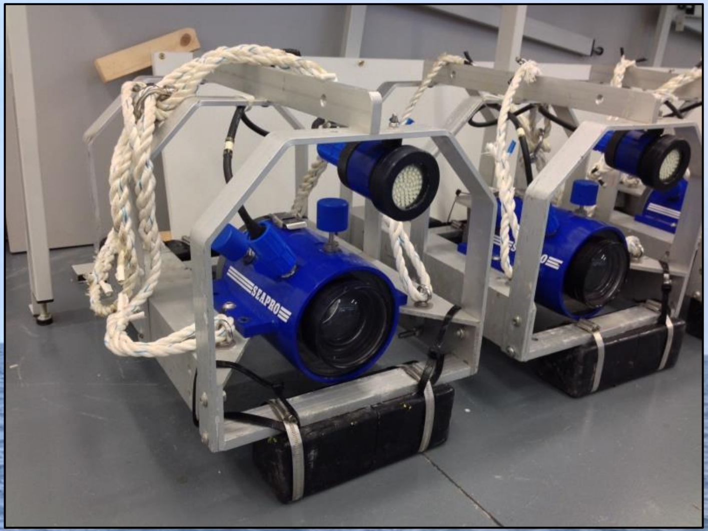
Baited remote underwater video systems to assess man-made infrastructures at sea:

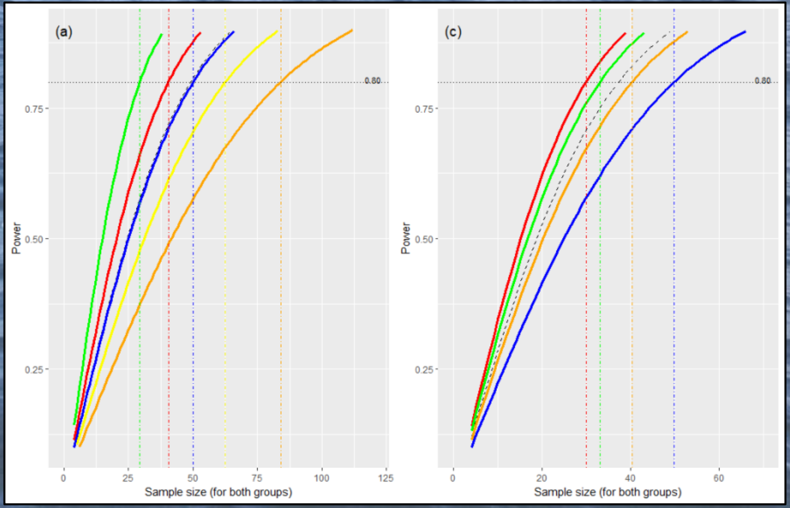
A case study for time and statistical power

<u>Dr Anthony Bicknell</u>
Dr Emma Sheehan
Prof. Brendan Godley
Dr Philip Doherty
Dr Matthew Witt

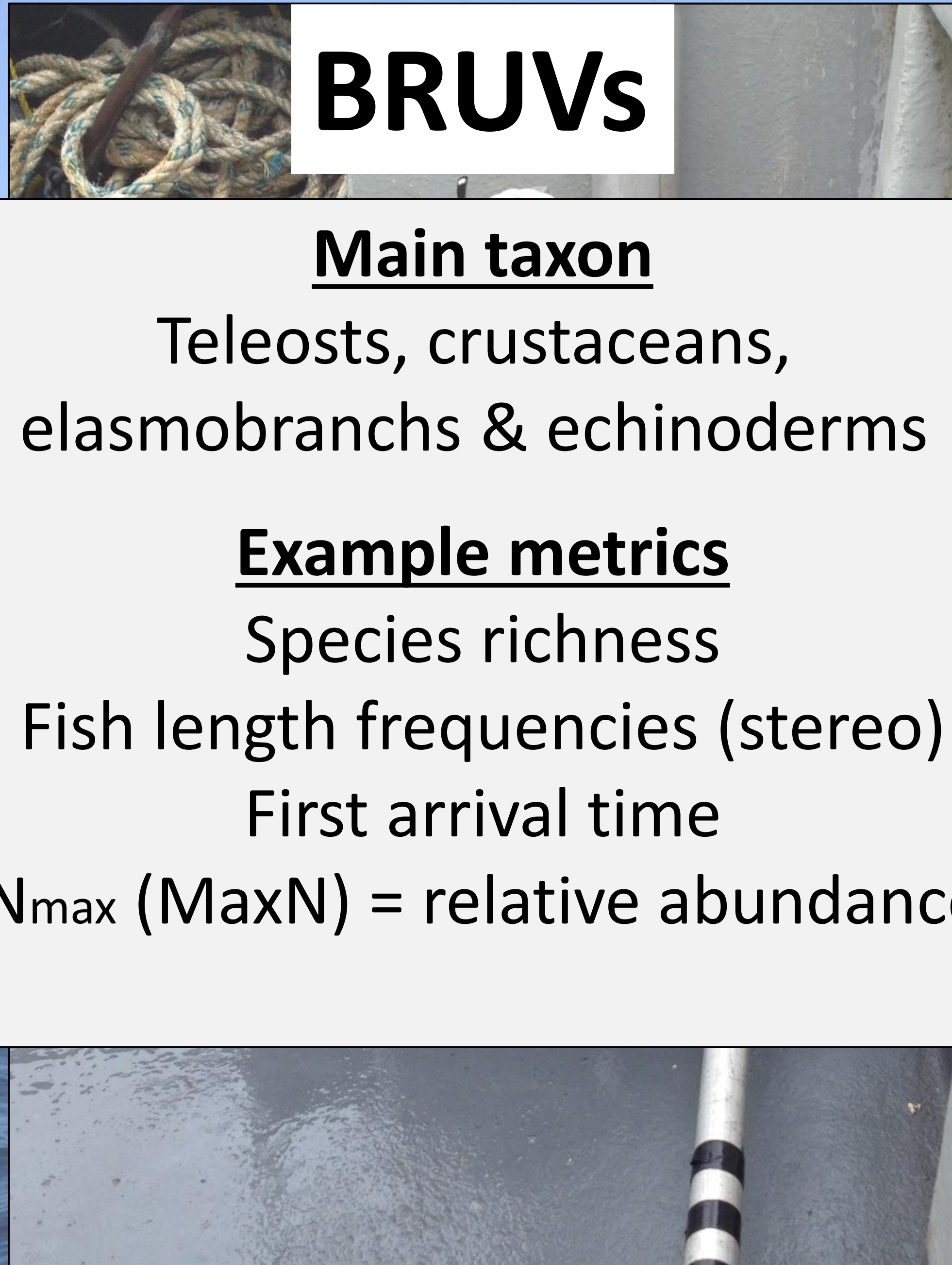
UNIVERSITY OF EXETER

WITH PLYMOUTH UNIVERSITY





BRUVs



Main taxon

Teleosts, crustaceans, elasmobranchs & echinoderms

Example metrics

Species richness

Fish length frequencies (stereo)

First arrival time

N_{max} (MaxN) = relative abundance

Image courtesy of pi

t al PLoS ONE, 2016

BRUVs survey requirements and challenges

Data requirements:

- Baseline data characterising spatial and temporal variability
- Continued monitoring (data collection) over relevant scales

Data challenges:

- Detect the potential effect from the natural ‘background noise’
- Recognize whether any detected change is biologically, ecologically or functionally meaningful

Overarching challenges:

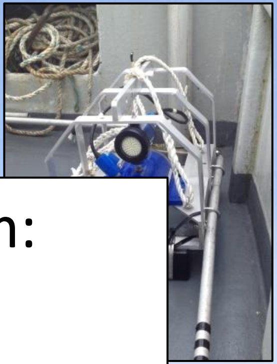
- Funding (salaries, equipment, boat hire etc.)
- Dynamic weather and sea state

BRUVs survey at Wave Hub site

Ideal scenario to design monitoring program:

- Familiar with study site
- Prior knowledge of spatial & temporal variability (system/receptor)
- Conduct power analysis to determine sample size to detect meaningful change
- No infrastructure, to allow baseline pre-installation data to be collected

<u>BRUVs survey at Wave Hub site</u>



<u>Actual</u> Wave Hub scenario to design monitoring program:

- Unfamiliar with site
- No prior data on spatial or temporal variability
- Cable and connection hub already installed (2010)

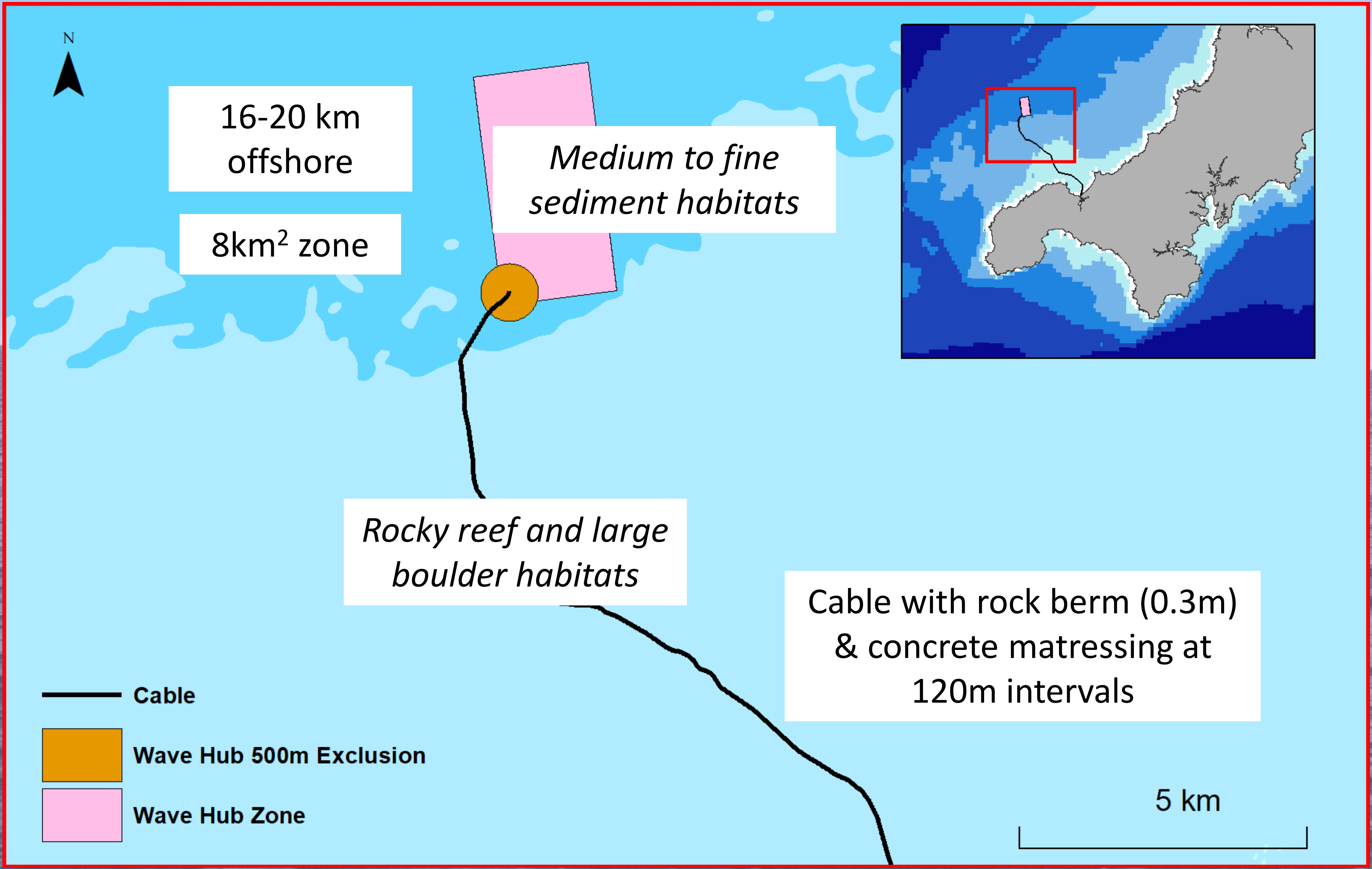
Resulting survey design was a compromise between:

a) Experimental and statistical theory; e.g.

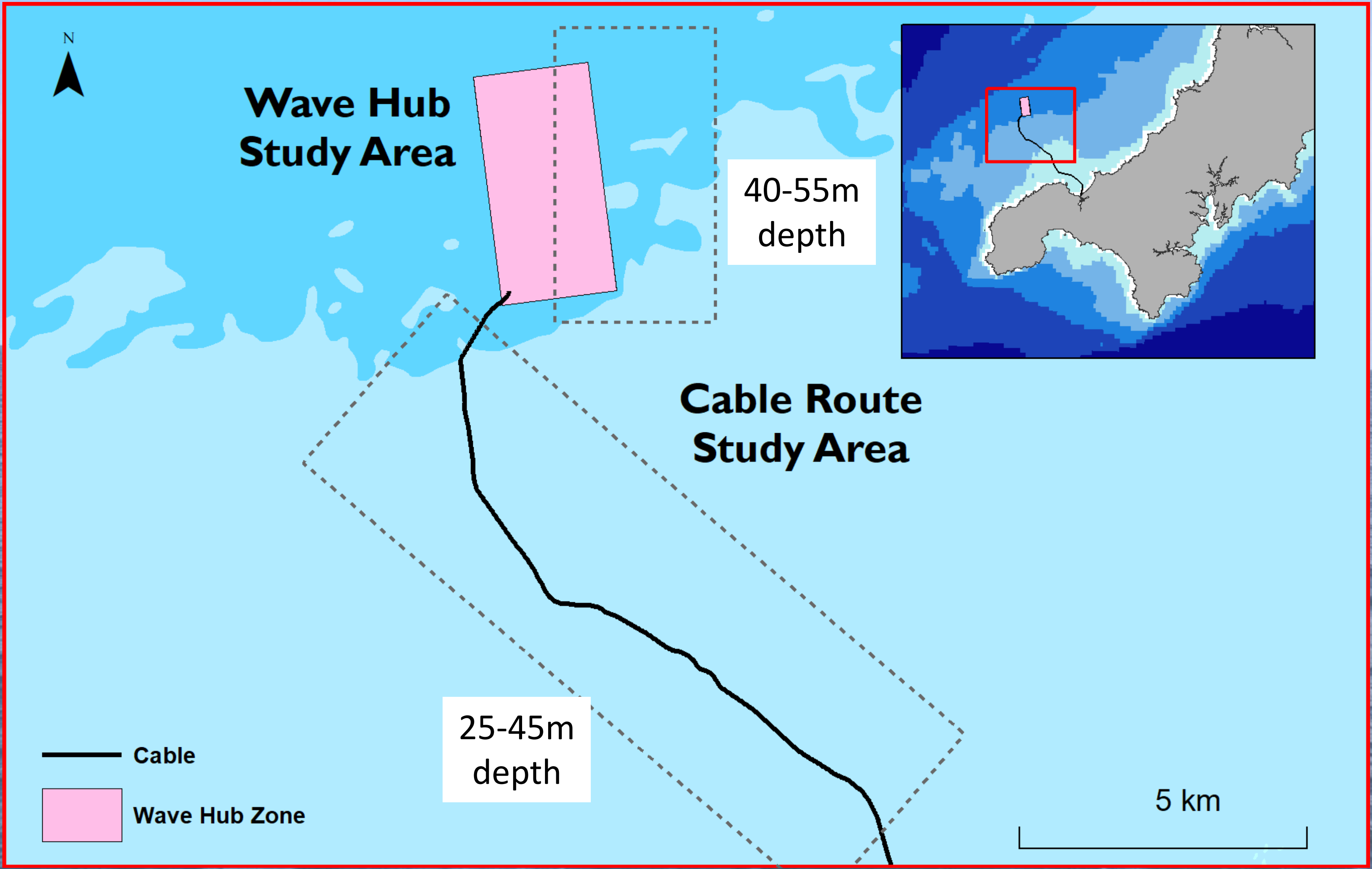
1.	⇧Sampling(precision)	=	⇧Power
2.	⇧Effect size	=	⇧Power
	(⇧Variance	=	⇩Power)

b) Available resources; money, people, time etc.

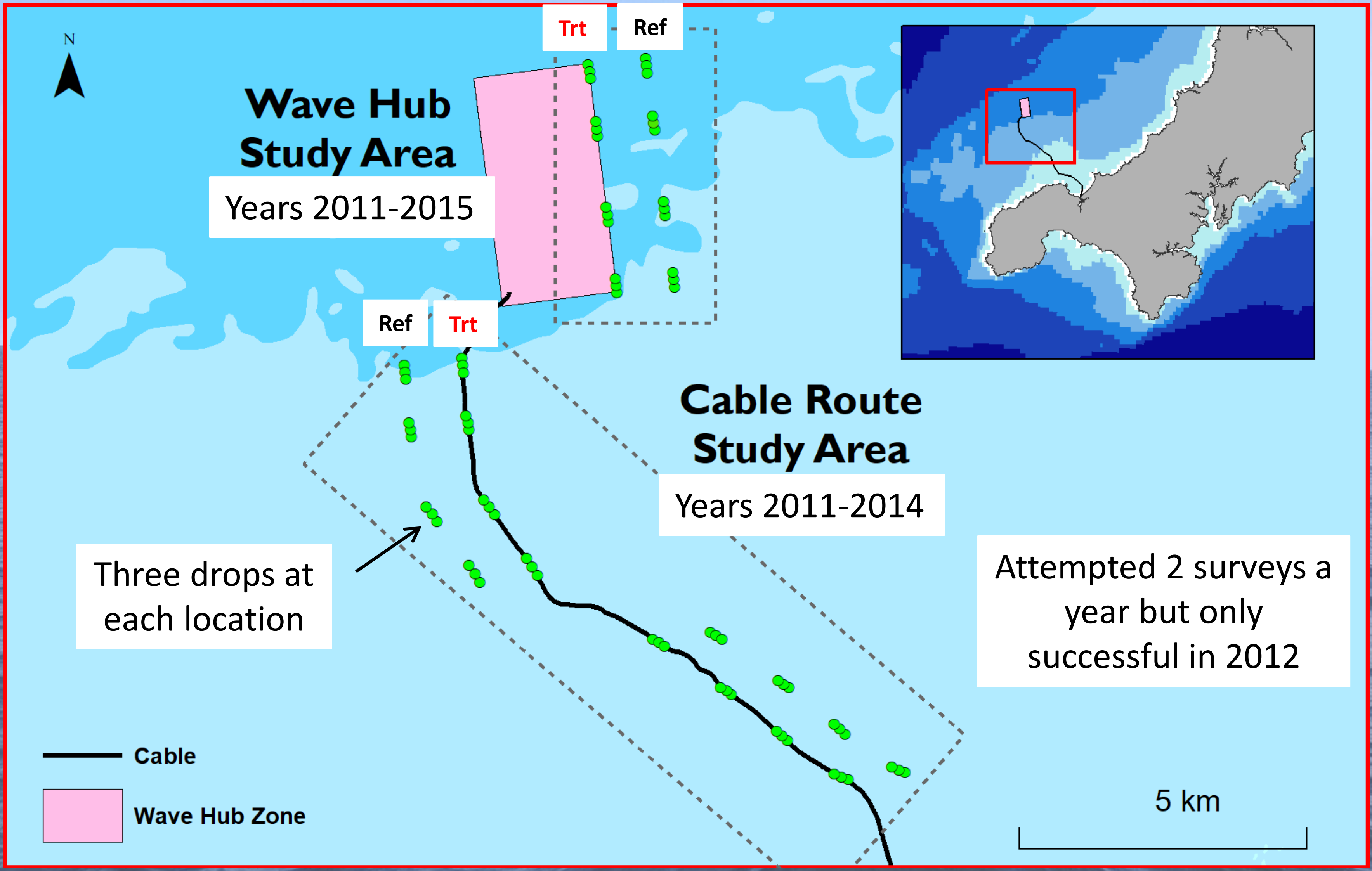
BRUV system survey - location



BRUV system survey - design



BRUV system survey - design



Unfortunately the Wave Hub test site stayed as pictured here:

- No permanent devices were deployed during our survey period 2011-2014/15

Opportunity to <u>reflect</u> on the BRUV method and survey design

Opportunity to reflect on the BRUV method and survey design

BRUV method:

- 297 deployments over 5 years
- 67% (198) provided 30 minutes footage of acceptable quality
    - Bad visibility and technical failures
    - Improved with experience
- Weather was the determining factor in sample size
    - Access to site

- Video footage analysis is time consuming
- Provides stored record for further/future analyses

Opportunity to reflect on the BRUV method and survey design

Survey design:

- Given the variation observed, what sample sizes are required to detect change with reasonable power?
- How did the survey design perform in these respects?

- **Performed power analyses** using overall species richness (*S*) & relatively abundance for fish (N_{max})
  - Two-sample t-test power analyses with 0.05 confidence level

(Only presenting Wave Hub study site data)

Power analysis results:

Wave Hub site (combined years) POWER = 0.8 α = 0.05

Species richness:

- 20% change (± ~1 species) = 100 samples (50 per group)
- 40% change (± ~2 species) = 30 samples (15 per group)

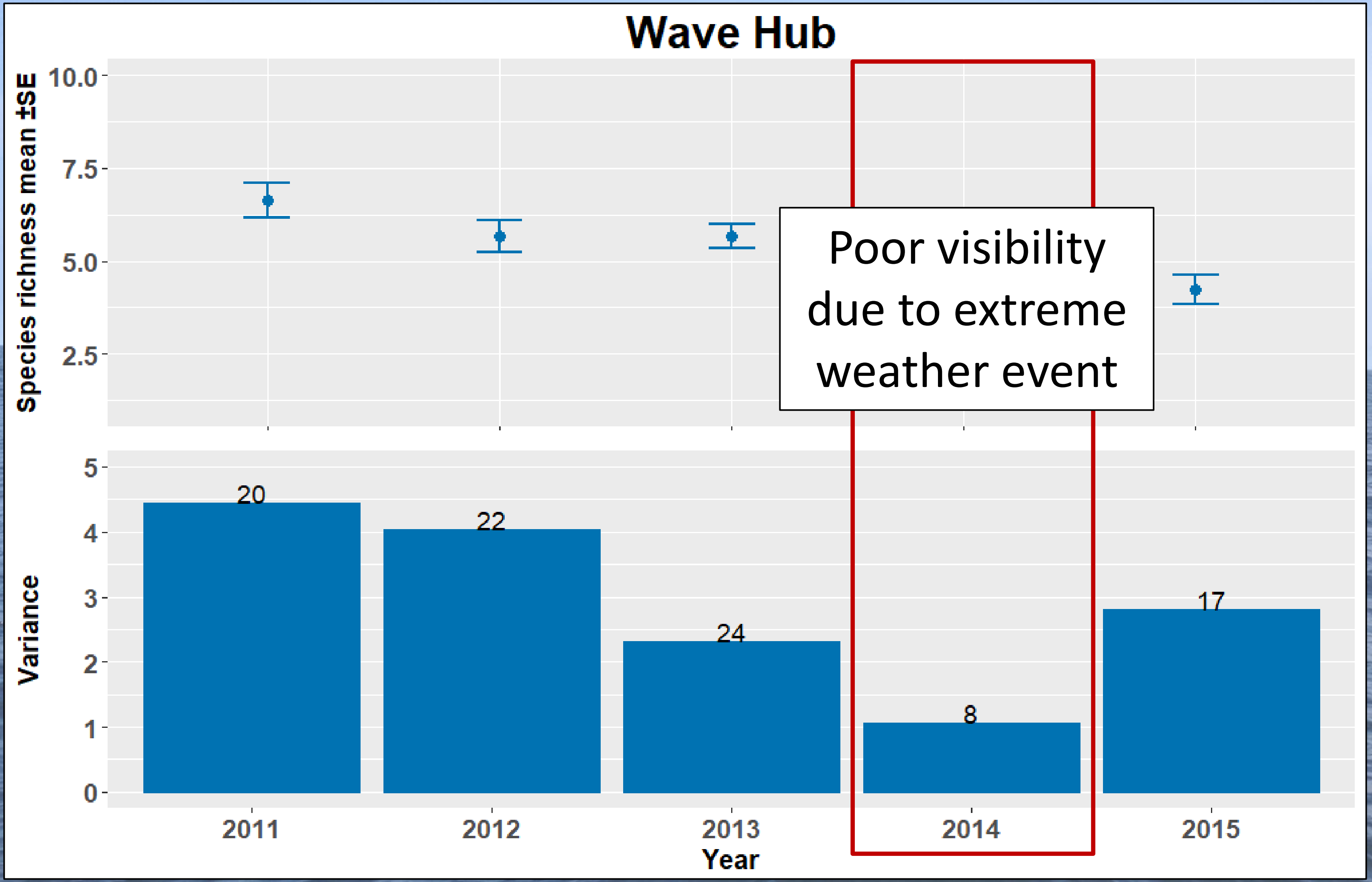
Fish relative abundance:

Performance varies with metric
……….but what level of change is meaningful?

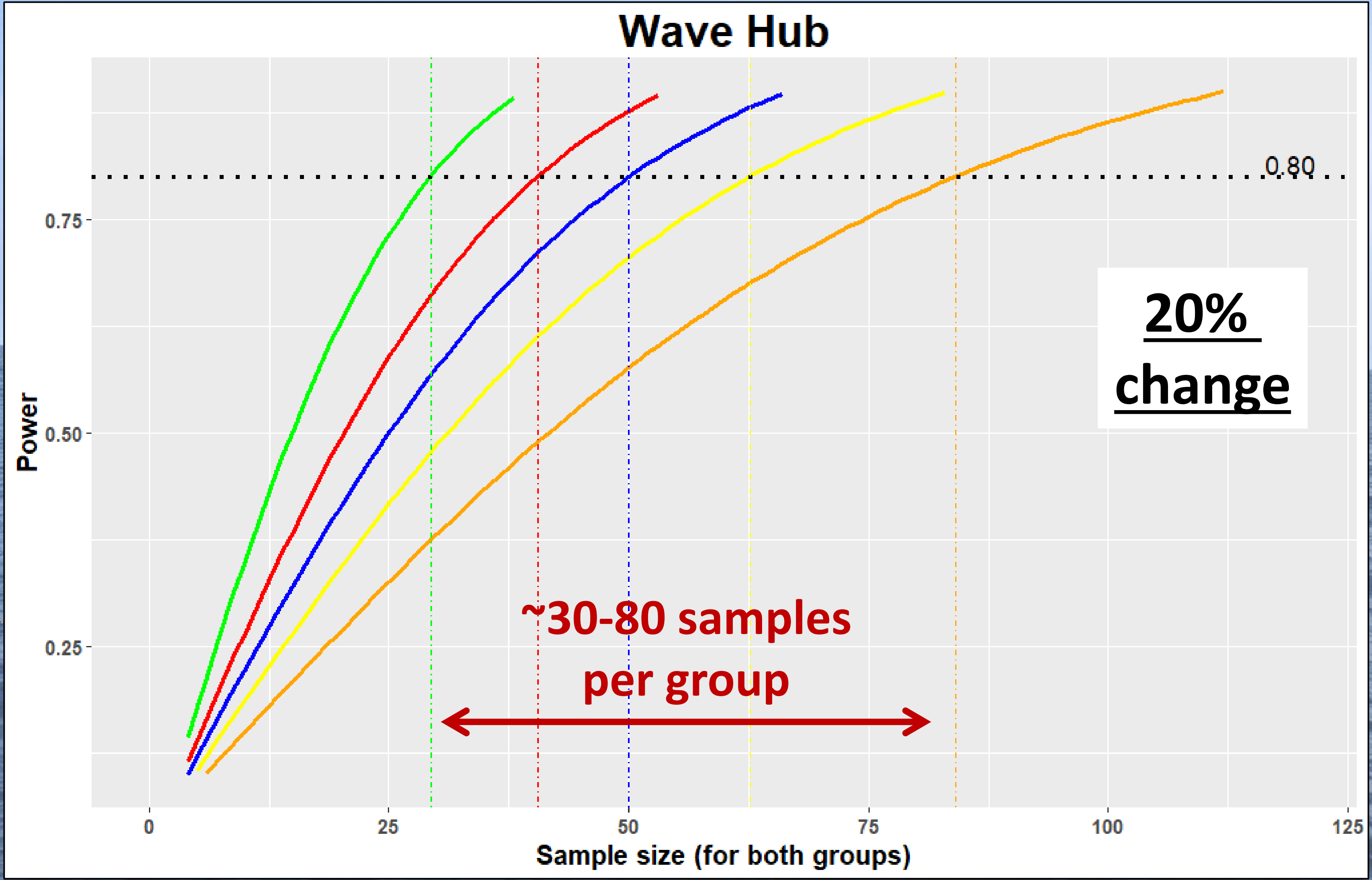
BRUV survey performance:

- 91 samples (42 treatment, 49 reference)
  - Potential to detect ~22%> change in richness
  - Potential to detect ~38%> change in abundance

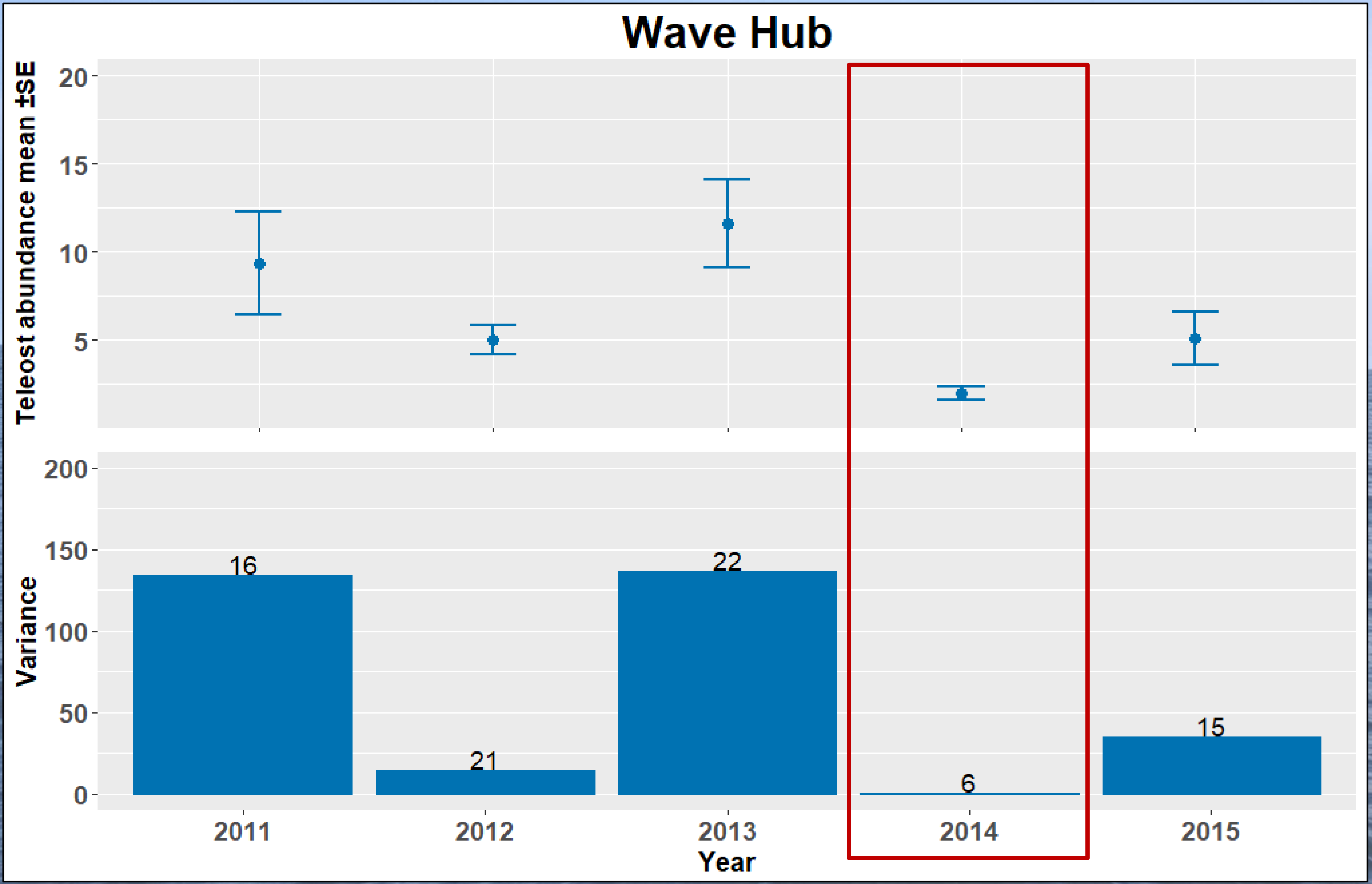
Species richness by year



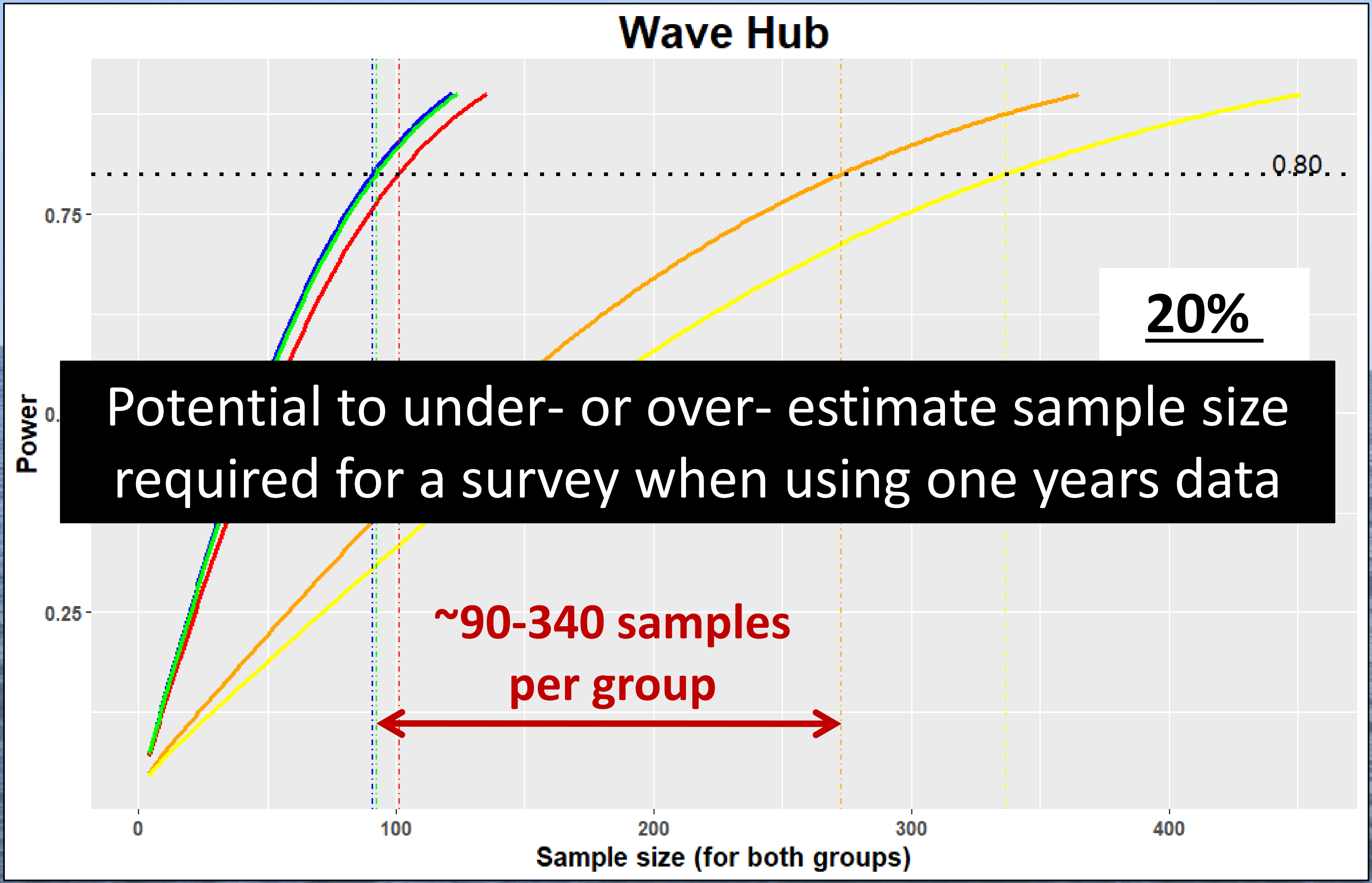
Species richness by year (power)



Fish abundance by year



Fish abundance by year (power)



Potential to under- or over- estimate sample size required for a survey when using one years data

Summary

- BRUV demonstrated its value to gather epi-benthic species data in a highly dynamic marine environment
  - Suitable tool for pre- or post- monitoring of MRED installations

- On reflection of the BRUV survey design at the Wave Hub test site:
  - The ability to detect change varied with the metric used
  - High annual variation suggest caution should be taken when using single year data to inform sampling effort

Funding acknowledgements

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Thank you. Any questions?

BRUV footage from Billia Croo site

(courtesy of CEFOW project survey)

Common/flapper skate ***Dipturus batis***

Power analysis results:

Cable Route site (combined years) POWER = 0.8 α = 0.05

Species richness:

- 20% change (± ~1.5 species) = 76 samples (38 per group)
- 40% change (± ~3 species) = 20 samples (10 per group)

Fish relative abundance:

- 20% change (± ~2 indivs) = 150 samples (75 per group)
- 40% change (± ~4 indivs) = 40 samples (20 per group)

BRUV Survey performance:

- 107 samples (55 treatment, 52 reference)
  - Potential to detect ~17%> change in richness
  - Potential to detect ~25%> change in abundance