North West Shoals to Shore Research Program

The effect of marine seismic surveys on the movement, abundance and community structure of demersal fish assemblages on the North West Shelf

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AIMS: Australia's tropical marine research agency.

Objectives

1. Use BRUVS to infer potential impacts of seismic activity on fish abundance and community structure.

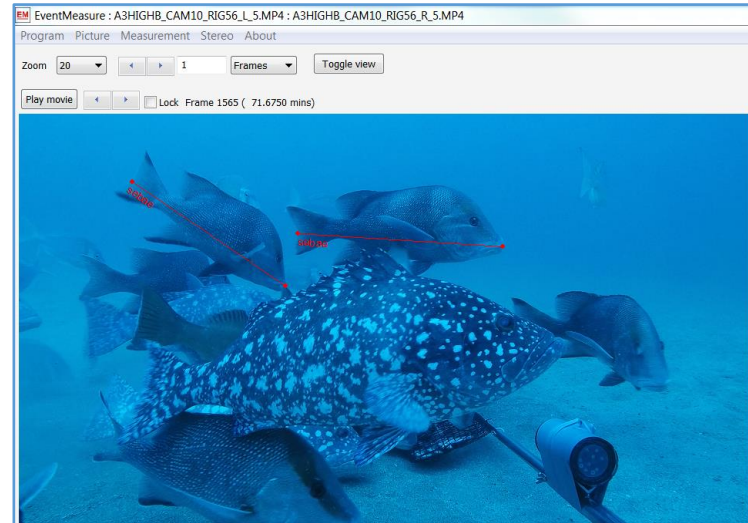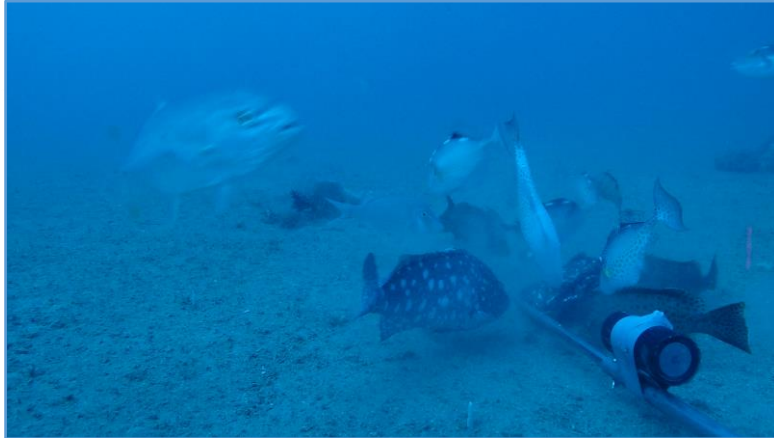2. Monitor tagged fish to infer potential impacts of seismic activity on behaviour

Methods

BRUVS

Technique and measurements

- Collects data on relative abundance, size, and behaviour: 1) range, 2) time to first feed, 3) probability of not feeding

- Analysed videos using *EventMeasure*

Methods

BRUVS

MBACI & dose-response designs

- *epower* package

- Bayesian generalised linear mixed models

- Compare two models with and without interaction (Before vs After*Control vs Impact)

- The model with probability ratio of **>0.5** has more support
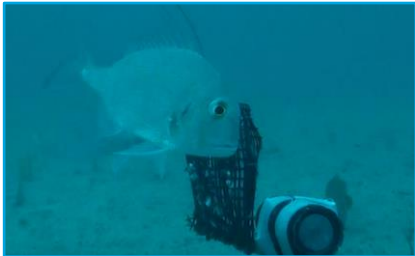
- Posterior distribution plots were built
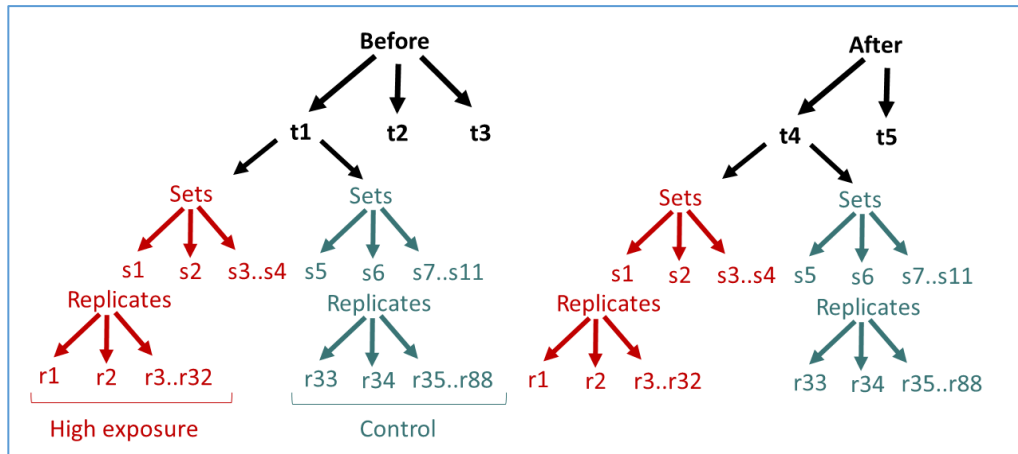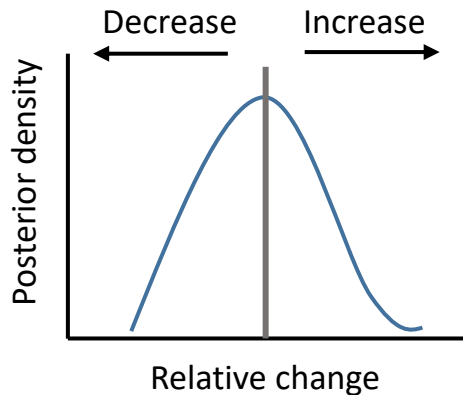
Methods

BRUVS

Focal species and groups

- All demersal species
- All target species (commercial targets)
- Three families (Lutjanidae, Lethrinidae, & Epinephelidae)

Argyrops notialis

Lutjanus sebae

Lutjanus vitta

Epinephelus areolatus

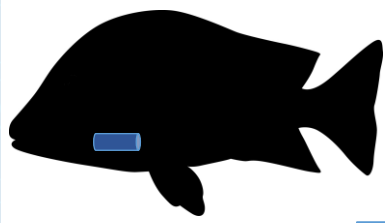*Lethrinus punctulatus*

Nemipterus furcosus

Epinephelus multinotatus
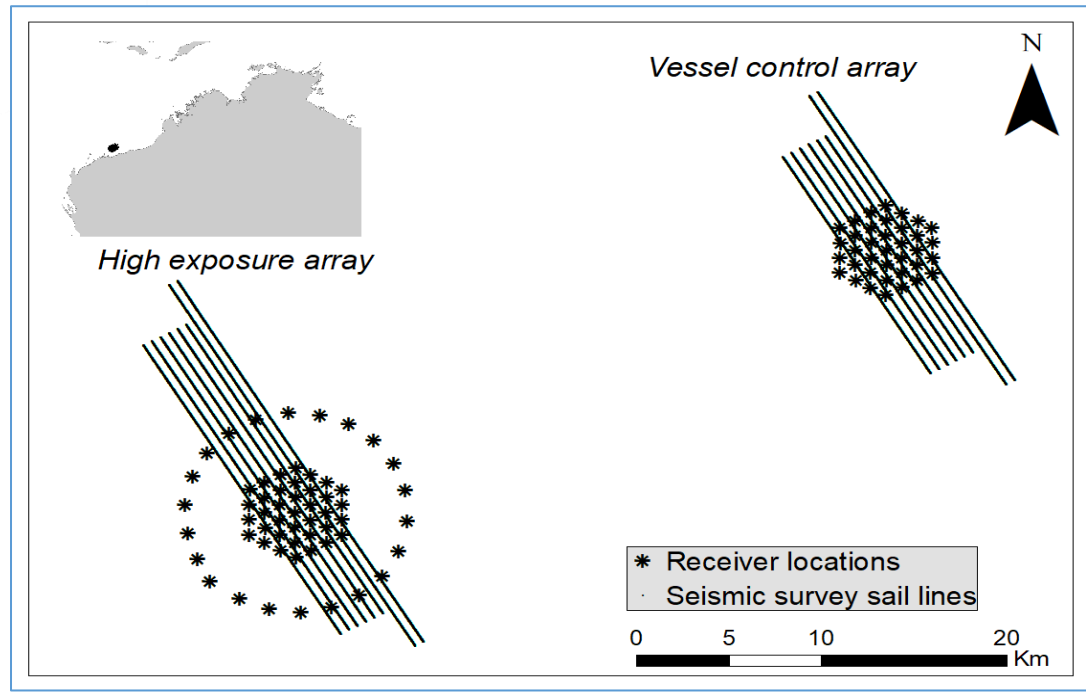
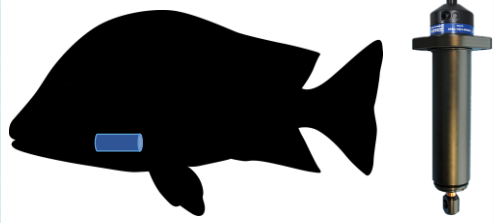*Plectropomus maculatus*

Telemetry

Array design

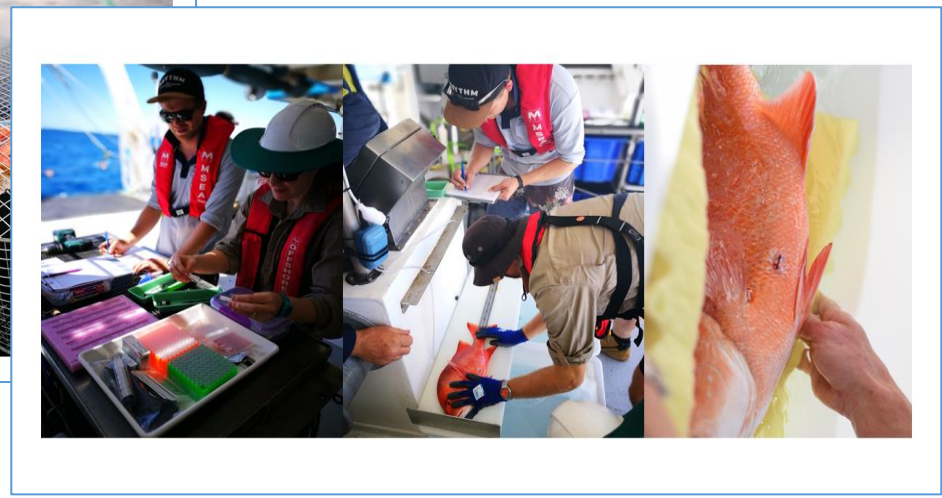- Two arrays of VR2AR receivers;
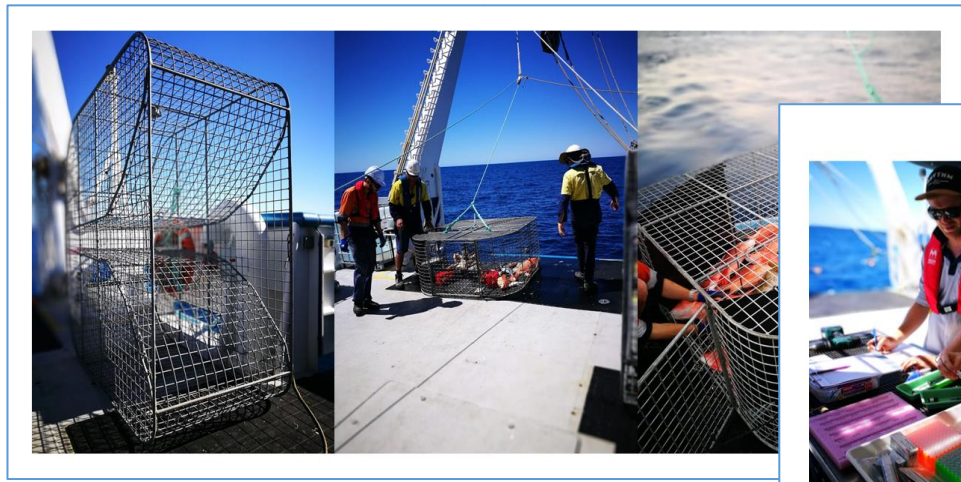- ~ 900m separation in hexagonal design
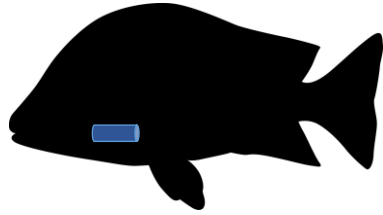
Methods

Telemetry

Trapping and tagging *L. sebae*

- Fish caught over two trips in traps
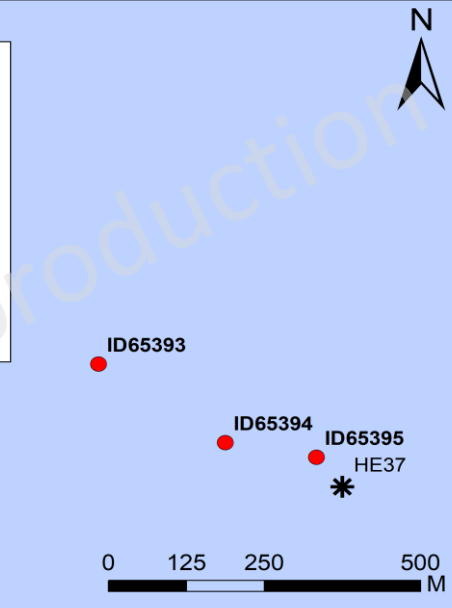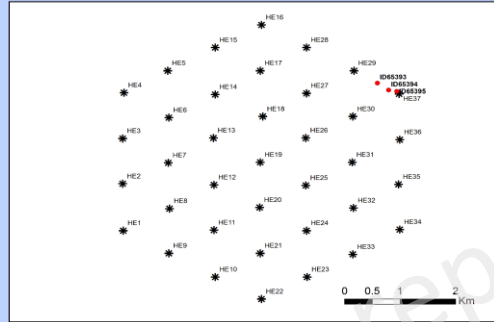- 387 fish tagged
- > 4 million detections

Methods

Telemetry

Range testing and sentinel tags

- Range testing near HE indicated max range 480 m
- Sentinel tags deployed in both arrays
- Detections used to standardise changes in environmental noise (As per Payne *et al*. 2010)
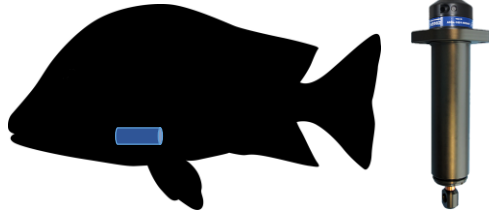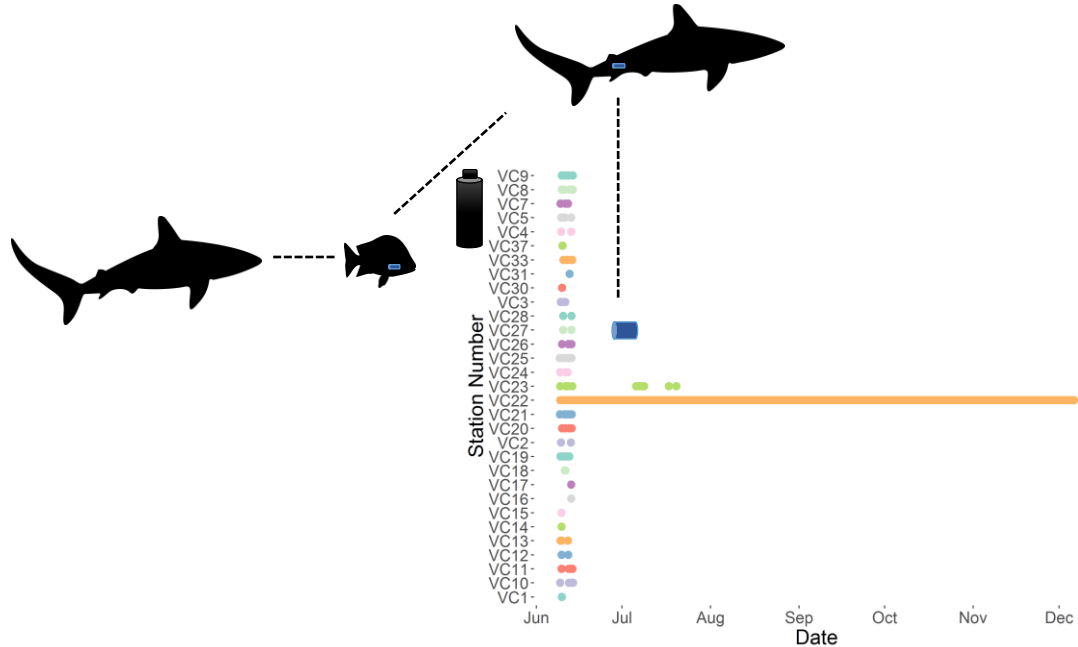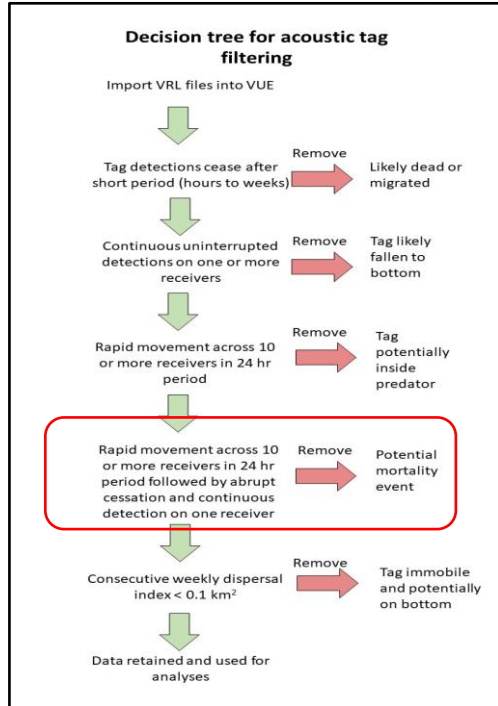

High Exposure Array sentinel tags

Telemetry

Detection filtering

- Detections filtered to remove suspect data
- E.g. Khan *et al.* 2015 & Villegas-Ríos *et al.* 2020

Decision tree for acoustic tag filtering

Import VRL files into VUE

Tag detections cease after short period (hours to weeks) → Remove → Likely dead or migrated

Continuous uninterrupted detections on one or more receivers → Remove → Tag likely fallen to bottom

Rapid movement across 10 or more receivers in 24 hr period → Remove → Tag potentially inside predator

Rapid movement across 10 or more receivers in 24 hr period followed by abrupt cessation and continuous detection on one receiver → Remove → Potential mortality event

Consecutive weekly dispersal index < 0.1 km² → Remove → Tag immobile and potentially on bottom

Data retained and used for analyses

Results

Zone	Total
Control	119
Vessel control	153
Low exposure	32
Medium exposure	175
High exposure	150
Total	**629**

BRUVS

Sampling

- 651 BRUVS deployed across 5 trips
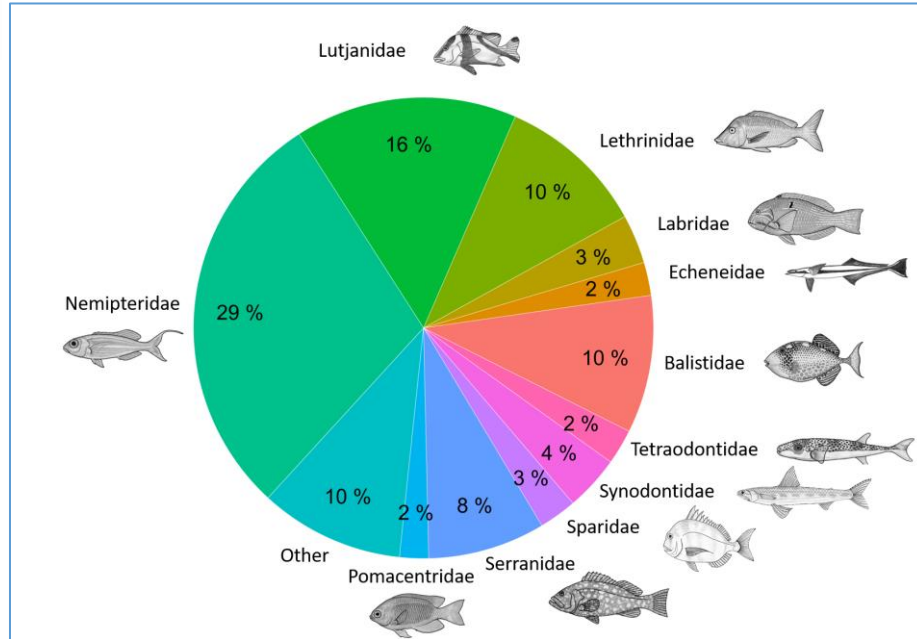- 629 used in analyses
- 100 per zone except low exposure
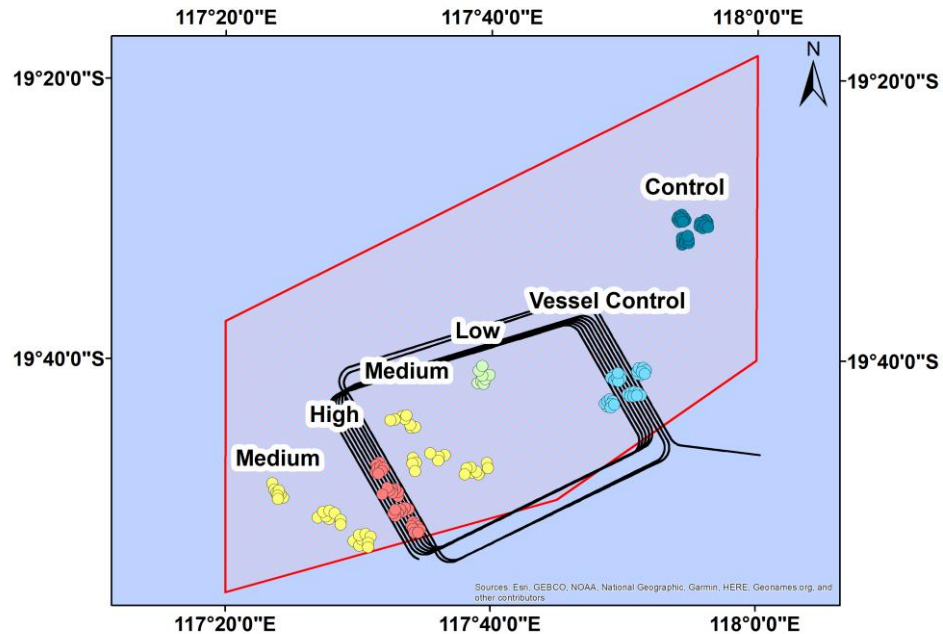
BRUVS

Community composition

- 148 demersal species

- 35 are known targets

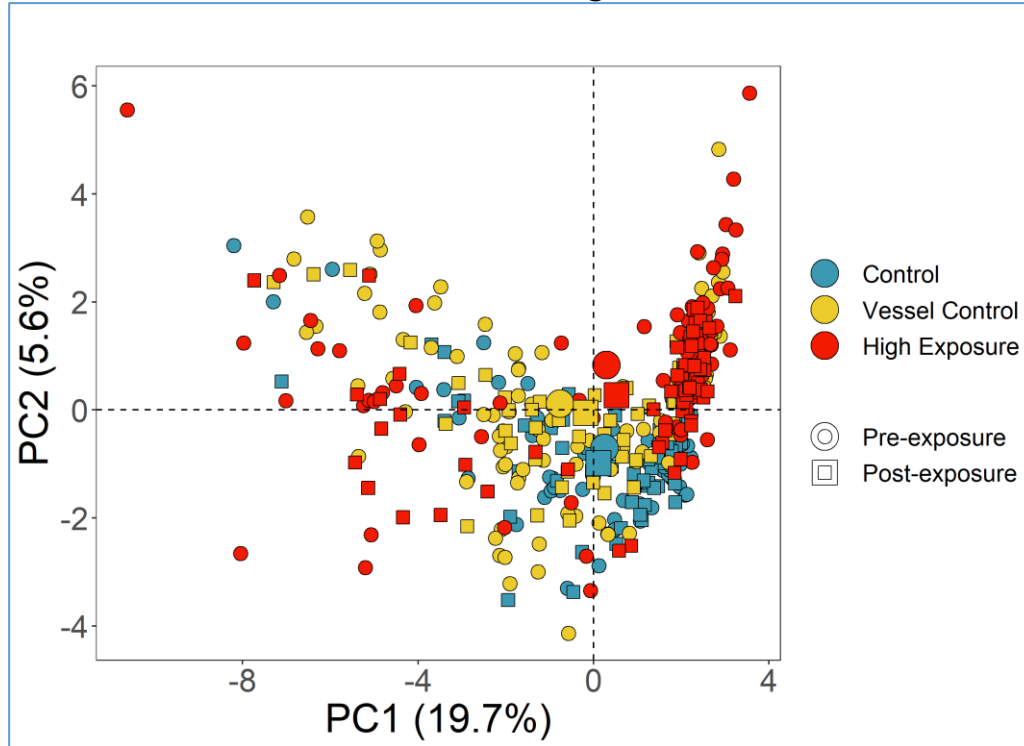- Most abundant rosy threadfin bream (*Nemipterus furcosus*)

BRUVS

Community composition

- No significant change in community at HE post-seismic relative to controls using PERMANOVA BvAxCvI; *p* = 0.234
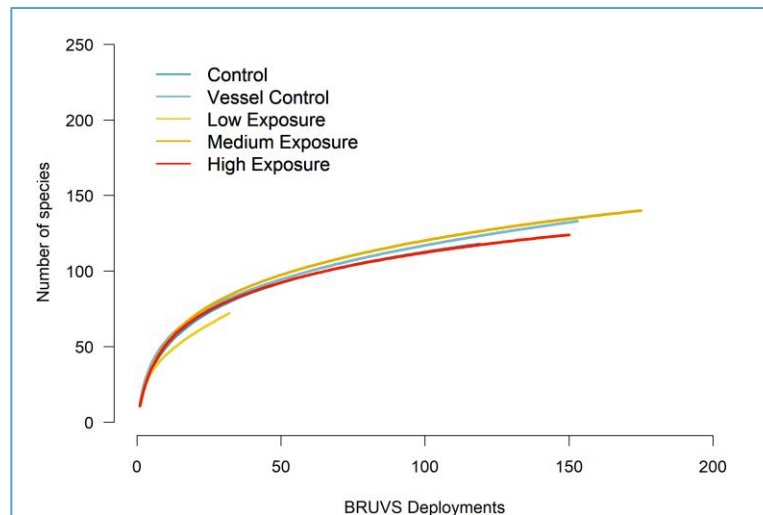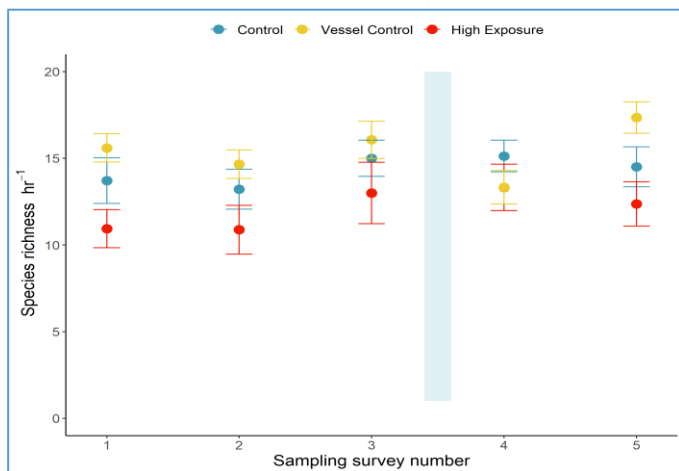
Results

BRUVS

Species richness

- Max number of species per deployment was 33
- Mean number was ~14 per deployment
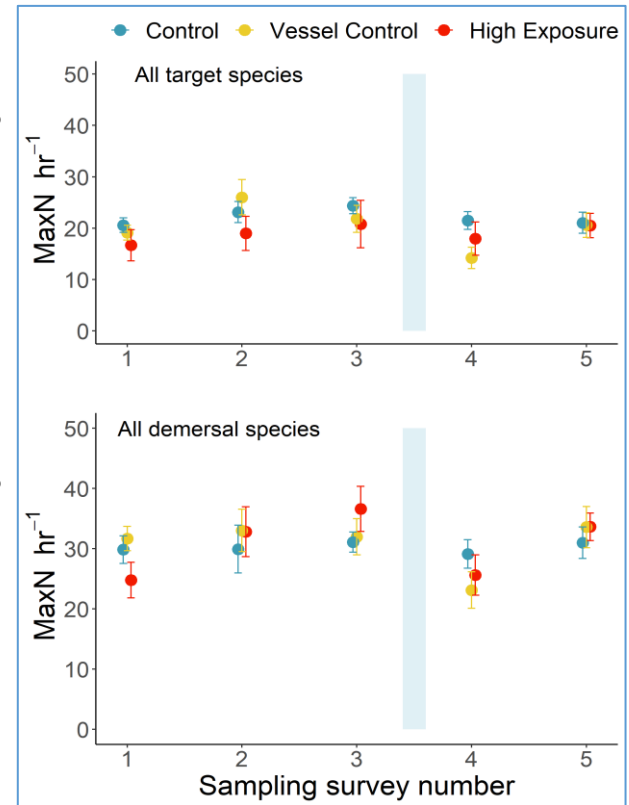- Species accumulation curves plateaued

BRUVS

Relative abundance

- Mean 19.6 hr

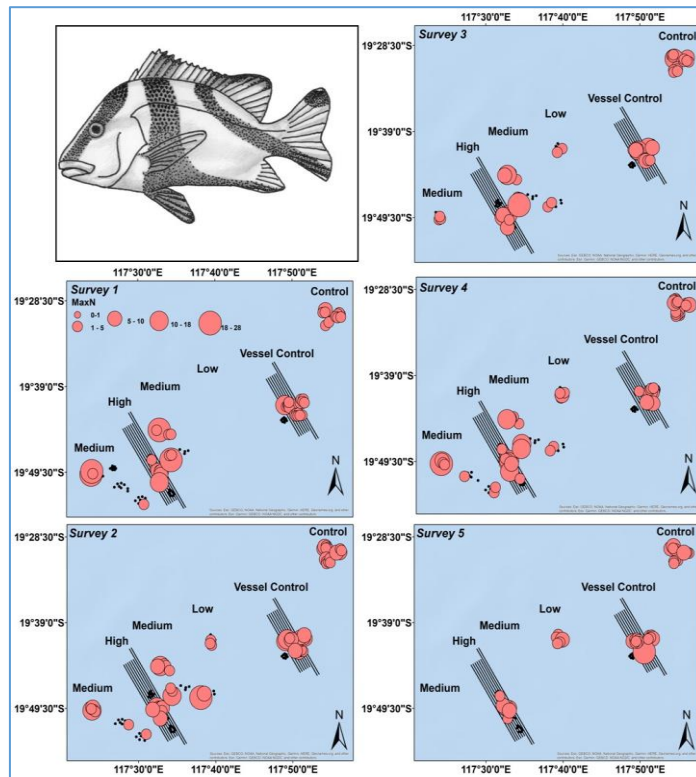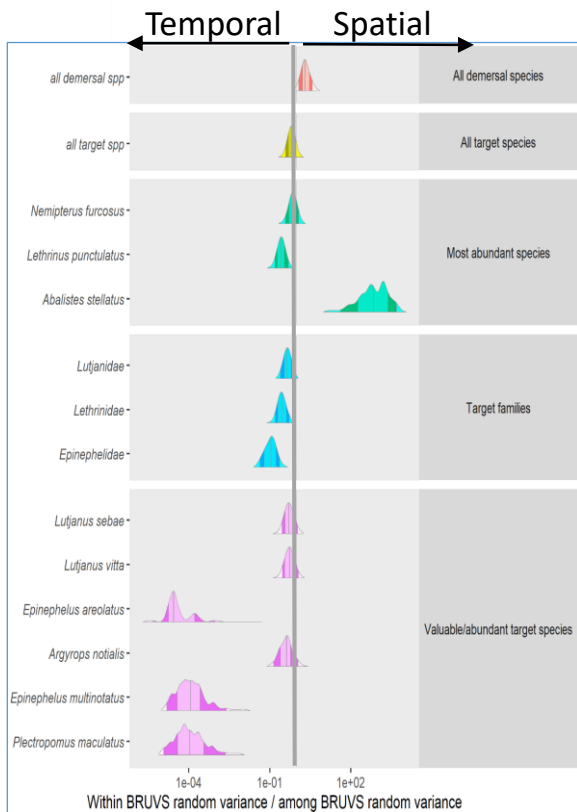- No consistent patterns

- Mean 31.6 hr

- No consistent patterns

BRUVS

Spatial and temporal abundance

- Temporal variance greater than spatial variance

BRUVS

BACI posterior distribution abundance
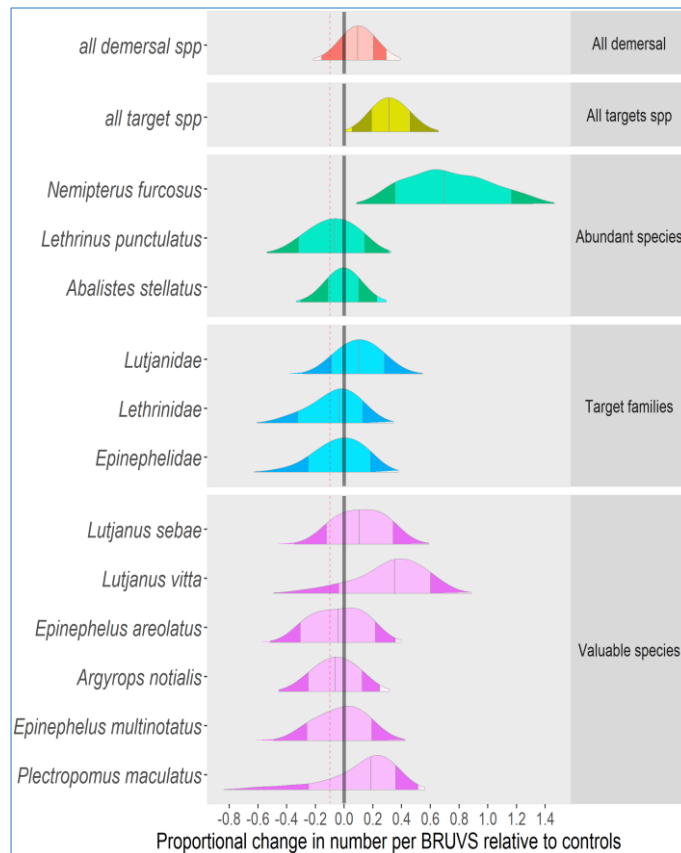
- 418 deployments used
- No evidence of decline (interaction model <0.5)
- Evidence of increase of all demersal & targets
- Driven by:
  1) *N. furcosus*
  2) *L. vitta*
  3) *L. sebae*

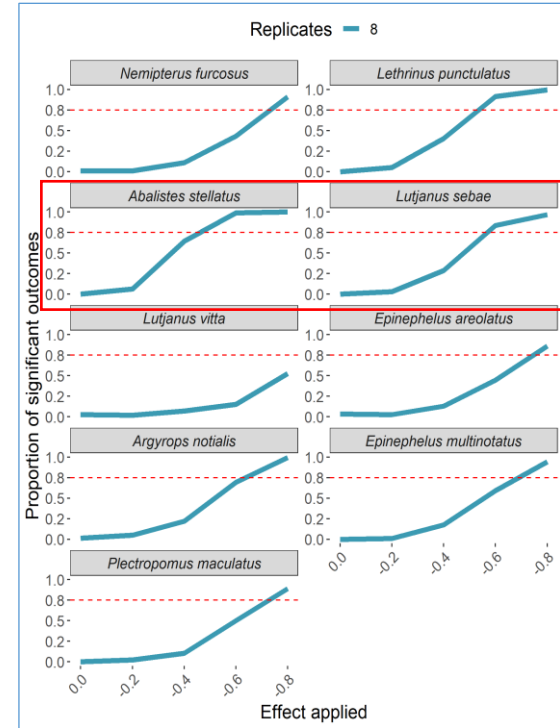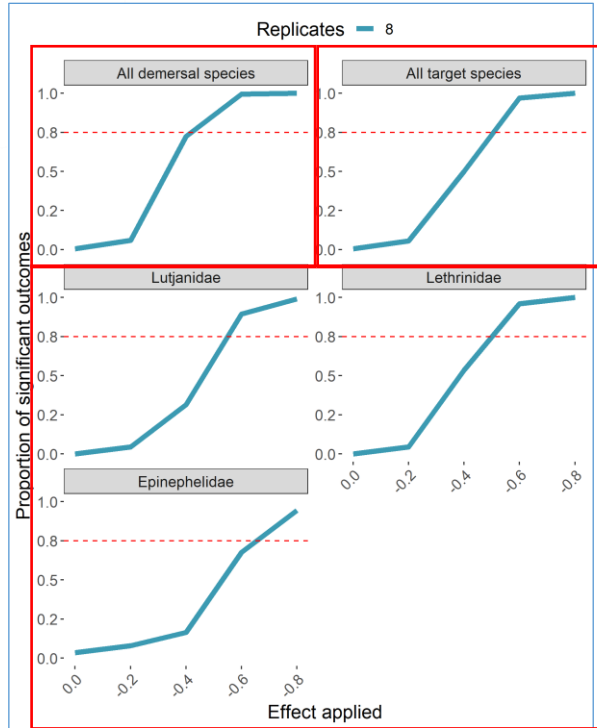Proportional change in number per BRUVS relative to controls

BRUVS

Power to detect change

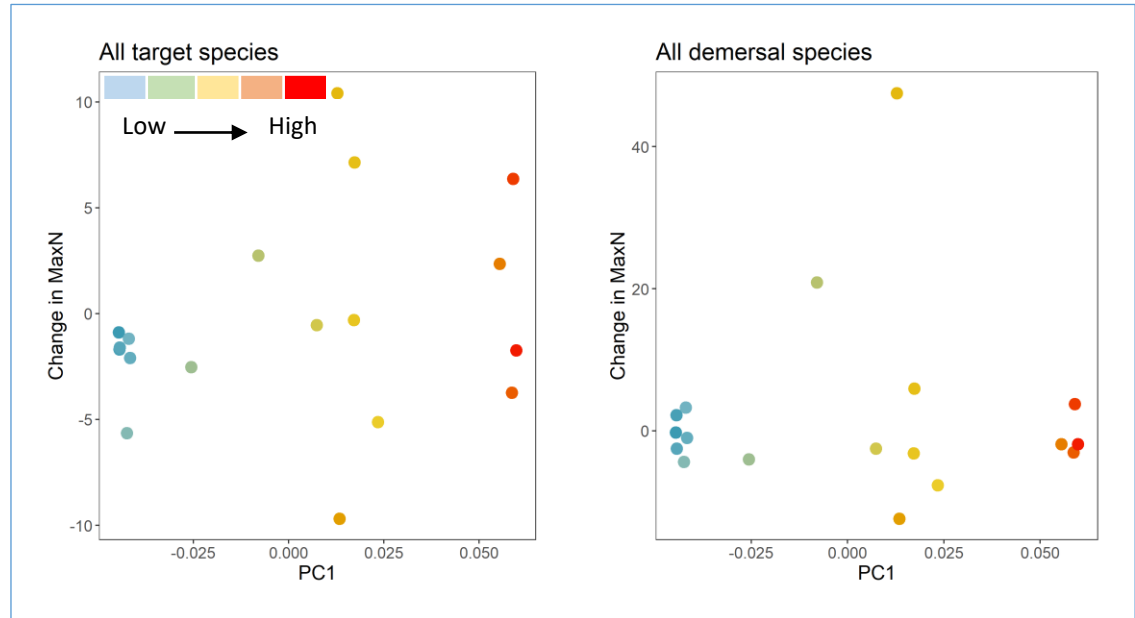- >70% prob of detecting 40% change in all demersal & target species groups

Results

BRUVS

Dose-response analysis on abundance

- PCA of seismic exposure metrics - PC1 & PC2 accounted for 99.77% of variation in model

- A non-significant positive relationship with increasing exposure for all target species

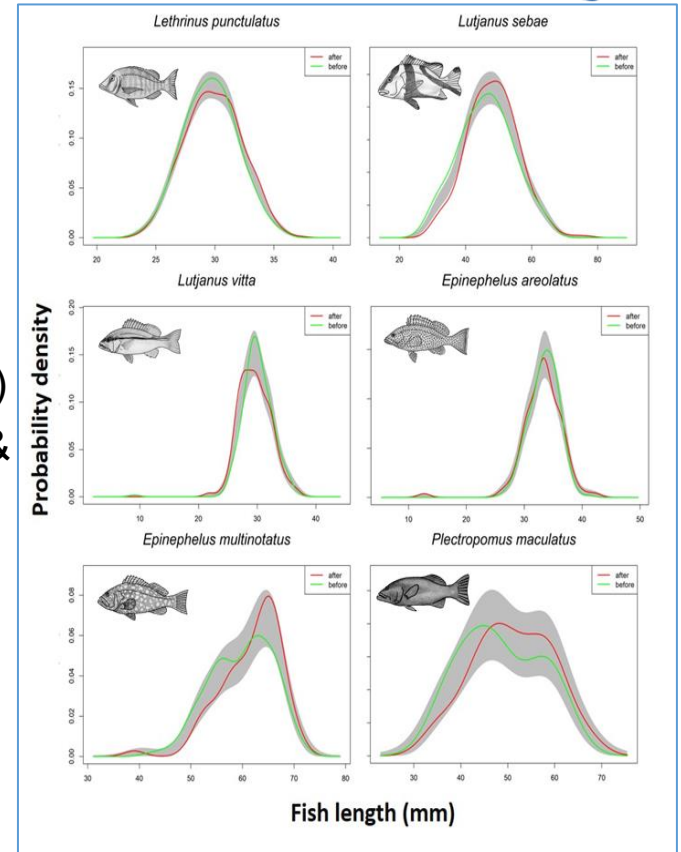**Comparison of length frequencies**

- Length distributions predominantly adults

- Similar size classes observed to other studies in region (e.g. Harvey *et al.* 2012 & Langlois *et al.* 2015)
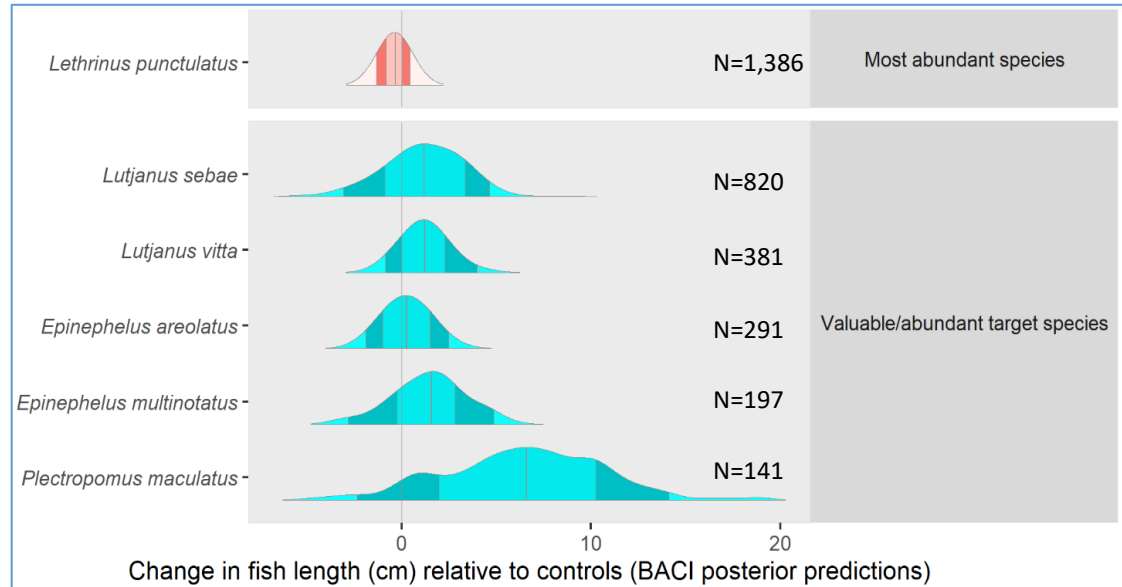
- Comparable between pre- & post- treatments

BRUVS

MBACI posterior distribution size structure

- 3,200 length measurements (give cm change)
- Small increase in length at High Exposure Zone
- No models with interaction term were favoured (< 0.5)

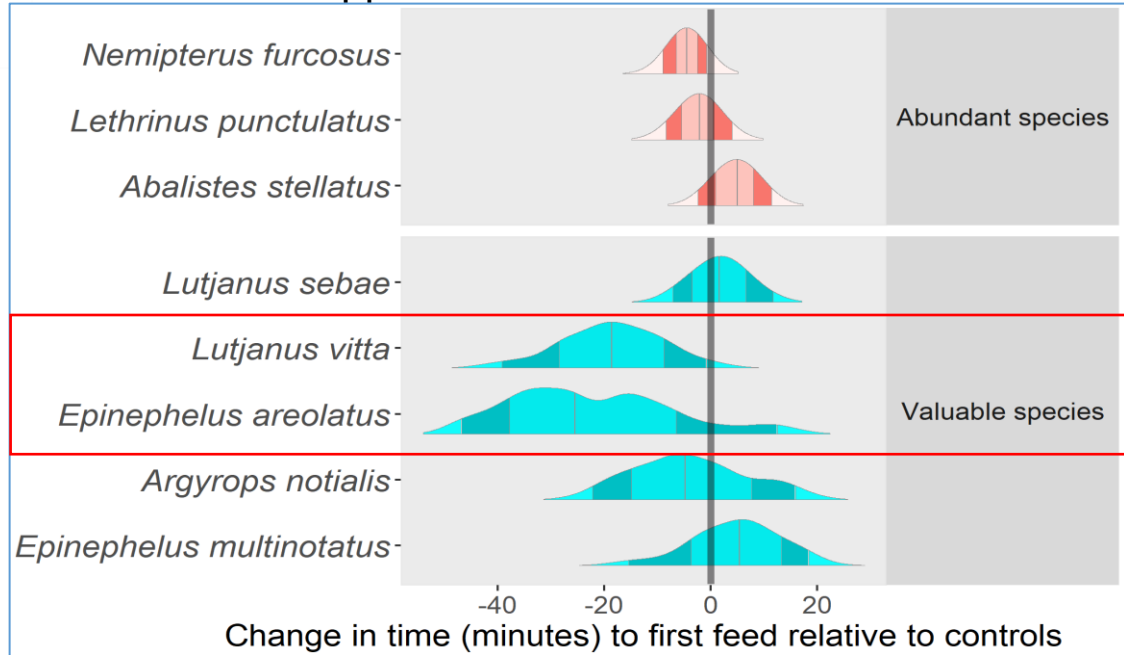Change in fish length (cm) relative to controls (BACI posterior predictions)

BRUVS

Time of first feeding

- No strong evidence of a change
- No models with interaction term were favoured (< 0.5)
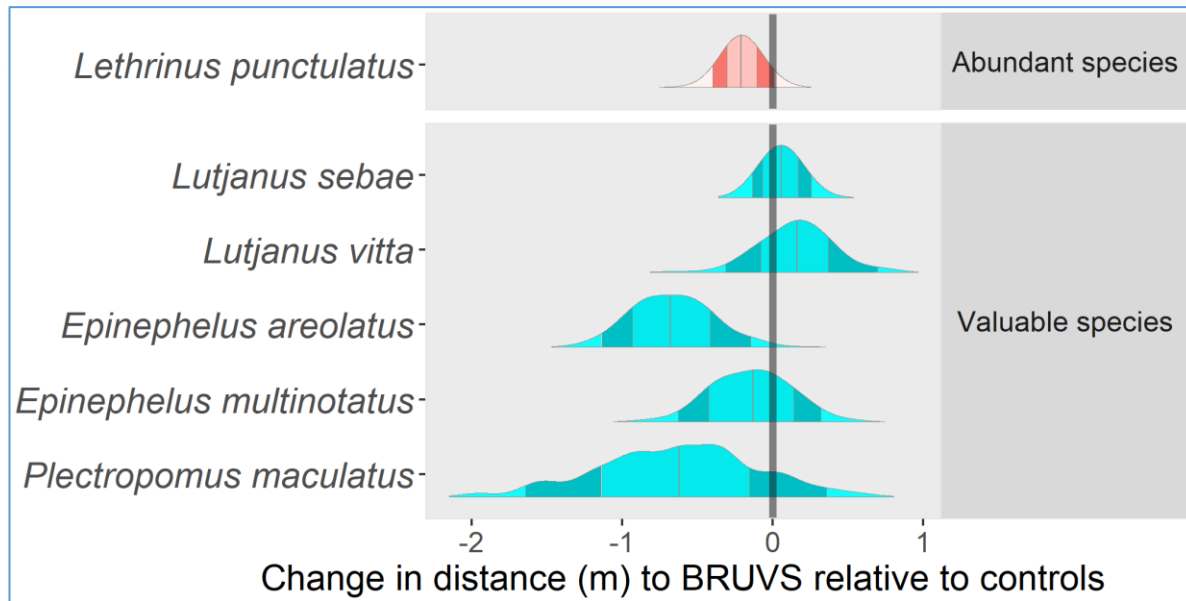- Some support for reduced time for *E. areolatus & L. vitta*

Change in time (minutes) to first feed relative to controls

BRUVS

Distance to BRUVS

- Slight reduction in distance to BRUVS at HE
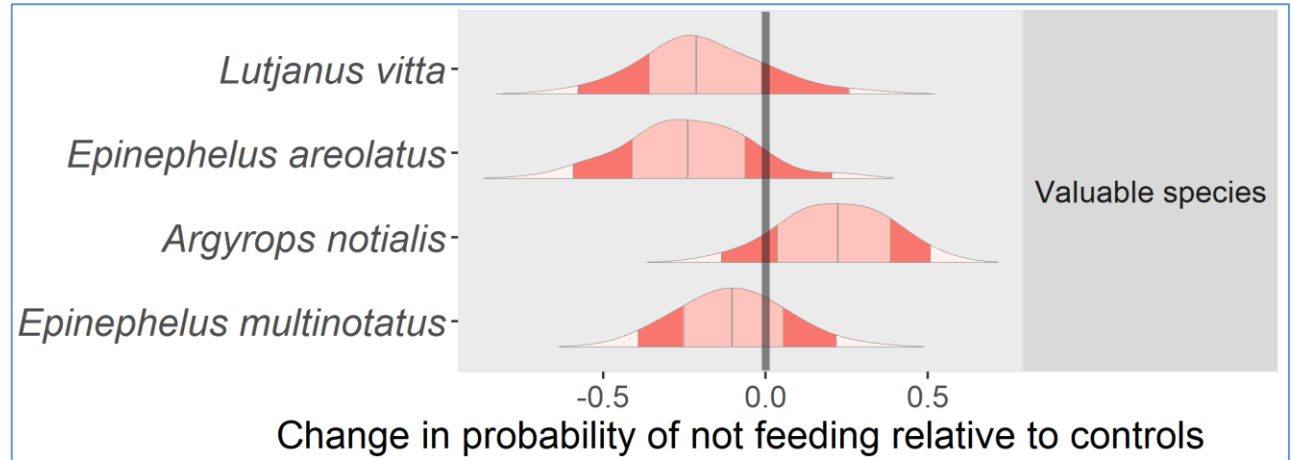- No models with interaction term were favoured (< 0.5)

BRUVS
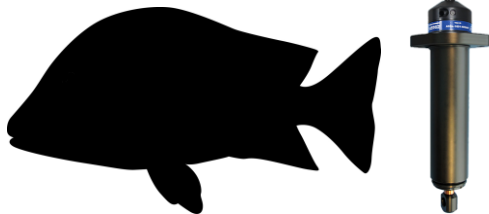
Posterior distribution in change of feeding

- Many species did not feed on bait

- Four species had moderate feeding rates (i.e. not zero or one inflated)

- No models with interaction term were favoured (< 0.5)

Change in probability of not feeding relative to controls

Telemetry

Fish detections

- 57% of tags detected by arrays
- Predation high – at least 43% at HE and 22% at VC
- Tags use in analyses were 43 from HE and 23 from VC

Number retained for analysis

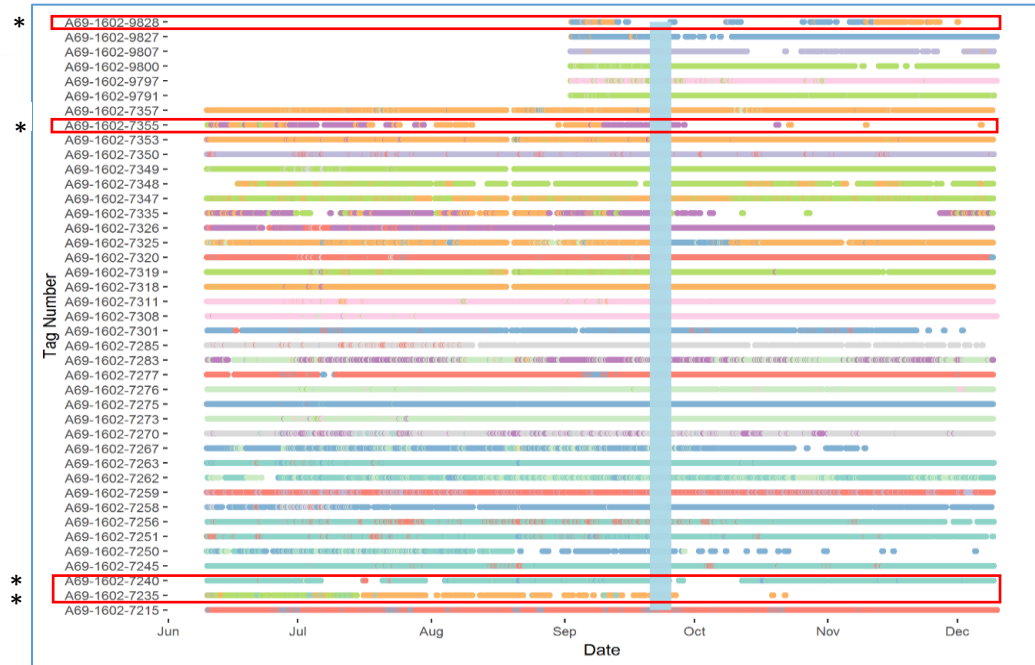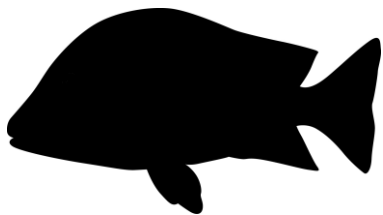| Array	Number tagged	Number detected	% usable	Mean fork length (cm)	Total detections	Included in analyses
High exposure	196	123	35	480	3,353,189	43
Vessel control	191	103	22	487	1,077,440	23
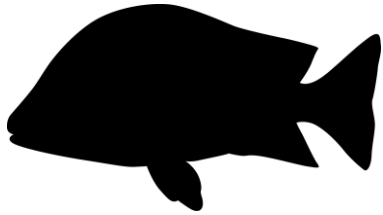
Telemetry

Residency

- High residency at HE array

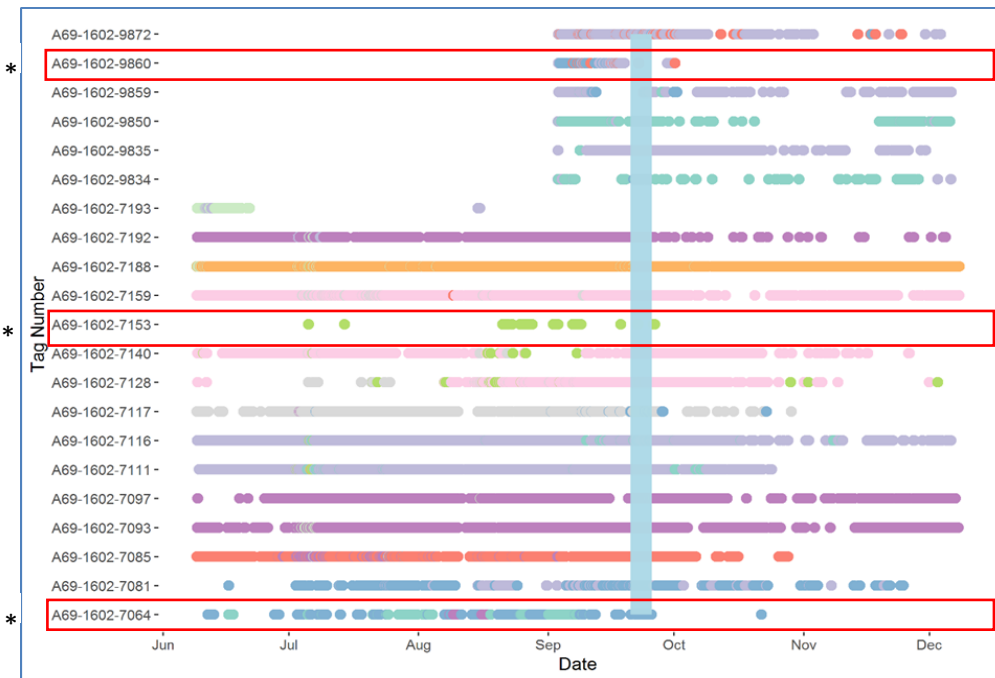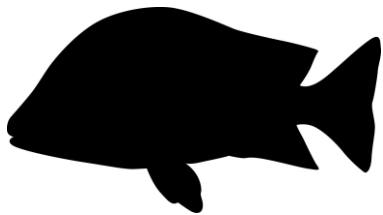- Some gaps after seismic*

- No evidence of long-term displacement

Telemetry

Residency

- High residency at VC array

- Some gaps after seismic*

- No evidence of long-term displacement

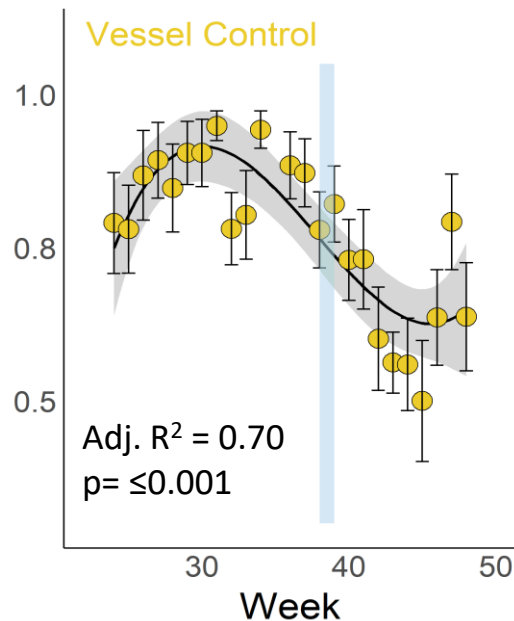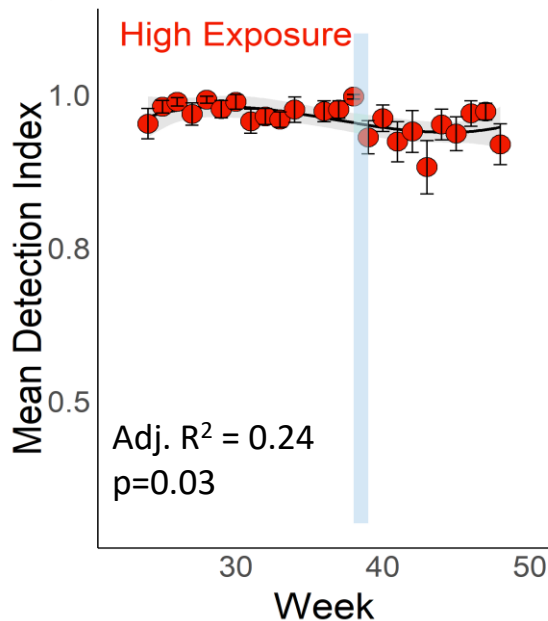## Telemetry

Weekly detection index (1 = 100% 0 = 0%)

- High exposure mean 0.92

- Vessel Control mean 0.76

- Decline in both arrays

High Exposure

Mean Detection Index

1.0

0.8

0.5

Adj. R^2 = 0.24
p=0.03

30   40   50
Week

Vessel Control

1.0

0.8

0.5

Adj. R^2 = 0.70
p= ≤0.001

30   40   50
Week

Conclusions

Summary

BRUVS

- No shifts in fish community structure seen in BRUVS due to seismic survey

- No decline in relative abundance of fish due to seismic survey

- No major changes in size distribution of fish due to seismic survey

- No consistent shifts in feeding behaviour due to seismic survey

Telemetry

- No evidence of displacement of *L. sebae* due to seismic survey using acoustic telemetry

- No evidence of shifts in spatial or temporal space use of *L. sebae*

QUESTIONS

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