MERIKA

Marine Energy Research Innovation and Knowledge Accelerator

# Biofouling of marine renewable energy devices; the good, the bad and the ugly.

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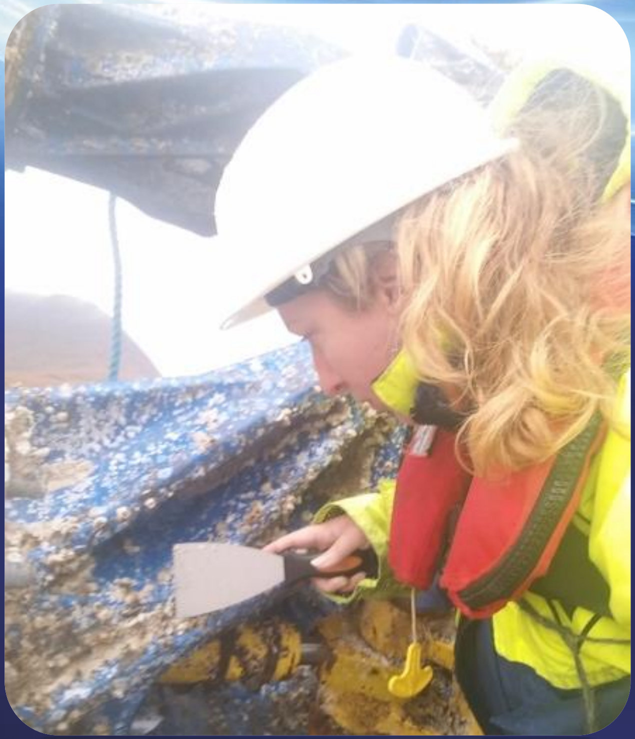
Talk contents

- Introduction to biofouling
- The good – artificial reef effects
- The bad – commercial and environmental implications
- The ugly – non-native invasive species
- Stakeholder consultation and highest priority issues
- First results from MRE deployments.
- Next steps



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# What is biofouling?

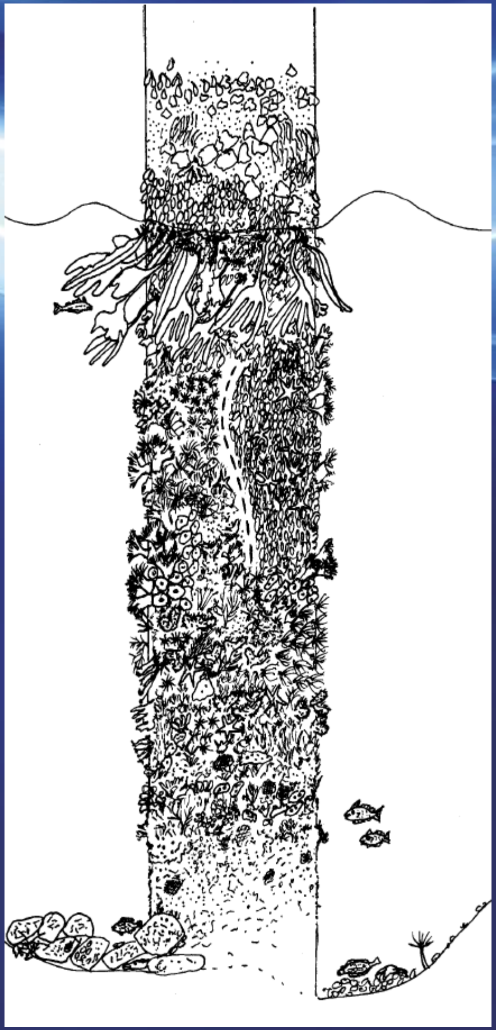
# Types of biofouling communities

**Intertidal** – barnacles, algae

**Kelp Zone** – kelps, barnacles, foliose algae

**Main column** – mussels, anemones, soft corals, hydroids, tubeworms, barnacles

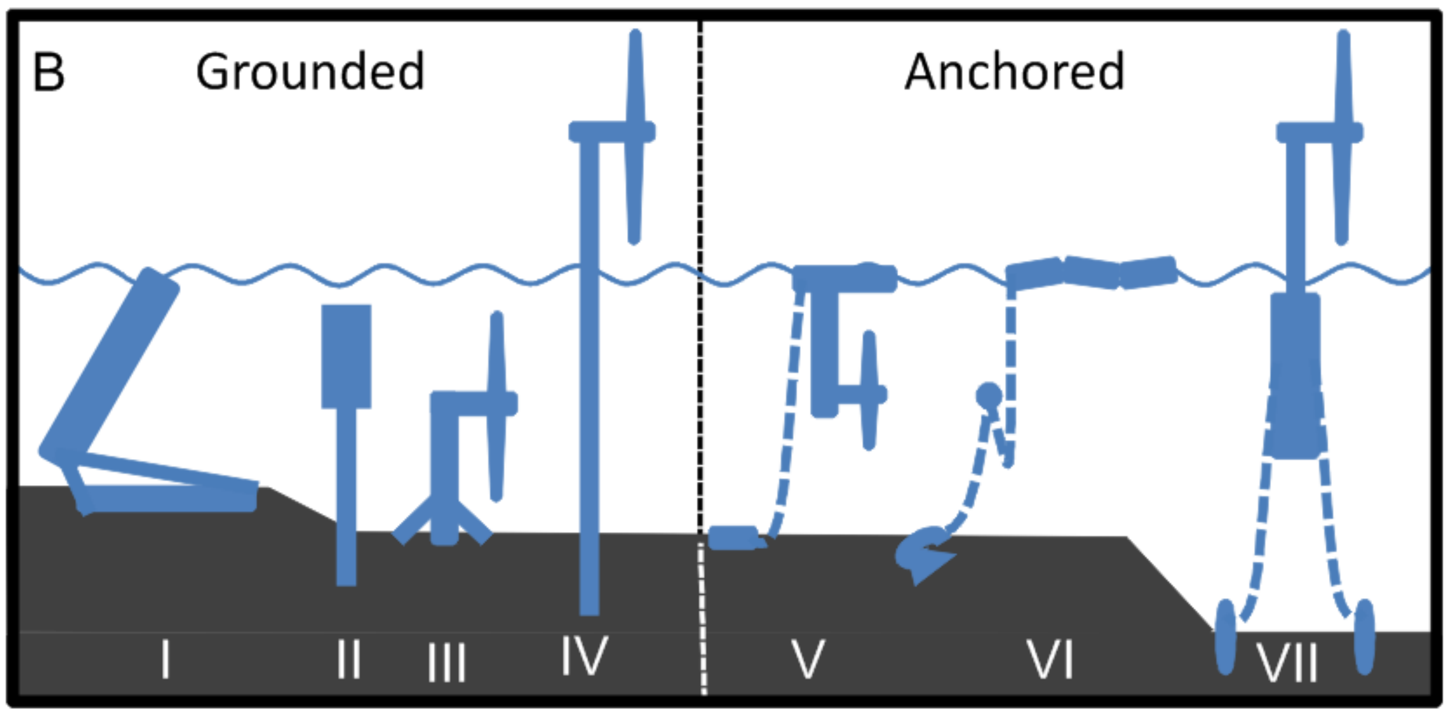
**Base** – varies depending on scour protection and seabed mobility



Hiscock, K., Tyler-Walters, H., Jones, H. (2002). AEA Technology, Environment Contract: W/35/00632/00/00.
Rees, J., Larcombe, P., Vivian, C., and Judd, A. (2006). Scroby Sands Offshore Wind Farm – Coastal Process Monitoring. Final Report. CEFAS

# Structural influences

- Free moving or static?
- Floating or fixed?
- Splash zone or intertidal zone?




Miller et al. (2013). Frontiers in Ecology and the Environment 11:8, 433-440


- Biofouling happens in all industries
- Particularly relevant in this one – devices are highly tuned to extract optimum energy

# The Good- artificial reef effects

Aim of many MRE companies – no anti-fouling coatings.

- High biodiversity
- Increases productivity
- Fish aggregation
- Ecosystem services E.g.
  - Filtration
  - Carbon deposition
  - Primary production


# The Bad- commercial & environmental implications

<u>Commercial</u>

- Weight
- Density
- Thickness
- Roughness
- Heat transfer coefficients

# The Bad- commercial & environmental implications

Commercial

- Decreased efficiency of energy extraction
- Decreased longevity of materials ( corrosion)
- Increased maintenance costs

# The Bad- commercial & environmental implications

Environmental

- Fish aggregation may increase risk of predator collision
- May change local benthic community structure
- Risk of non-native invasive species settlement and spread

# The Ugly- non-native invasive species (NNIS)

- Can be a licensing consideration
- Risk of "polluter pays" legislation
- Many NNIS are biofoulers
- Arrays may act as stepping stones into "uncontaminated"areas
- Multiple potential vectors:
  - Wet-towing devices
  - Servicing vessels
  - MRE harbours
  - Nearby industries e.g. Fish farms

# We asked the experts…

SAMS

DNV·GL

PML Plymouth Marine Laboratory

AkzoNobel

CATAPULT Offshore Renewable Energy

marinescotland

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WavEC Offshore Renewables

The University of Edinburgh

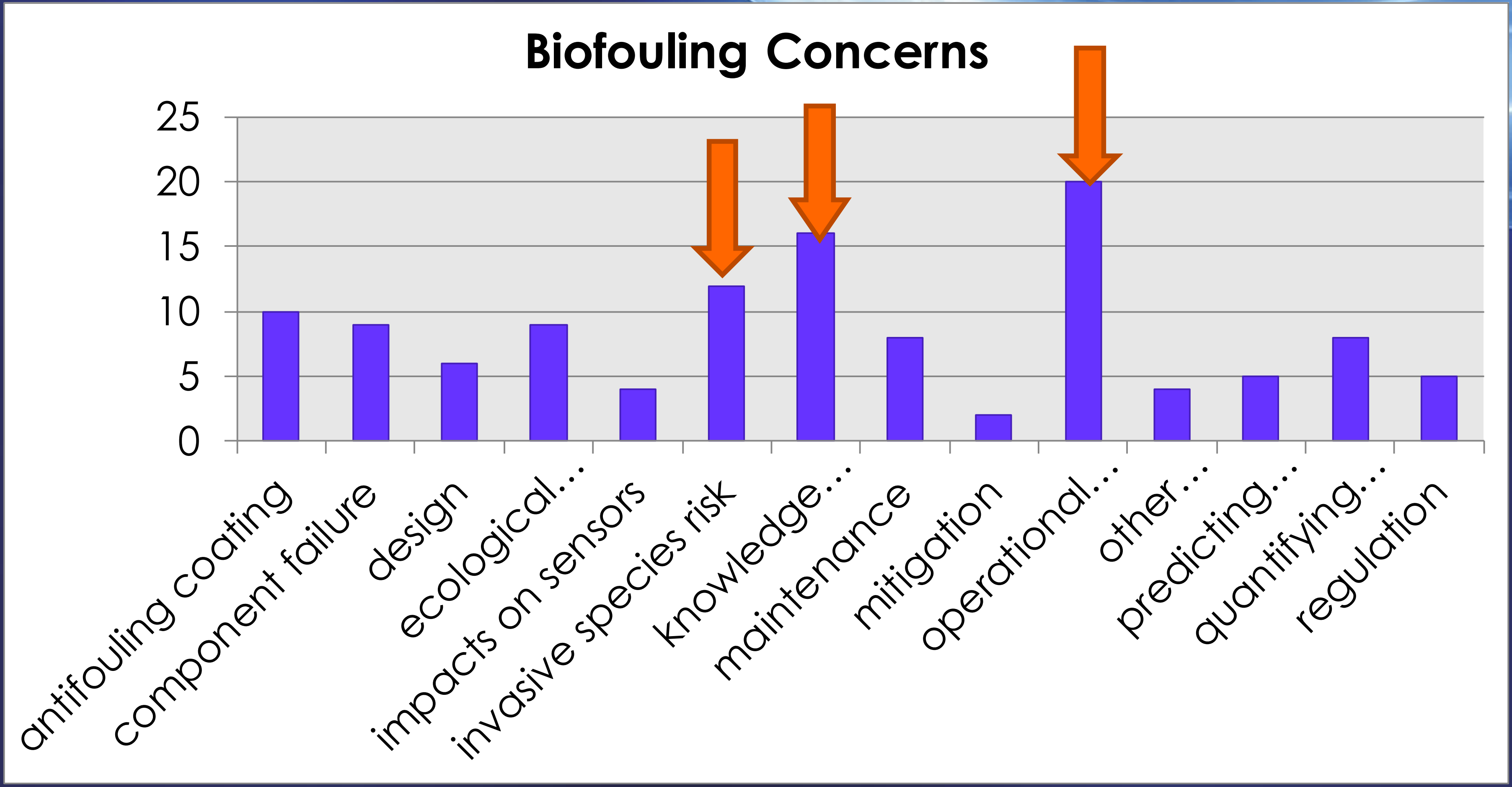
Prifysgol Bangor University

ALBATERN Wave Energy

INNOVATION™ Nova Innovation Ltd

Heriot Watt University

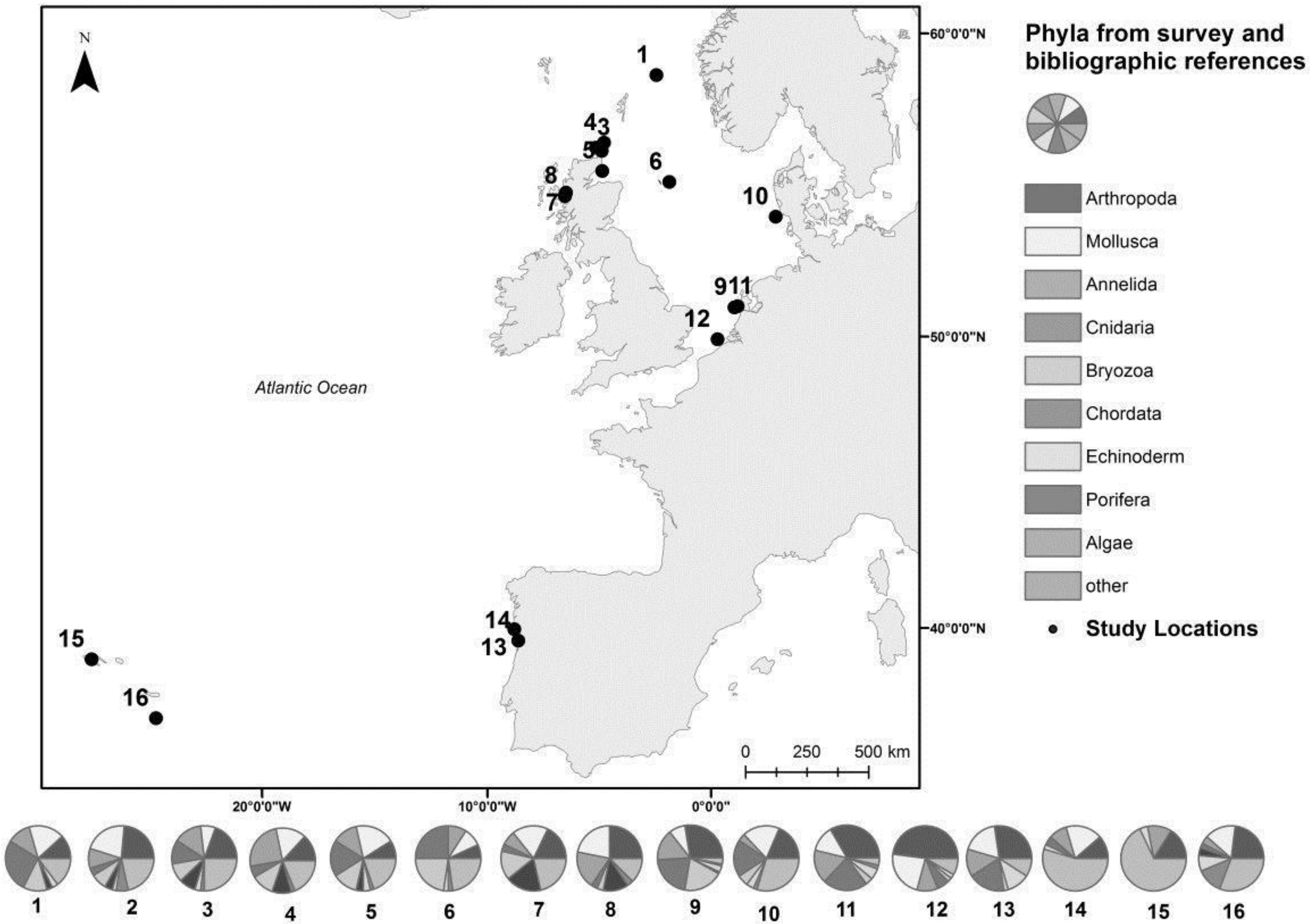
# Identifying issues & drivers



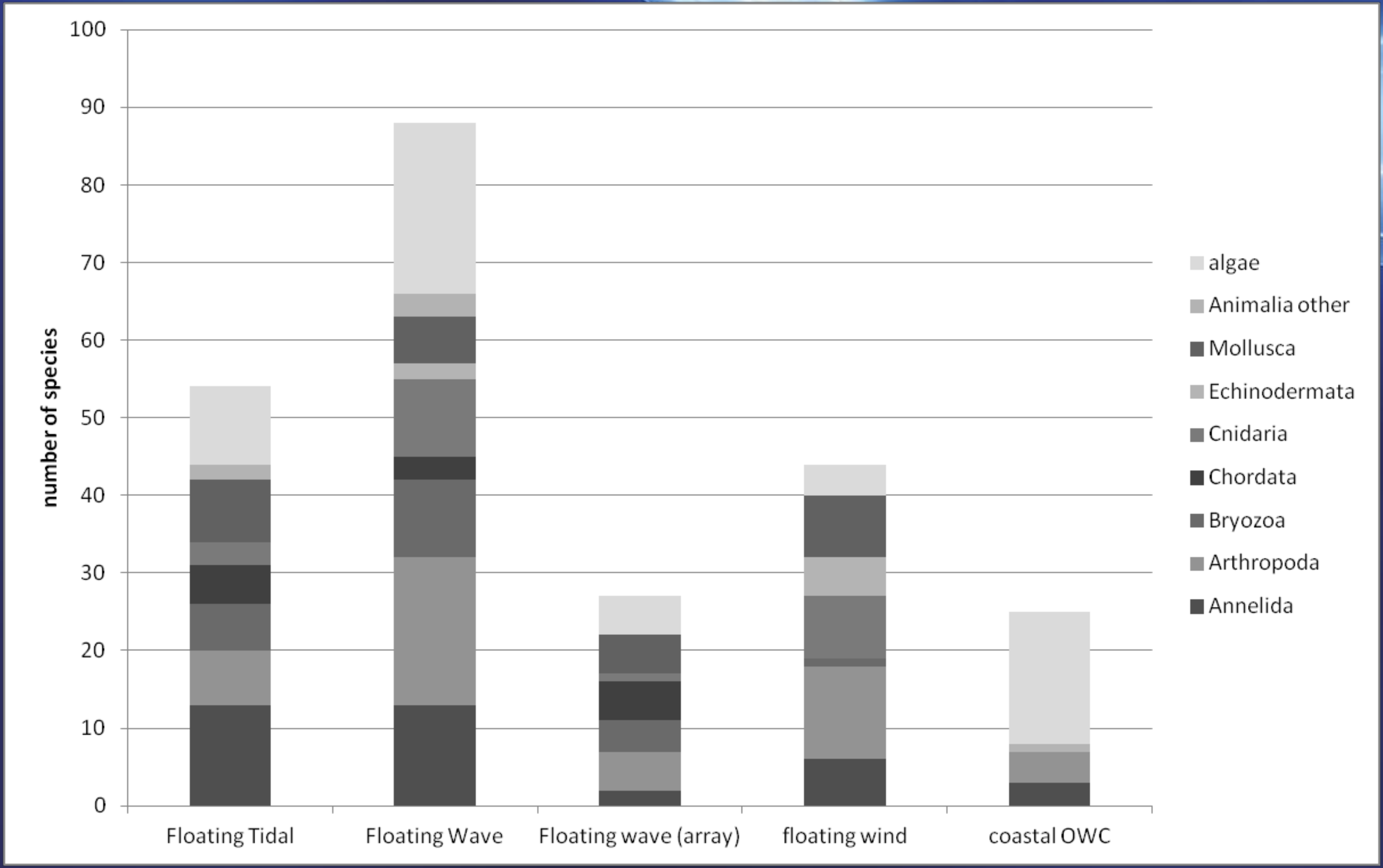
# First results from industry

Biofouling scrape samples were collected for 5 MRE devices and extracted from scientific literature for other marine structures.

| | Site | Location | Type | latitude | longitude | reference |
|---|---|---|---|---|---|---|
| 1 | Heather A | Shetland | Offshore fixed oil platform | 61.36304 | 1.579761 | Picken (1986) |
| 2 | Orkney buoys | Orkney | Nearshore floating buoy | 58.84953 | -3.01148 | A Macleod PhD (2013) |
| 3 | Floating Wave | Orkney | | | | |
| 4 | Floating Tidal | Orkney | | | | |
| 5 | Beatrice | N. Scotland | Offshore fixed oil platform | 58.11667 | -3.08333 | Picken (1986) |
| 6 | Montrose Alpha oil | N.E Scotland | Offshore fixed oil platform | 57.45065 | 1.388264 | Forteath et al. (1982) |
| 7 | Floating wave array | W Scotland | | | | |
| 8 | Skye buoys | W Scotland | Nearshore floating buoy | 57.27505 | -5.71501 | A Macleod PhD (2013) |
| 9 | Princess Amalia wind | Netherlands | offshore fixed wind | 52.59 | 4.22 | Vanagt et al. (2013) |
| 10 | Horns Rev windfarm | Denmark | offshore fixed wind | 55.50001 | 7.820015 | Leonhard & Pederson (2006) |
| 11 | OWEZ | Netherlands | offshore fixed wind | 52.606 | 4.419 | Bouma Lengkeek (2012) |
| 12 | Thornton Bank wind (2009) | Belgium | offshore fixed wind | 51.54548 | 2.92978 | Kerckhof et al (2010) |
| 13 | Floating wind | N. Portugal | | | | |
| 14 | Aguda sea wall | N. Portugal | Inshore fixed seawall | 41.04815 | -8.65674 | Santos J (2008) |
| 15 | coastal OWC | Azores | | | | |
| 16 | Azores | Azores | natural shoreline | 36.97 | -25.1 | Botehlo + (2009) |


Phyla from survey and bibliographic references
Arthropoda
Mollusca
Annelida
Cnidaria
Bryozoa
Chordata
Echinoderm
Porifera
Algae
other
Study Locations
Atlantic Ocean
N
60°0'0"N
50°0'0"N
40°0'0"N
20°0'0"W
10°0'0"W
0°0'0"
0 250 500 km
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

# High level biofouling data



# Summary of preliminary results

- Biofouling of up to 60kg/m2 recorded
- Broadly speaking, location matters. (e.g. Scotland vs Portugal)
- Biofouling in the top ~3m of floating structures is different to biofouling on fixed structures and at greater depths.
- Invasive species were found on all but 1 renewable energy device BUT they have not necessarily been introduced on the device and may already have been widespread in the area.

# Next steps:

- Ongoing experiments to get more refined biofouling data from MRE deployments
- Have a better steer on stakeholder needs
- Peer reviewed publications (Loxton et al. and Machado et al.) – watch this space!
- Biofouling prediction project
  - in development
  - Incorporating key issues and drivers

# WANTED

Any potential collaborators who have or could facilitate access to MRE test devices or test sites.

Contact: Jennifer.loxton@uhi.ac.uk
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# Thanks

Co-authors

Chris Nall
Ines Machado
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All developers and test site owners who helped us sample their sites.

Thank you for listening