Conference on Wind power and Environmental impacts

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Best Practice Ecological Analysis Methods for Offshore Wind in UK

Case study: Robin Rigg Offshore Wind Farm – An integrated approach the Marine Environmental Monitoring Plan (MEMP)




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Sharing Good Practice

Scottish Natural Heritage
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Summary Scope of talk:

1. UK Offshore Wind Industry Ecological Analysis Methods – key species groups
2. Intro to Robin Rigg Offshore Wind Farm – background & location
3. Marine Environment Monitoring Plan (MEMP) – conditions, remit & aims
4. Ecological Analysis of MEMP and Key Biological Species Groups
5. Ornithological Analysis
6. Benthic communities, Fish, Invertebrates & electro-sensitive fish
7. Marine Mammals
8. Summary

UK Industry Ecological Analysis Methods 2013:

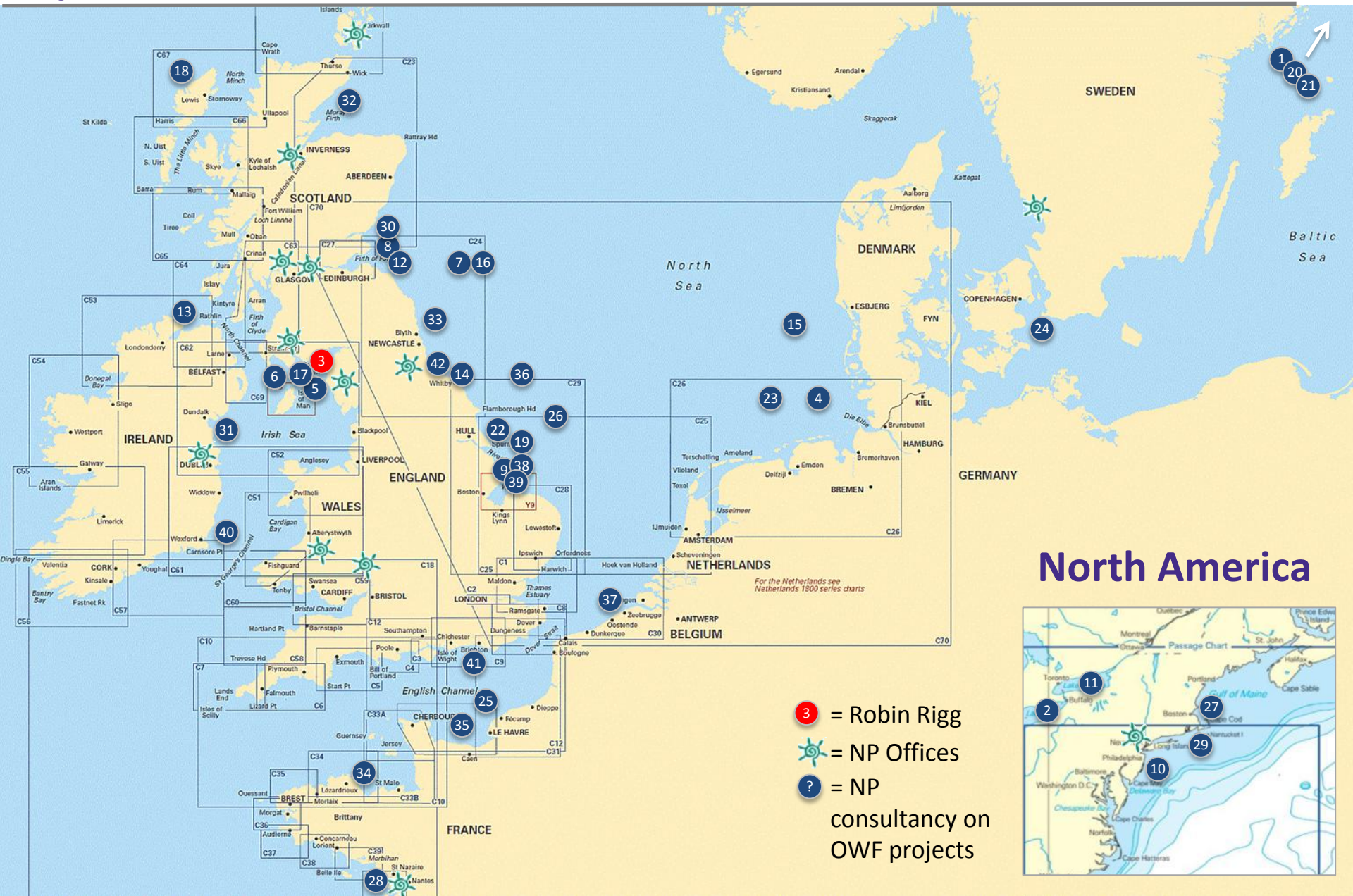
Offshore Wind Development Phases	Baseline (EIA) OWF, Cable & landfall + Cumulative effects	Construction (Planning consent / permit discharge)	Operational	Future Improvements
Birds	• Species density mapping • Collision Risk Modelling (CRM) • Population Viability Analysis (PVA) – predictions for EIA • Migratory flight-line analysis • Prey assessments • Linkage to designated sites	• Density-surface comparisons • Migratory flight-line analysis • Prey assessments	• Density-surface comparisons • Migratory flight-line analysis • PVA & CRM – observations with EIA prediction • Prey assessments	• Collision mortality • Understanding of displacement rates • Understanding of micro & macro avoidance
Marine Mammals	• Site-specific - Assessment Frameworks • Species density mapping: Acoustic data, Visual counts (boats/aerial/haul-out), • Noise modelling predictions(piling) • PVA – predictions for EIA	• Occurrence comparisons • Analysis of predictions and mitigation measures	• Occurrence comparisons • Population Viability Analysis (PVA) – confirm predictions for EIA	• Improve acoustic models • Use of site-specific Frameworks • Improve detection rates • Dissemination of industry knowledge
Benthic Communities	• Benthic surveys (geophysical, DDV Grabs) • Biotopes mapped • Species habitats of conservation importance • Intertidal cores & biotope mapping	• Benthic surveys at reduced number of sites • Biotopes mapped • Data statically analysed in primer	• Benthic surveys at a reduced number of sites • Biotopes mapped • Data statically analysed in primer	• Analysis of data in terms of the 'function' of the ecosystem
Fish	• Epibenthic beam trawl surveys • Fish surveys using commercial gear • Determination of abundance and assemblage of fish and invertebrates	• Epibenthic beam trawl surveys • Fish surveys using commercial gear • Detemination of abundance & assemblage fish and invertebrates	• Epibenthic beam trawl surveys • Fish surveys using commercial gear • Detemination of abundance & assemblage fish and invertebrates	• Baseline survey • Greater understanding of the bathymetry and of catch data

Robin Rigg OWF, The Solway Firth:

- 180MW (60 x 3MW WTG) offshore wind farm
- Baseline EIA 2001-2002 – Natural Power
- Granted consent in Mar 2003, EON ownership from Sept 2003
- Constructed from Jan 2008 – Feb 2010
- Operational from Mar 2010
- Inc: Offshore & onshore sub-station
- 2 x 14 km export cables, Inter-array cables
- 500m spacing

Natural Power Europe Offshore wind project experience:

Planning & Development | Ecology & Hydrology | Wind Technical
Construction & Geotechnical | Asset Management | Due Diligence



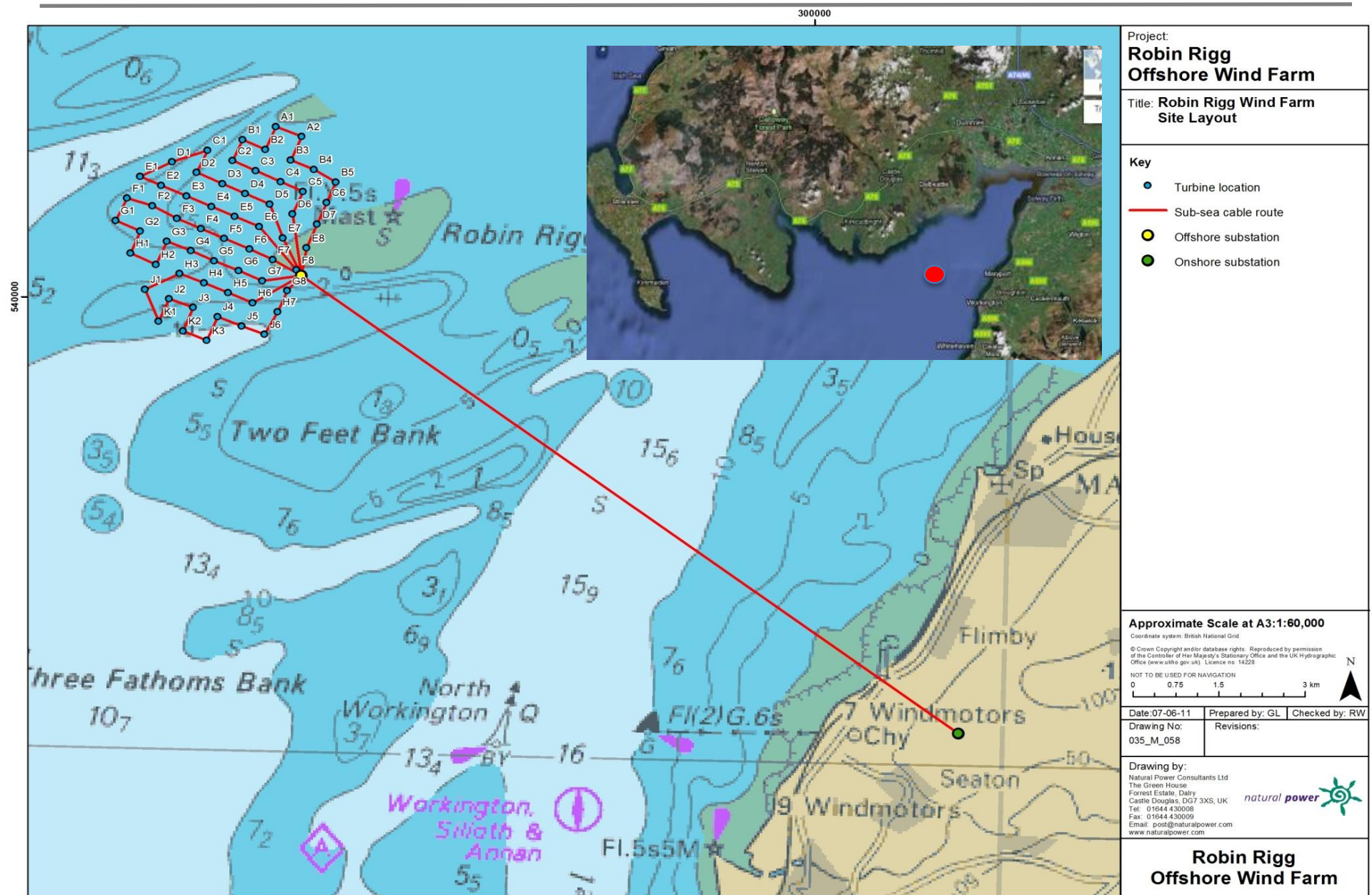
3 = Robin Rigg

= NP Offices

? = NP consultancy on OWF projects

North America

Robin Rigg Array Layout, The Solway:



Marine Environment Monitoring Programme (MEMP):

MEMP complies with condition 6.4 of Section 36 Consent Condition, of the Electricity Act:

Scope of MEMP:

"The MEMP should be sufficiently robust to detect and/or predict direct and indirect adverse impacts, likely to have a significant effect on the marine environment, arising from pre-construction, construction, operation and decommissioning".

The MEMP states:

"The remit of the Monitoring Programme will be to allow changes to the physical and ecological environment caused by the construction and operation of the wind farm to be recorded principally in areas where there is some uncertainty in the effects of the wind farm on the receiving environment, where those effects are potentially damaging. The monitoring programme should be designed so that if potentially adverse significant impacts are predicted which can be reasonably attributed to the wind farm, mitigation measures can be adopted in time to avoid irreversible significant impacts"

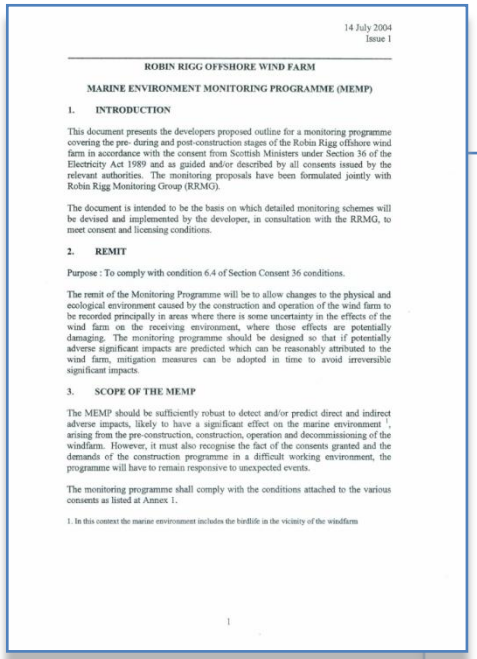
Marine Environmental Monitoring Plan (MEMP):

Structure of the MEMP into Ecological Groups:

Key Areas of Ecological focus from the ES predictions MEMP constructed in 2004 based on uncertainty at the time (8 years of progress).

- Benthic Communities (OWF & Cable)
- Non-migratory Fish
- Electro-sensitive Fish
- Birds (Seabirds)
- Marine Mammals (Harbour porpoise & seals)
- Migratory Fish
- Managed and overseen by the RRMG – Robin Rigg Management Group, akin to an onshore steering group or management group.

Reporting on MEMP Monitoring, Data, management & analysis to RRMG by EON/Natural Power



14 July 2004
Issue 1

ROBIN RIGG OFFSHORE WIND FARM

MARINE ENVIRONMENT MONITORING PROGRAMME (MEMP)

1. INTRODUCTION

This document presents the developers proposed outline for a monitoring programme covering the pre- during and post-construction stages of the Robin Rigg offshore wind farm in accordance with the consent from Scottish Ministers under Section 36 of the Electricity Act 1989 and as guided and/or described by all consents issued by the relevant authorities. The monitoring proposals have been formulated jointly with Robin Rigg Monitoring Group (RRMG).

The document is intended to be the basis on which detailed monitoring schemes will be devised and implemented by the developer, in consultation with the RRMG, to meet consent and licensing conditions.

2. REMIT

Purpose : To comply with condition 6.4 of Section Consent 36 conditions.

The remit of the Monitoring Programme will be to allow changes to the physical and ecological environment caused by the construction and operation of the wind farm to be recorded principally in areas where there is some uncertainty in the effects of the wind farm on the receiving environment, where those effects are potentially damaging. The monitoring programme should be designed so that if potentially adverse significant impacts are predicted which can be reasonably attributed to the wind farm, mitigation measures can be adopted in time to avoid irreversible significant impacts.

3. SCOPE OF THE MEMP

The MEMP should be sufficiently robust to detect and/or predict direct and indirect adverse impacts, likely to have a significant effect on the marine environment [1], arising from the pre-construction, construction, operation and decommissioning of the windfarm. However, it must also recognise the fact of the consents granted and the demands of the construction programme in a difficult working environment, the programme will have to remain responsive to unexpected events.

The monitoring programme shall comply with the conditions attached to the various consents as listed at Annex 1.

1. In this context the marine environment includes the birdlife in the vicinity of the windfarm

1

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Robin Rigg Offshore Wind Farm, Scotland
EON Climate & Renewables
Analysis of MEMP Ecological data
(Pre-construction & construction phases)

Executive Summary

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OWF Phases - Ecological Data collection, Surveys & Monitoring:

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001		F, Bth	F, Bth	F	B, F	B, F	B, F	B, F	B, F	B, Bth	B, F, Bth	B, F, Bth
2002	B	B	B	B	B	B	B	B	B	B	B	B
2003				B	B							
2004	B	B, M	B, M, I		B, M		B, M	B, M	B, M	M	M	M
2005	M											
2006												
2007							B, M, Bth	F			F, Bth	
2008	B M	B, M, F	B, M, EF F, I	B, M, F	B, M, Bth	B, M, EF	B, M, F	B, M	B, M, EF	B, M	B, M, F, Bth	B, M
2009	B, M	B, M, EF, F	B, M, I	B,M	B,M	B, M, F	B, M	B, M, F	B, M, I	B, M		B, M, F
2010	B, M	B, M, F	B, M, I	B, M, EF, F	B, M, Bth	B, M	B, M, EF, F	B, M	B, M, I	B, M, EF, F	B, M	B, M, I
2011	B, M, I	B, M, I	B, M, EF, F, I	B, M, Bth	B, M	B, M	B, M	B, M	B, M, I	B, M	B, M	B, M
2012	B, M, EF, F	B, M	B, M	B, M, I	B, M, F	B, M	B, M	B, M	B, M	B, M	B, M	B, M
2013	B, M, F	B, M										

Baseline

Pre-construction

Construction

Operation

Key to notation:
B = Birds (ESAS boat surveys)
Bth = Benthic (trawls)
M = Marine Mammals (boat observations)
EF = Electro-sensitive fish (trawls)
F = Fish (non migratory)
I = Intertidal Benthic (surveys)

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MEMP: Ornithology analysis

Dr Gillian Lye & Dr Chris Pendlebury

Ornithology analysis (post construction & operation):

Key bird species considered for analysis identified by the RRMG:

- **Common scoter,** *Melanitta nigra*
- **Red-throated diver,** *Gavia stellata*
- **Gannet,** *Morus bassanus*
- **Guillemot,** *Uria aalge* & Razorbill, *Alca torda*.
- **Cormorant,** *Phalacrocorax carbo*
- Manx shearwater, *Puffinus puffinus*
- Scaup, *Athya marila*
- Kittiwake, *Rissa tridactyla*
- Herring gull, *Larus argentatus*
- Great black-backed gull, *Larus marinus*

**species underlined are shown mapped in subsequent slides where data was sufficient for analysis methods*

Ornithology analysis (post construction & operation):

Standardised approach & data continuity

- Complex dataset but consistent, data analysed in a standardised way across all species.
- Greater details of the ecological approach & methods are available on the Scottish Government – Marine Scotland website and by contacting Natural Power, Dr Gillian Lye.

Abundance

- Per bird species, mean numbers observed per unit effort (sampling block) were compared
- Analysed by the three wind farm phases (pre-construction, construction and operation).
- The average number of birds observed per sighting was also calculated for each period to look for evidence of changes in group size.

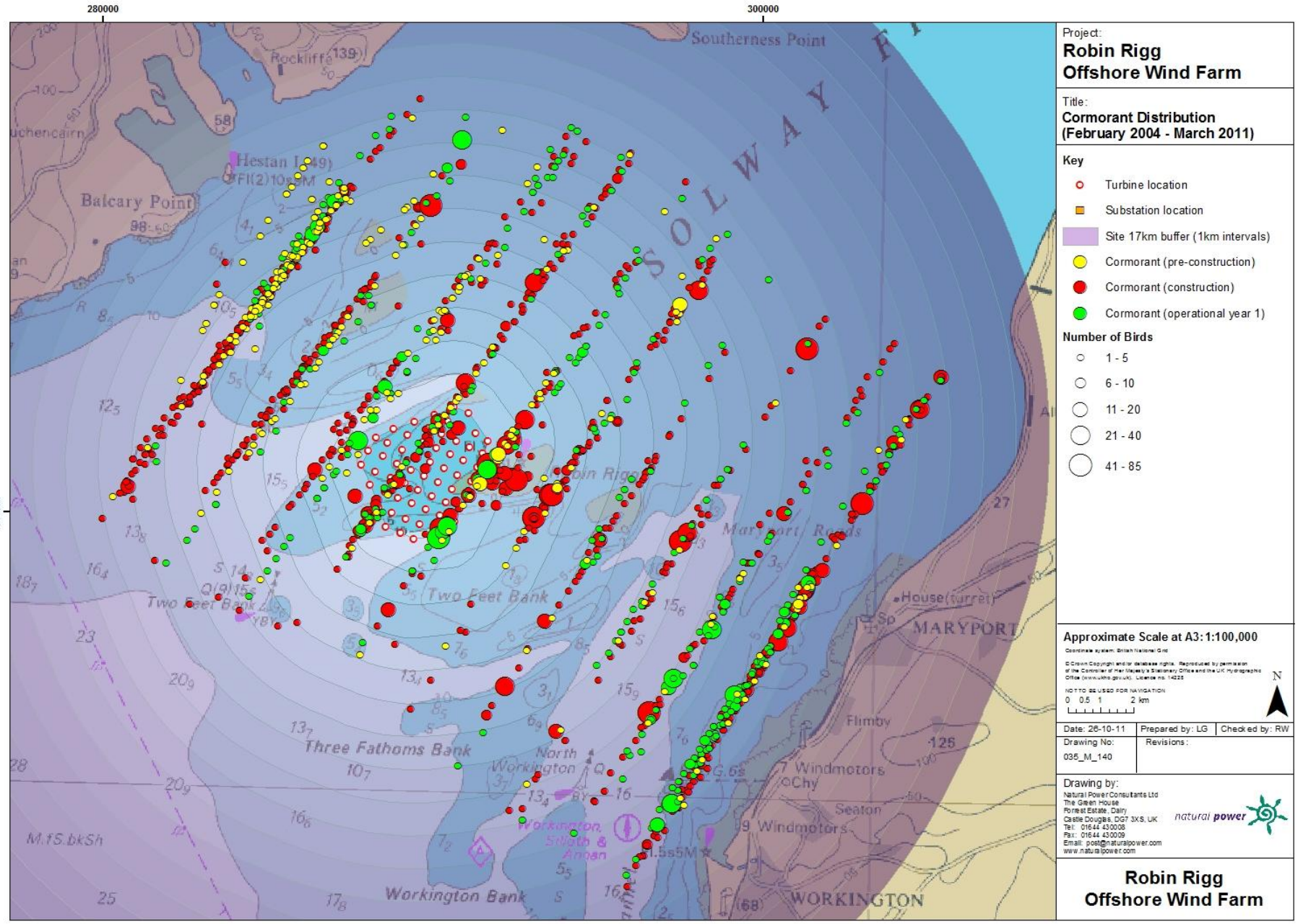
Spatial Distribution

- Density surface plots for relative abundance and distribution for each species during 3 phases.
- For each species, behaviour (in flight or on the sea) and development phase, a two-dimensional x-y smooth was fitted using the GAM function in *R* v2.13.1.

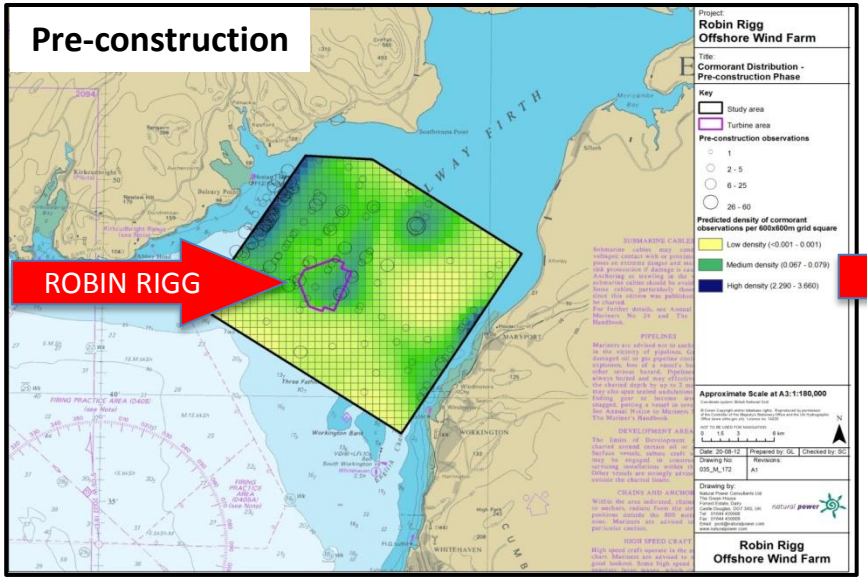
Collision risk

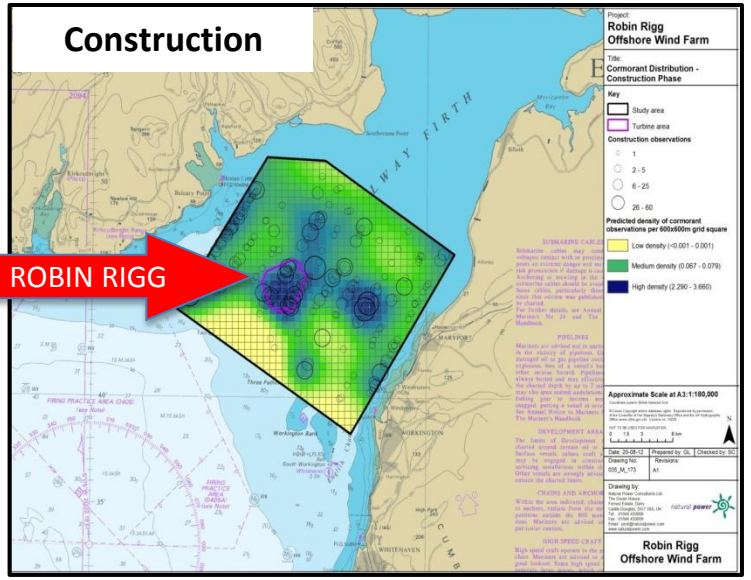
- Available flight height data were grouped into six bands for analysis, these data is not presented here (0-5 m; 6-25 m; 26-34 m; 35-125 m; 126-200 m and 200 m plus).
- Height bands to account for rotor height of the turbines (35-125 m).

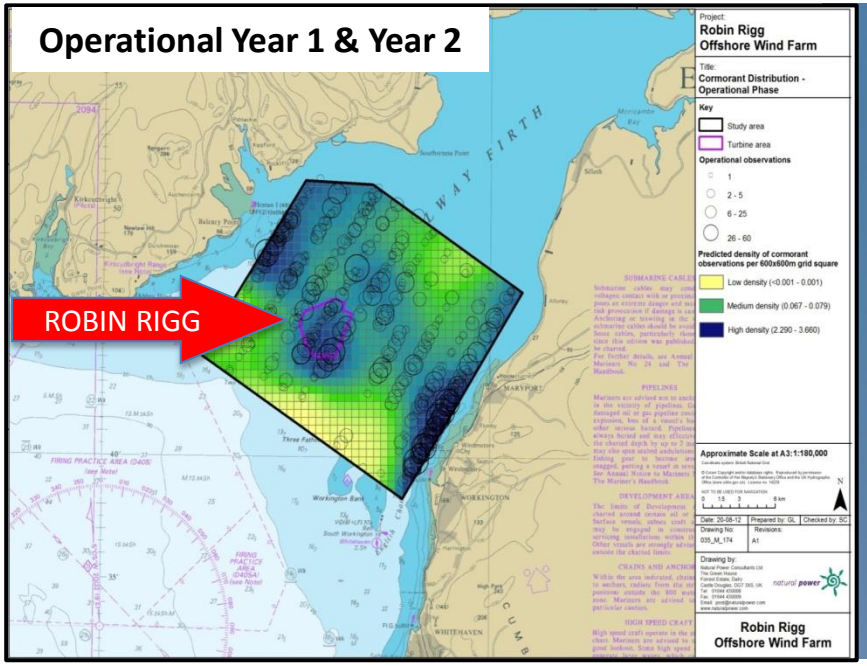
e.g. Cormorant Raw Count Observations: (on the water) (Ops Yr1)



Cormorant *(Phalacrocorax carbo)* – Density Surfaces – 3 Phases: (on the water)

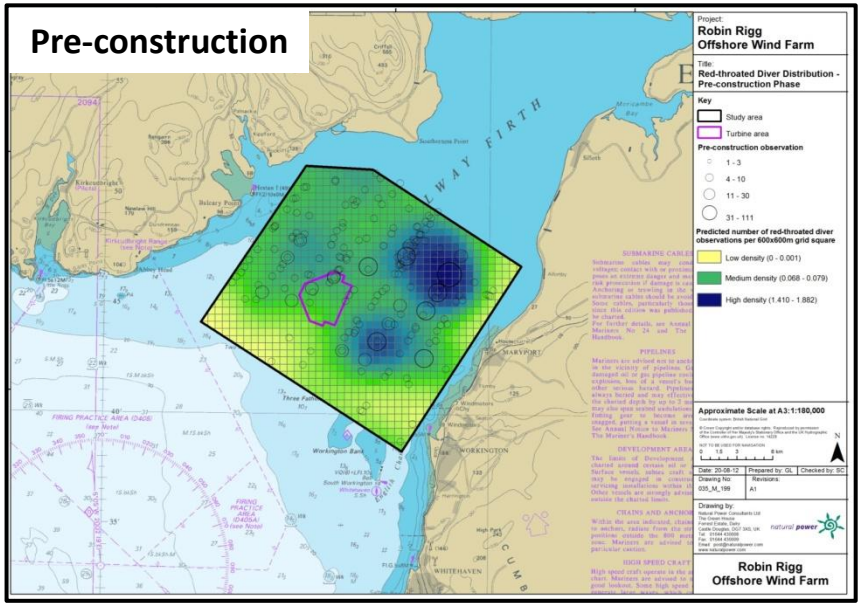




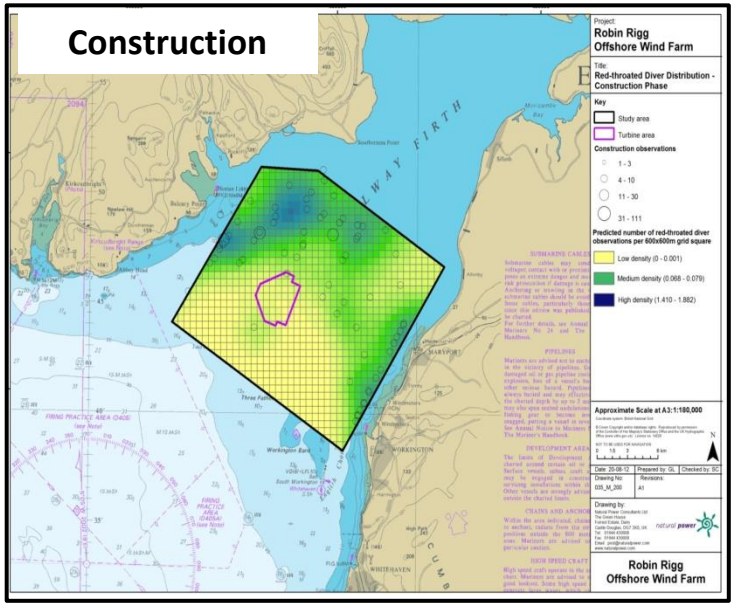


Red-throated diver *(Gavia stellata)* – Density Surfaces – 3 Phases: (on the water)

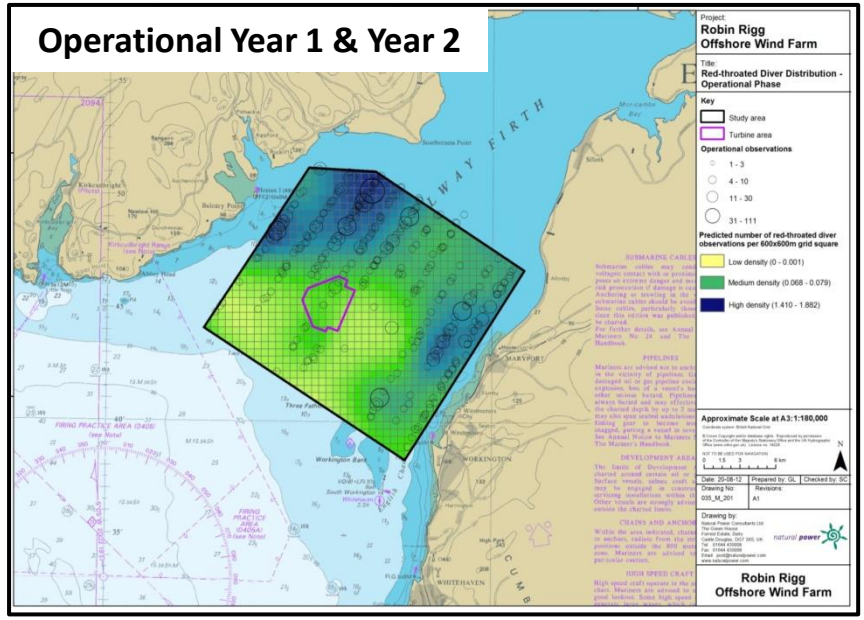
Pre-construction



Construction



Operational Year 1 & Year 2



	Predictions from ES	Construction analysis	Operational year 1 analysis	Operational year 2 analysis
Red-throated diver	➢ Some displacement expected (up to 800 m from wind farm area). ➢ Displacement from an area greater than 5 km required to influence national population. ➢ Collision impacts predicted to be low (3.3 birds per annum).	➢Across the survey area, more divers (all species) were observed in flight during the construction phase than pre-construction. ➢ Evidence for shift away from wind farm area during construction.	➢No overall decrease in numbers (pre vs. post), some evidence of a decrease in numbers within the wind farm site. ➢Wind farm area not used much prior to construction - impacts small.	➢Fewer birds recorded op 2 than Op 1 but overall, sightings higher compared to previous phases. ➢98% birds observed flying below rotor height.

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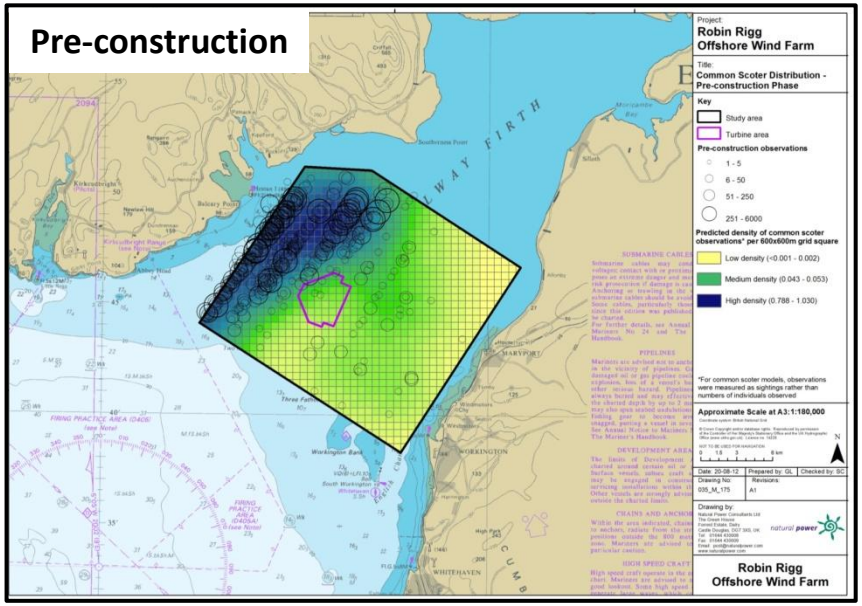
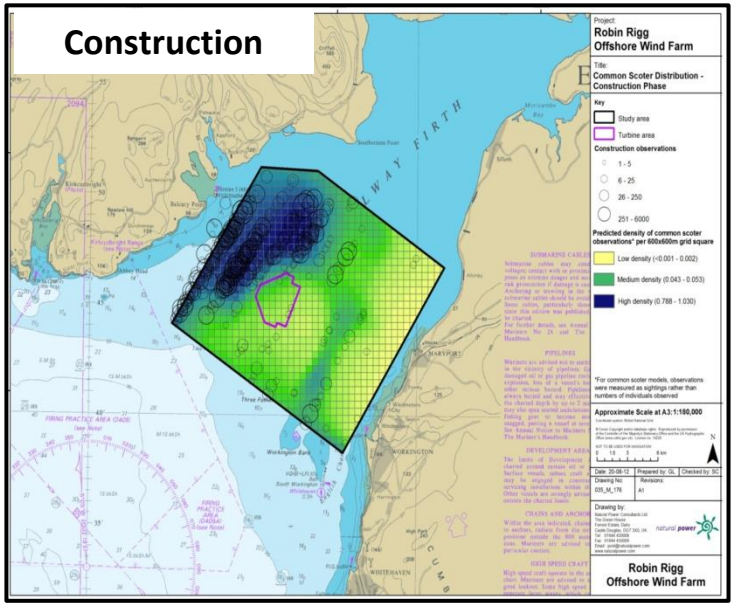
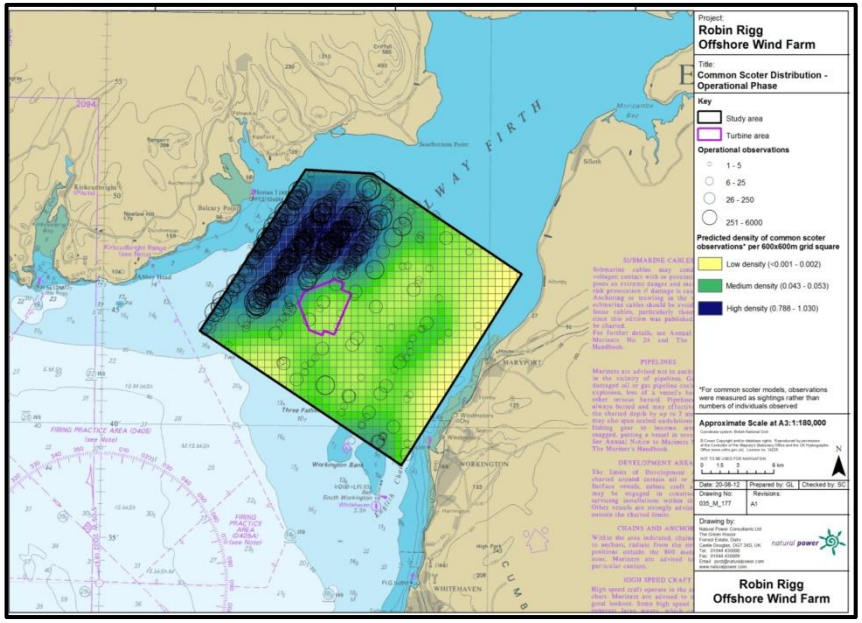
Common Scoter *(Melanitta nigra)* – Density Surfaces – 3 Phases: (on the water)

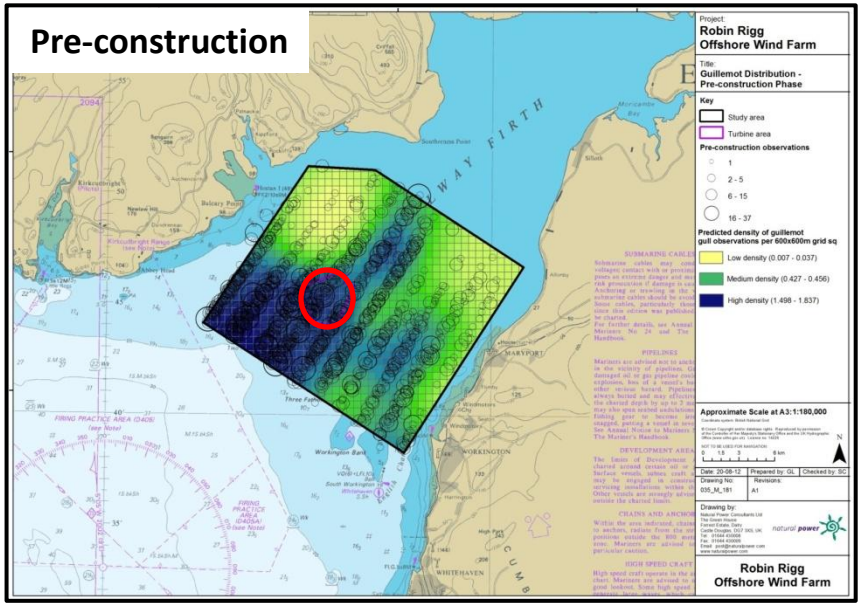


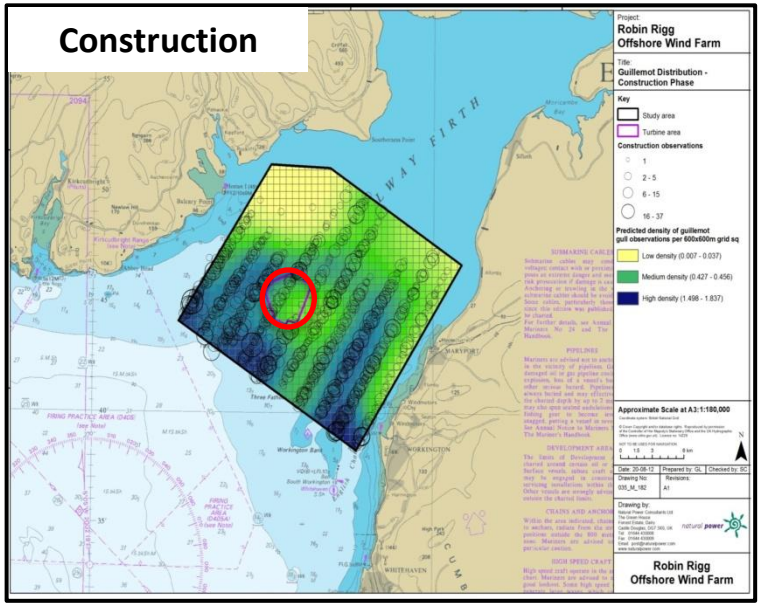


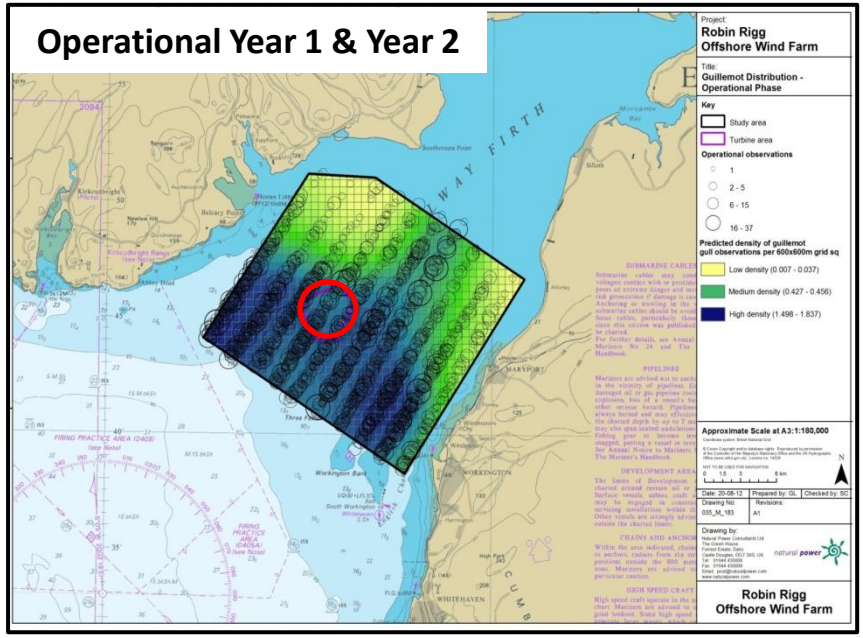


	Predictions from ES	Construction analysis	Operational year 1 analysis	Operational year 2 analysis
Common scoter	➢Some displacement expected (up to 800 m from wind farm area). ➢ Displacement from an area greater than 3 km required to influence national population. ➢ Collision impacts predicted to be low (3.4 birds per annum).	➢Some evidence for a decrease in birds across the whole survey area. ➢ Shift in focus of core areas for common scoter along the northern coastline in inshore areas. ➢ Changes unlikely to be linked to the Robin Rigg development.	➢ No indication of an impact on numbers observed on the sea within study area (pre vs. post). ➢ Some evidence for a decrease in number of flying birds (pre vs. post) but more data required to confirm.	➢Fewer birds recorded in Op 2 compared to Op 1. ➢No change in distribution. between phases. ➢Virtually all flying birds below 25 m - low collision risk.

Guillemot *(Uria aalge)* – Density Surfaces – 3 Phases: (on the water)

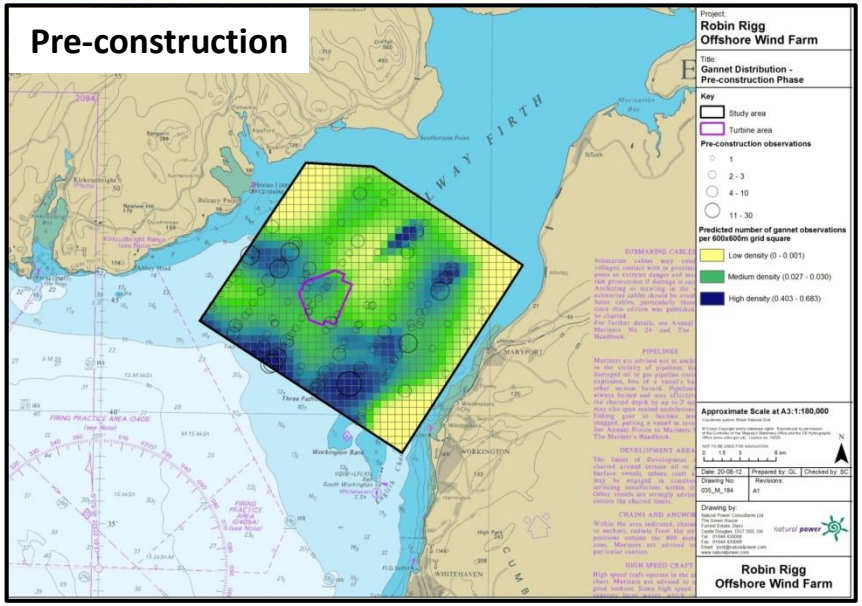


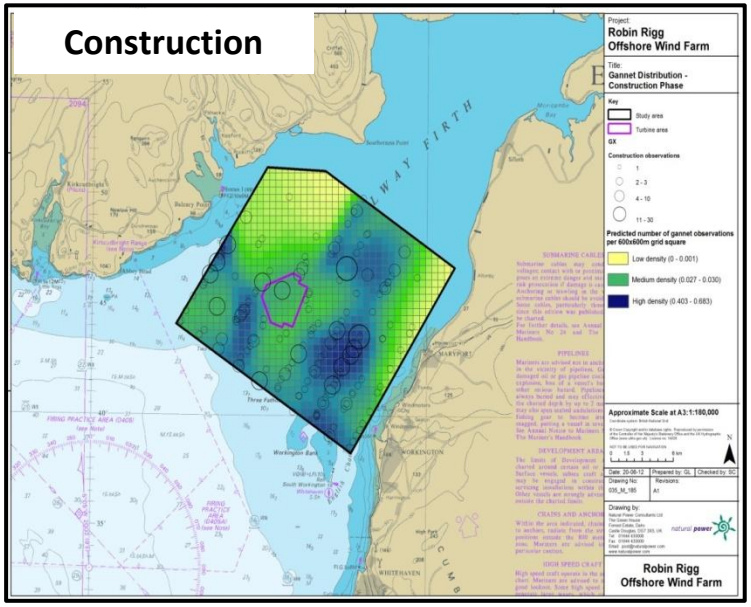


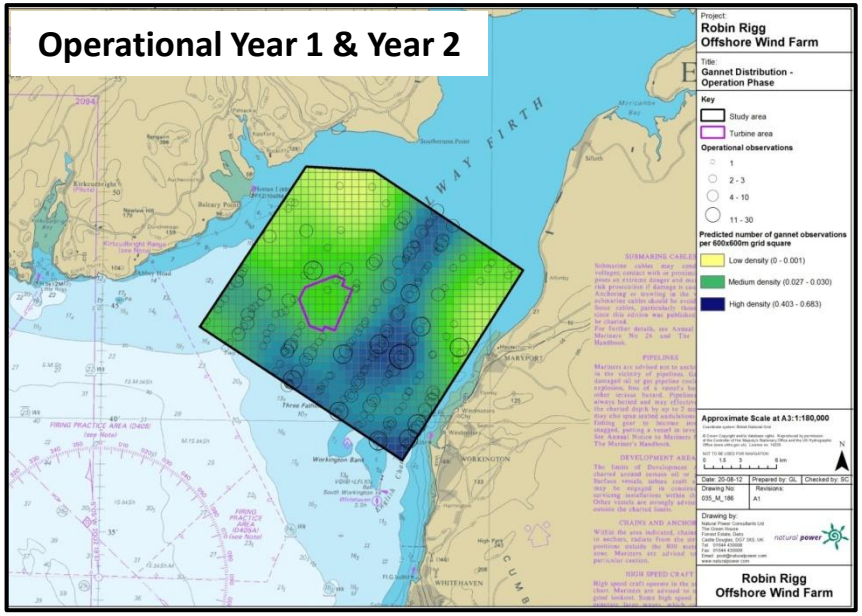


	Predictions from ES	Construction analysis	Operational year 1 analysis	Operational year 2 analysis
Guillemot	➢Observed in the relatively deeper waters of the outer Solway. ➢Numbers were highest in spring-summer but with second peak in the autumn.	➢Evidence for a decrease in numbers in flight. ➢Evidence for a decrease on the sea during construction. ➢The data support partial displacement of away from the wind farm area during construction.	➢Decrease in numbers pre vs. construction. ➢Increase in numbers construction vs. operation.	➢Numbers remain consistent across operational years. ➢No birds observed flying at rotor height.

Gannet *(Morus bassanus)* – Density Surfaces – 3 Phases: (on the water)







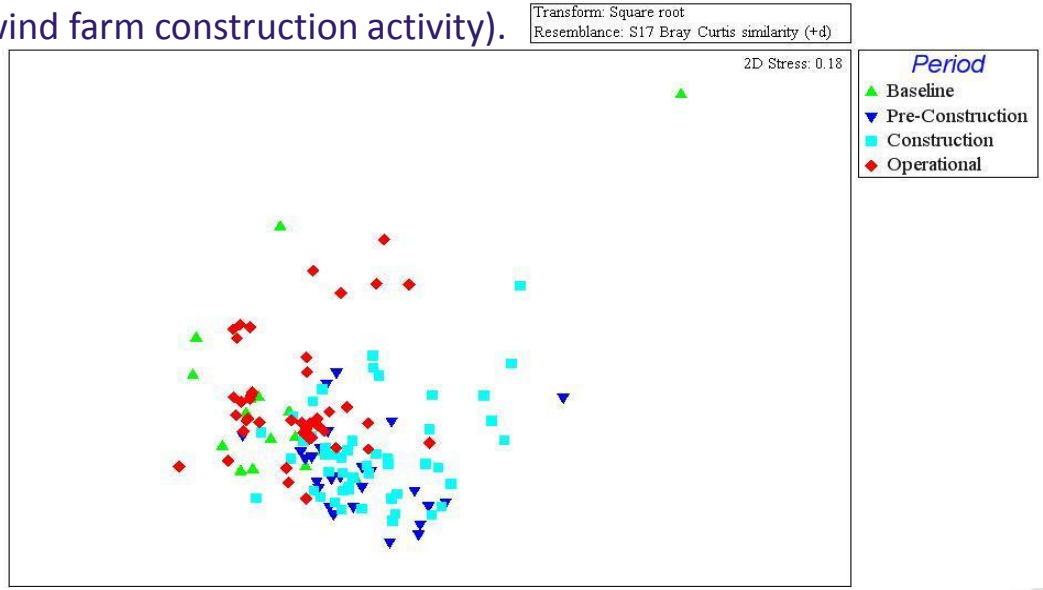
	Predictions from ES	Construction analysis	Operational year 1 analysis	Operational year 2 analysis
Gannet	➢Predominantly recorded during the Spring-Summer (breeding season) with peak counts between April and October. ➢Observations evenly distributed across the survey area.	➢Evidence for a decrease in flight and on sea during the construction phase.	➢Decrease in numbers on the sea (pre vs. post) but not for birds in flight.	➢More observed in Op 2 compared to Op 1. ➢Small percentage observed flying at rotor height (4-9%).

MEMP: Benthic communities, Fish & invertebrates and Electro-sensitive fish

Dr Jane Lancaster

Benthic communities analysis:

- Significant variation in community structure was observed over time although changes unrelated to RR OWF construction.
- Specific changes in species composition (shown in the cluster analysis) occurred between baseline data collection & pre-construction and also pre-construction & operation
  (i.e. in the absence of any offshore wind farm construction activity).
- There has been a slight shift in biotopes over the course of the surveys 2011-2012, operational species assemblages are now the same as baseline, indicating a cyclical changes.

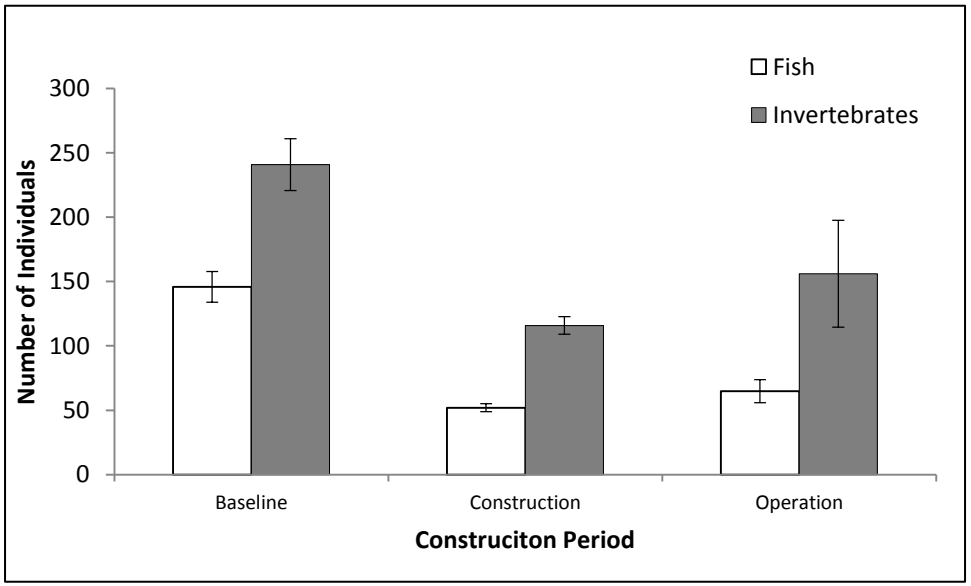


No change can be attributed to the offshore wind farm within the dynamic coastal environment of the Solway Firth.

Fish & Invertebrates (trawl surveys):

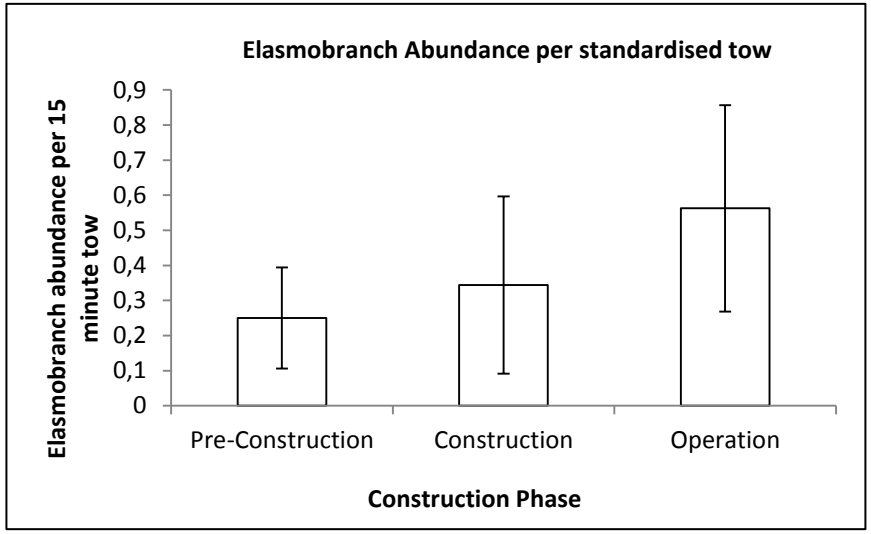
- Significant change in species assemblage & catch numbers recorded.
- Greatest decline in overall fish & invertebrate numbers between baseline and construction year 1.
- There has been a slight recovery in catch numbers during operation.

- Changes in catch rates are highly likely to have been affected by the changes in shifting sand banks with the Solway.
- Fish are captured in greatest numbers in the channels and the channels shifted significantly in the 7 years between baseline and construction.
- In contrast for consistency (comparative purposes) the sampling stations remained in the same location.
- No correlation was found between the catch (or decline of catch) and distance from the Robin Rigg Offshore Wind Farm.



Electro-sensitive Fish (trawl surveys):

- 3 species of electro-sensitive fish recorded.
  - thornback ray (*Raja clavata*),
  - lesser spotted dogfish (*Scyliorhinus canicula*)
  - and blond ray (*Raja brackyura*).
- Survey along the export cable route elasmo-branch abundance was low throughout the duration of the survey with only 43 individuals recorded in 80 trawls.
- No significant difference detected between survey periods.
- Electrosensitive fish were more common on the west side of the Solway (away from the cable) in all surveys including pre-construction.



MEMP: Marine mammals analysis

Dr Sarah Canning

Marine Mammal Monitoring Plan:

Aim

- Pre-construction: To establish background data of abundance & distribution of marine mammals in Solway Firth to establish/confirm measures to be adopted during construction.
- Construction/Operation: To comply with planning requirements/conditions - *Section 36 of Electricity Act 1989 & Condition 26 of FEPA licence.*

Survey type

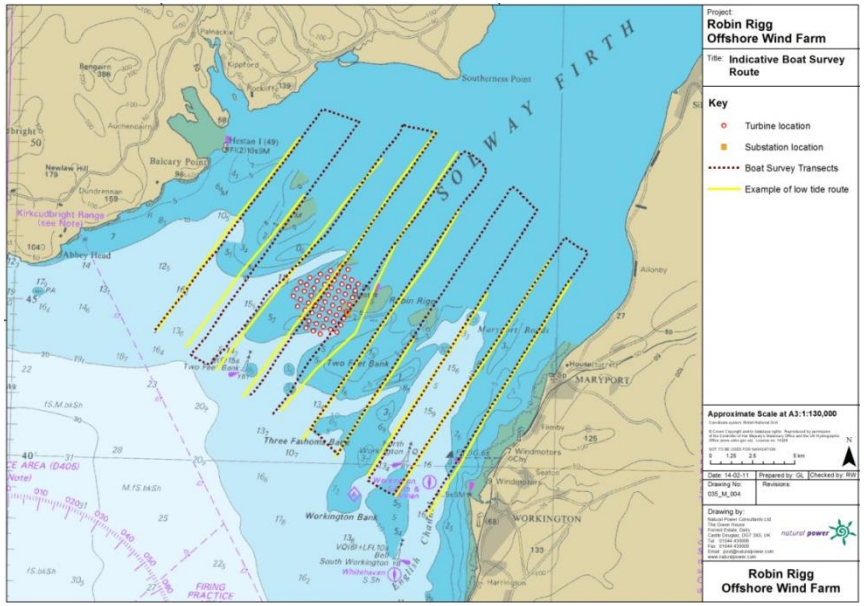
- Boat-based surveys to coincide with bird surveys using formal survey procedure & dedicated MMO.

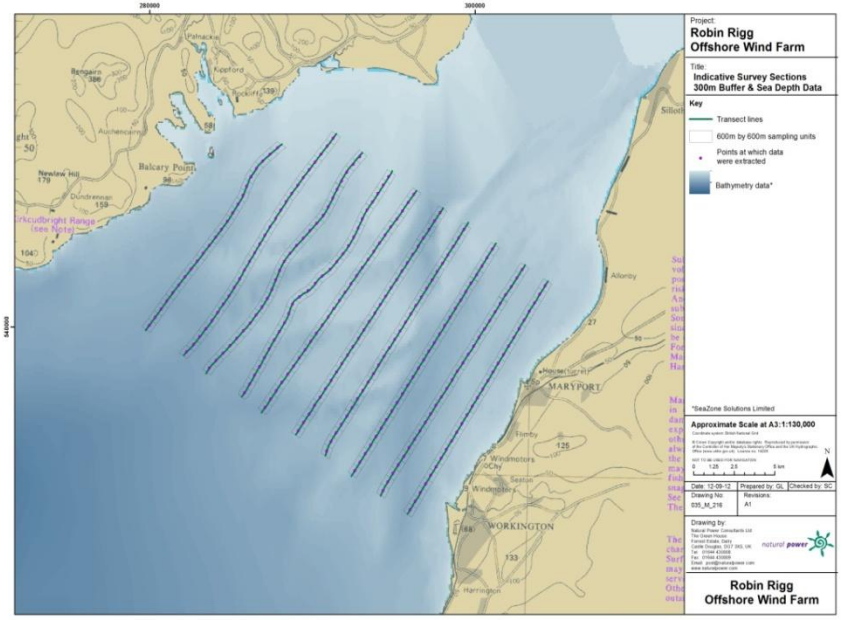
Timing & Frequency

- Pre-construction: once per month for one year
- Construction: twice per month for duration of construction (high/low tide)
- Operation: Once per month for two years

Boat-based survey methodology:

- 10 transect lines surveyed, each about 18 km long, spaced 2 km apart.
- Primary vessel used 16 m long with viewing height of 4 m above sea level (pre-COWRIE guidelines some depth restrictions/tidal variation on site).
- Same MMO used throughout all surveys = consistency of observer bias.





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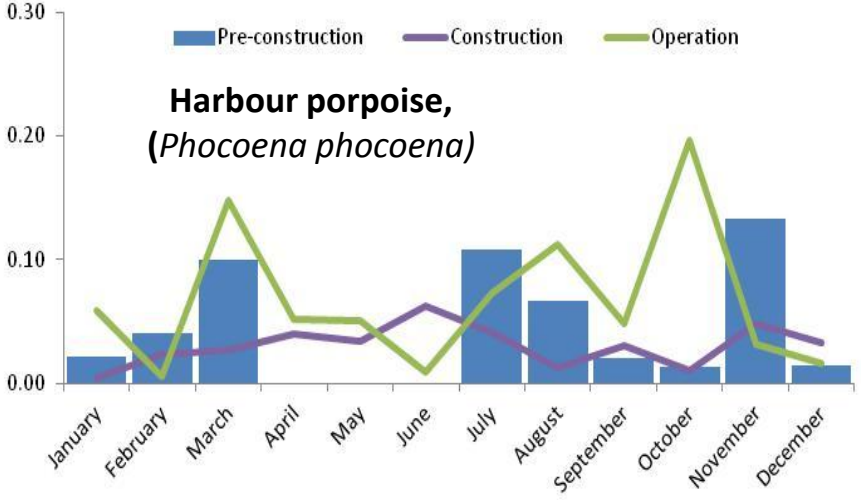
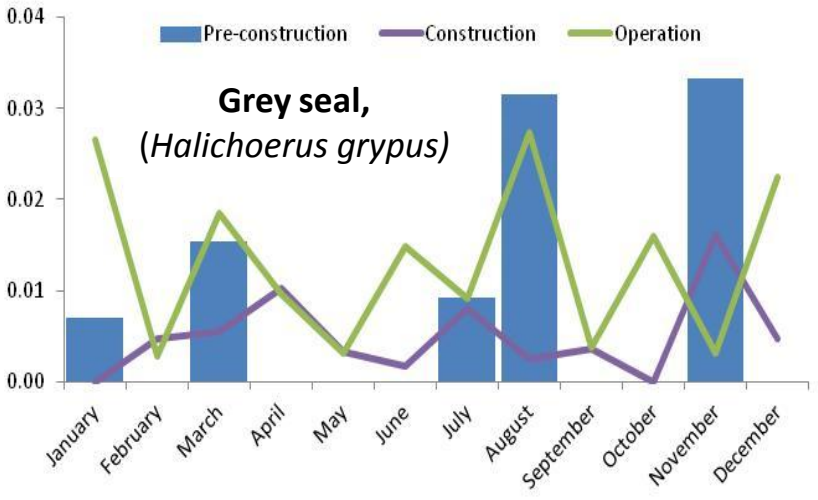
Marine Mammal Observations:

- Two species recorded, harbour porpoise & grey seal
- In total, 558 harbour porpoise and 106 grey seal were recorded; monthly Sighting Per Unit Effort (SPUE) presented below for all data.

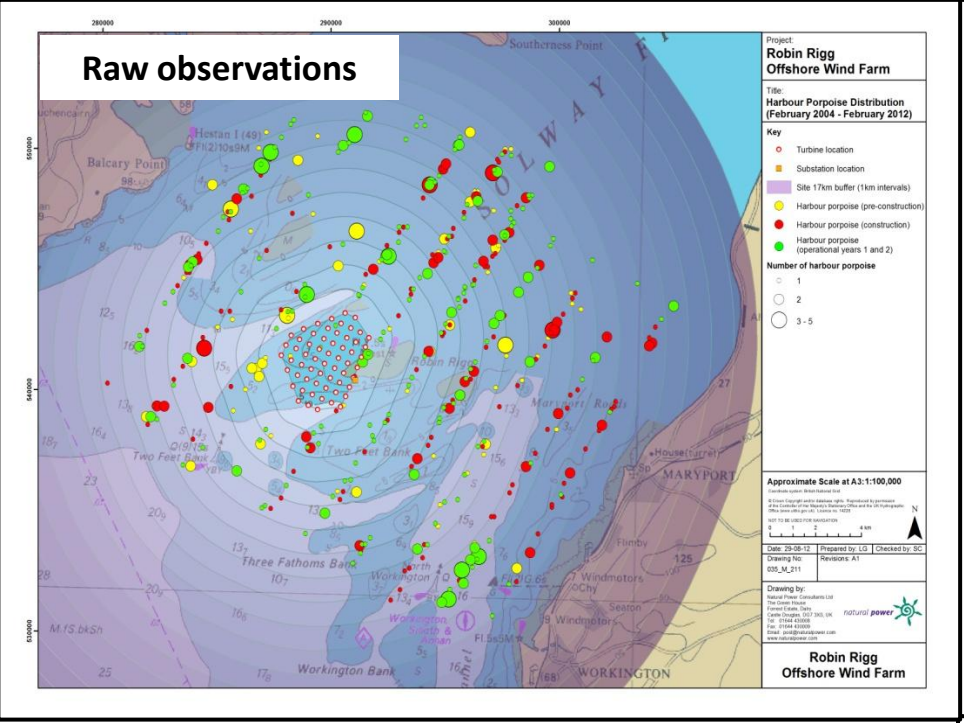


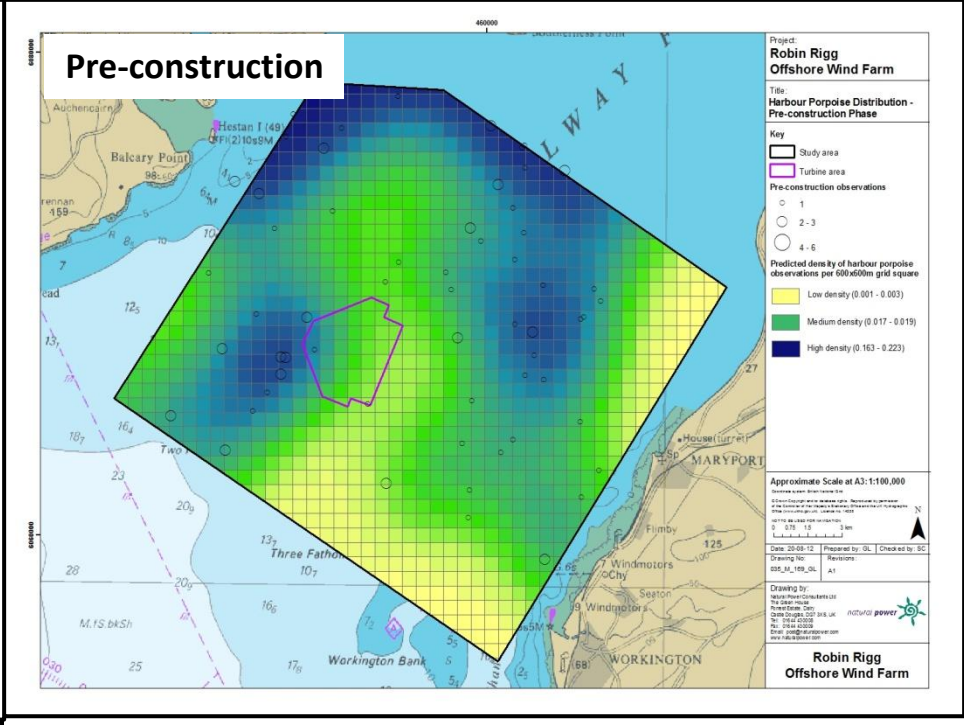


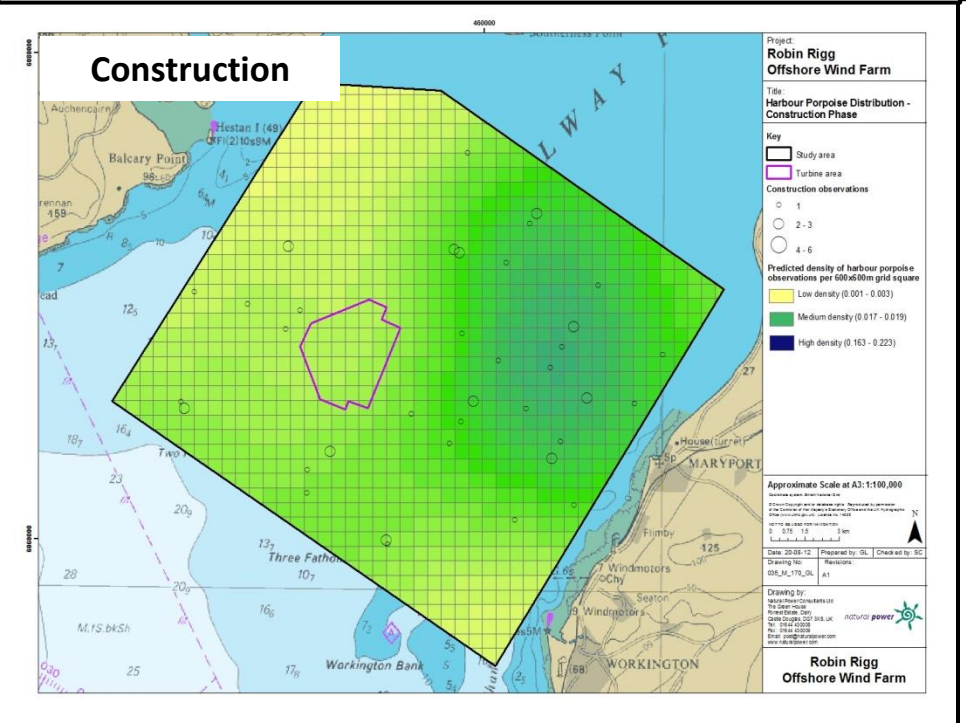
Grey seal	Pre-construction	Construction	Operation
No sightings (individuals)	19 (20)	35 (35)	49 (51)
SPUE (IPUE)	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
Harbour porpoise	**Pre-construction**	**Construction**	**Operation**
No sightings (individuals)	71 (99)	165 (212)	190 (247)
SPUE (IPUE)	0.05 (0.07)	0.03 (0.03)	0.05 (0.06)

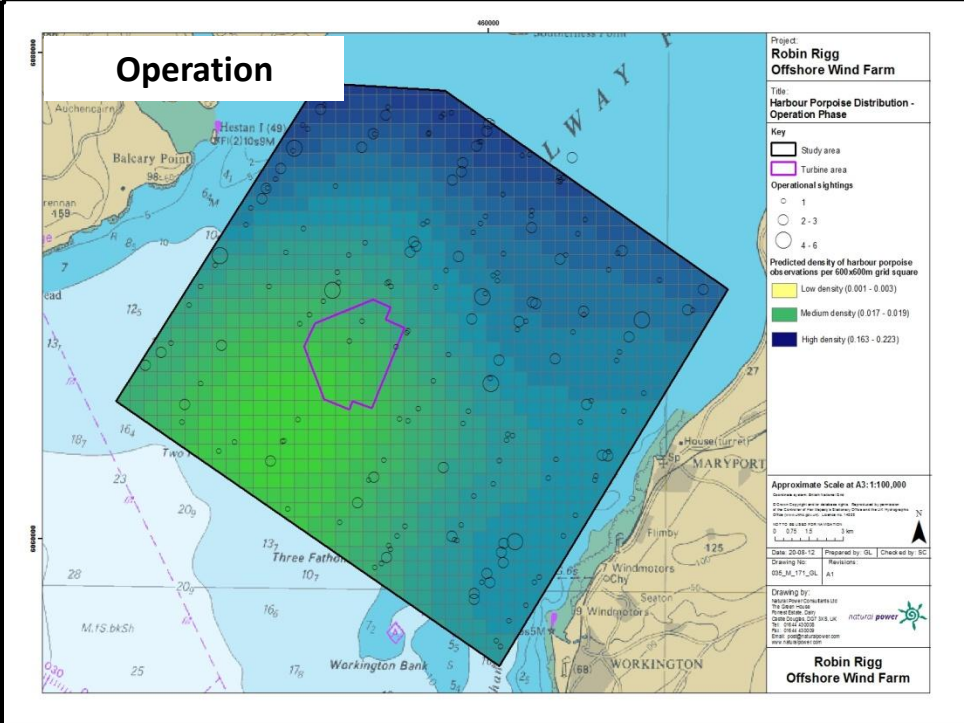
Marine Mammal Spatial Distribution:

- Density surface plots were produced (harbour porpoise only) in order to illustrate the relative abundance and distribution during the three phases of development.
- For each development phase, a two-dimensional x-y smooth was fitted using the GAM function in R v2.13.1.
- Harbour porpoise were recorded throughout the study area in all phases, although in differing densities.
- Density surface data suggest a decrease in sightings during the construction phase of the development with numbers increasing, particularly in the inner Firth areas of the survey area, during operational years one and two.
- This would be expected from other data on OWF (Germany, Denmark) in relation to mono-pilling noise effects.


Raw observations
Project:
Robin Rigg
Offshore Wind Farm
Title:
Harbour Porpoise Distribution
(February 2004 - February 2012)
Key
Turbine location
Substation location
Site 17km buffer (1km intervals)
Harbour porpoise (pre-construction)
Harbour porpoise (construction)
Harbour porpoise
(operational years 1 and 2)
Number of harbour porpoise
1
2
3 - 5
Approximate Scale at A3: 1:100,000
Robin Rigg
Offshore Wind Farm

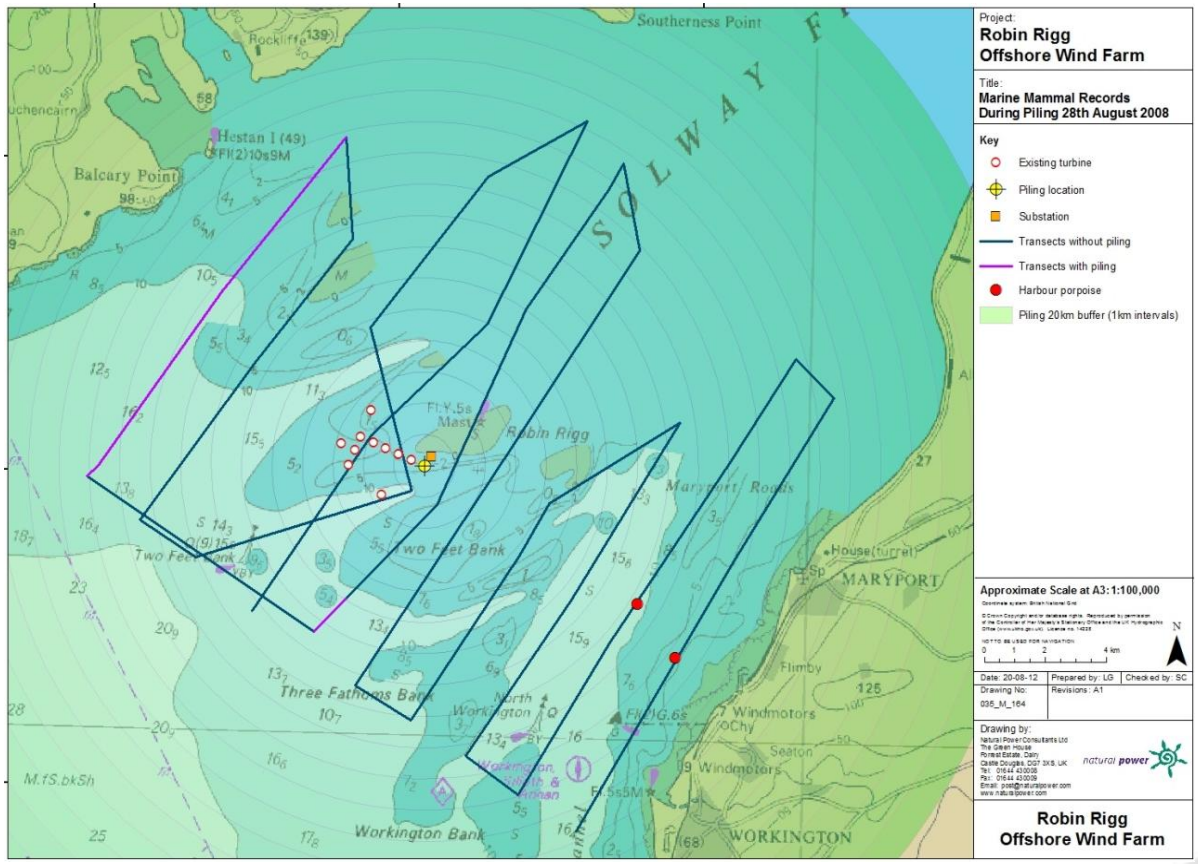

Pre-construction
Project:
Robin Rigg
Offshore Wind Farm
Title:
Harbour Porpoise Distribution -
Pre-construction Phase
Key
Study area
Turbine area
Pre-construction observations
1
2 - 3
4 - 6
Predicted density of harbour porpoise
observations per 600x600m grid square
Low density (0.001 - 0.003)
Medium density (0.017 - 0.019)
High density (0.163 - 0.223)
Approximate Scale at A3: 1:100,000
Robin Rigg
Offshore Wind Farm


Construction
Project:
Robin Rigg
Offshore Wind Farm
Title:
Harbour Porpoise Distribution -
Construction Phase
Key
Study area
Turbine area
Construction observations
1
2 - 3
4 - 6
Predicted density of harbour porpoise
observations per 600x600m grid square
Low density (0.001 - 0.003)
Medium density (0.017 - 0.019)
High density (0.163 - 0.223)
Approximate Scale at A3: 1:100,000
Robin Rigg
Offshore Wind Farm


Operation
Project:
Robin Rigg
Offshore Wind Farm
Title:
Harbour Porpoise Distribution -
Operation Phase
Key
Study area
Turbine area
Operational sightings
1
2 - 3
4 - 6
Predicted density of harbour porpoise
observations per 600x600m grid square
Low density (0.001 - 0.003)
Medium density (0.017 - 0.019)
High density (0.163 - 0.223)
Approximate Scale at A3: 1:100,000
Robin Rigg
Offshore Wind Farm

Pile driving monitoring surveys:

- Four surveys conducted during piling, mammals observed on 2.
- Harbour porpoise were observed 8.2 km from the piling event four hours after piling and at 10 km, five hours post piling
- Four monitoring surveys conducted the day after piling. Marine mammals were observed during three of the four surveys.



Summary for Offshore Wind:

- Key advantage has been **consistency in approach for comparing data pre, during & post construction**.
- Continued **advancement of ecological analysis methods & modelling**.
- Indication of **construction effects** – displacement effects on seabirds and pilling noise on harbour porpoise.
- Extent of **habituation** (from bird species and marine mammals) as operational years increase.
- **No effects recorded that are attributable** to the RR OWF from **benthic communities & fish**.
- License conditions from UK regulators need to be **practical to implement and ecologically appropriate**.
- Lack of more **robust pre-construction and construction data** (at Robin Rigg a pre-construction year for fish, additional marine mammal data collection techniques and seal-haul out data would have been an advantage to the developer and RRMG).
- **Lack of flexibility in monitoring / survey stations** (specified by licence conditions) proved problematic in such a mobile ecosystem as the Solway Firth with shifting sand banks.
- Data analysis is planned for publication in peer reviewed journals for dissemination along with distribution on Marine Scotland website.

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- Dave Piercy, Steve Percival
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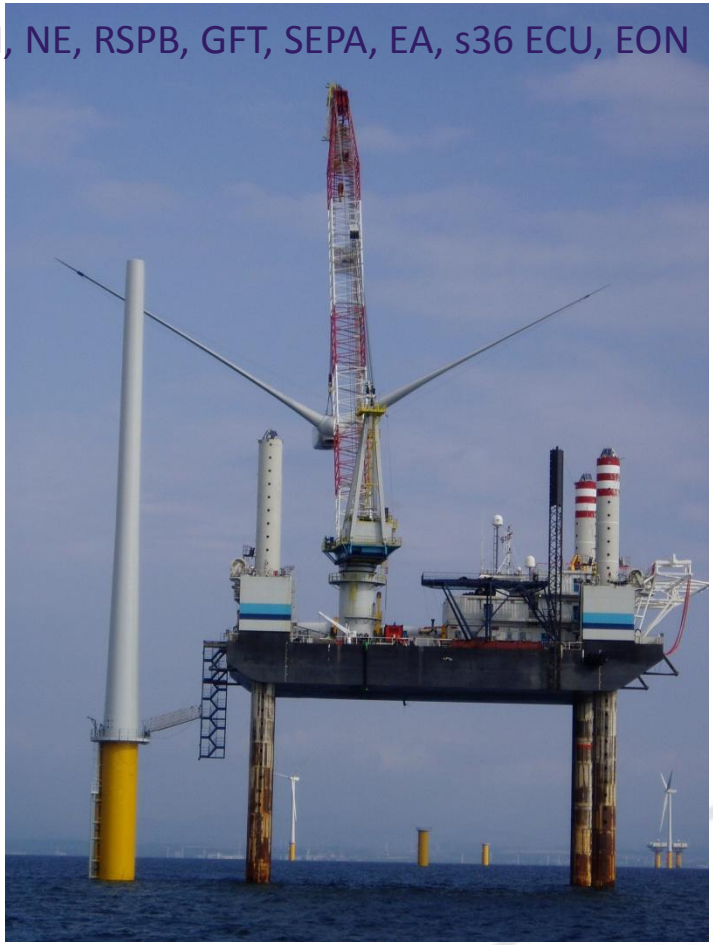
- Galloway Fisheries Trust (GFT)



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