MAPS
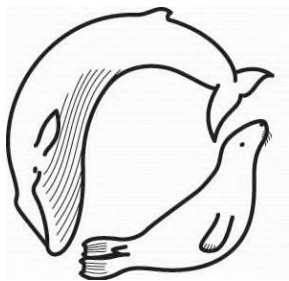
Man-made structures and Apex Predators: Spatial interactions and overlap

James Grecian, Elizabeth Masden, Debbie JF Russell

djf.russell@gmail.com

Objective

- Establish the magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scale
  - **With regard marine apex predators**


S.Russell

S.Russell

M. Arso

Why marine predators

- Indicator species
- Monitoring
  - Large scale
  - Fine scale
- Potential Effects
  - Vary with structure life-stage
  - Negative
    - Disturbance
    - Hearing damage
    - Habitat changes
    - Collision risk
  - Positive
   - Rest stops
    - De facto MPAs
    - Artificial Reefs

©poogaspics

M.Page

INTRODUCTION

Cetaceans

- ## Known
  - Harbour porpoise
    - Displaced during windfarm construction
      - Dähne *et al.* 2013
    - Foraging at structures
      - Todd *et al.* 2009; Scheidat *et al.* 2011

- ## Unknown
  - To what extent do structures drive or even overlap with distribution ?

- ## Data available
  - Small Cetacean Abundance in the North Sea and adjacent waters survey
    - Hammond *et al.* 2013
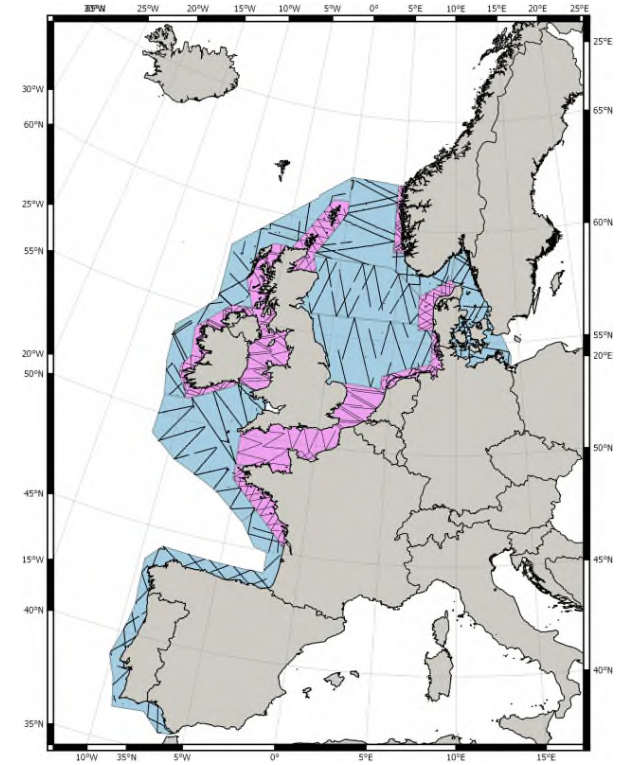
Seabirds

- Known
  - Windfarms
    - E.g. Cleasby *et al*. 2015
- Unknown
  - To what extent do structures drive or even overlap with distribution ?
  - Do seabirds use structures for foraging?
- Data available
  - European Seabirds At Sea (ESAS) survey data (1979-2011)
  - RSPB/CEH telemetry data (FAME & STAR projects)
    - black-legged kittiwakes (n= 267), razorbill (n=125), northern fulmar (n=32) and common guillemot (n=64), European shag (n=73)

Wakefield *et al*. 2017
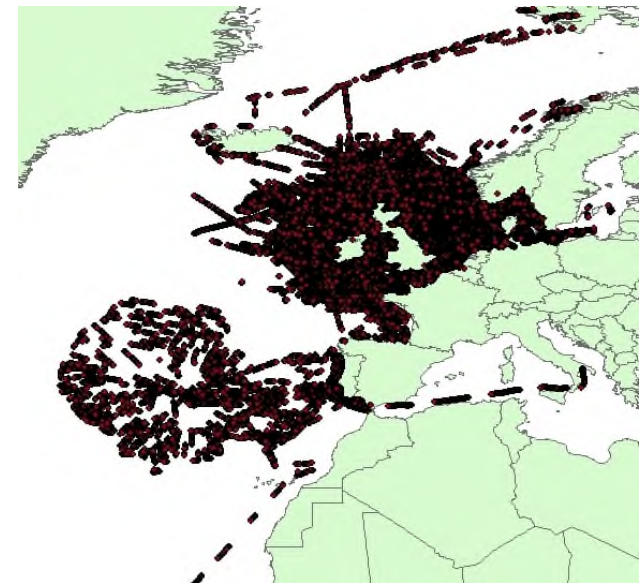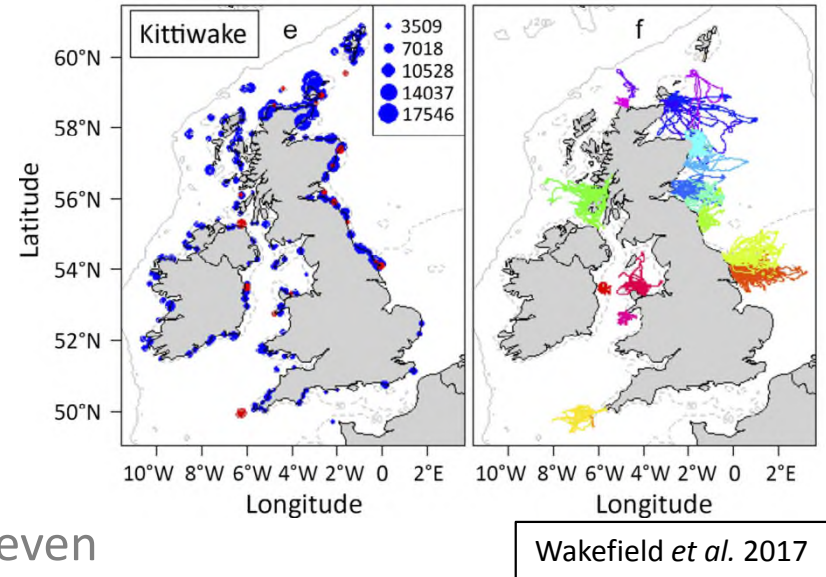
INTRODUCTION

Seals

- ## Known
  - Displacement and potential hearing damage
    - Hastie *et al.* 2015, 2017; Russell *et al.* 2016
  - Individuals foraging at structure
    - Russell *et al.* 2014

- ## Unknown
  - To what extent do structures drive or even overlap with distribution?
  - How prevalent is the use of structures for foraging?

- ## Data available
  - GPS Telemetry data
    - 30 grey seals
    - 55 harbour seals
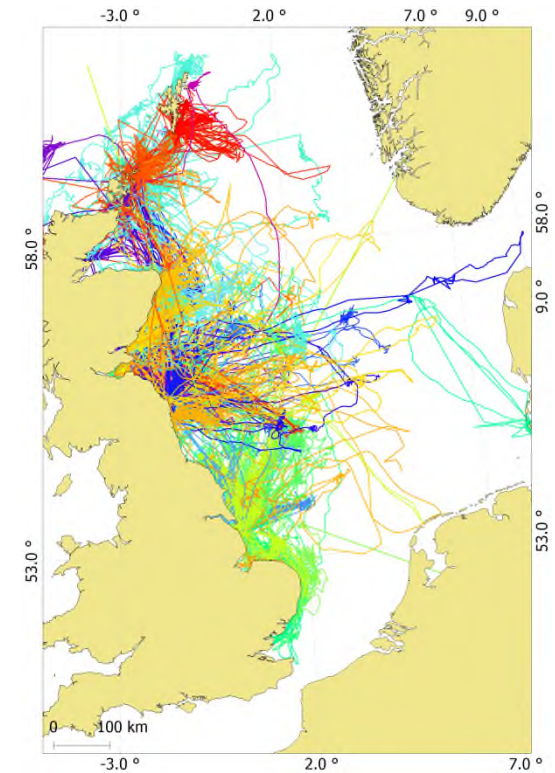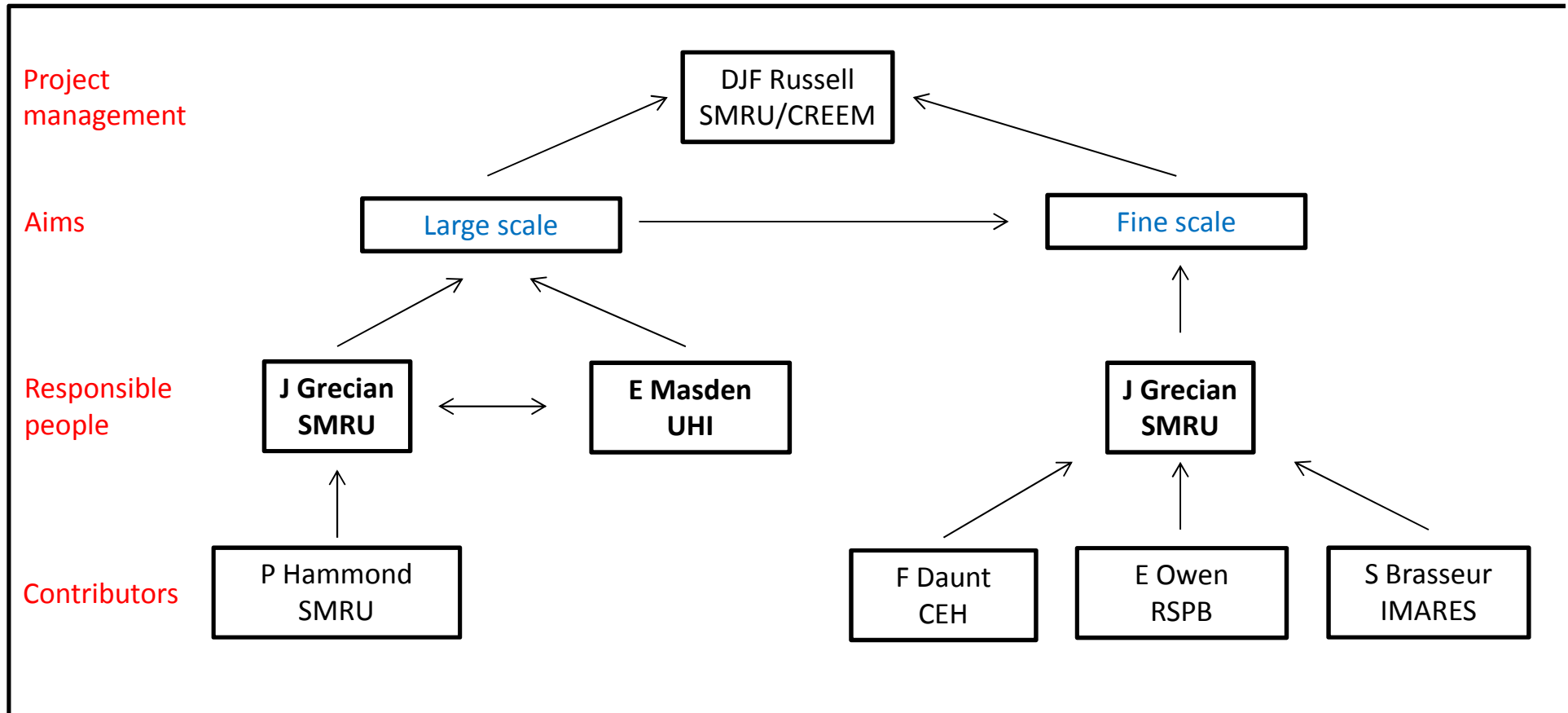
Aims

1. Large scale
   - Assess the influence of, and overlap between, man-made structures and the distribution of apex predators in the North Sea
     - Cetaceans
     - Seabirds
     - Seals

2. Fine scale
   - Assess the prevalence of the use of man-made structures for foraging in the North Sea.
     - Seabirds
     - Seals

Project organisation

1. Large scale

- The magnitude of the effects of man-made structures on distribution **compared** to the spatial and temporal variability of the North Sea ecosystem

- Include environmental drivers shown to influence distribution
  - Static covariates
    - Distance from coast (haul-out in seals)
    - Depth
    - Sediment type
      - Proxy for prey availability
  - Dynamic covariates
    - Winter sea surface temperature (lagged by one year)
   - Proxy for prey availability

- Presence of a structure within 1 km

METHODS

1. Large scale

- **Statistical Modelling**
  - Population level inference
  - Habitat preference analyses
  - Allow flexible non-linear effects of covariates
    - Generalised additive models
  - Seabirds and Cetaceans (survey data)
    - Account for detectability of animals
    - Account for differences between transects
  - Seals (telemetry data)
    - Control for habitat availability
    - Control for accessibility
    - Control for multiple individuals
  - References
    - Aarts *et al.* 2008
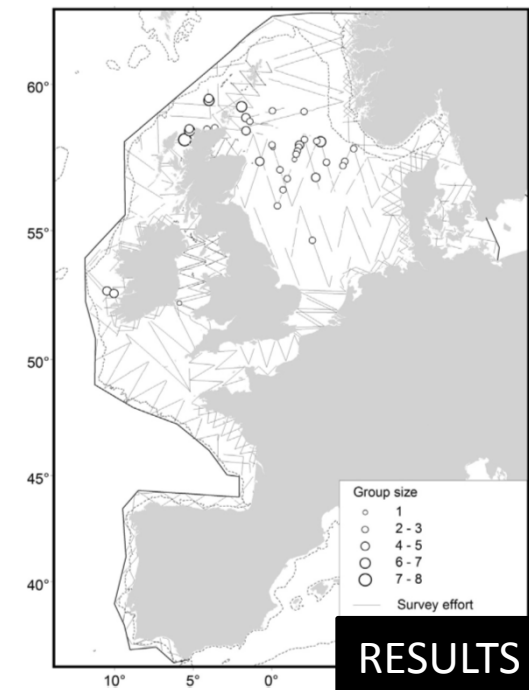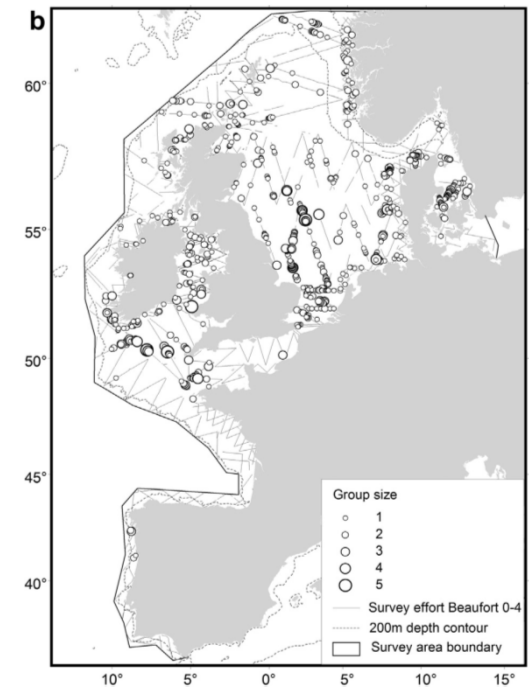   - Hammond *et al.* 2013
    - Russell *et al.* 2016

METHODS

1. Large scale - cetaceans

- Harbour porpoise
    - Depth
    - Distance to coast
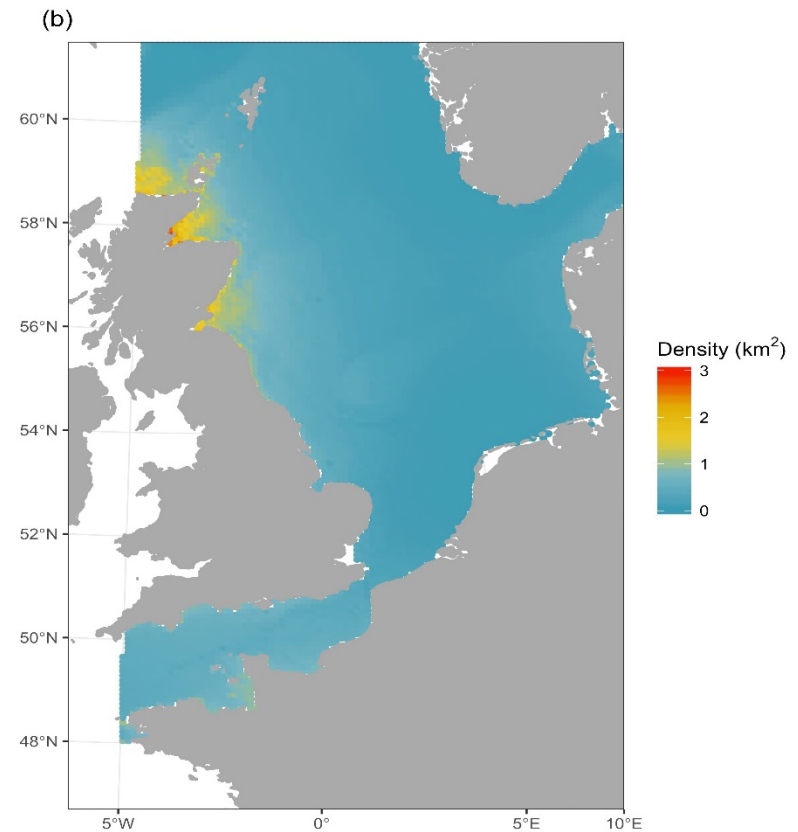   - Lagged winter sea surface temperature
    - Structure presence
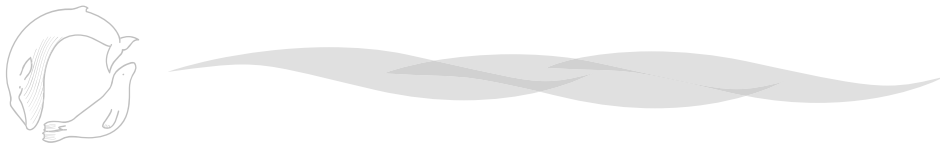
1. Large scale - cetaceans

- ## White-beaked dolphin
  - lagged winter sea surface temperature

- ## Minke Whale
  - No covariates retained

- ## Issues with model fitting

RESULTS

1.Large scale - seabirds

- **Black-legged kittiwake**
  - No covariates

- **Common guillemot**
  - depth

- **European Shag**
  - No covariates

- **Northern fulmar**
  - Distance to coast
  - Sediment type
  - Structure presence

- **Razorbill**
 - Did not converge

(b)

Density (km^2)

1. Large scale - seals

- Grey seals
  - Depth
  - Distance to haul-out site
  - Lagged winter sea surface temperature
  - Sediment type
  - Structure presence

- Harbour seals
  - Depth
  - Distance to haul-out site
  - Lagged winter sea surface temperature
  - Sediment type

- Spatial predictions

2. Fine scale

1. **Identify encounters**
   - Within 500m of structure
2. **Identify behavioural states**
   - Hidden Markov Models
     - Russell et al. 2015, 2016
   - States
     - Foraging
       - Slow tortuous movements
     - Travelling
       - Faster, more directed movements
     - Resting
       - Slow movements/activity data
3. **At a population level, does encountering a structure affect probability of foraging?**
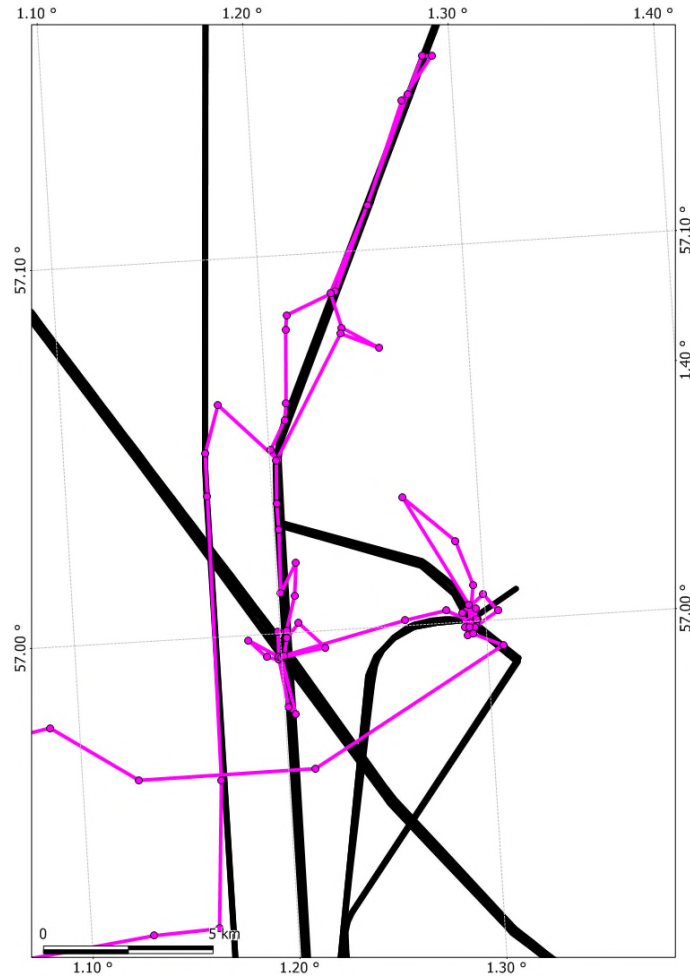
METHODS
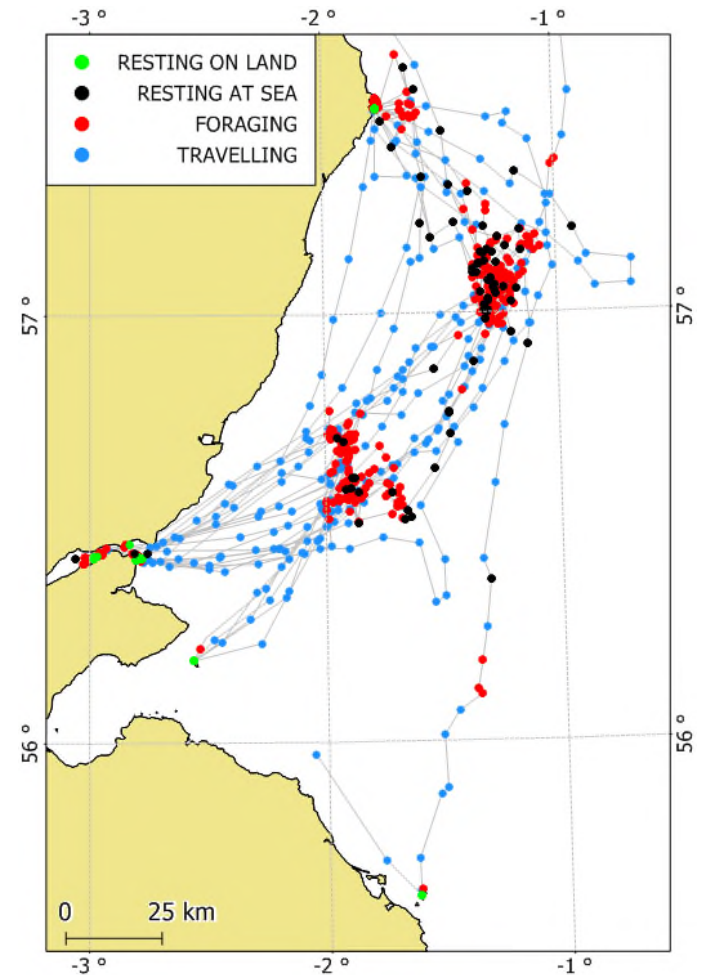
2. Fine scale - seabirds

E.Owen

- Assigned behavioural states
  - Black-legged kittiwake
  - Common guillemot
  - Northern Fulmar
  - Razorbill

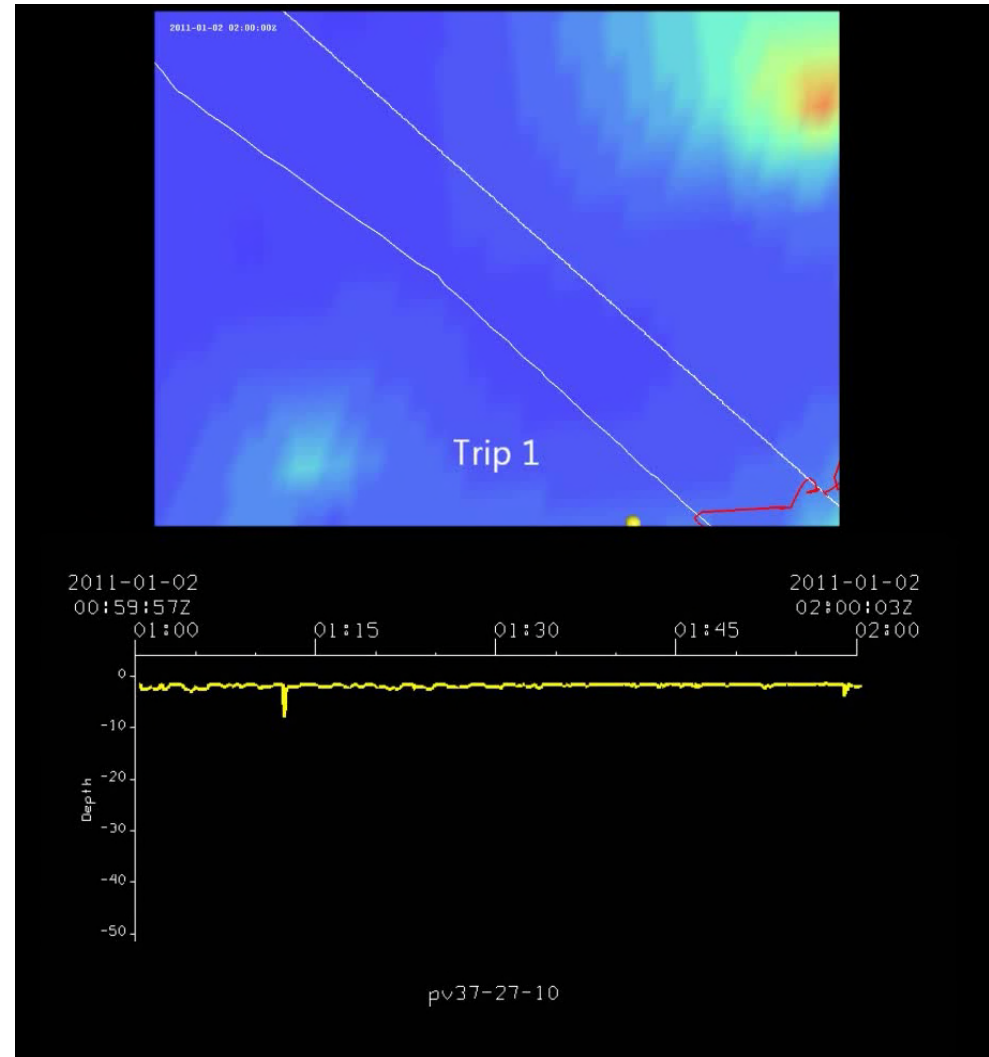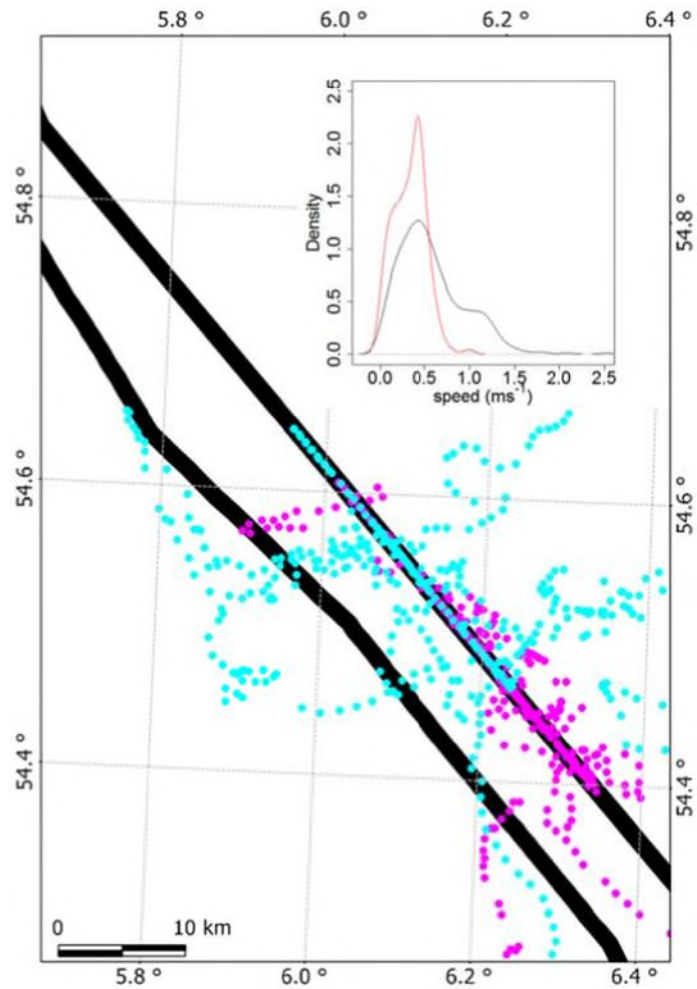- At a **population level** the presence of structures did **not** increase the likelihood of foraging

RESULTS

2. Fine scale - seals

- Ongoing

2. Fine scale - seals

Cetaceans

M. Arso

- Known
  - Harbour porpoise
    - Displaced during windfarm construction
      - Dähne et al. 2013
    - Foraging at structures
      - Todd et al. 2009; Scheidat et al. 2011
    - Evidence that structures have some influence on the North Sea harbour porpoise distribution
  - White beaked dolphin and minke whale
    - No evidence that, at a population level, distribution is influenced by structures
    - Data suitability issues

- Next steps
  - Robustness of harbour porpoise result
    - SCANS I
    - SCANS III
  - Minke whale and white-beaked dolphin
    - Restrict spatial extent of analyses

DISCUSSION

Seabirds

S.Russell

- Known
  - Windfarms
    - E.g. Cleasby et al. 2015
  - Large scale
    - No evidence that, at a population level, distribution is influenced by structures
      - Data suitability issues
  - Fine scale
    - Structures appear to influence the behaviour of some individuals
    - At a population level, no impact of structures on foraging behaviour

- Next steps
  - Large scale
    - Using data from loggers to investigate the influence of structures on the summer foraging distributions.
      - Wakefield et al. 2017
  - Fine scale
    - Determine the mechanism underlying any association between individuals and structures
      - Vessel Monitoring data
      - Structure type (visibility)

DISCUSSION

Seals

F.Landes

- Known
  - Displacement and potential hearing damage
    - Hastie et al. 2015, 2017; Russell et al. 2016
  - Individuals foraging at structure
    - Russell et al. 2014
  - Large scale
    - At a population level, distribution is not impacted by structures
      - May change with increasing near shore abundance of structures
    - Overlap with structures quantified
  - Fine scale
    - Evidence that some individuals forage at platforms
    - Effects of structure age

- Next steps
  - Structure type and age effects
    - Additional telemetry data in areas with structures of various ages
      - Department of Business, Energy and Industrial Strategy
    - Information regarding whether pipelines are buried

DISCUSSION

Thank you

- INSITE
  - Industry sponsors
  - ISAB
  - Richard Heard
- Colleagues at SMRU, CREEM, UHI, RSPB and CEH
- SMRU Instrumentation
- Professor Paul Thompson, University of Aberdeen
- Joint Nature Conservation Committee (JNCC) for provision of ESAS data
- Data funders
  - Argyll Bird Club, Department for Business, Energy & Industrial Strategy, Environment Wales, European Union, Fair Isle Bird Observatory Trust, JNCC, Marine Scotland, Natural England, Natural Environment Research Council, Natural Resources Wales, SMRU, Scottish Natural Heritage, RSPB, Vodafone UK.

@_SMRU_