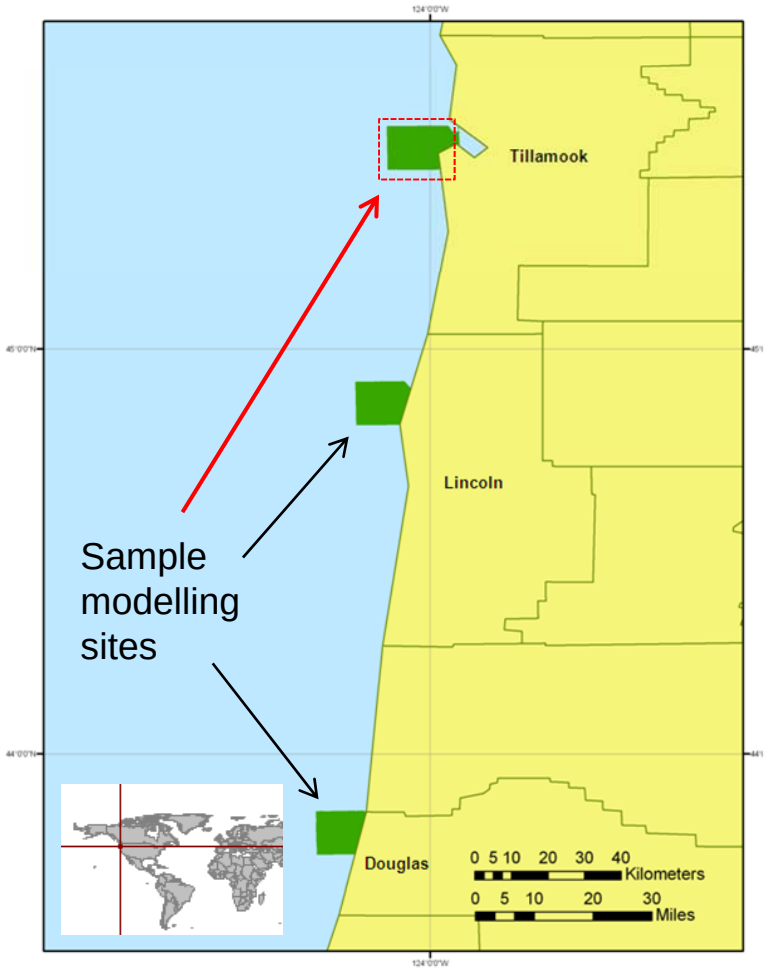
Modeled subsea noise footprint for full field of operating WTGs

- Underwater noise from operation of full set of 110 turbines at 8 m/s wind speed.
- Noise is mostly coupled to water by vibration of turbine towers.
- Source levels based on reported measurements at Swedish wind farm.



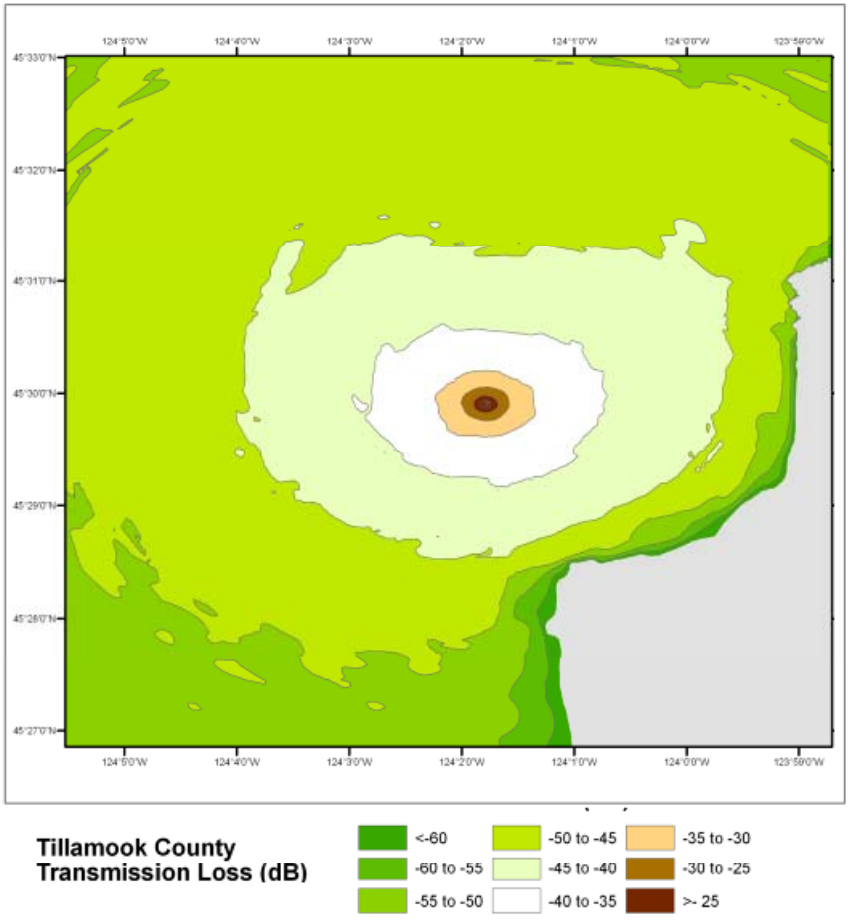
Generalized acoustic forecasting for region-scale strategic planning

- Oregon Wave Energy Trust (OWET) initiative to define a noise impact estimation framework for future WEC projects along coastline.
- Initial study included some sample modeled footprints of sound transmission loss at candidate locations for wave energy development.
- Report available: www.oregonwave.org



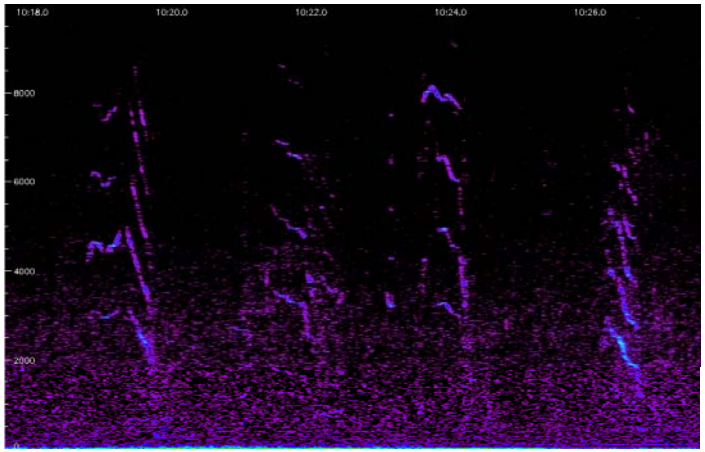
Modeled nominal sound loss map at candidate wave energy site

- Transmission loss (TL) is dependent on depth of source and on frequency spectral content.
- Broadband TL maps are only notional but allow a generalized comparison between sites and enable preliminary mapping of potential impact ranges.



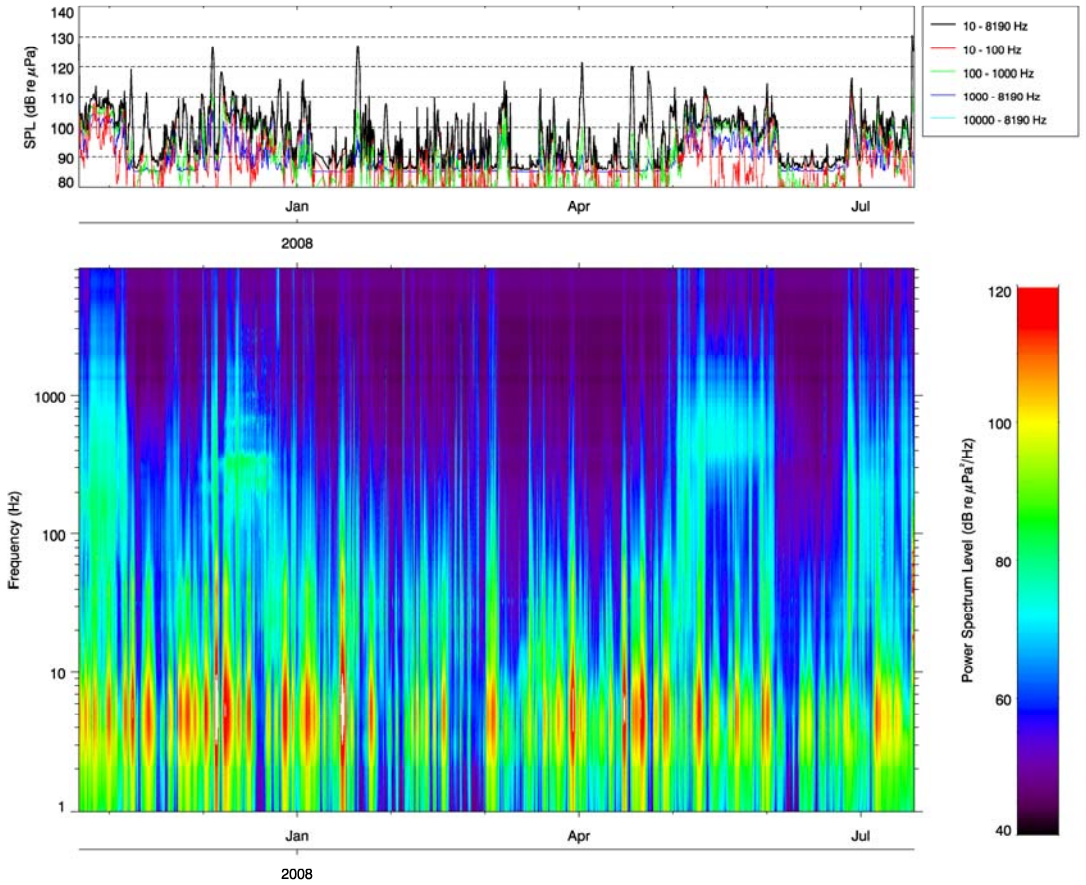
Putting forecasts into context: ambient noise characterization

- Model based acoustic level forecasts must be referenced to a baseline measurement of existing noise in the region.
- Baseline ambient noise studies are required for meaningful assessment.
- Analysis of sound monitoring data can also yield valuable ecosystem information.



Data: Managing information to support decision making

- Acoustic modeling requires significant environmental data as input.
- Baseline noise studies generate large datasets.
- Managing data is challenging – storage, processing, interpretation, sharing and presentation.
- Coastal & Marine Spatial Planning



To summarize:

- Advanced numerical modelling technologies for sound level estimation are available and can be run effectively over large regions and for a variety of ocean energy development and operation scenarios.
- Early stage standardized assessment of potential acoustic impact footprints for multiple projects over a region can inform spatial planning and facilitate environmental optimization of designs.
- Comprehensive baseline studies of ambient noise are an essential counterpart to forecasting.