Ecological interactions with a marine renewable energy installation in a temperate ecosystem

Authors: Emma V. Sheehan, Amy Cartwright, Luke Holmes, Anthony W. J. Bicknell, Martin J. Attrill, Brendan J. Godley, Jan Sundberg, Matthew J. Witt

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Overarching research interests

- Better describe natural environmental variation to aid interpretation of observed responses/effects
- Optimise win:win scenarios (low-carbon energy, conserve & promote biodiversity)
- Understand potential for overspill around development sites
- Deliver techniques to provide cost-effective, rapid and repeatable data collection
- **Specific interest(s):**
  - Benthic assemblage and seabed integrity (PU)
  - Mobile species distribution and response (PU/UE)
  - Seabird distribution and response (UE)
  - Fish response and behaviour (UU)

What has a decade of study taught us?

- To improve explanatory power for questions regarding upscaling we need studies that:
  - multi-site
  - multi-device type
  - multi-scale (spatial)
  - multi-year
  - multi-method
  - Integrated ecosystem approach
- **These requirements are based on good statistical sampling practice, ecological understanding and are supported by data collected to date**
- Ultimately, challenging to predict outcomes of sectorial upscaling; de-risking industry is hard



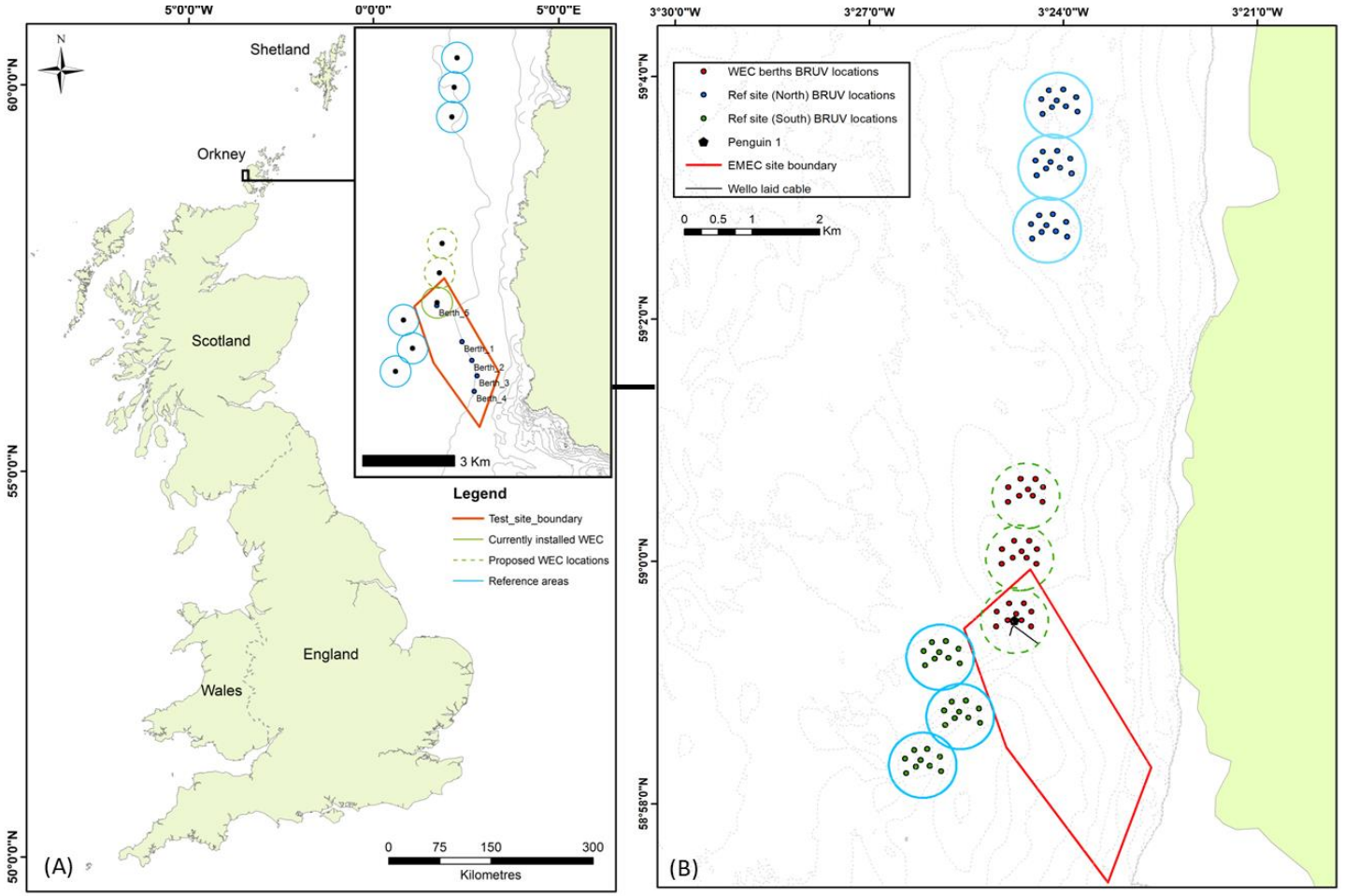

Clean **E**nergy **F**rom **O**cean **W**aves

(CEFOW) @ EMEC; using Wello's Penguin WEC

H2020 funded project - started Wave Hub in 2015;
moved to EMEC in 2017. Project concludes in 2020.

CEFOW is about Wello Penguins – but also addresses our need for multi-site studies prior to upscaling; data exist from Wave Hub, FAB, Lysekil and now CEFOW@EMEC

Penguin@EMEC deployments

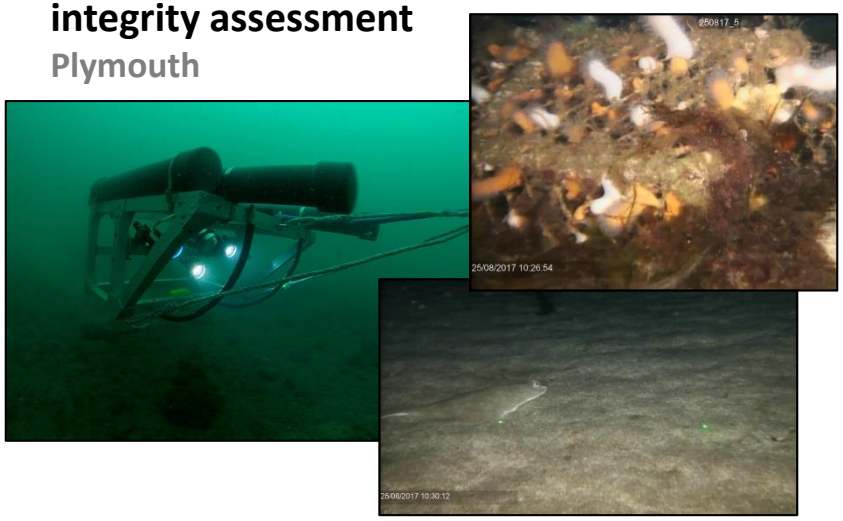


3 Penguin wave energy converters; one to be deployed in each of 2017, 2018 and 2019. Penguin 1 deployed in Jan. 2017. **First CEFOW biodiversity surveys conducted Summer 2017.** Survey employs treatment sites, near and far reference sites, replication, redundancy. Future-proofed for site expansion by other devices.

Integrated ecosystem science themes for CEFOW @ EMEC

(1) Seabed biodiversity & integrity assessment

Plymouth

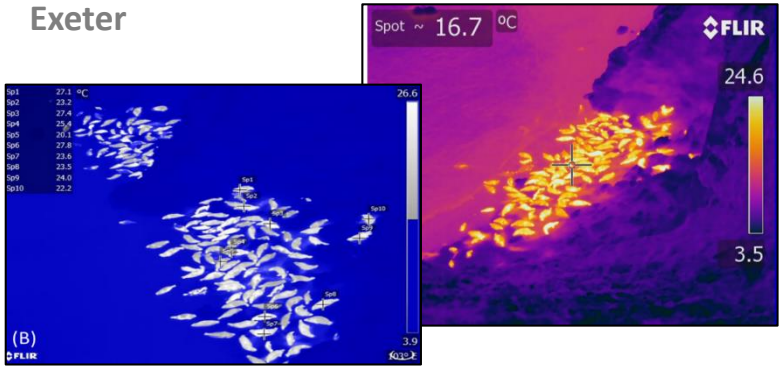


(2) Mobile species assessment

Exeter

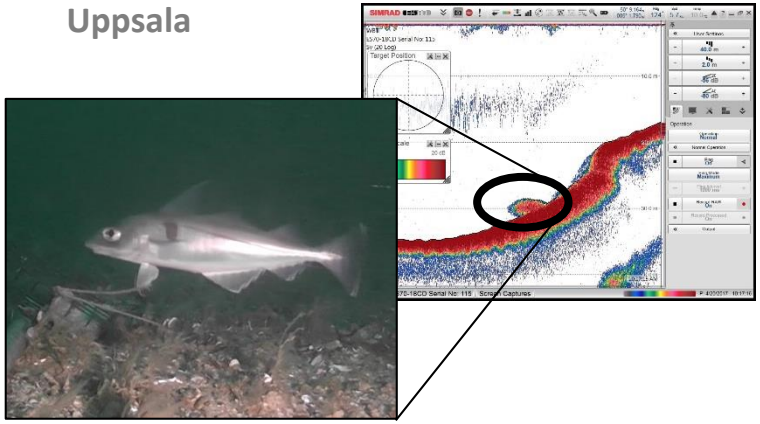
(3) Seabirds and seals

Exeter



(4) Fish behavioural dynamics

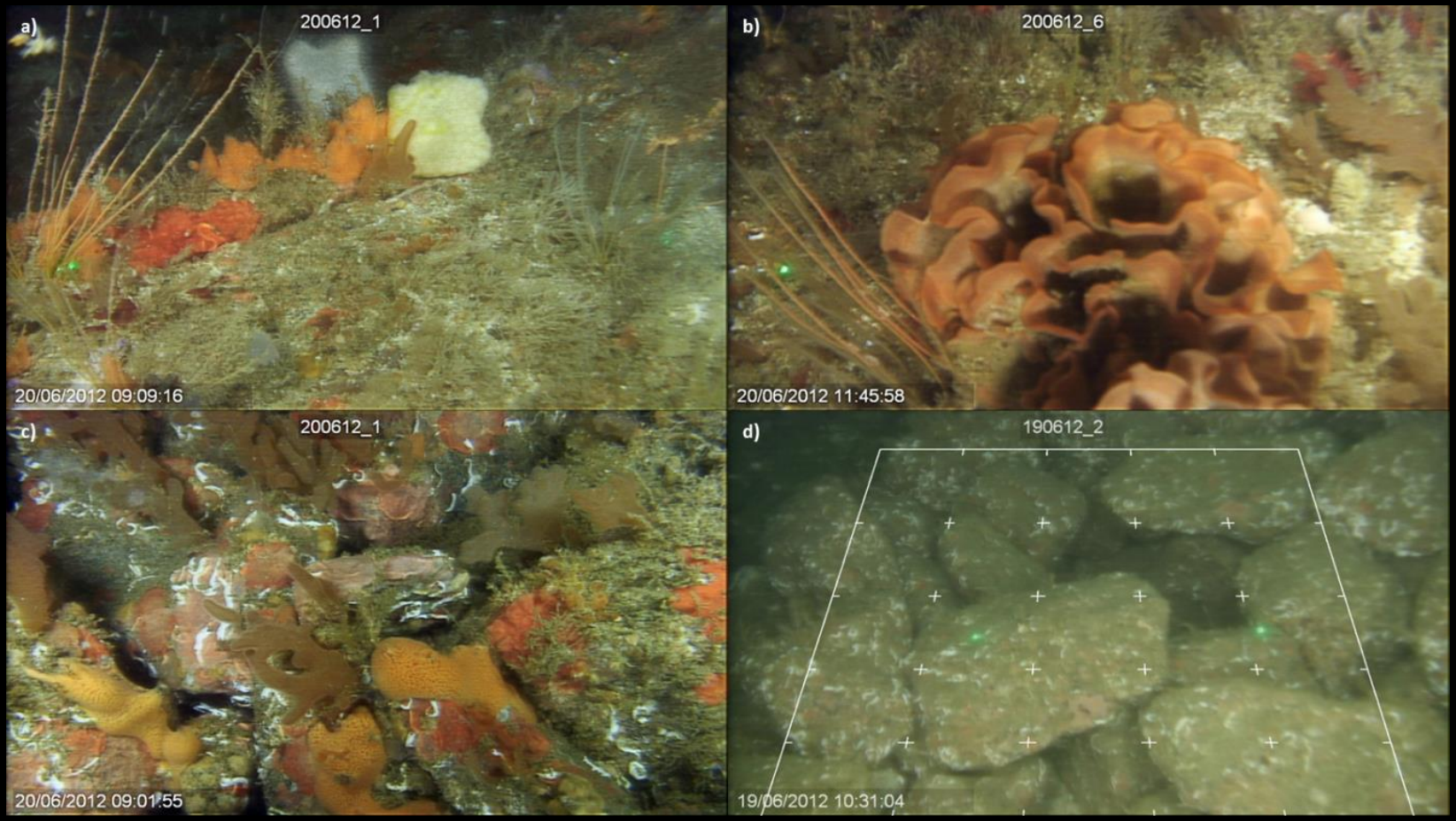
Uppsala



(1) Seabed biodiversity & integrity assessment

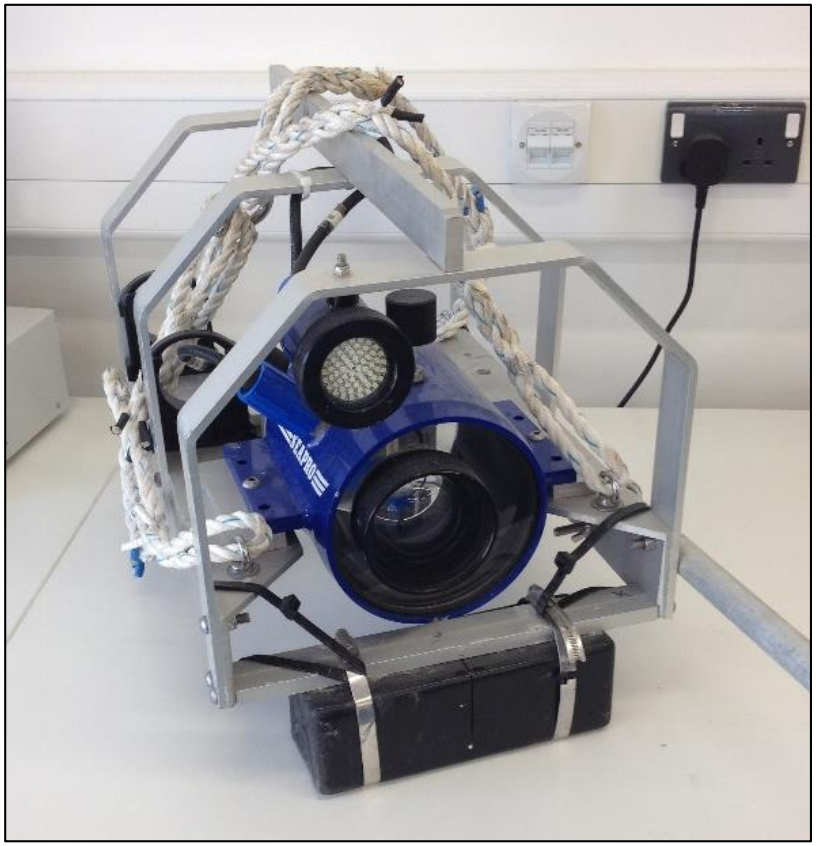
HD towed camera. Provides large area coverage; optimised for sessile benthic organisms; cost-effective; rapid data collection. **PLYMOUTH**

Robust methodology; quantitative outputs on organisms and habitats; technique transferable between sites with ease.
SAME method at multiple sites – greater explanatory power. **Plymouth**



(2) Mobile species assessment

Static baited video camera deployments. **EXETER**

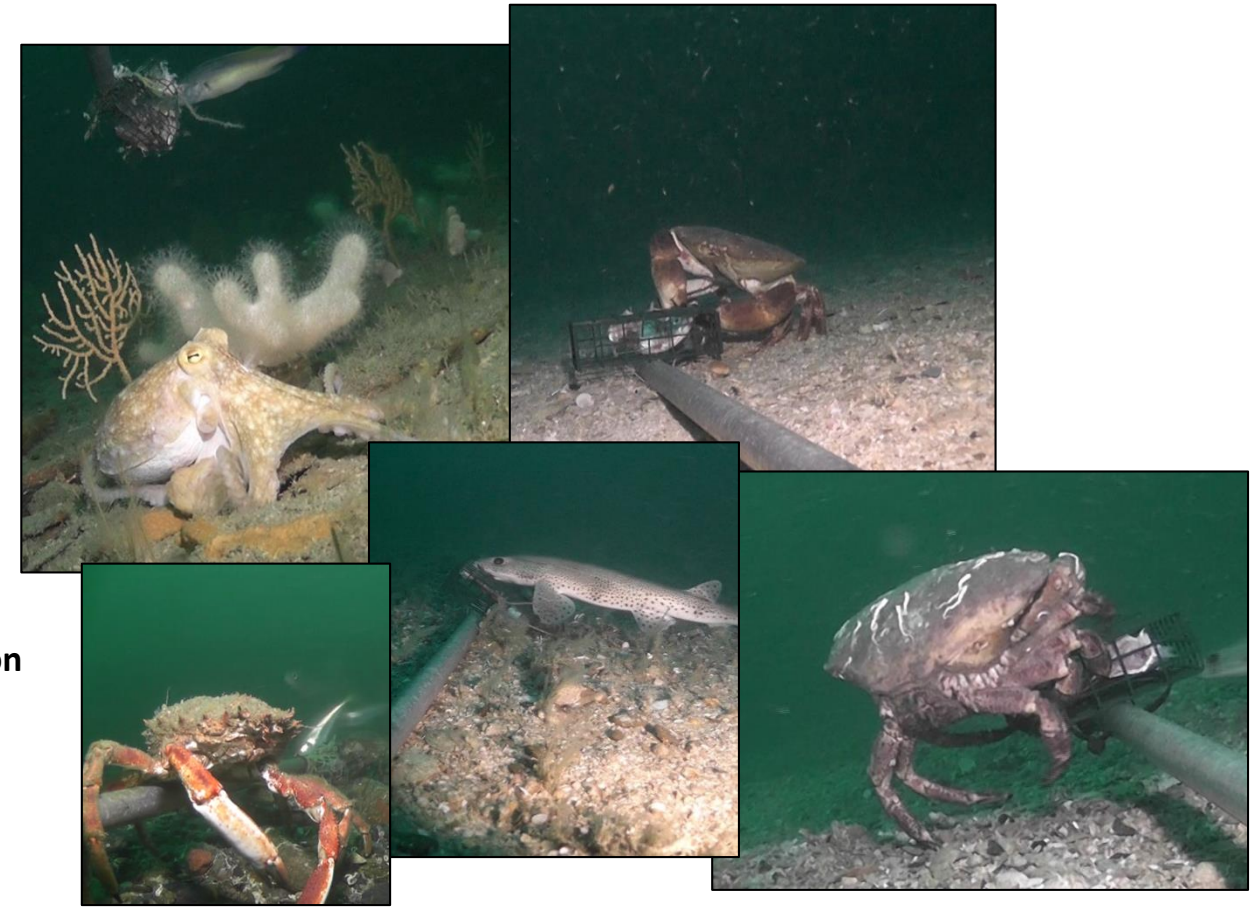


30-min. deployments; standardised bait and lights; HD-quality video, weighted to seabed; multiple deployments per day possible.

SAME method at multiple sites – GREATER EXPLANATORY POWER

Baited remote underwater video (BRUVs)

Cost effective sampling regime
Multiple deployments
High level of replication possible
Most states of tide

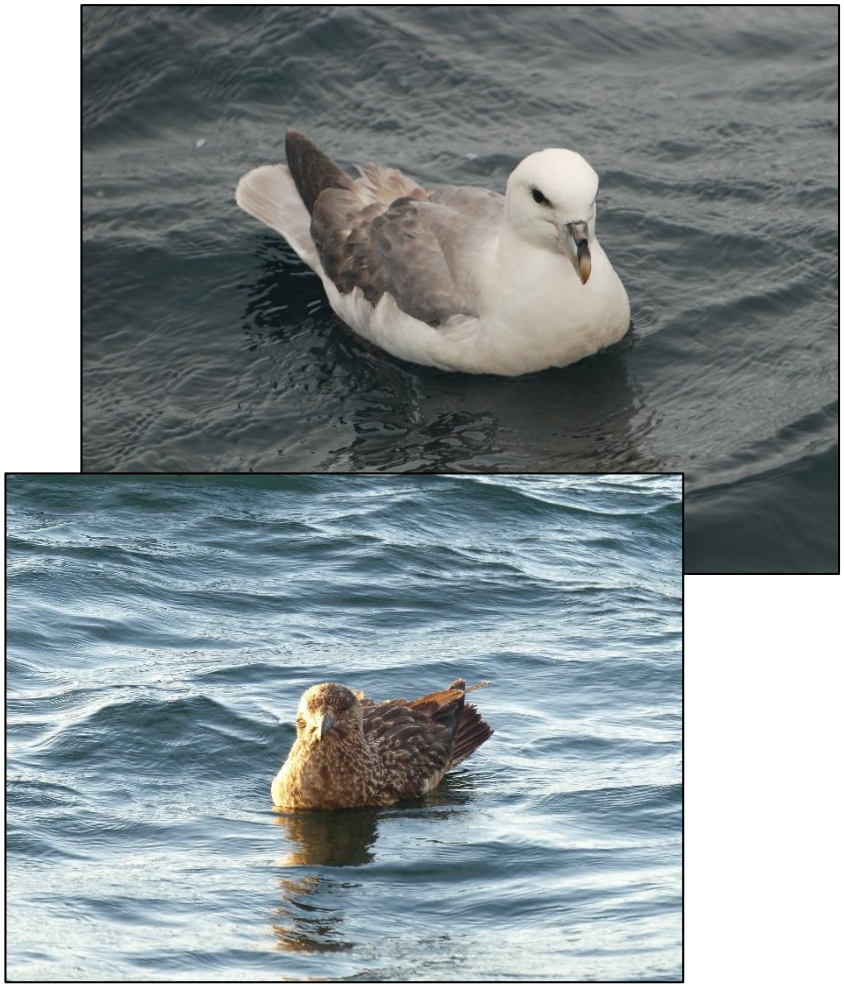


Assessing macro–mobile fauna
Used widely (MPAs mostly)
Mono or stereo versions
Investigating changes in:

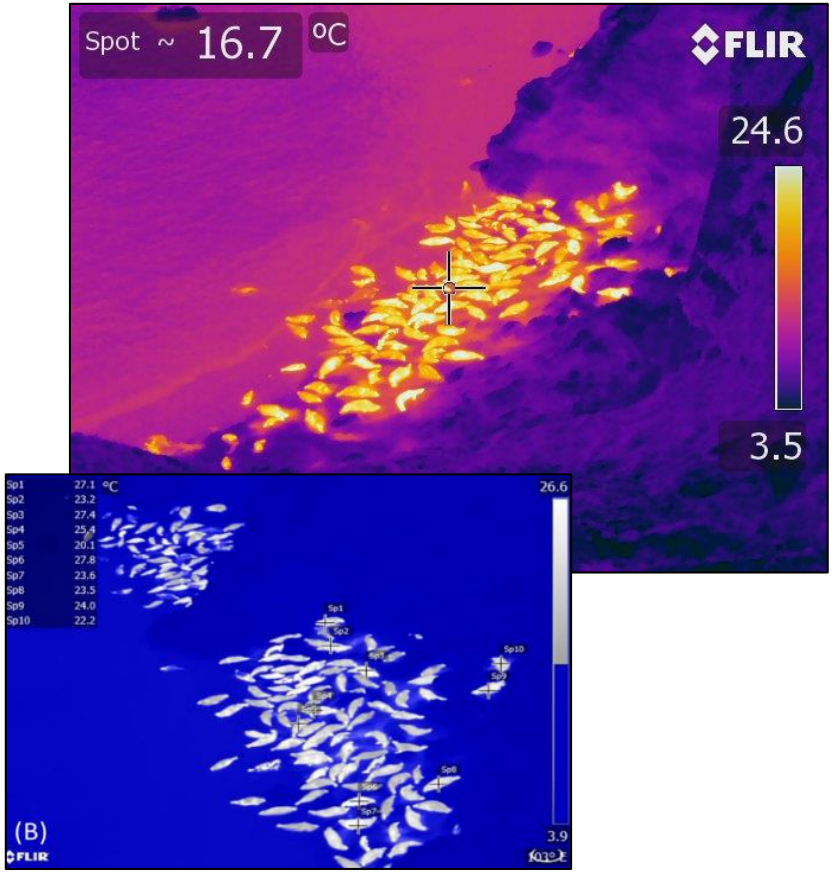
- **Community composition**
- **Species abundance**
- **Species richness**
- **Behaviour**
- **Body size**

(3) WEC-mounted infra-red and optical cameras

Provides coverage through time; automated object detection possible based on thermal signature & thresholding; infra-red for night-time work; optical video for context. **EXETER**



Detection of seabirds and seals resting on device or in its vicinity

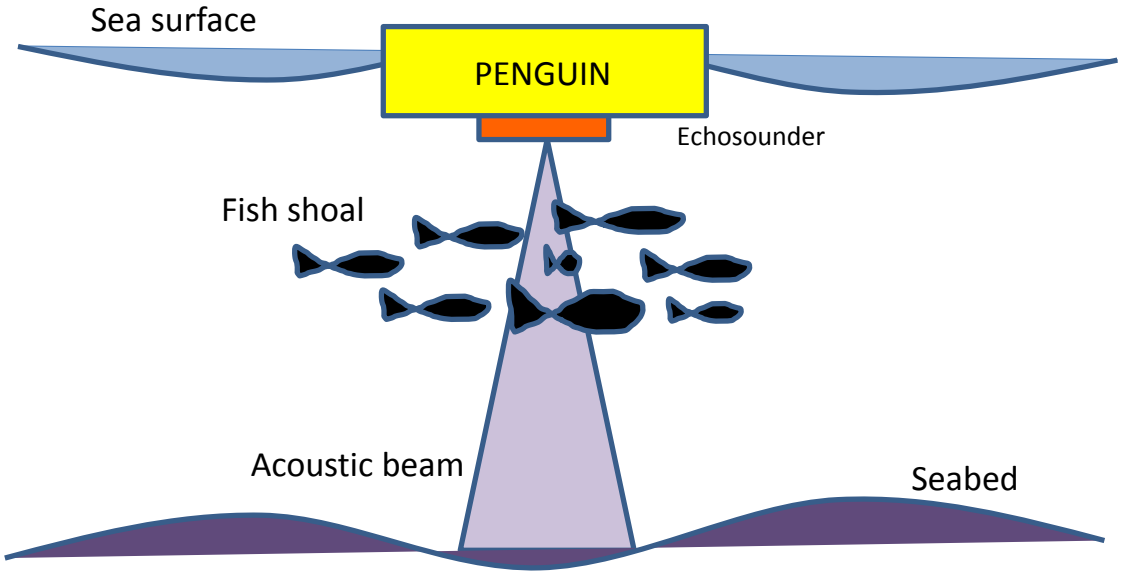


Automated object detection and enumeration (here for grey seals)

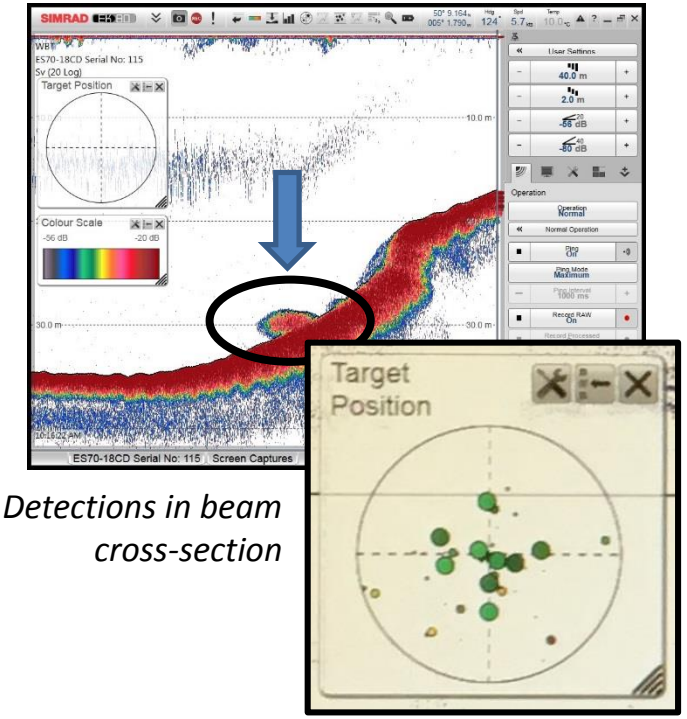

Thermal IR camera survived
1-year; optical network camera
suffered water ingress.
Challenging to repatriate data
to land. Work in progress…

(4) Fish behavioural dynamics at Penguins

(*from WEC2 onwards*). **UPPSALA**



Echogram showing fish on seabed



Detections in beam cross-section

Quantitative biomass summation or object counting; duty-cycled or 24/7 operation. Device or seabed mounted. Motion-corrected. Behavioural dynamics.

Our thoughts on good study design…

- Design using pilot data & power analysis – optimise your chances of detecting device-relate responses, not environmental noise
- Compromise needed when designing study: cost, power to detect, time, technology limitations etc.
- Gather knowledge on spatial and temporal abundance from the wider area to provide context
- Know your species. From desk-study, what are likely natural levels of variation? Could the survey detect subtle changes?
- Conduct sampling effort across relevant spatial and temporal area extents, deciding upon these can however be challenging
- Incorporate sampling redundancy in case data stations are lost due to unforeseen issues in site development, equipment failure, poor weather
- Your sampling strategy will be based upon a decision you make on what minimum level of change you can detect for a given sampling effort
- **But, what level of change is ecologically relevant….?**
- Expect useful sampling programmes to take several YEARS before you can draw meaningful conclusions

Concluding thoughts…

- CEFOW data can be integrated with findings from other sites due to consistent approach (**multi-site; multi-year; multi-device**) – greater explanatory power
- All sampling strategies are resource limited; <u>BUT be careful of being too resource limited</u>, sampling effort must be extensive to make data collection and results meaningful
- High levels of INTER-ANNUAL variation may mask or interact with device-level effects (+/-); **need for multi-year studies**
- However, what level of change is ecologically relevant….? Do we need to think about functional services rather than species *per se*?
- Role for ecological process modelling? Ecosim, Ecopath and Ecospace to help with prediction of upscaling effects (temporal x spatial x ecosystem services)

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