Ship Noise in Australia's Exclusive Economic Zone

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Marine Biodiversity Hub
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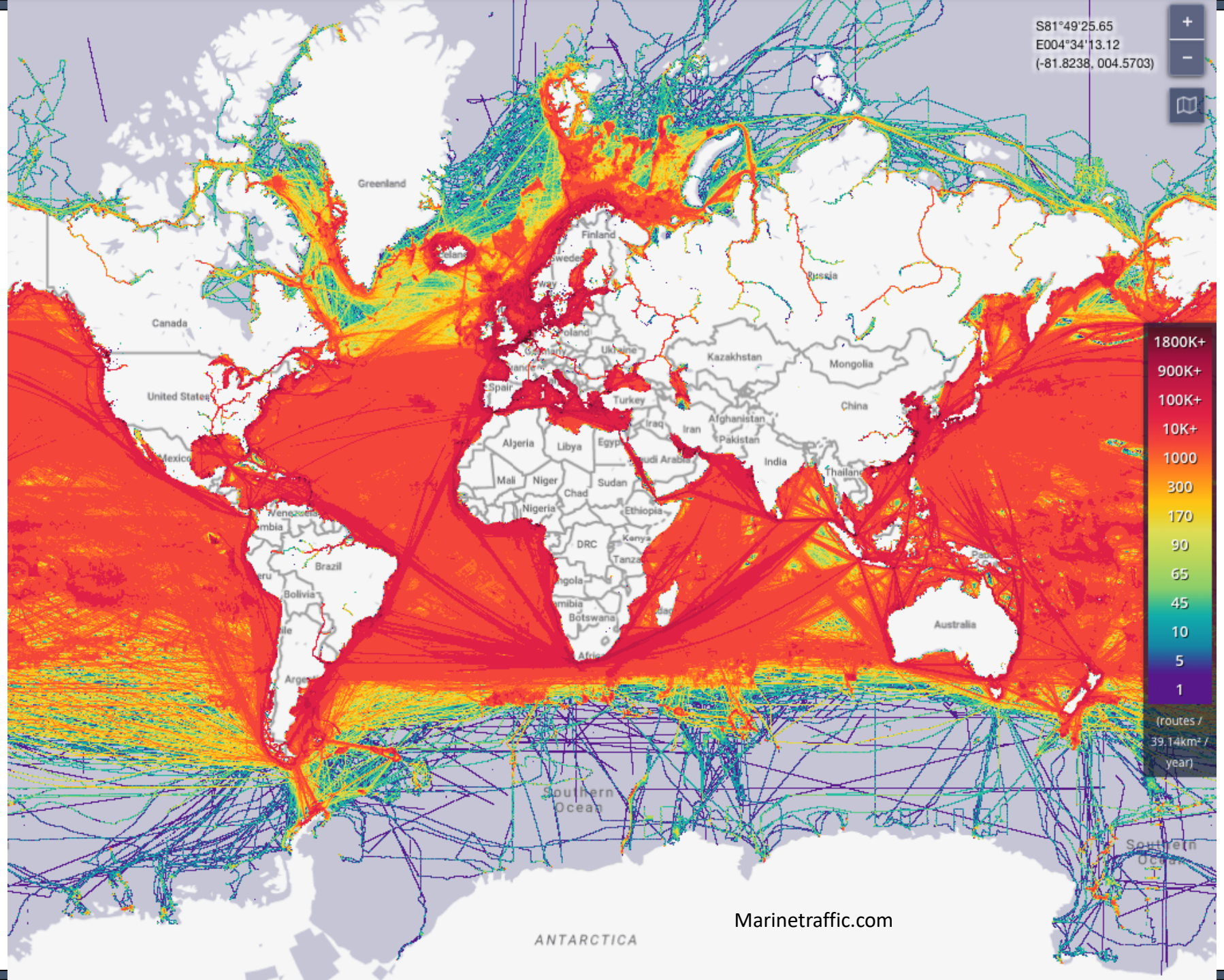
Aim:

Determine the amount of ship noise in the Australian EEZ



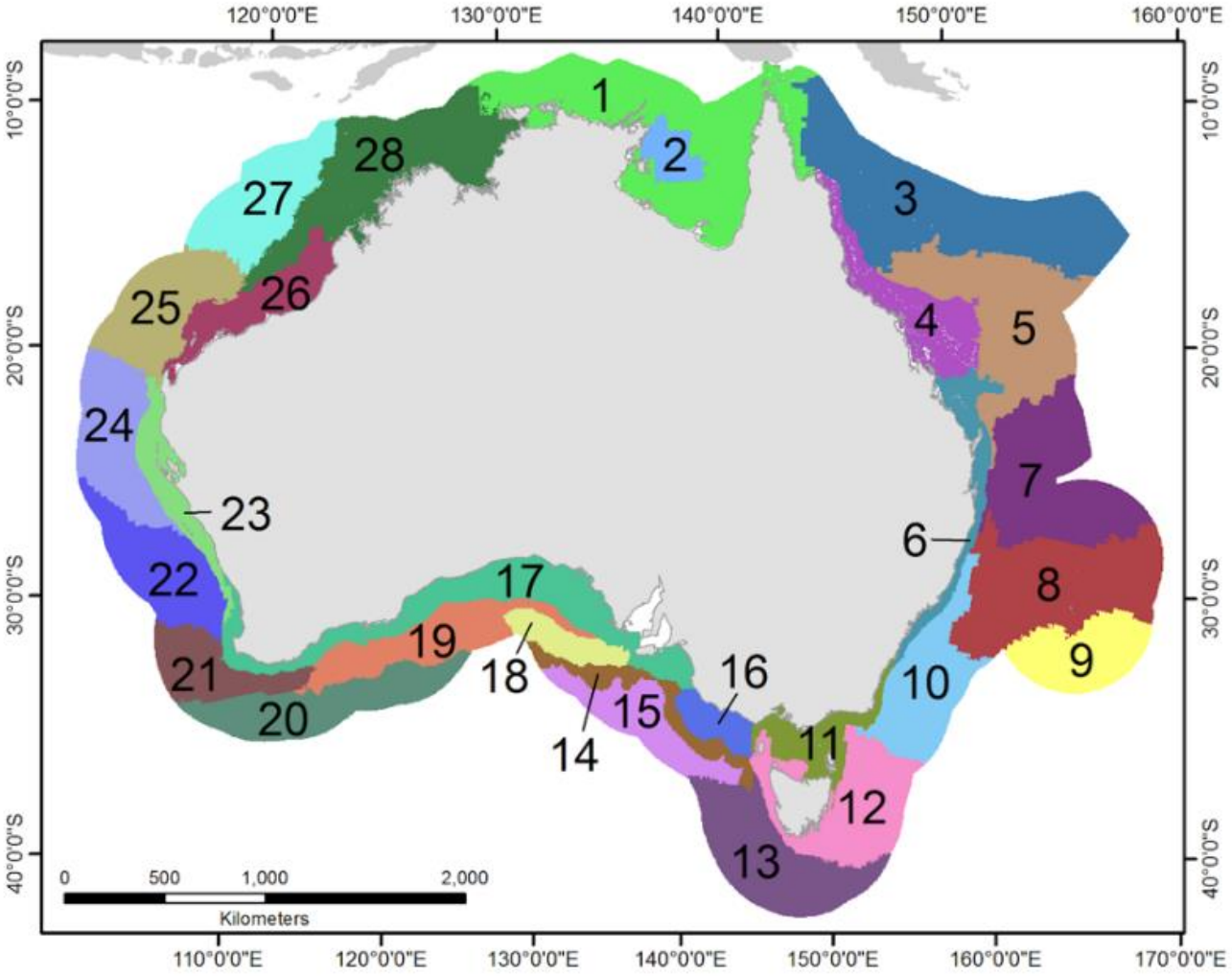
Problem:

Very large area to model, measure, monitor, assess

http://onlinedatingsoundbarrier.blogspot.com/2016/06/rocket-internet-se-ceo-seeks-to-soothe.html

Marine Acoustic Zones of Australia

	Derived Variable	Input Variable
Water Column	sea surface temperature	sea surface temperature
	sea surface salinity	sea surface salinity
	sound speed gradient profile	sound speed profile
Seafloor	compressional sound speed, shear sound speed, compressional absorption coefficient, shear absorption coefficient, density	% clay
		% silt
		% sand
		% gravel
	sediment thickness	sediment thickness
	bedrock type	bedrock type
Bathymetry	water depth	water depth



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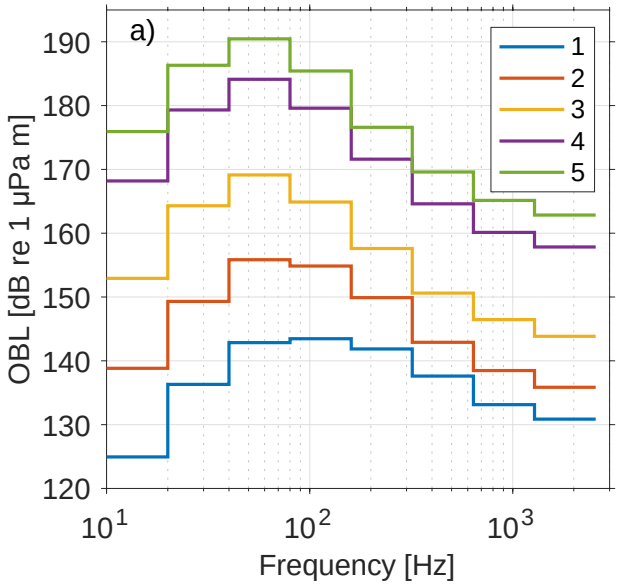
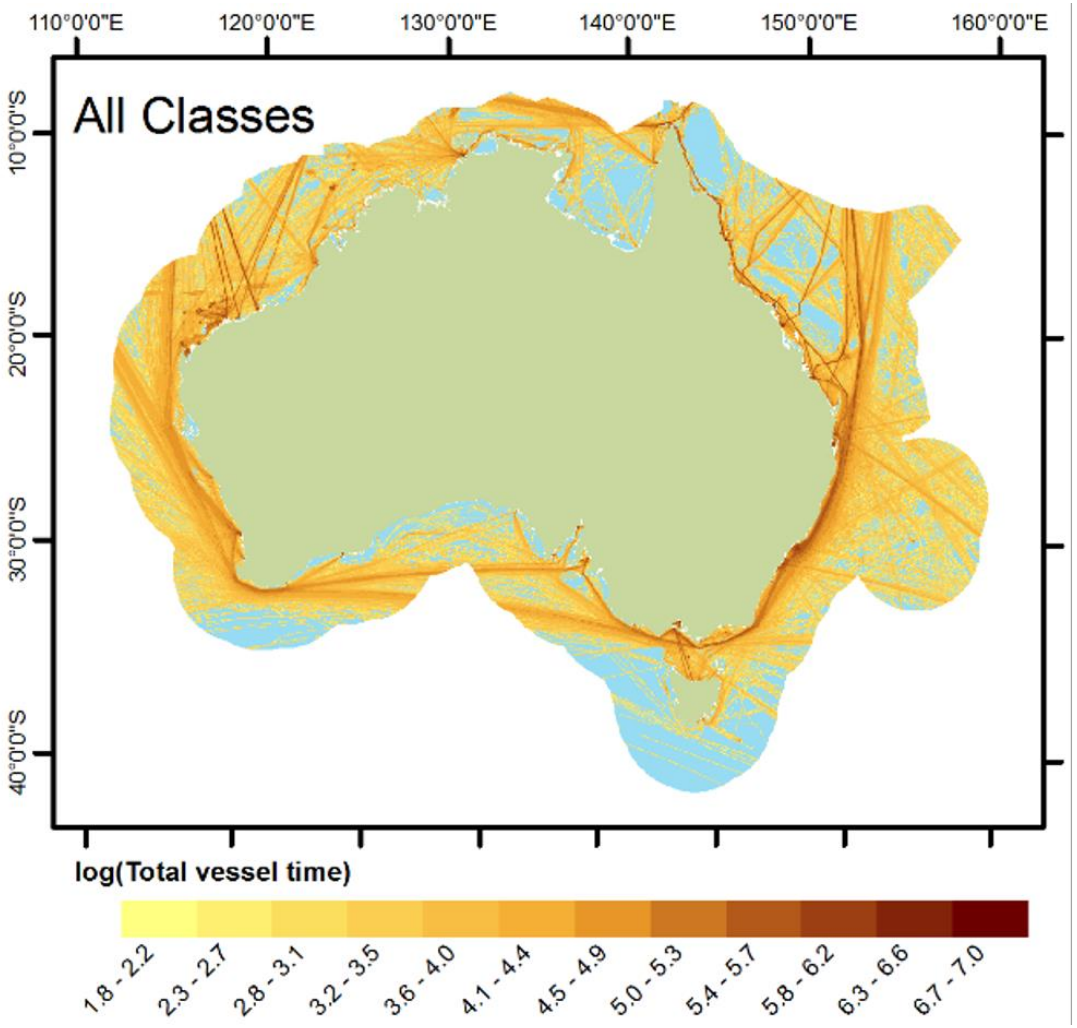
Ship Noise in Australia

1. Within each acoustic zone
2. Plot ship AIS data
3. QC, clean, interpolate
4. Grid AIS data on a 5 km x 5 km chart
5. Accumulate time spent in each cell over 6 winter months, by ship class
6. Ship length classes: <25 m (1), ≥25–<50 m (2), ≥50–<100 m (3), ≥100–<200 m (4), and ≥200 m (5)
7. Define ship source spectra by class





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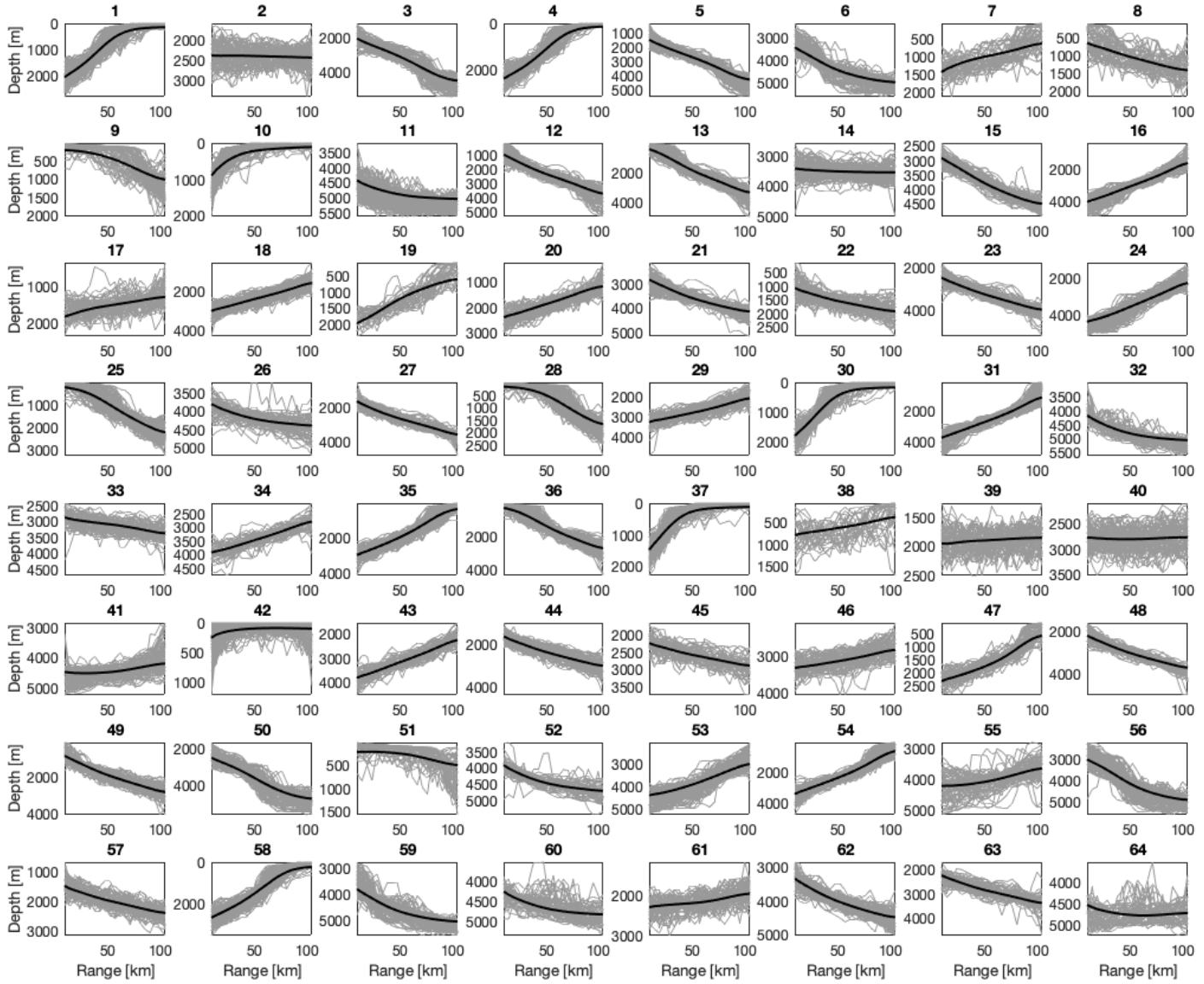
7. Define ship source spectra by class
8. Extract source-receiver transects over 360° and 100 km range from each source cell
9. Cluster bathymetry transects (self-organising neural network + k-means)



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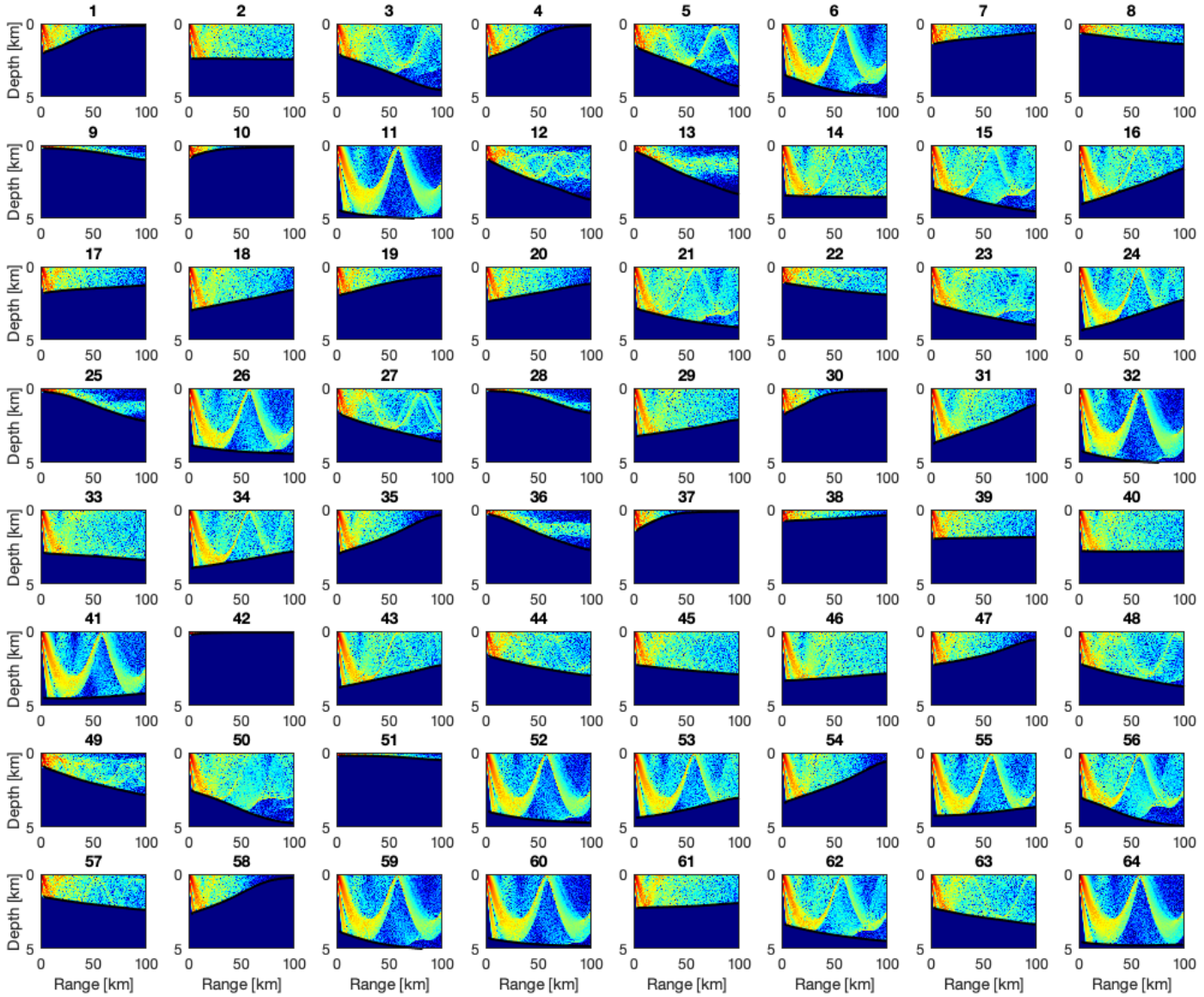
8. Extract source-receiver transects over 100 km range from each source cell
9. Cluster bathymetry transects
10. Model sound propagation along bathymetry centroids



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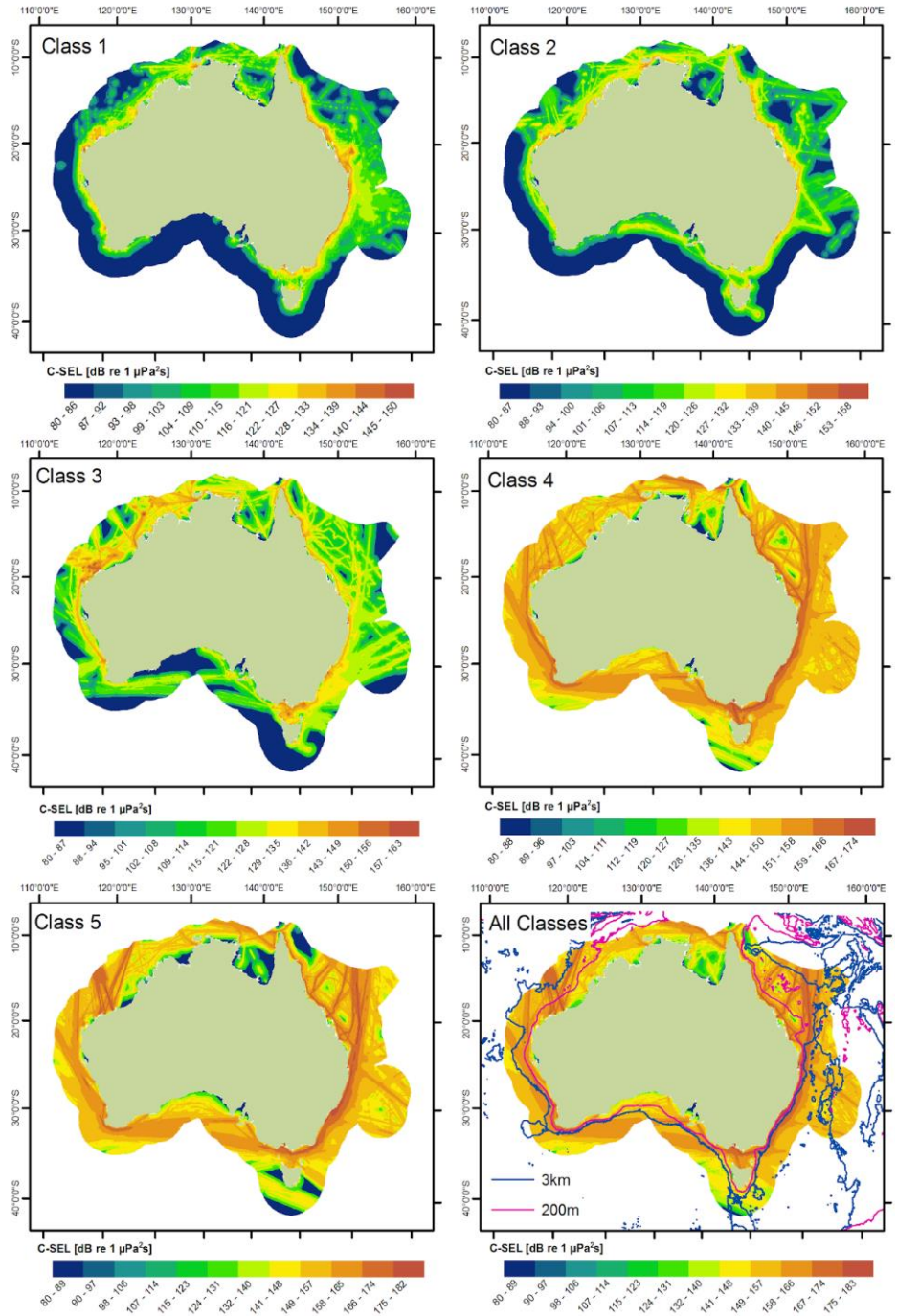
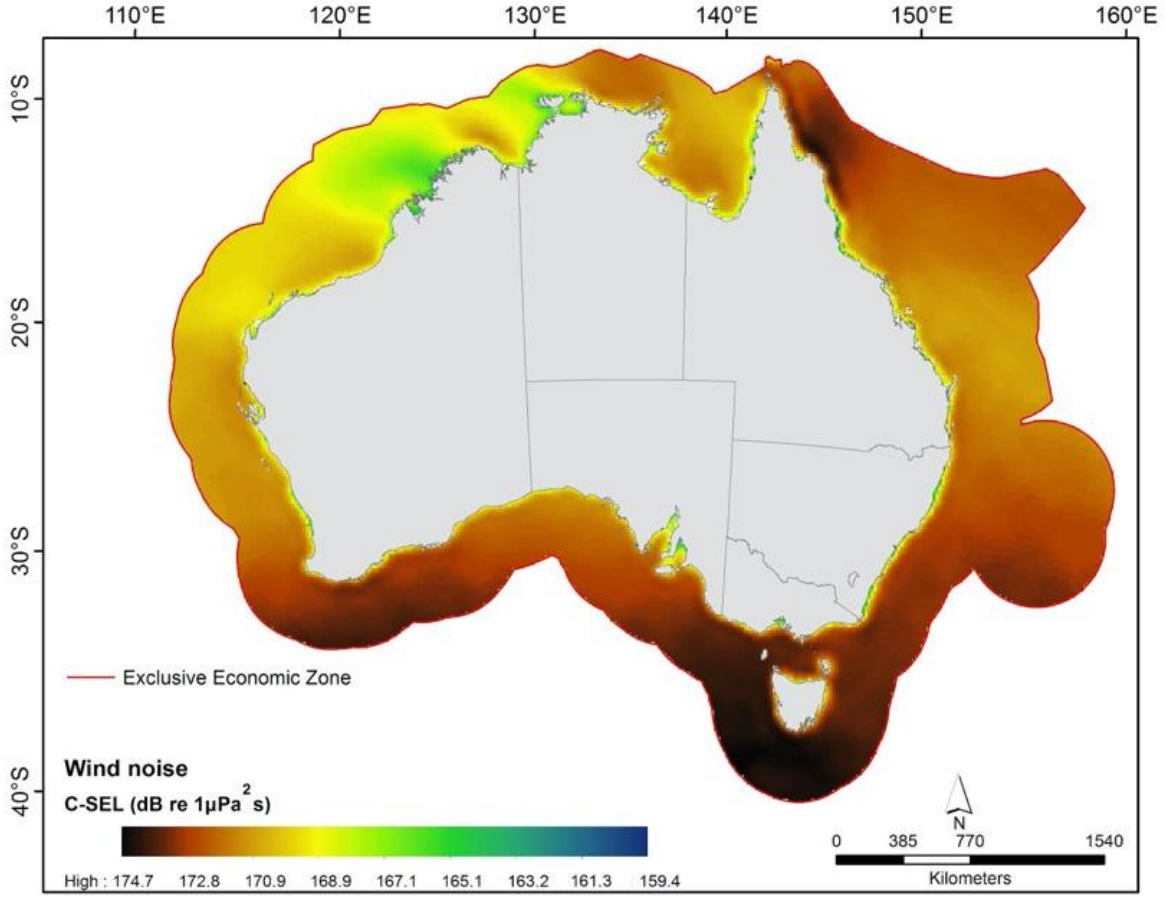
10. Model sound propagation along bathymetry centroids
11. Apply propagation loss to all source-receiver transects
12. Accumulate sound exposure over time, ship class, zone, EEZ

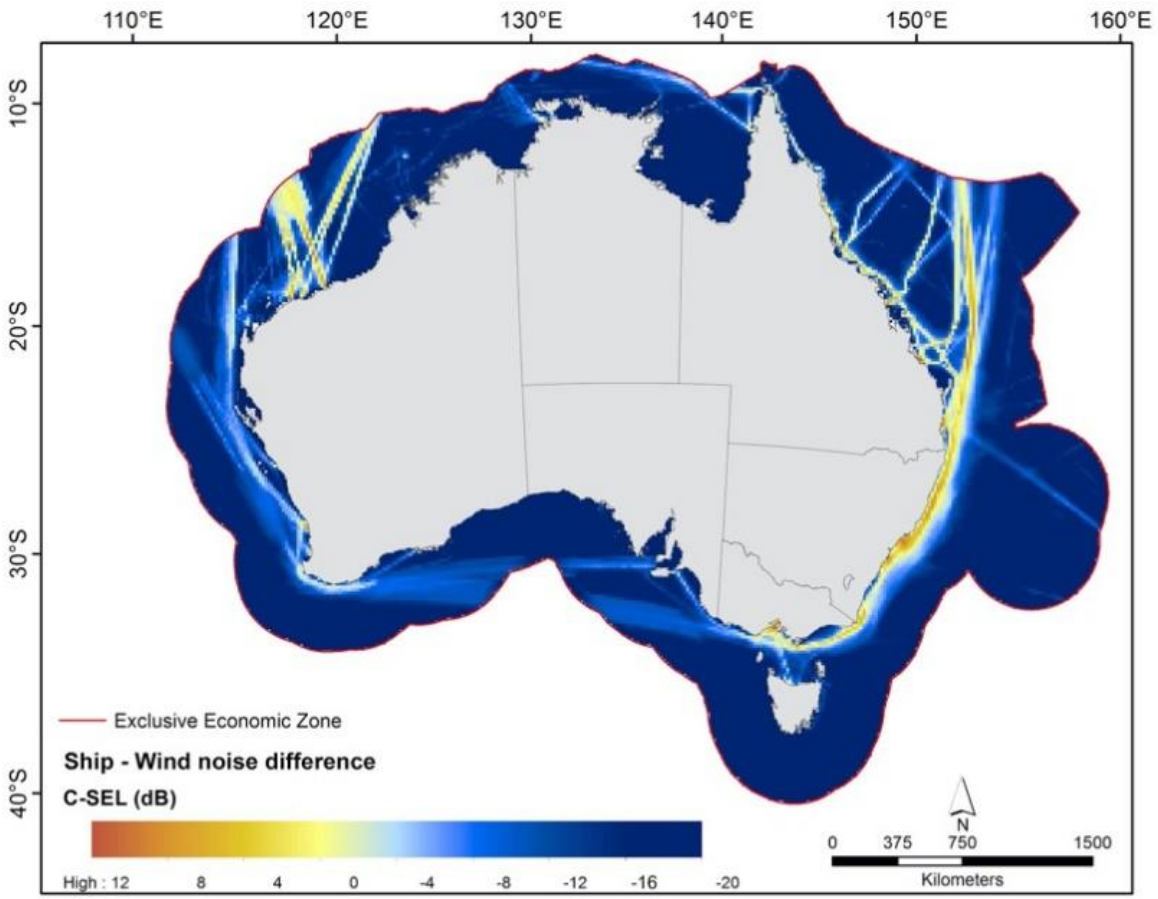


Model Wind Noise in Australia – for comparison

Wind Noise Underwater



Ship – Wind Noise

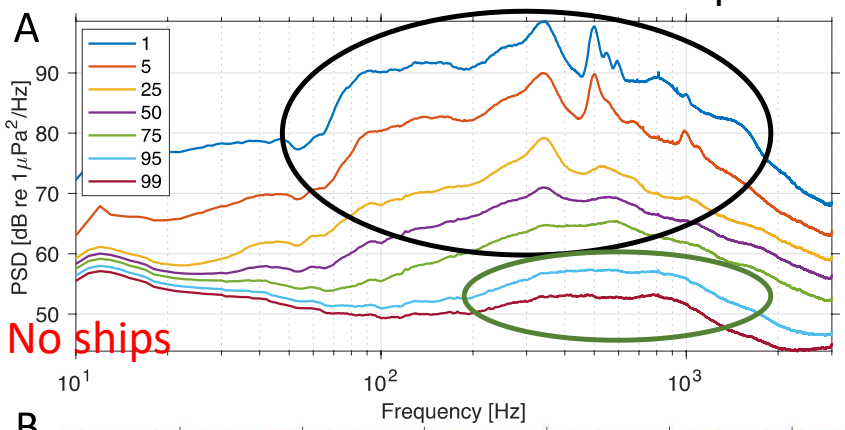


Validate with 25 6-month recordings

Location	Long	Lat	Winter	C-SEL [dB re 1 µPa2s] measured	SPL [dB re 1 µPa] measured	Ship C-SEL [dB re 1 µPa2s] modelled	Wind C-SEL [dB re 1 µPa2s] modelled	Ship+Wind C-SEL [dB re 1 µPa2s] modelled	C-SEL difference measured - modelled [dB]	Notes
NW Shelf	115.4	-20.2	2010	172	100	160	170	170	2	several strong fish choruses and periods of strong wind; pristine
Bremer Canyon WA	119.6	-34.7	2015	175	103	158	172	172	3	quiet soundscape with blue whale and spot call chorus and wind; distant shipping only noticeable <5% of the time
Tuncurry NSW	152.9	-32.3	2016	181	109	177	172	178	3	full of ships; blue whale choruses in the background
Bonaparte Gulf WA	128.2	-13.1	2012	174	102	144	170	170	4	dominated by Omura's whale chorus throughout winter; some fish choruses; strong wind periods; some ships; distant seismic survey
NW Shelf	121.3	-15.5	2013	172	100	151	168	168	4	3 seismic surveys overlapping in time at different ranges; Omura's whales and humpback whales
Portland VIC	141.2	-38.5	2014	179	107	167	173	174	5	3 overlapping whale choruses (Antarctic blue, pygmy blue, spot call); wind and ships
Portland VIC	141.2	-38.5	2016	180	108	167	173	174	6	broad ship noise hump at 50Hz, choruses of Antarctic blue whale, pygmy blue whale, spot call, and fish
Kangaroo Isl. SA	135.9	-36.1	2017	179	107	156	173	173	6	dominated by choruses of Antarctic blue whales, pygmy blue whales, spot calls, and fish
Perth Canyon WA	115	-31.9	2016	179	107	164	172	172	7	dominated by pygmy blue whale chorus, also strong fish chorus throughout, fin whales in June, spot call in June-July, humpback whales in Sept.
Portland VIC	141.2	-38.5	2012	181	109	167	173	174	7	strong wind and ships; Antarctic blue whale chorus entire winter; strong spot call in Aug.
Portland VIC	141.2	-38.5	2017	181	109	167	173	174	7	Antarct blue whale chorus and fish all winter; some strong pygmy blue whales; many ships
NW Shelf	115.9	-19.4	2013	177	105	155	170	170	7	strong humpback whale song

Location	Long	Lat	Winter	C-SEL [dB re 1 µPa2s] measured	SPL [dB re 1 µPa] measured	Ship C-SEL [dB re 1 µPa2s] modelled	Wind C-SEL [dB re 1 µPa2s] modelled	Ship+Wind C-SEL [dB re 1 µPa2s] modelled	C-SEL difference measured - modelled [dB]	Notes
Kangaroo Isl. SA	135.9	-36.1	2016	180	108	156	173	173	7	dominated by Antarctic blue whale chorus; spot calls; fish; strong wind; very few ships
Perth Canyon WA	115	-31.8	2014	180	108	164	172	172	8	dominated by pygmy blue whale chorus, also strong fish chorus throughout, fin whales in June, spot call in June-July, humpback whales in Sept.
NW Shelf	115	-21.5	2010	177	105	157	168	168	9	industrial noise, fish choruses throughout, humpback whales from 1 Aug.
NW Shelf	124.9	-14.4	2007	176	104	148	166	166	10	dominated by fish choruses, very little anthropophony; pristine
Portland VIC	141.2	-38.5	2015	184	112	167	173	174	10	strong wind; strong fish; Antarctic blue whale chorus for nearly entire winter in the ship noise band; spot call in July-Aug.
NW Shelf	114.8	-21.4	2010	180	108	157	169	169	11	dominated by humpback whale and fish choruses, also dwarf minke chorus; pristine
Portland VIC	141.2	-38.5	2015	185	113	167	173	174	11	Antarctic blue whale chorus entire winter, spot call, strong fish, strong wind and ships
NW Shelf	115.2	-19.9	2006	183	111	157	170	170	13	dominated by seismic surveys all winter that year
NW Shelf	115.3	-19.9	2010	184	112	160	170	170	14	strong industrial noise throughout this winter
NW Shelf	113.9	-20.2	2012	184	112	155	169	170	14	a lot of industrial noise and seismic survey at the time
NW Shelf	114.8	-20.6	2010	186	114	153	169	170	16	dominated by industrial noise and seismic surveys, near and far
NW Shelf	122.2	-14.3	2008	184	112	154	167	167	17	dominated by 3 seismic surveys at different ranges, covering entire winter
NW Shelf	121.9	-14.1	2008	192	120	140	167	167	25	dominated by industrial noise at the time

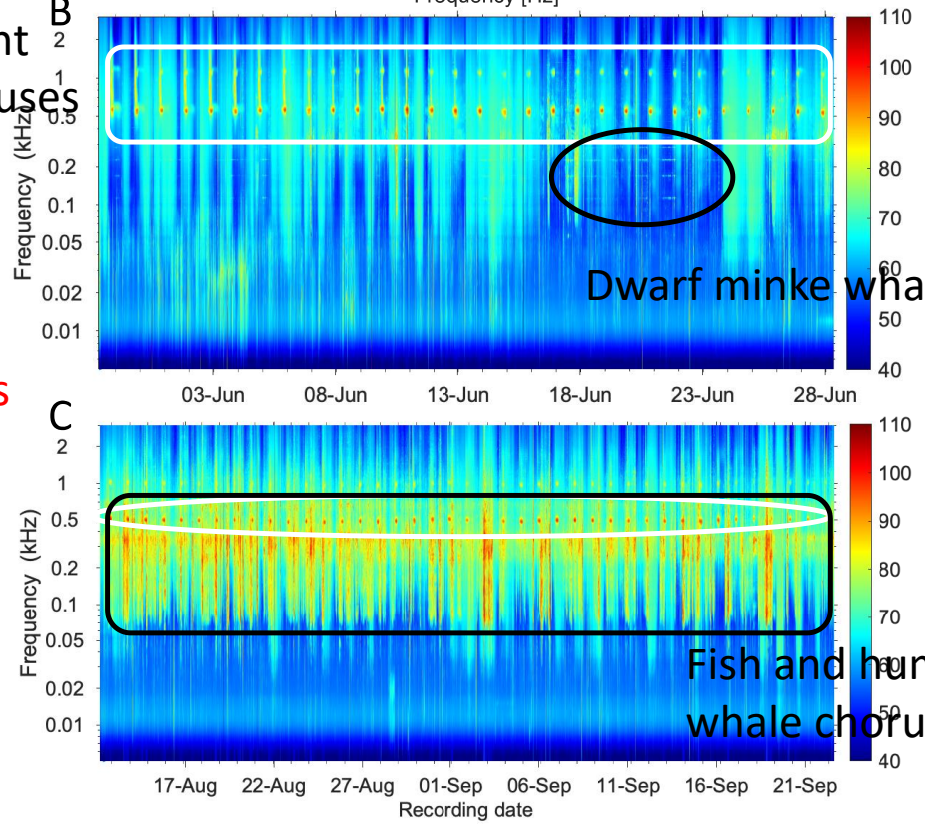
Humpback whales



Wind

No ships

3 different fish choruses



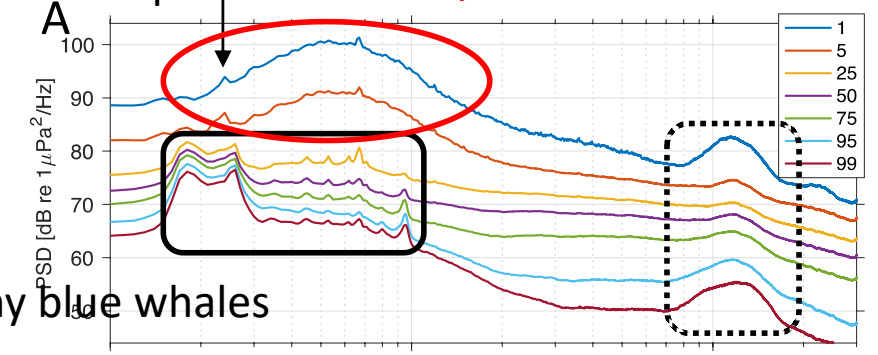
Dwarf minke whale chorus

No ships

Fish and humpback whale choruses

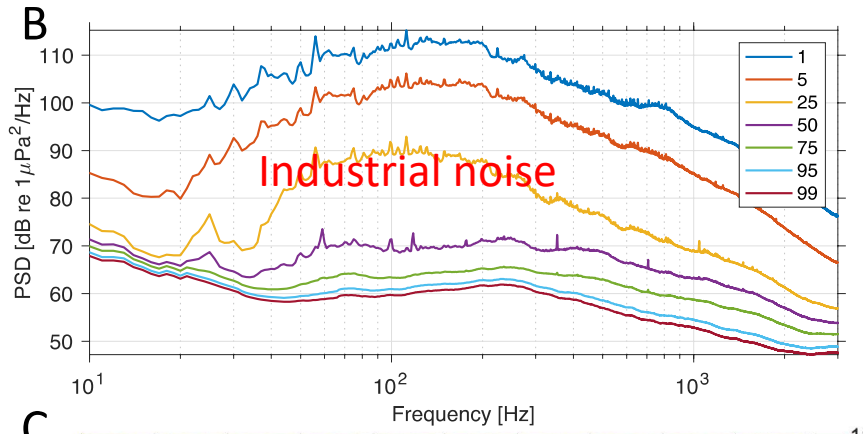
Spot call

Ship noise

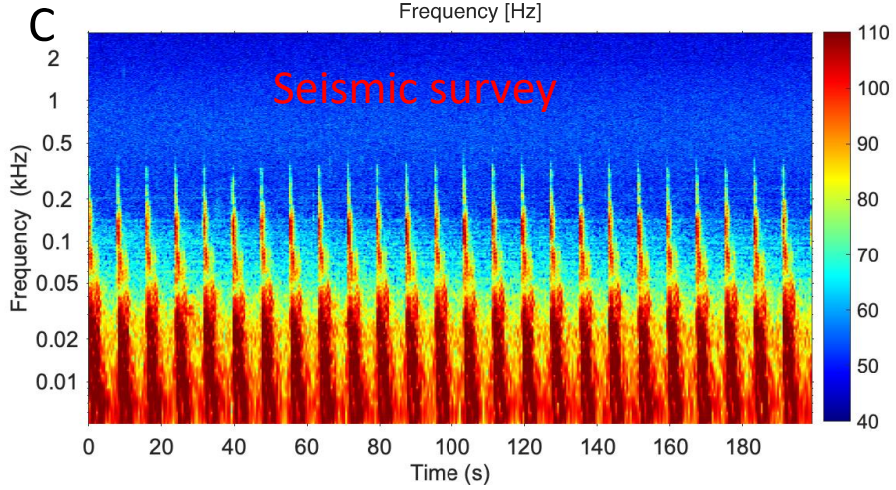


Fish chorus

Pygmy blue whales

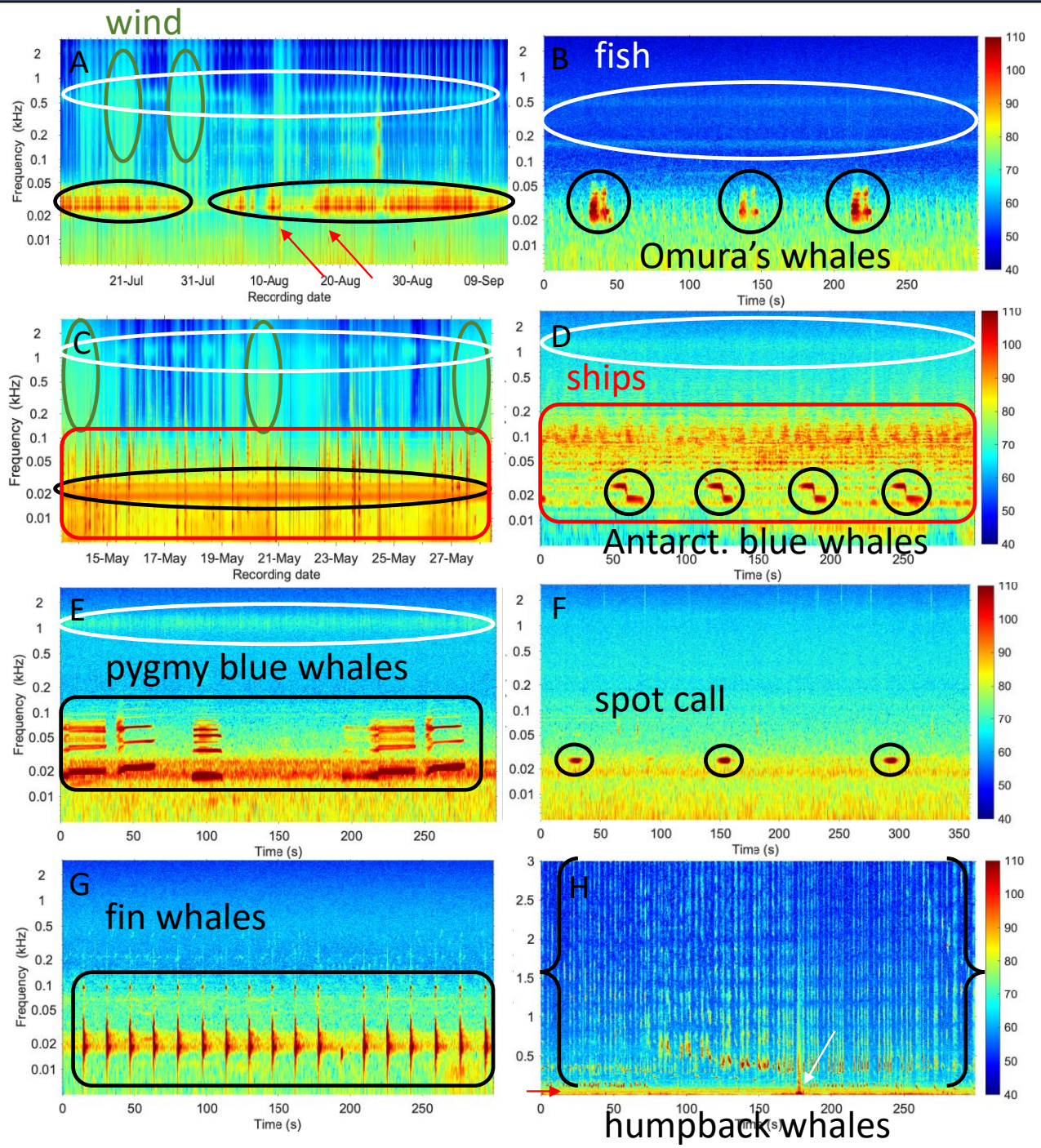


Industrial noise



Seismic survey

- Good agreement between model and measurement when the only sources were ships and wind.
- Animal choruses seasonally and regionally dominate the Australian marine soundscape.
- Strong winds dominate along Australia's southern coast.
- Ship noise dominated near the major shipping lanes and ports.
- Other industrial noise dominate(s/d) regionally and temporarily.
- Pristine (= dominated by natural, geophysical and biological sources) soundscapes remain in several places.
- Must not look at one source at a time, but consider any one source in the context of the local soundscape.



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Thank you!

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