Robin Rigg Offshore Wind Farm
Marine Environmental Monitoring Plan (MEMP): Ecological Analysis Data

Richard Walls, Director of Ecology & Hydrology, Natural Power Consultants
Sally Shenton, Site Manager, Robin Rigg, E.On Climate & Renewables

Sharing Good Practice: Marine Renewables, Battleby 03.11.2011
Summary Scope of talk:

1. Introduction to Robin Rigg Offshore Wind Farm
2. Timescales for Robin Rigg, Key Milestones
3. DVD of Robin Rigg Construction will be playing during the breaks/lunch
4. EIA predictions, MEMP Focus & RRMG
5. Natural Power - Ecological Analysis of MEMP Biological groups
6. Benthic communities
7. Non-migratory & electro-sensitive fish
8. Marine Mammals: (Harbour porpoise & grey seal)
9. Ornithology: (Red-throated diver, Common scoter, cormorant, guillemot, razorbill, kittiwake, herring gull & gannet)
10. Summary
Robin Rigg - Chronology:
- Baseline EIA 2001-2002 – Natural Power
- Granted consent in March 2003
- EON ownership from Sept 2003
- Constructed from January 2008 – Feb 2010
- Operational from March 2010
- OFTO sold in March 2011
Robin Rigg OWF, The Solway Firth:

180MW offshore wind farm:
- 60 turbines
- Offshore sub-station
- Onshore sub-station
- Onshore office & maintenance
- 2 x 14 km export cables
- Inter-array cables
- OFTO
Robin Rigg, The Solway:

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Robin Rigg
Offshore Wind Farm

Project: Robin Rigg
Title: Robin Rigg Wind Farm
Site Layout

Key:
- Turbine location
- Sub-sea cable route
- Offshore substation
- Onshore substation

Approximate Scale at A3: 1:60,000

Drawing by:
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Date: 07.06.11
Prepared by: GL
Checked by: RW
Revisions:

035_M_058
Grid Connection – post-OFTO:

Offshore Transmission Operator

Seaton Onshore Substation

Onshore 132kV cable x2

Robin Rigg Offshore Substation

Submarine 132kV cable x2

Inter-array cables at 33kV x 64

Windfarm

Connection Point 300mm along offshore cable
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.

- Benthic Communities (OWF & Cable)
- Non-migratory Fish
- Electro-sensitive Fish
- Birds (RH, CX, 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 & Ecological Marine Monitoring, data & analysis to RRMG by EON/Natural Power
MEMP: Benthic communities
### Benthic survey dataset & Timescales:

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#### EIA
- Pre-construction
- Construction
- Operation

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**marinescotland**

**Scottish Natural Heritage**

**e.on**

**Climate & Renewables**

**natural power**
Benthic communities:

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Project
Robin Rigg
Offshore Wind Farm

Title:
Locations of Benthic Sampling Stations and Fish Trawls

Key
- Baseline sampling station
- Trawl routes

Approximate Scale at A3: 1:120,000

Drawing by:
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Benthic – Analysis:

- **Analysis of Biotope, Community structure & Sp Diversity**
- A total of 3590 individuals from 220 taxa identified; (baseline, pre-construction & construction)
- A variety of statistical tests were used to examine the data including: Bray Curtis similarity tests (illustrated by MDS plots), Diversity tests, ANOVA, ANOSIM and PERMANOVA+.

### Species and Number of Individuals

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathyporeia elegans</td>
<td>1002</td>
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<tr>
<td>Nephtys cirrosa</td>
<td>454</td>
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<tr>
<td>Scalibregma inflatum</td>
<td>258</td>
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<tr>
<td>Fabulina fabula</td>
<td>165</td>
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<tr>
<td>Mysella bidentata</td>
<td>148</td>
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<tr>
<td>Pseudocuma longicorne</td>
<td>144</td>
</tr>
<tr>
<td>Magelona johnstonii</td>
<td>139</td>
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<tr>
<td>Scalibregma mesnili</td>
<td>107</td>
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<tr>
<td>Pomatoceros lamarcki</td>
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<td>Bathyporeia nana</td>
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<tr>
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<tr>
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<td>Gastroscoccus spinifer</td>
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<td>Nephtys caeca</td>
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<td>Echinocardium cordatum</td>
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<td>Bathyporeia elegans</td>
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<td>Donax vittatus</td>
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<td>Ophelia borealis</td>
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<tr>
<td>Bathyporeia sarsi</td>
<td>28</td>
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</tbody>
</table>

Nonmetric multi-dimensional scaling ordinations of benthic abundance data (untransformed) for each sampling period (baseline; pre-construction and during construction).
### Benthic - Key Findings:

<table>
<thead>
<tr>
<th>Ecological Group</th>
<th>Predictions from ES</th>
<th>Main conclusions: Pre-construction-construction analysis</th>
</tr>
</thead>
</table>
| Benthic          | • The only biotope present within the wind farm site was *SS.SSa.IFiSA.NcirBat*, characterised by *Nephys cirrosa* and *Bathyporeia* species in infralittoral sand.  
• Habitat loss for the above species as a result of the Robin Rigg was predicted to be 0.4%.  
• No significant long-term impacts on benthos were predicted. | • The benthic environment at the Robin Rigg wind farm site is dynamic.  
• changes in community structure & diversity over time are expected at any given sampling location.  
• Species diversity and community structure varied significantly among years.  
• Community structure did not vary between the control, cable-route and site areas.  
• No evidence that changes in species diversity and/or community structure are attributable to construction of the Robin Rigg wind farm. |

**Operational Year 1 Preliminary Analysis:**

- **Biotype classification:**
  - Predominant biotype remained same since baseline (EIA) data period.
- **Variation in community structure:**
  - No significant difference in benthic community types during the four survey periods;
  - Ops Yr1 confirmed only changes in benthic community between baseline & pre-construction
  - A dip in the numbers of fish & invertebrates captured during construction (although Non-significant)
- **Species diversity:**
  - Diversity low during all periods, as expected for the Solway Firth
MEMP: Non-migratory & electro-sensitive fish
Non-migratory & electro-sensitive fish monitoring:

<table>
<thead>
<tr>
<th>Fish</th>
<th>Jan</th>
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EIA Pre-construction Construction Operation

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![Fish Images]
Electro-sensitive fish:

- Turbines connected (4 loops 33kV AC submarine cables, Linked to shore via 2 submarine HV 132 kV AC cables.
- Focal species: *elasmobranchs* (sharks, rays and skates) (COWRIE/FEPA guidance)
- 8 surveys along cable route for EMF fish & fish caught from non-migratory fish sampling.
- 3 species found in vicinity of Robin Rigg (figures in brackets represent number found):

  - Thornback ray (57)
  - lesser spotted dogfish (56)
  - blond ray (1)

**Distribution of elasmobranches during baseline surveys (2001-2002: left)**

**Construction phase surveys (2008-2009: right)**

(Mean per location)
NM Fish & ESF - Key Findings:

<table>
<thead>
<tr>
<th>Ecological Group</th>
<th>Predictions from ES</th>
<th>Main conclusions: Pre-construction-construction analysis: Yr1, below table</th>
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<tbody>
<tr>
<td>Non-migratory Fish</td>
<td>• Negligible impacts on commercially important flatfish (plaice/sole).</td>
<td>• Significant change in community structure of fish and epifauna among years.</td>
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<td>• Short-term displacement of demersal species (e.g. whiting).</td>
<td>• Community structure did not vary between the control, cable-route and site areas.</td>
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<td>• Impacts on migratory and non-migratory fish expected to be low.</td>
<td>• Evidence for a general decrease in species richness of both fish and epifaunal species through time, potentially due to re-positioning of channels.</td>
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<td>• No evidence that observed changes in species richness and/or community structure is attributable to construction of the Robin Rigg wind farm.</td>
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<tr>
<td>Electro-sensitive fish</td>
<td>• Focal electro-sensitive fish found in proximity to the Robin Rigg wind farm were</td>
<td>• Electro-sensitive species found within the vicinity of the Robin Rigg wind farm will be able to detect EMF from cabling.</td>
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<tr>
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<td>thornback ray, lesser spotted dogfish and Blond ray. These were observed in small</td>
<td>• During baseline/pre-construction the majority of electro-sensitive fish species were found on Scottish Solway coast, away from the cable route suggesting this area is not as important for these species.</td>
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<td>numbers.</td>
<td>• Potential effects of EMF from the electrified cable on electro-/magneto-sensitive fish are likely to remain negligible/minimal significance.</td>
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**Abundance:**
• Number of fish decreased during construction period but increased to almost pre-construction values in Ops Yr1;
• Similar trend for invertebrates with double the number recorded during Ops Yr1 compared to baseline;

**Variation in community structure:**
• Wind farm area - Very little change in community structure between study periods for fish & epifauna.
• Cable route – Some evidence of a change in fish structure between periods. No change for epifauna.

**Species diversity:**
• Some evidence of a difference in diversity between study periods for both the wind farm area (pre-cons vs. Ops Yr1) & cable route (Ops Yr1 1 vs. pre-construction/cons).
MEMP: Marine Mammals
Marine mammal summary:

1. Boat-based observations (pre-COWRIE), single observer
2. Segment transects by distance to produce replicate sampling blocks of equal effort
3. For each phase, fit General Additive Models (GAMs) to data including covariates
### Key Findings: marine mammals

<table>
<thead>
<tr>
<th>Species</th>
<th>Predictions from ES</th>
<th>Main conclusions from construction analysis</th>
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| **Harbour porpoise** | 120 individuals recorded pre-construction (not adjusted for survey effort circa 6 mths).  
- Short-term avoidance of local area of construction works expected.  
- Mitigation should be used to avoid startle/alarm responses in response to the onset of piling activities.  
- Impact on small cetacean species expected to be low. | 271 individuals recorded during construction (not adjusted for survey effort circa 25 mths).  
- Harbour porpoise observations across the study area decreased between the pre- and during construction periods, but this could not be directly attributed to construction activities.  
- Numbers of harbour porpoises observed increased significantly with days since the last piling and/or construction activity suggesting short-term displacement associated with these activities.  
- Evidence from other studies would indicate that noise effects cause displacement effects to marine mammals such as harbour porpoise at Robin Rigg. |
| **Grey seal**   | 73 individuals recorded pre-construction (not adjusted for survey effort circa 6 mths).  
- Short-term changes in behaviour of seals close to the site at the start of construction.  
- Low risk of physiological risks to seals due to piling.  
- Seals expected to habituate to construction activities.  
- Impact on seals considered to be moderate. | 184 individuals recorded during construction (not adjusted for survey effort circa 25 mths).  
- Low numbers of grey seal observations (95 observations when hauled out individuals are excluded) greatly reduce the likelihood of detecting any response to construction activities.  
- Grey seals were not observed within 3km of the wind farm area during pre-construction surveys or within 1.5km of the wind farm during construction.  
- Grey seal observations across the study area decreased between the pre- and during construction periods, but this could not be attributed to construction activities.  
- No evidence was found for impacts of piling on grey seal but this is likely to be due to the very low number of grey seals observed during the construction period (57 observations when hauled out individuals are excluded). |
MEMP: Ornithology
**Bird & Marine Mammal Surveys:**

- Boat-based visual surveys collected on monthly basis
- One survey per month pre-construction & operation (alternating high/low tide)
- Two surveys conducted per month during construction phase, (1 = high tide & 1 = low tide per mth)
- 10 boat transects, each about 18 km long, 2 km apart

Pre-COWRIE guidelines for baseline works.

(Primary vessel used 16 m long with viewing height of 4 m above sea level).

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EIA | Pre-construction | Construction | Operation
Boat-based Survey Area (study area):
Data collation, processing & GIS:

• Boat data divided into equal sized sampling units: Birds = 600 m²; Mammals = 1 km²
• Linked each sampling unit with underlying sea depth & geology data
• Calculate sampling unit mid point and distance to coast
• Link sightings recorded per day with corresponding sampling units of individual survey section for same day
Birds Statistical Analysis:

- Use distance sampling analysis to account for birds not seen by observers during surveys.
- Segment transects by distance (600m) to produce replicate sampling blocks of equal effort.
- For each phase, fit General Additive Models (GAMs) to data including covariates: (sea state, sea depth, sediment type, x, y & month).
- Use the model to estimate bird abundance and predict bird distribution across the survey area (R version 13.1).
- This approach produces the modelled density surfaces shown in the following figures of phases.
- Test for significant differences in bird number & distribution among the phases.
Bird & marine mammal summary:

- Raw count data for the Whole Study Area – which includes RR WF site (average count per survey month):

<table>
<thead>
<tr>
<th>Key species</th>
<th>No sightings per month effort</th>
<th>No individuals per month effort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre Construction</td>
<td>Construction</td>
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<tr>
<td>Birds</td>
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<tr>
<td>Common scoter</td>
<td>24</td>
<td>74</td>
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<tr>
<td>Cormorant</td>
<td>10</td>
<td>38</td>
</tr>
<tr>
<td>Gannet</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>Guillemot</td>
<td>87</td>
<td>163</td>
</tr>
<tr>
<td>Kittiwake</td>
<td>20</td>
<td>35</td>
</tr>
<tr>
<td>Manx shearwater</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Razorbill</td>
<td>23</td>
<td>48</td>
</tr>
<tr>
<td>Red-throated diver</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Sandwich tern</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Scaup</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Marine Mammals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harbour porpoise</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Grey seal</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Birds (on water) analysis:

- **Estimated abundances based on the Model** developed using R (Density Surface Model):

<table>
<thead>
<tr>
<th>Species</th>
<th>Study area</th>
<th>Site</th>
<th>% of total within site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Preconstruction</td>
<td>Construction</td>
<td>Operation</td>
</tr>
<tr>
<td>Common scoter</td>
<td>20784 (269)</td>
<td>13298 (747)</td>
<td>61123 (205)</td>
</tr>
<tr>
<td>Red-throated diver</td>
<td>123 (153)</td>
<td>89 (173)</td>
<td>164 (205)</td>
</tr>
<tr>
<td>Manx shearwater</td>
<td>** (16)</td>
<td>34 (86)</td>
<td>1098 (27)</td>
</tr>
<tr>
<td>Gannet</td>
<td>72 (60)</td>
<td>48 (97)</td>
<td>** (11)</td>
</tr>
<tr>
<td>Cormorant</td>
<td>97 (110)</td>
<td>68 (222)</td>
<td>189 (102)</td>
</tr>
<tr>
<td>Kittiwake</td>
<td>350 (145)</td>
<td>111 (323)</td>
<td>166 (56)</td>
</tr>
<tr>
<td>Herring gull</td>
<td>274 (63)</td>
<td>78 (126)</td>
<td>23 (25)</td>
</tr>
<tr>
<td>Great black-backed gull</td>
<td>23 (36)</td>
<td>15 (112)</td>
<td>393 (50)</td>
</tr>
<tr>
<td>Guillemot</td>
<td>1221 (1942)</td>
<td>1109 (3461)</td>
<td>1455 (954)</td>
</tr>
<tr>
<td>Razorbill</td>
<td>1894 (484)</td>
<td>484 (1059)</td>
<td>2108 (218)</td>
</tr>
<tr>
<td>Auk species</td>
<td>2962 (2506)</td>
<td>1482 (4689)</td>
<td>5881 (1242)</td>
</tr>
</tbody>
</table>

** = too few data to analyse
Number in brackets = number of observations used in analysis
Red-throated Diver Distribution (Raw observations): (on the water)
Red-throated Diver - Density Surfaces – 3 Phases: (on the water)

**Pre-construction**

- **Study area**
- **Turbine area**

**Pre-construction observations**
- 1
- 2-3
- 4-5
- 6-15
- 16-108

**Predicted distribution of red-throated diver**
- Low density (0 - 0.002 birds per grid square)
- Medium density (0.111 - 0.129 birds per grid square)
- High density (2.507 - 3.162 birds per grid square)

*Predicted for month of peak abundance - April*

**Approximate Scale at A3: 1:100,000**

**Construction**

- **Study area**
- **Turbine area**

**Construction phase observations**
- 1
- 2-3
- 4-5
- 6-15
- 16-108

**Predicted distribution of red-throated diver**
- Low density (0 - 0.002 birds per grid square)
- Medium density (0.111 - 0.129 birds per grid square)
- High density (2.507 - 3.162 birds per grid square)

*Predicted for month of peak abundance - April*

**Approximate Scale at A3: 1:100,000**

**Operational Year 1**

- **Study area**
- **Turbine area**

**Operation year 1 observations**
- 1
- 2-3
- 4-5
- 6-15
- 16-108

**Predicted distribution of red-throated diver**
- Low density (0 - 0.002 birds per grid square)
- Medium density (0.111 - 0.129 birds per grid square)
- High density (2.507 - 3.162 birds per grid square)

*Predicted for month of peak abundance - April*

**Approximate Scale at A3: 1:100,000**

**Difference (Pre-Ops Year1)**

- **Study area**
- **Turbine area**

**Change in predicted distribution of dives**
- Decrease in density (2.799 - 2.137 fewer birds per grid square)
- Little change in density
- Increase in density (2.176 - 3.057 more birds per grid square)

*Predicted for month of peak abundance - April*

**Approximate Scale at A3: 1:100,000**

**e-on Climate & Renewables**
Common Scoter Distribution (Raw observations): (on the water)
Common Scoter - Density Surfaces – 3 Phases: (on the water)
Cormorant Raw Observations: (on the water)
Cormorant – Density Surfaces – 3 Phases: (on the water)

**Pre-construction**
- Study area
- Turbine area
- Pre-construction observations
  - 1
  - 2-5
  - 6-10
  - 11-20
  - 31-65
- Predicted distribution of cormorant:
  - Low density (0 - 0.001 birds per grid square)
  - Medium density (0.001 - 0.097 birds per grid square)
  - High density (2.754 - 5.387 birds per grid square)

**Construction**
- Study area
- Turbine area
- Construction phase observations
  - 1
  - 2-5
  - 6-10
  - 11-20
  - 31-65
- Predicted distribution of cormorant:
  - Low density (0 - 0.001 birds per grid square)
  - Medium density (0.001 - 0.097 birds per grid square)
  - High density (2.754 - 5.387 birds per grid square)

**Operational Year 1**
- Study area
- Turbine area
- Operation year 1 observations
  - 1
  - 2-5
  - 6-10
  - 11-20
  - 31-65
- Predicted distribution of cormorant:
  - Low density (0 - 0.001 birds per grid square)
  - Medium density (0.001 - 0.097 birds per grid square)
  - High density (2.754 - 5.387 birds per grid square)

**Difference (Pre-Ops Year1)**
- Study area
- Turbine area
- Change in predicted distribution of cormorant:
  - Decrease in density (1.849 - 1.315 fewer birds per grid square)
  - Little change in density
  - Increase in density (2.811 - 5.255 more birds per grid square)
  - Significant change in bird numbers

Approximate Scale at A:1/180,000

<e-on Climate & Renewables logo>
Cormorant:
Kettiwake & Herring gull Observations & Density Surfaces:

Difference (Pre-Ops Year1)
Guillemot Raw Observations: (on the water)
Guillemot – Density Surfaces – 3 Phases: (on the water)

Pre-construction

Construction

Operational Year 1

Difference (Pre-Ops Year1)
Razorbill Raw Observations: (on the water)
Razorbill - Density Surfaces – 3 Phases: (on the water)

Pre-construction

Construction

Operational Year 1

Difference (Pre-Ops Year1)
Gannet Raw Observations: (on the water)
Gannet - Density Surface – 3 Phases: (on the water)

Pre-construction

Construction

Difference (Pre-Ops Year1)
Birds Analysis Summary at this stage:

(Birds on the water):

Applying Caution at an early stage:

1. **Little indication of an effect** on:
   - Common scoter, Red-throated diver & Scaup as predicted by ES
2. **Increase in Cormorant** during construction phase & into Ops Yr1+
3. No obvious displacement of gull species (GBB, HG & KI)
4. **Indication from Ops Yr1 of a displacement rates** of circa 30% for Auk species
   *(between pre-construction & Ops Yr1) from the modelled densities for Site vs. Study area*
5. **Indication from Ops Yr1 of a displacement rates** of circa 50% for Gannet
   *(between pre-construction & Ops Yr1) from the modelled densities for Site vs. Study area*
   (More post-construction data being collected for analysis)
7. Fulmar, LBB, Manx shearwater, & Tern sp – too little or infrequent data to model
8. Unable to model birds in flight due to no snapshot data, simple analysis alternative
Summary of MEMP:

1. Next steps will be the finalisation of Ops Yr1 & Ops Yr2 data
2. Confirmation of preliminary findings
3. Dissemination of key ecological findings from the MEMP
4. RRMG meetings will plan the next steps & lessons learned from the process
Acknowledgements:

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- Dr Sarah Canning – *Natural Power*
- Dr Jane Lancaster – *Natural Power*
- Dr Chris Pendlebury – *Natural Power*
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- Eric Rexsted & Monique MacKenzie, *CREEM, The University of St Andrews*
- AMEC (formerly ENTEC)
- Galloway Fisheries Trust (GFT)

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