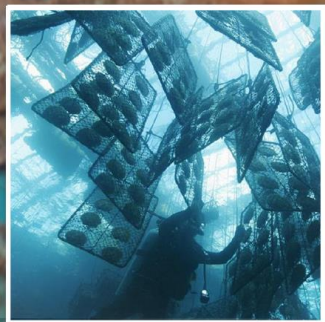# NORTH WEST SHOALS TO SHORE RESEARCH PROGRAM
Passive Acoustics

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Centre Marine Science Technology, Curtin University

Acknowledgements

AIMS: Australia's tropical marine research agency.

CMST Curtin role:

Experimental planning:

Logistical support

Measure ambient noise & environmental features at sites

Multibeam & single beam sonar, mapping

Predict sound exposures for planning purposes

Design ramp up configuration

Measure experimental sound exposures at sites

Sound exposures:

Pearl oyster benthic fauna, thus ground motion most pertinent, waterborne particle acceleration next important

Fish site demersal & in water column, particle acceleration most important sound, pressure as proxy

Sonar:

Multibeam mapping

Single beam, fish analysis before & after, ditto non-fish backscatter

AIMS North West Shoals to Shore –
Sonar (single & multibeam), passive acoustics – ambient and seismic exposure

**Pearl & fish sites
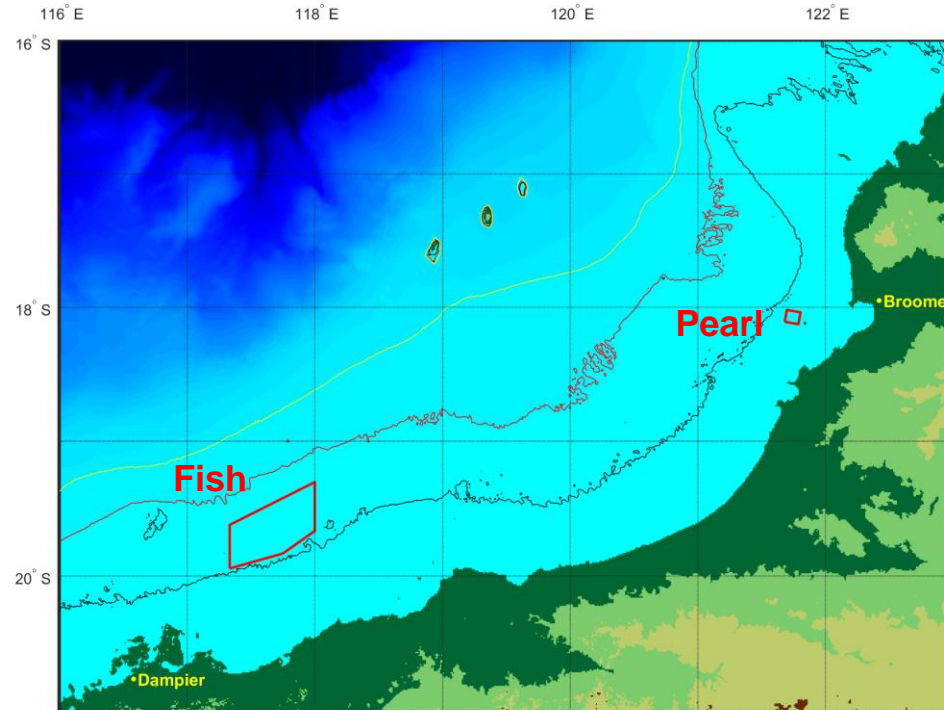250 n mile apart**

Instruments:

Solander multibeam

Biosonics DTX-1000, 38 kHz split-beam, 120 & 400 kHz single beam

Sound Pressure (CMST),

3-axis particle velocity (Geospectrum M20),

3-axis ground motion (geophones CMST)

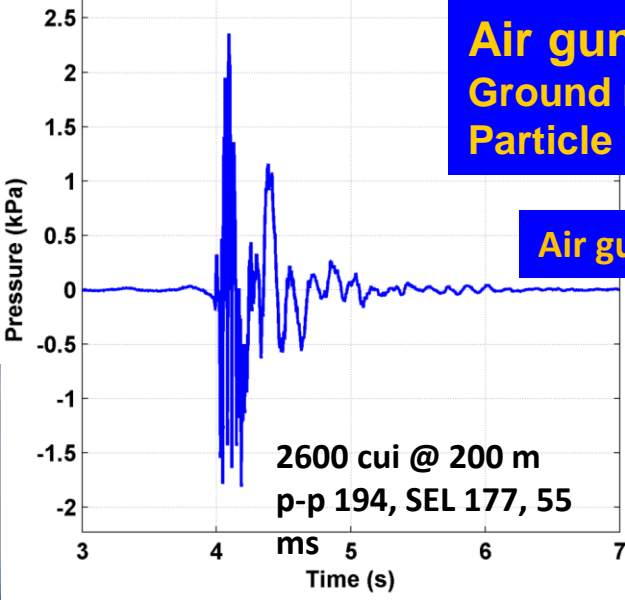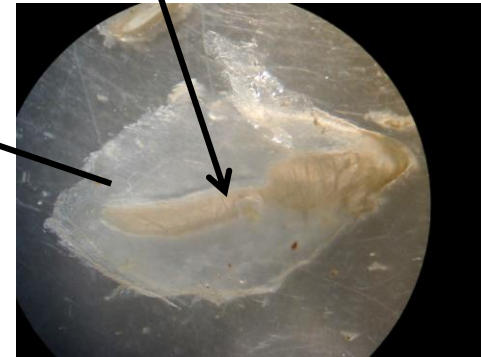**Ambient from moorings, start Apr-2018, 5 moorings, 6 instruments still in water**

Air gun impact mechanisms differ
Ground motion for benthos
Particle motion (pressure) for fish

Air gun signal

2600 cui @ 200 m
p-p 194, SEL 177, 55 ms

Air gun array

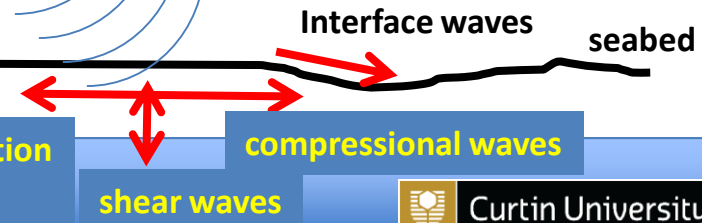Otolith drives hair cells
= sound

Membrane with hair cells

Fish has rock in head

pm drives rock (otolith)

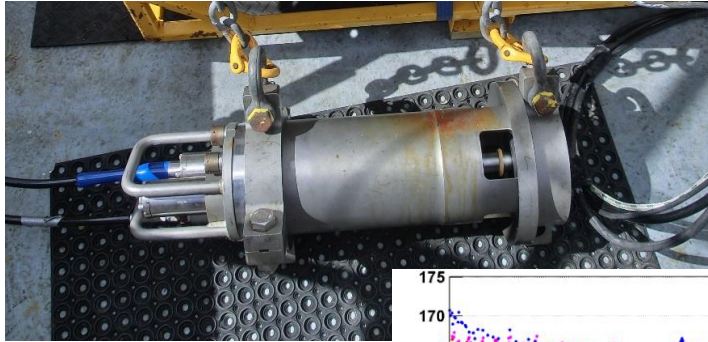Waterborne particle motion (pm)
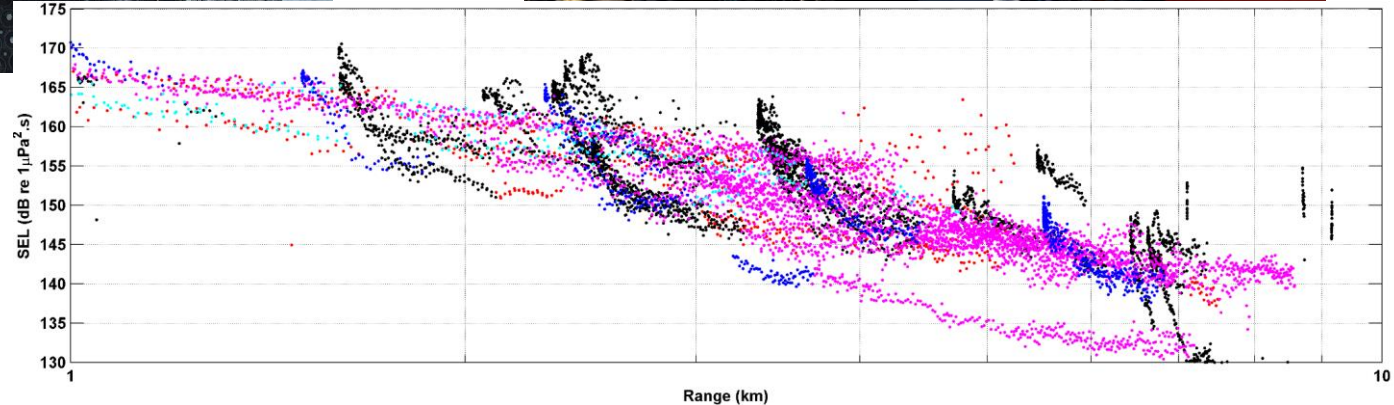pressure is proxy for pm

Local seabed excitation
Can be high

Interface waves

seabed

compressional waves

shear waves

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Characterise sound propagation at site
1 – is it homogenous?
2 - establish seabed type for modelling
3 – define sampling sites

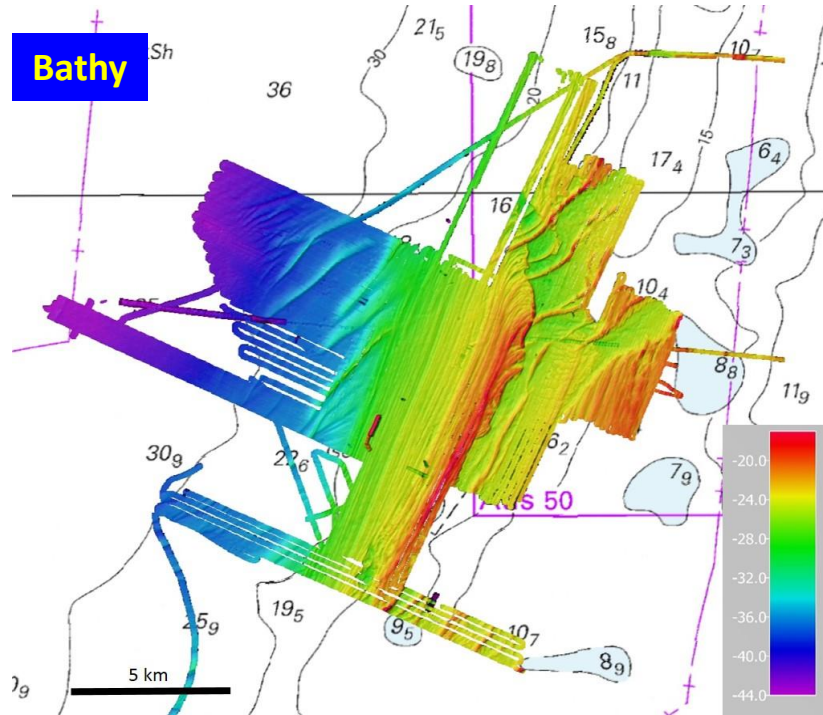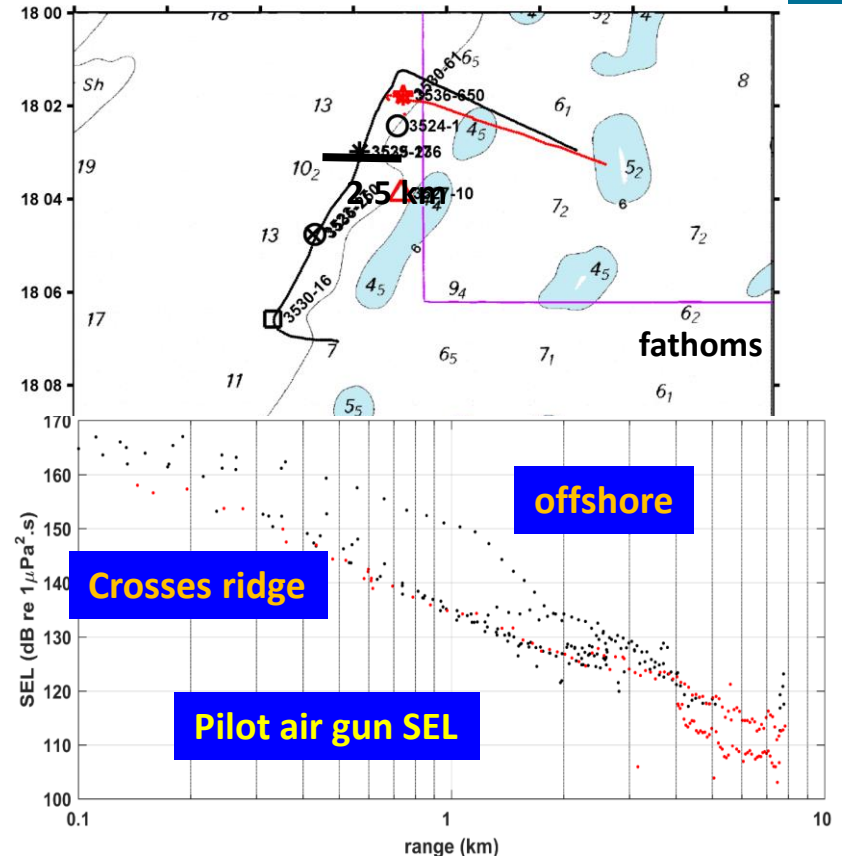**"Uniform"**
experimental site
that was not uniform

Pearl site, pilot measures

Limestone ridges – ideal holding area for shell but disastrous for sound propagation

Much angst in setting sites

Bathy

Pilot air gun
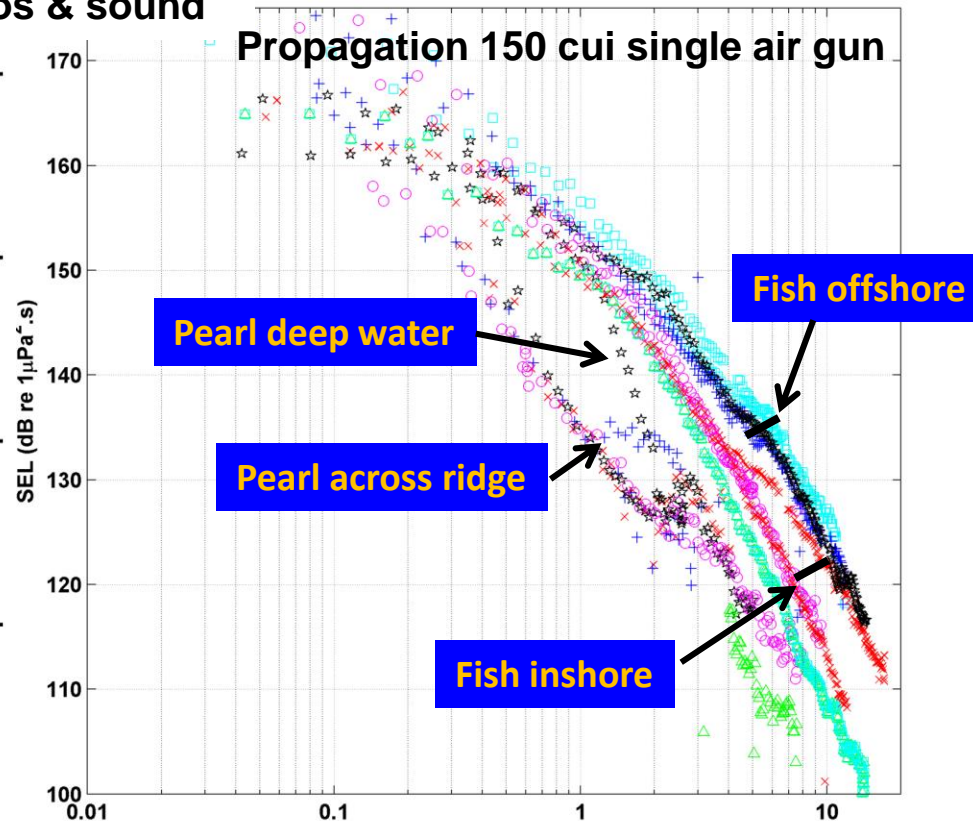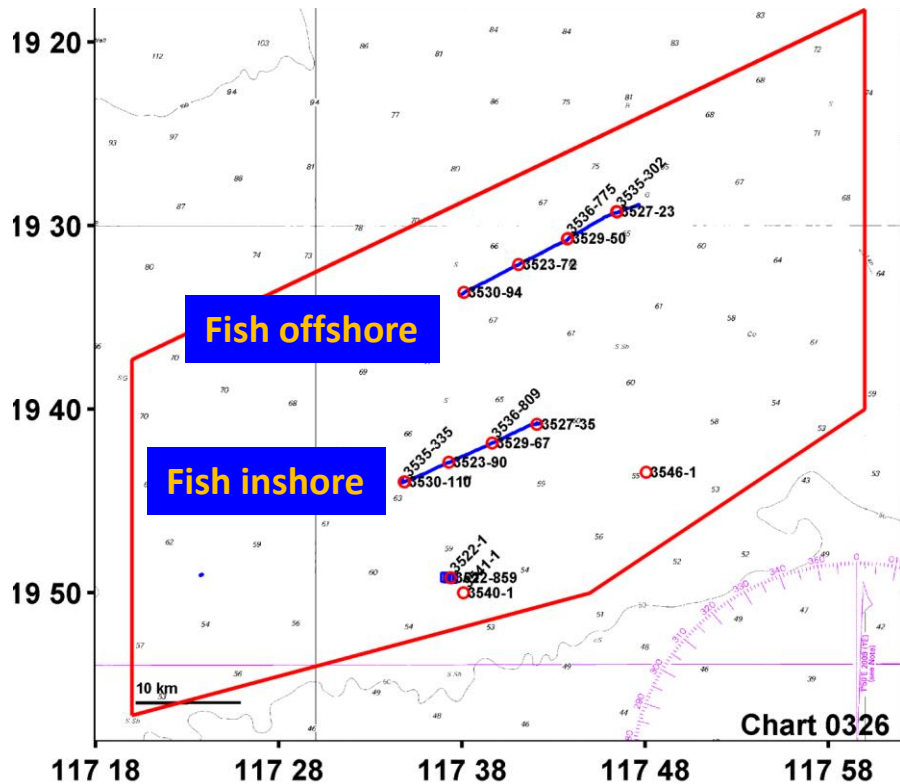
offshore

Crosses ridge

Pilot air gun SEL

fathoms

Fish site pilot study – sound propagation

Thin layer sand over limestone all sites,

Sand thickness over limestone critical – benthos & sound

Fish offshore

Fish inshore

Propagation 150 cui single air gun

Pearl deep water

Fish offshore

Pearl across ridge

Fish inshore

Pearl site layout – pilot modelling allowed exposure regimes to be defined – ranges for pearl line layouts

Decided to set lines as below with Pearl & Seismic lines parallel

Distances designed to double exposure from one Seismic line & give one Pearl line 2 overhead passes

Range (horizontal) achieved from nearest

     Line-1 shot:

-0.854 km (two overhead passes)

0.031 km
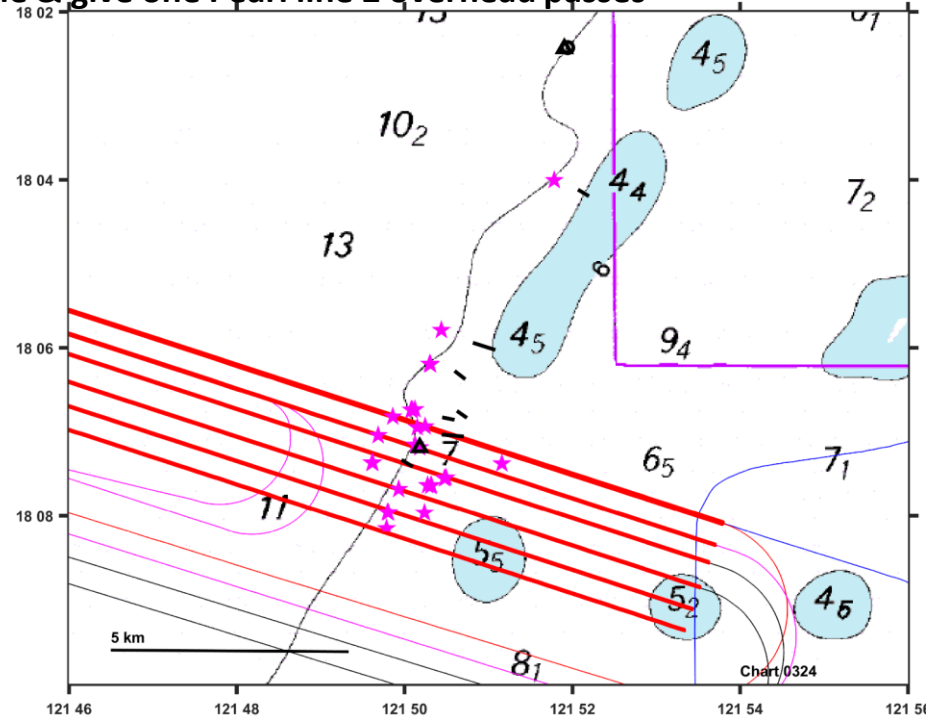
0.282 km

0.437 km

1.233 km

2.046 km

5.891 km (control)

Magenta asterix – measure sites

Black triangles - long term locations

Black bars - pearl lines

Solid red lines – active seismic

Fish site layout after affirmation ranges from pilot measures
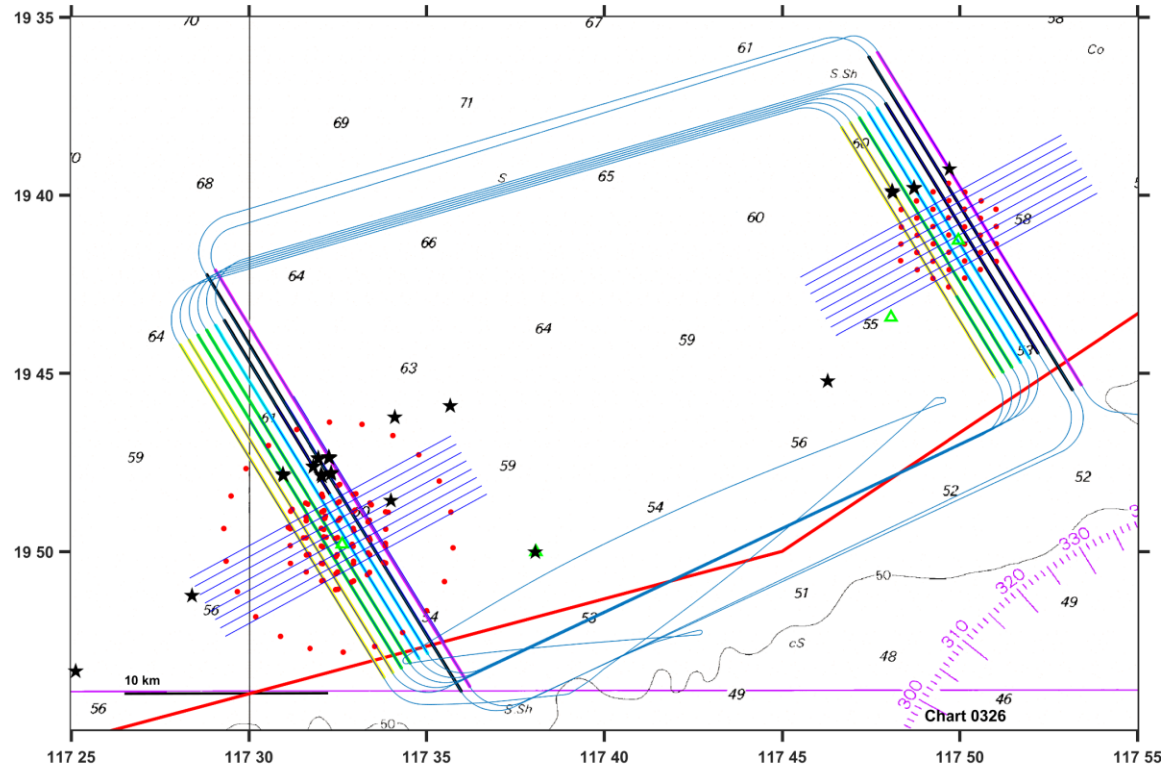
Black asterixes – measure sites

Red dots – fish tag receivers

Green triangles – long term

Blue lines – sonar transects
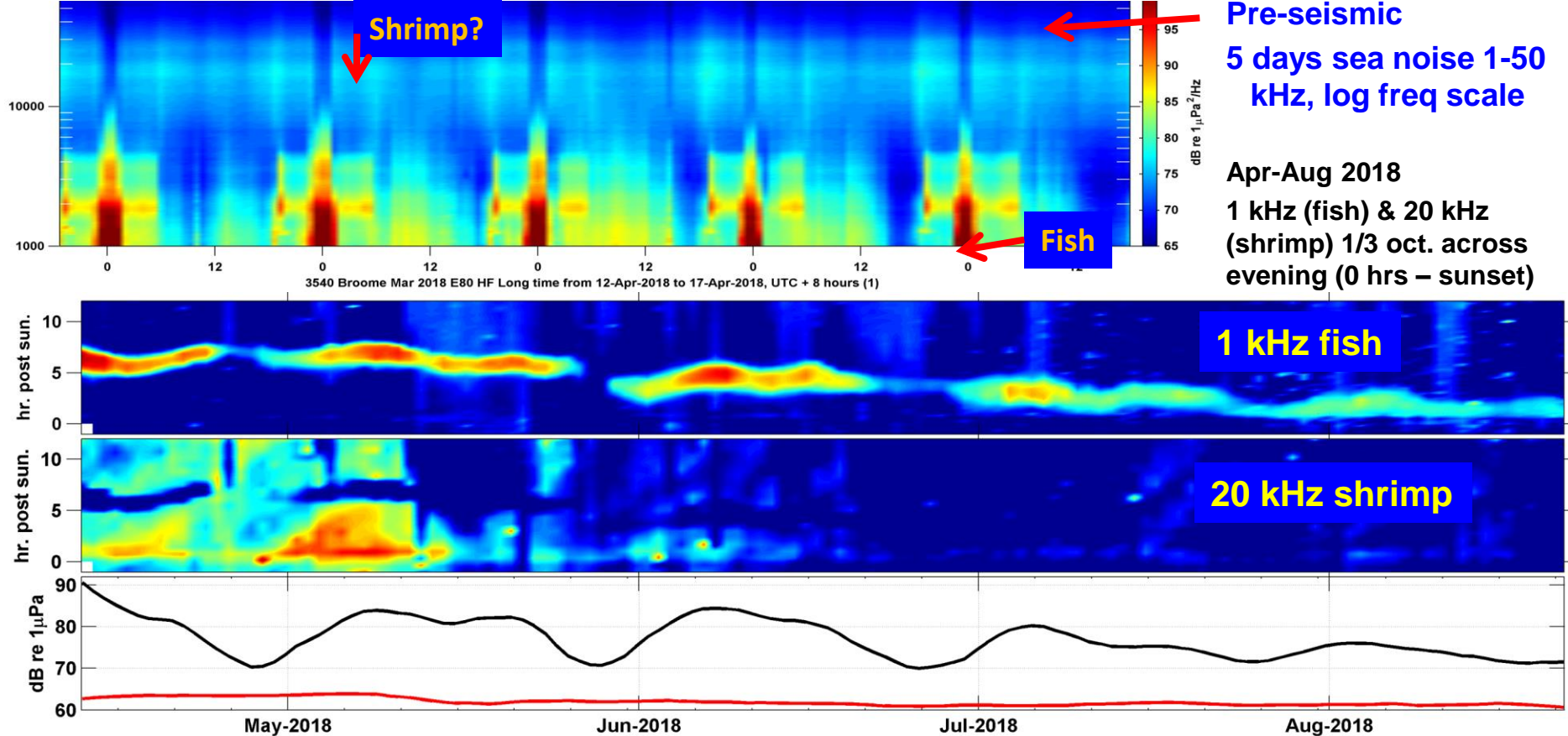
LHS heavy lines - active seismic

RHS heavy lines – vessel control

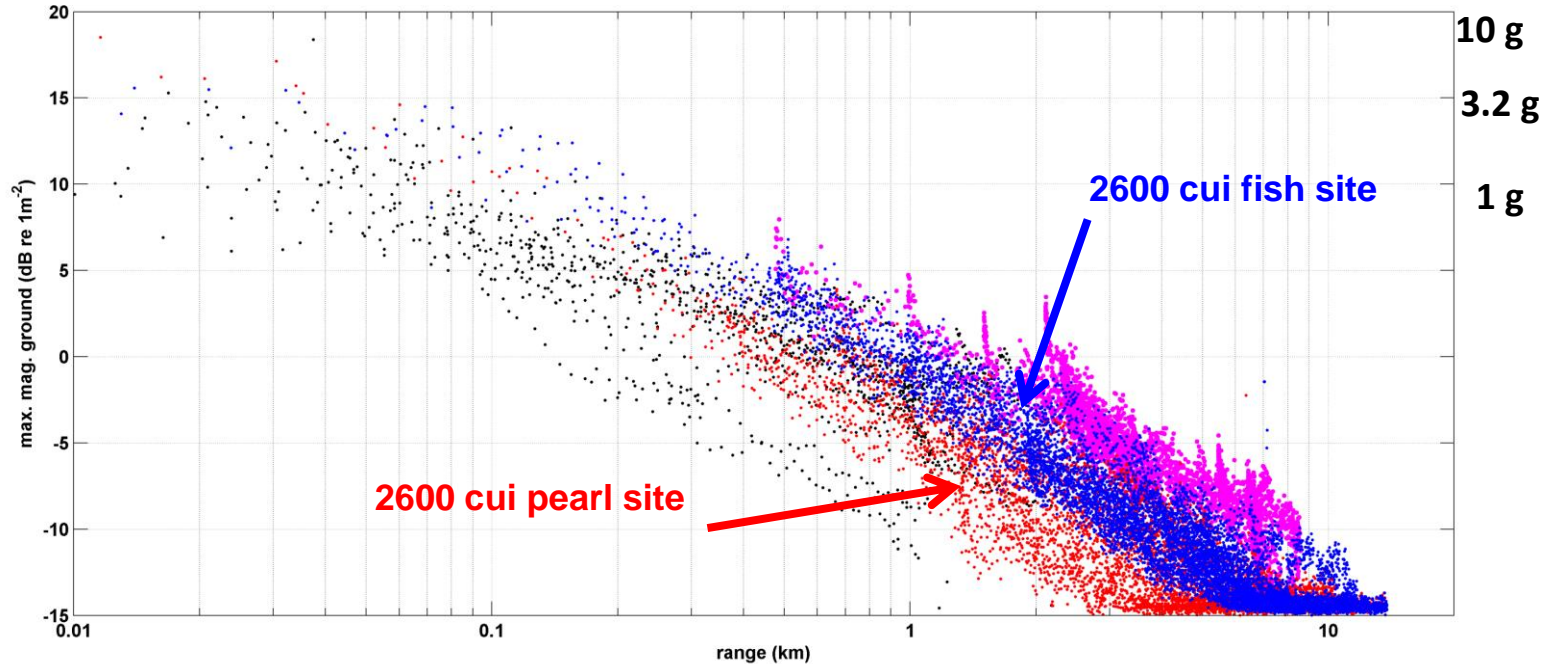# Measurements Pre, During & Post exposures – see what happens shrimp & fish

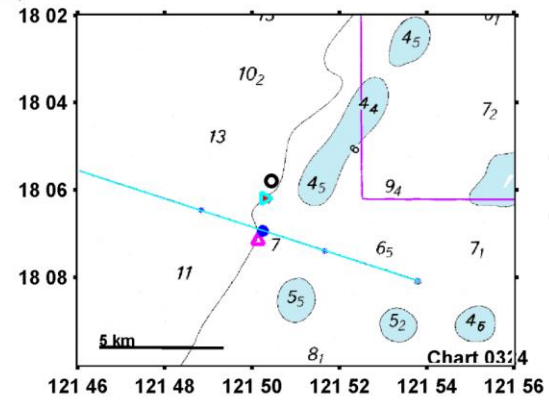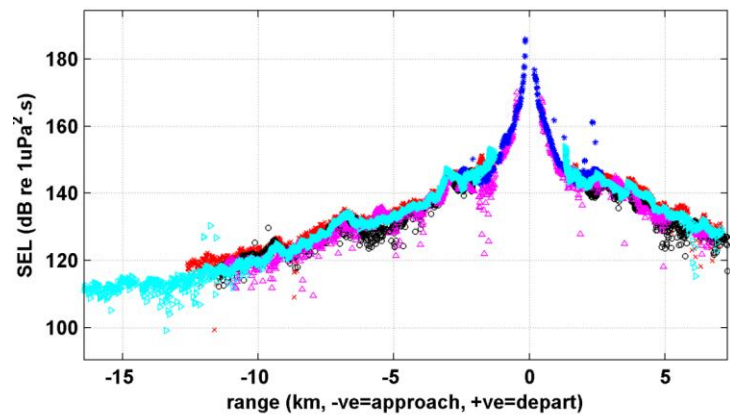**5 long term moorings Apr-2018 to Aug-2018, 5 left in situ & to be recovered**
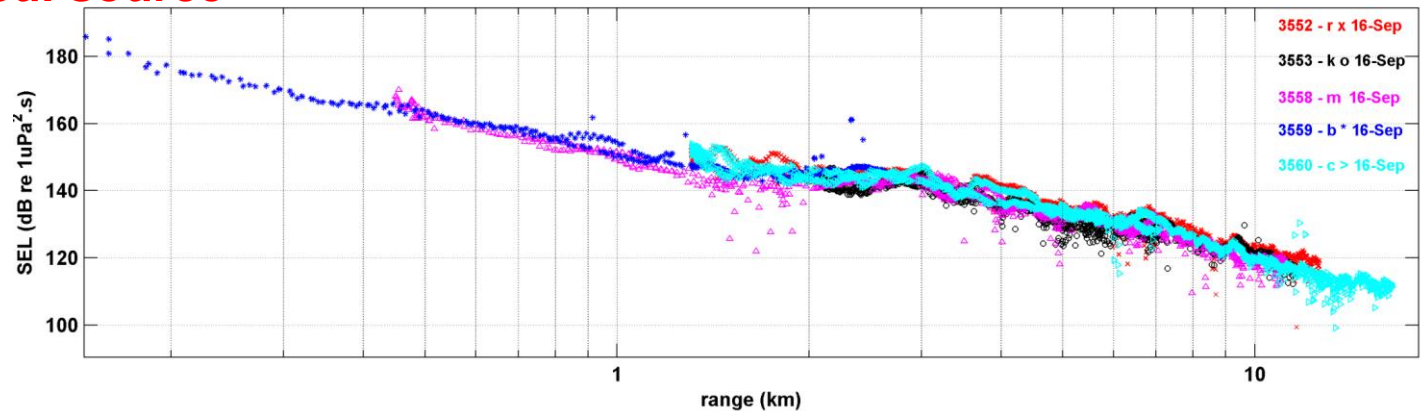

Pre-seismic

5 days sea noise 1-50 kHz, log freq scale

Apr-Aug 2018
1 kHz (fish) & 20 kHz (shrimp) 1/3 oct. across evening (0 hrs – sunset)

Shrimp?

Fish

1 kHz fish

20 kHz shrimp

3540 Broome Mar 2018 E80 HF Long time from 12-Apr-2018 to 17-Apr-2018, UTC + 8 hours (1)

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Geophone measurements – maximum magnitude ground motion in dB – pearl & fish + comparison sites
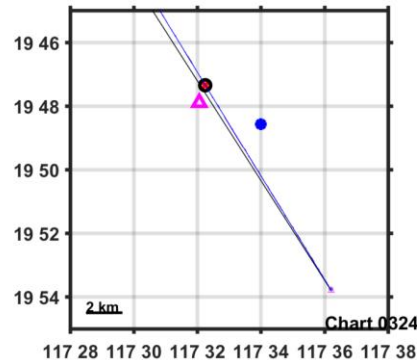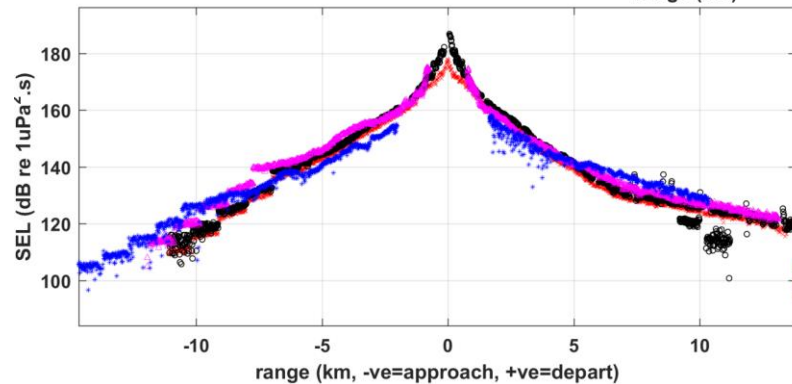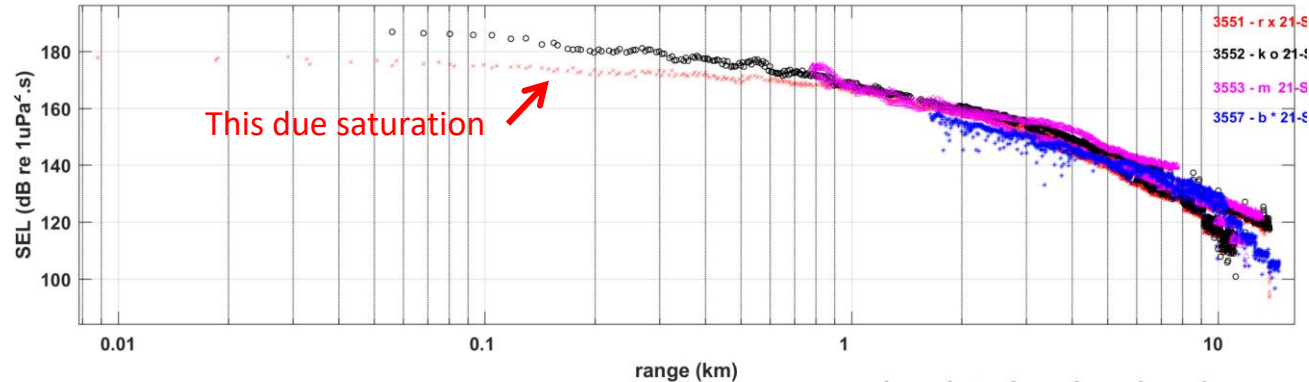
16-Sep (first pearl line)

– remarkably uniform

– good, allows exposure predictions each pearl panel

Fish Site pressure measures – sound exposure level, 2600 cui source

21-Sep (first fish line) – remarkably uniform – good, allows exposure predictions across fish site

This due saturation

Saturation:

Three sets instruments
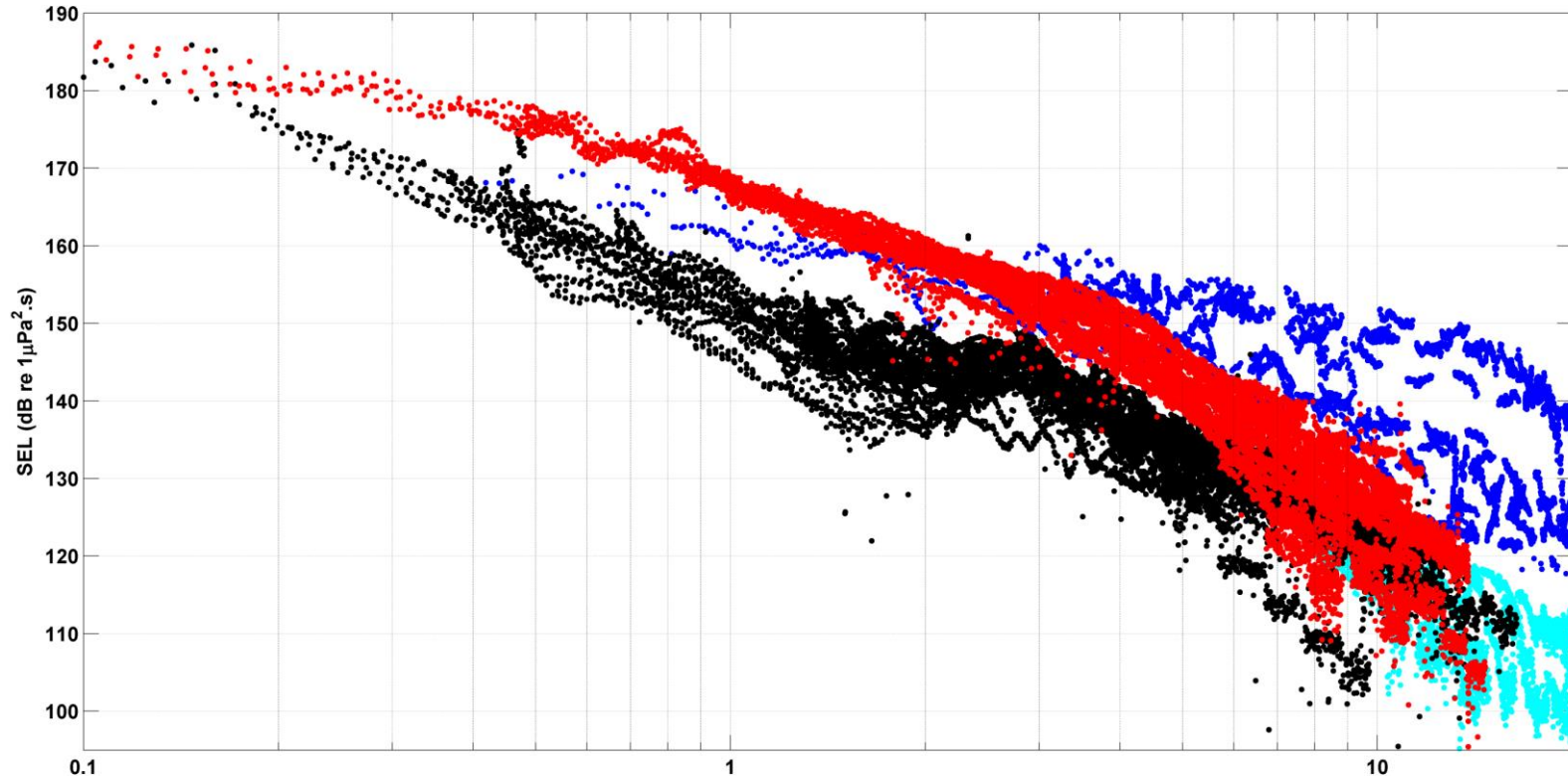
1 < 100 m

2 100 m to 1 km

3 > 1 km

There was a consistent asymmetry at fish site:

Seaward approach had greater attenuation than departure

Fish & pearl sites, pressure measures 2600 cui
Red is fish, black is pearl, (Comparison: blue is 3140 cui, 150-300 m water deep sand, cyan is 3480 cui thin sand over limestone)

Summary

Successful predictions & measurements

Shallow sand over limestone prevailed (~ < 0.25 m at pearl site, ~ 0.5-1 m at fish site)

Good match modelled and pilot measures, allowed accurate predictions

Potentially more complex site for pearl shell but seems to have been relatively uniform

Much to do:

- particle motion analysis
- metric to use for 3-axis data? (geophone & particle motion)
- finish air gun pressure analysis
- pearl panel exposures - all panels – metrics?
- Fish exposure - selected sites – metrics?
- control vessel noise
- ambient noise
- fish & shrimp choruses pre-, during & post seismic, both sites
- single beam sonar analysis (probably target counting, not biomass approach)