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AGIR pour la BIODIVERSITÉ

ORJIP Bird avoidance behaviour and collision impact monitoring at offshore wind farms

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Consenting risk is a major issue for offshore wind

The challenge

Consent to build increasingly depends on the risk of environmental impact

Developers to prove that the risk is acceptable

Two most notable environmental impacts:
Birds – fatalities due to collision, and population displacement
Marine Mammals –injury from high levels of underwater noise due to construction, and population displacement


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Gannets, puffins, kittiwakes: birds at risk in Scottish windfarm surge

After a long legal battle, 335 turbines will now be built in Scottish waters

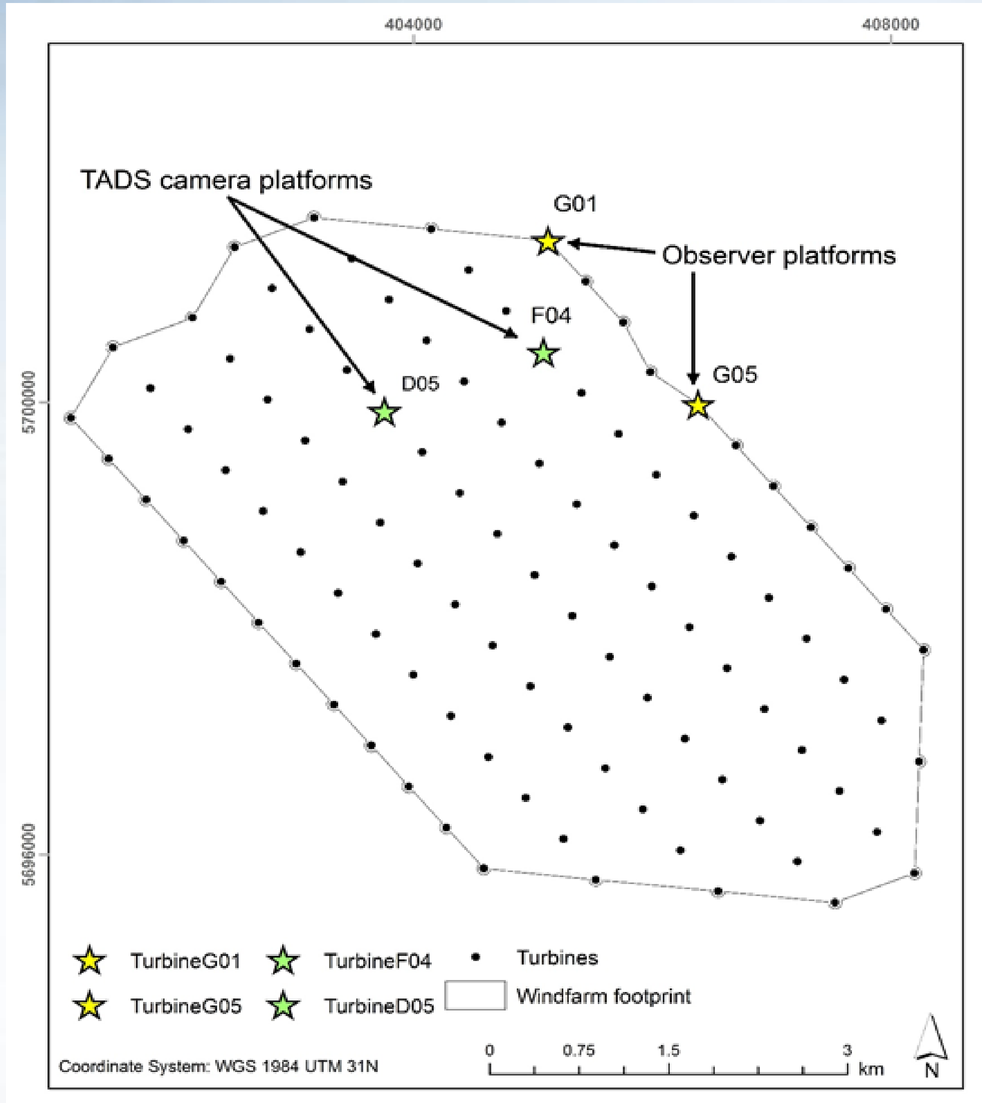
ORJIP Bird collision avoidance study

Offshore Renewable Joint Industry Programme (ORJIP)

Objective: To improve the evidence base informing bird collision avoidance rates to inform consenting decisions

ORJIP study site

Combination of observer-aided and automated tracking at species level



Five Priority Species

Northern Gannet/
Fou de bassan

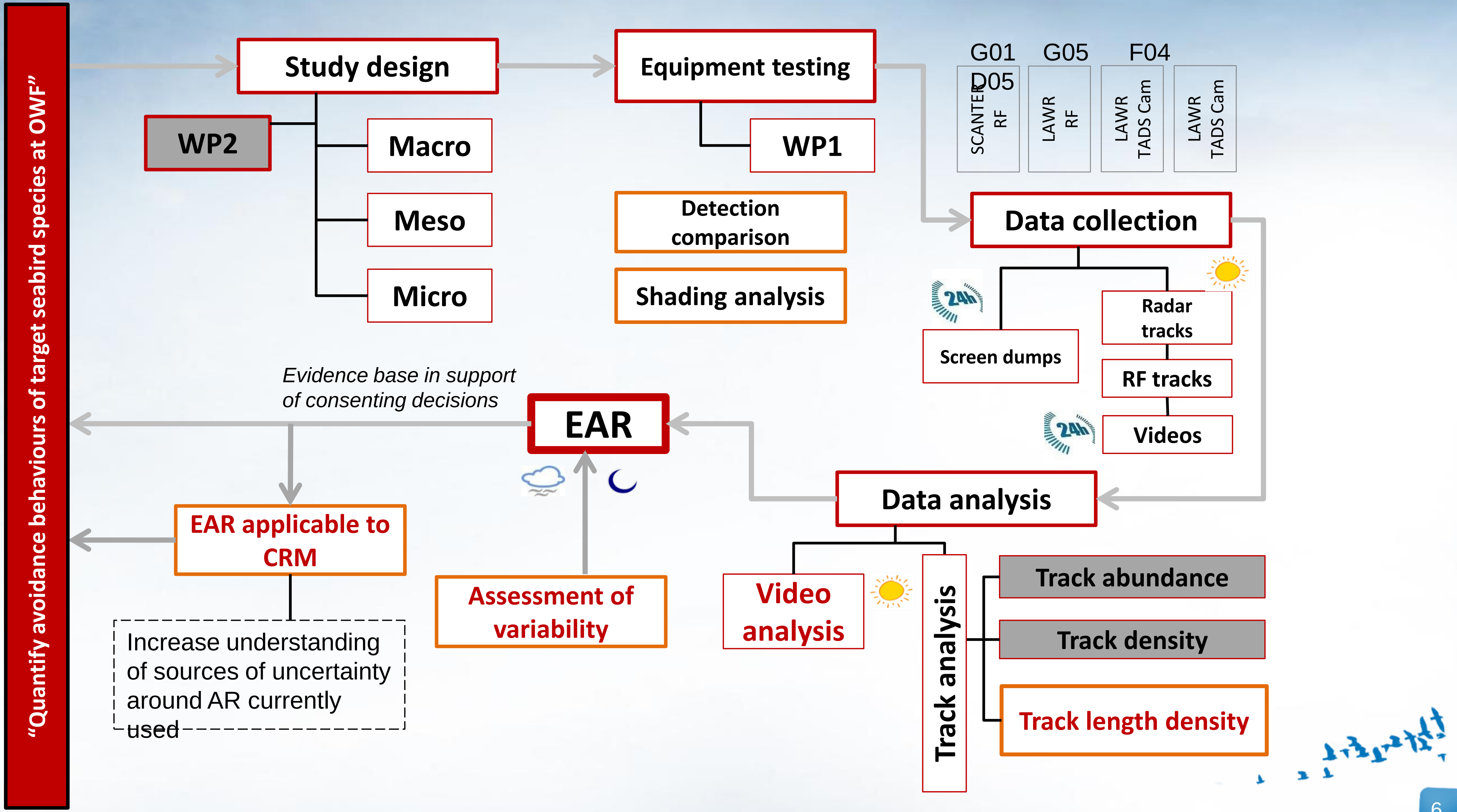
Herring Gull
Goéland argenté

Black-legged kittiwake
Mouette tridactyle

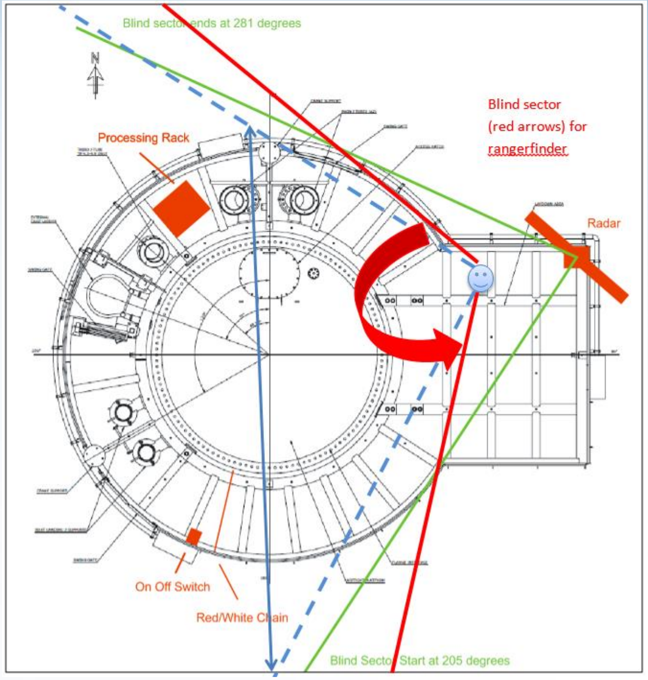
Lesser Black-backed Gull
Goéland brun

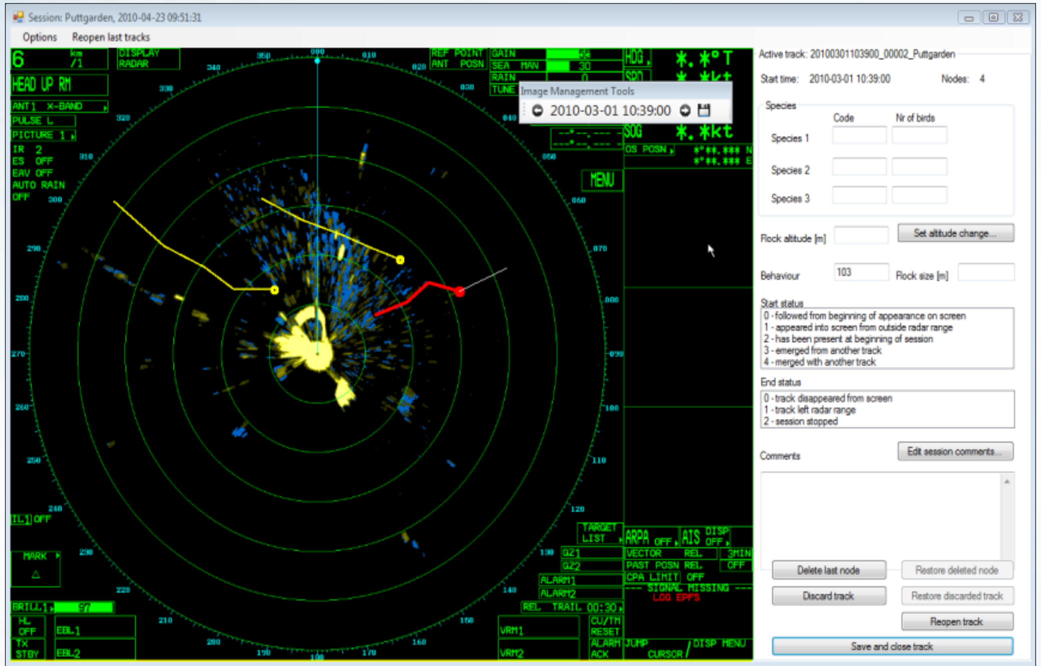
Great Black-backed Gull
Goéland marin

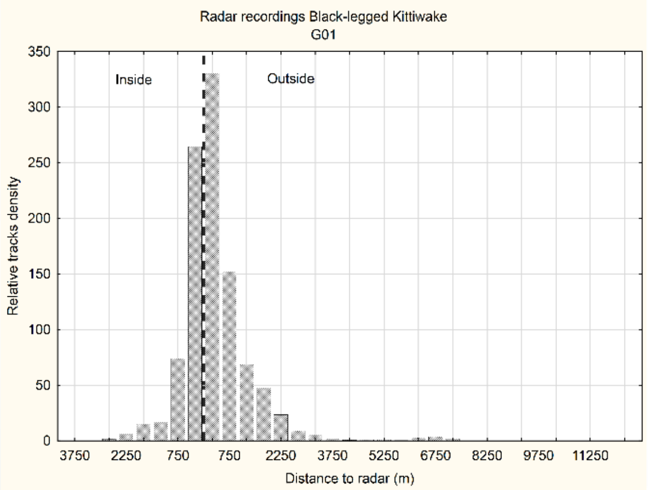
ORJIP analytical framework



Observer-aided radar tracking

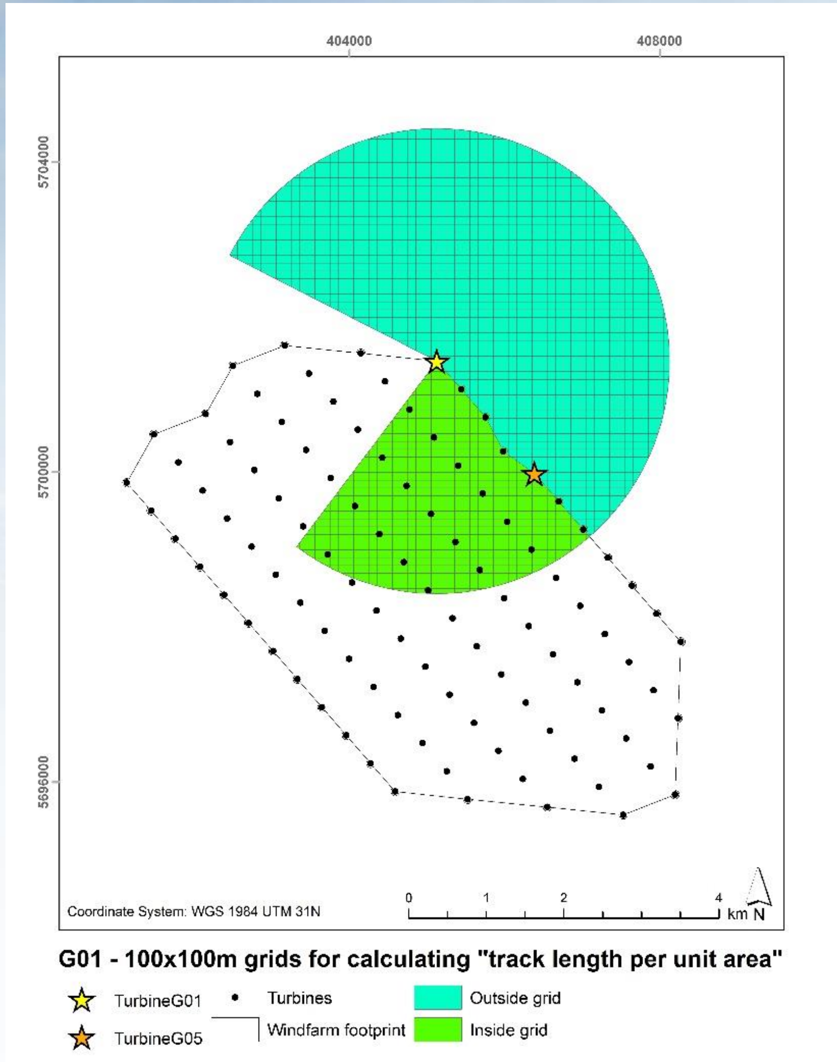


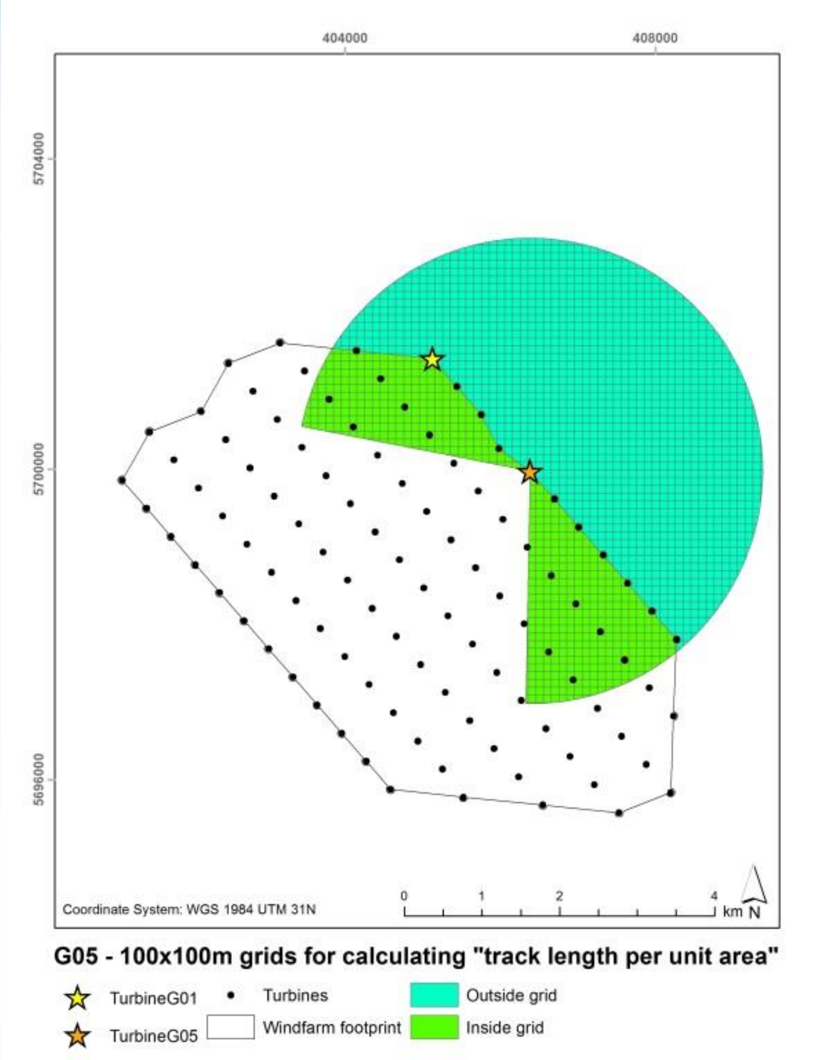




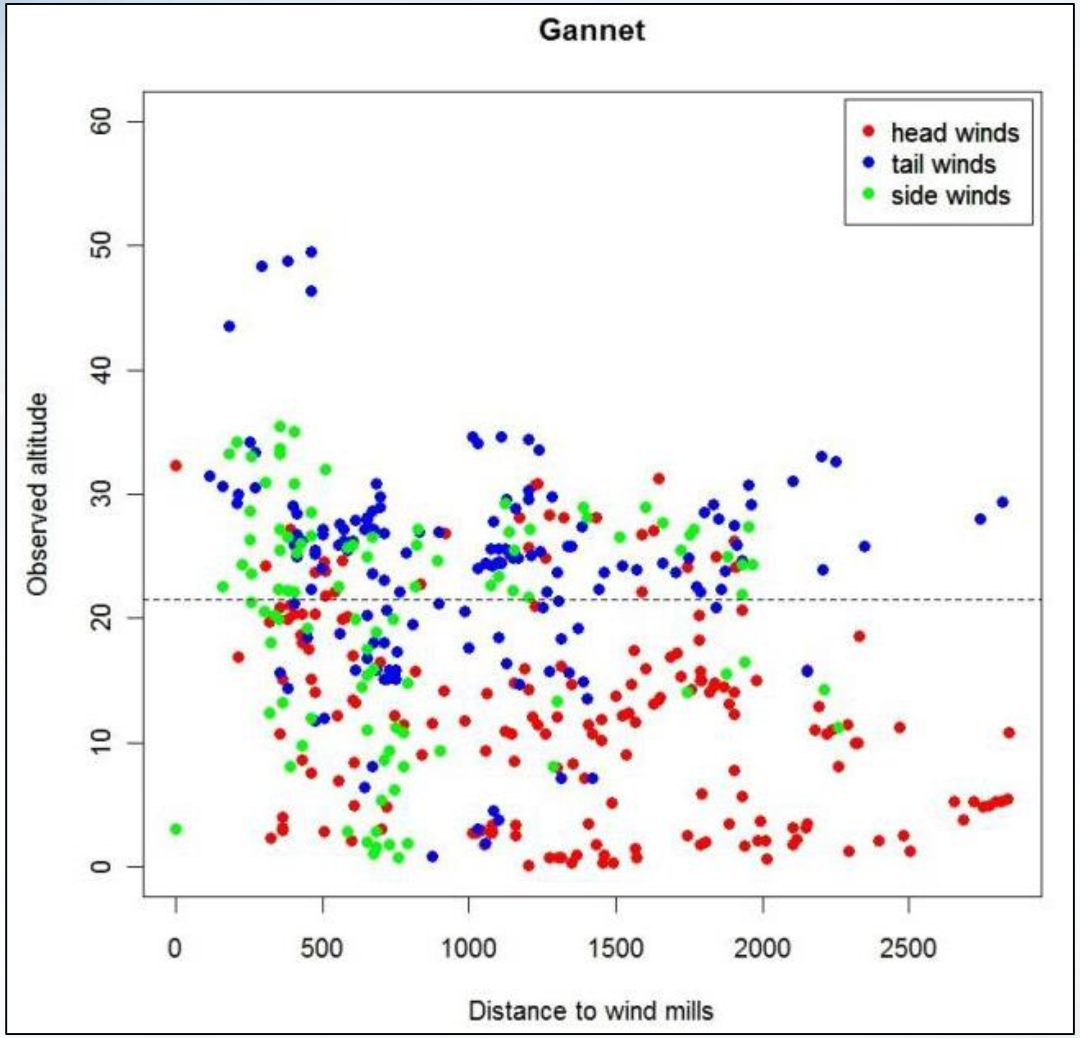
Observer-aided rangefinder tracking

3 km detection range



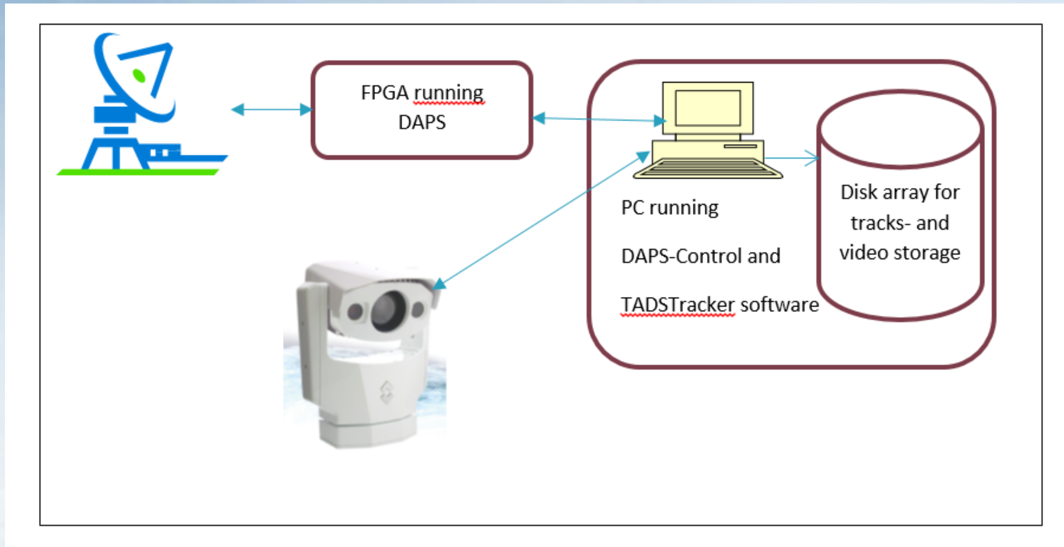


Weather-induced variability in bird flight behaviour



Source: Skov & Heinänen 2015; Predicting the weather-dependent collision risk for Birds at Wind Farms. Wind & Wildlife Proc. Springer Science

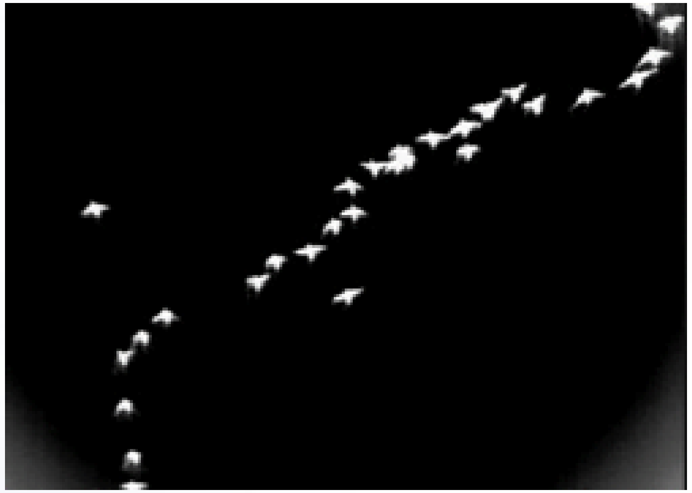
Development of radar-camera integration



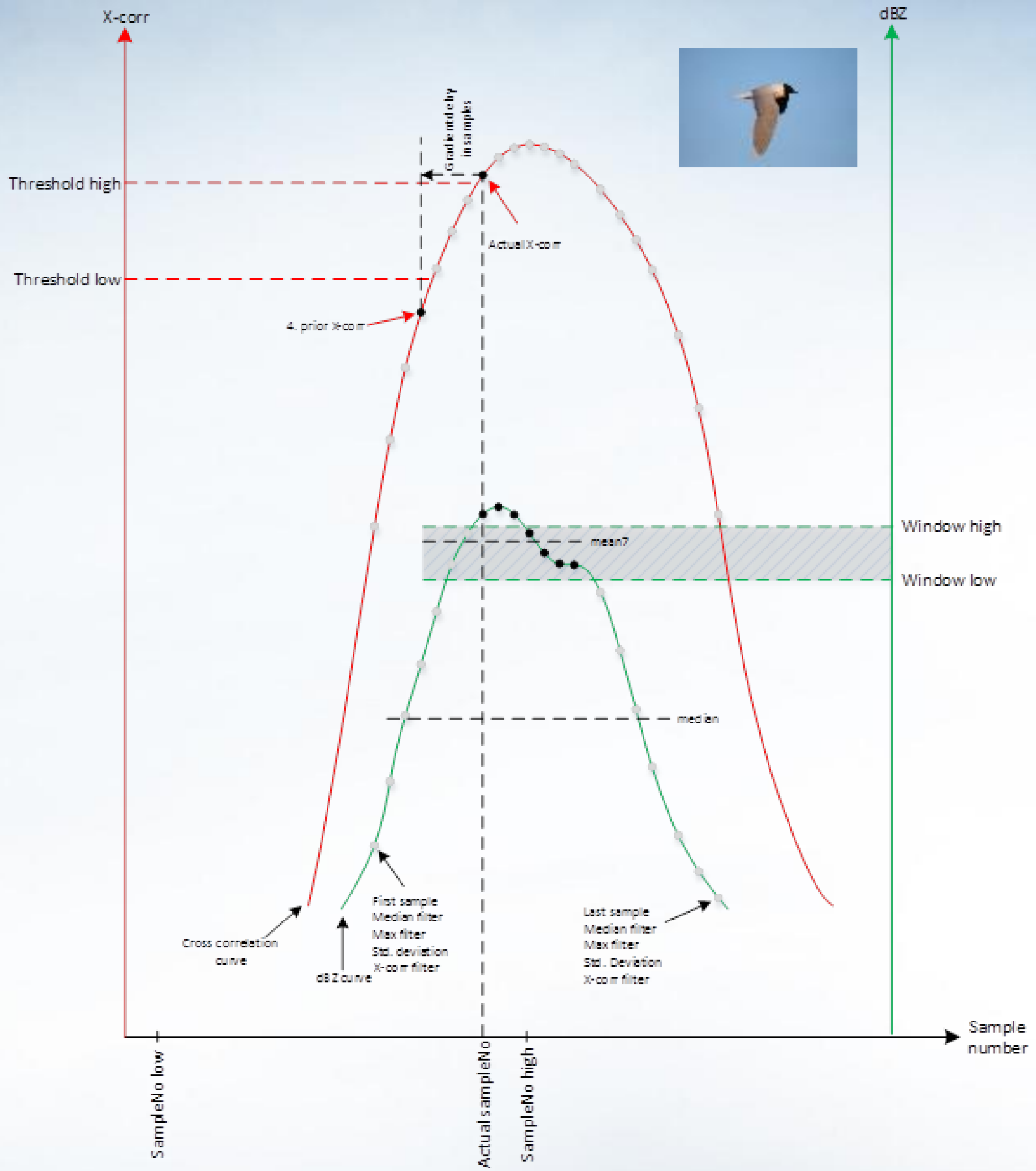
MUSE (MUlti-SEnsor animal detection system):

High-speed signal processing

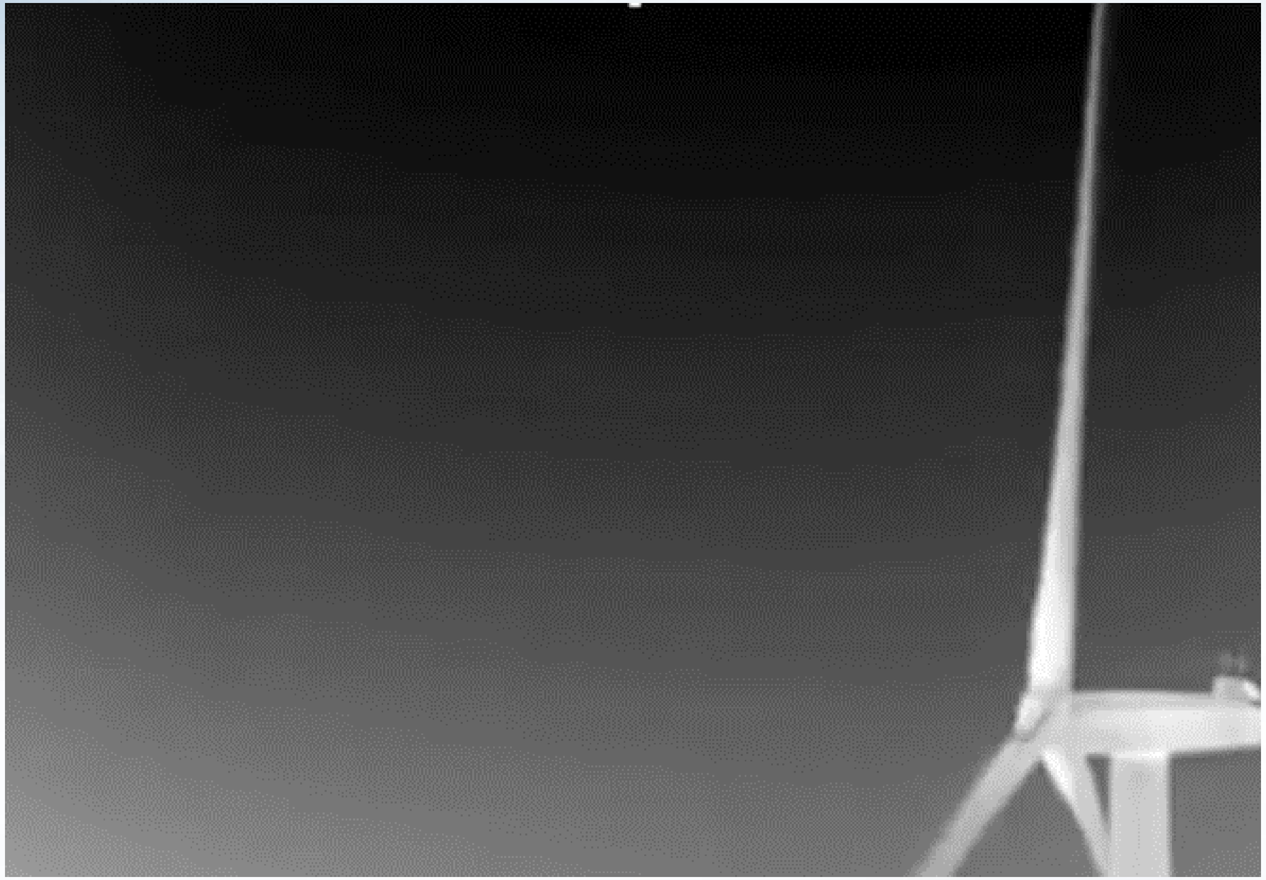
Embedded programming



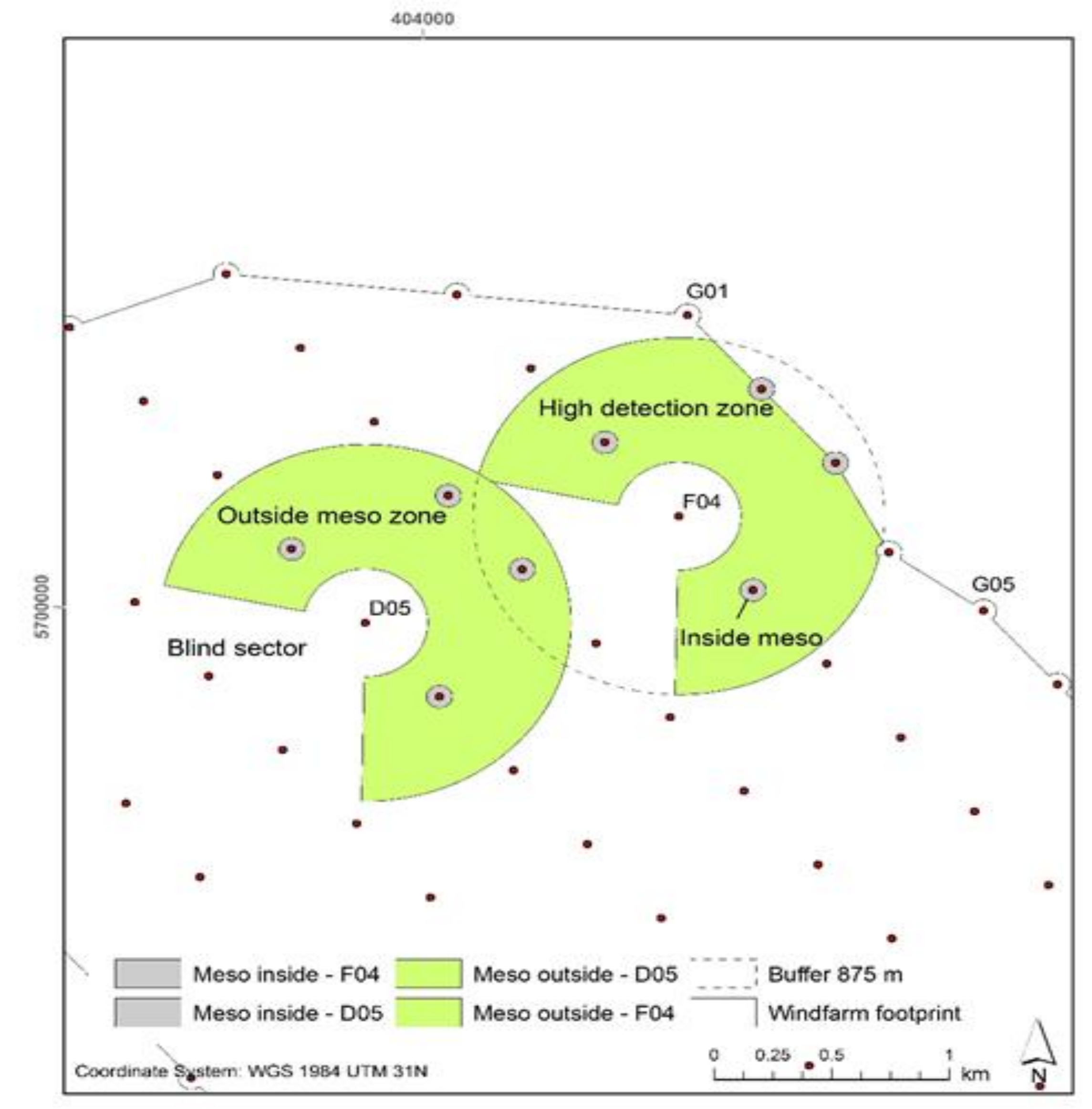
Characterisation of radar bird signals



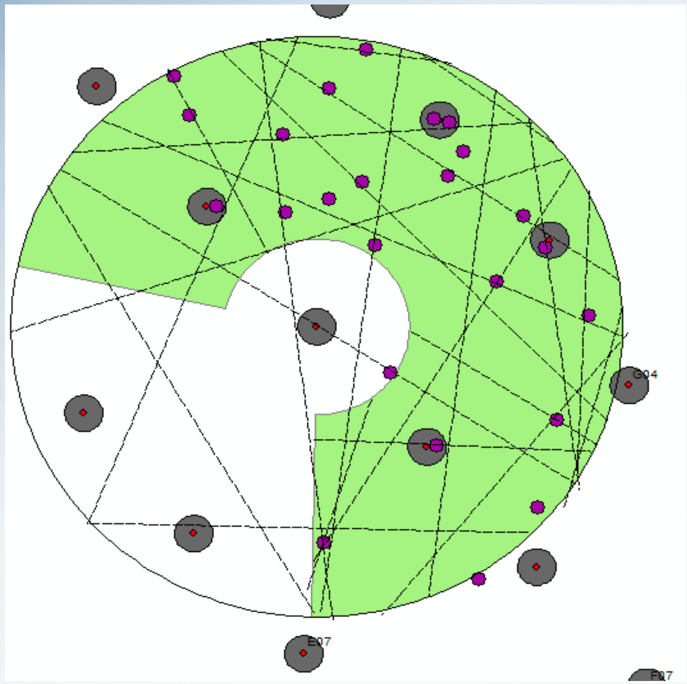
Video (thermal sensor) showing micro avoidance of Herring Gull



1 km radar-camera ranges



Calculation of mean track lengths in wind farm

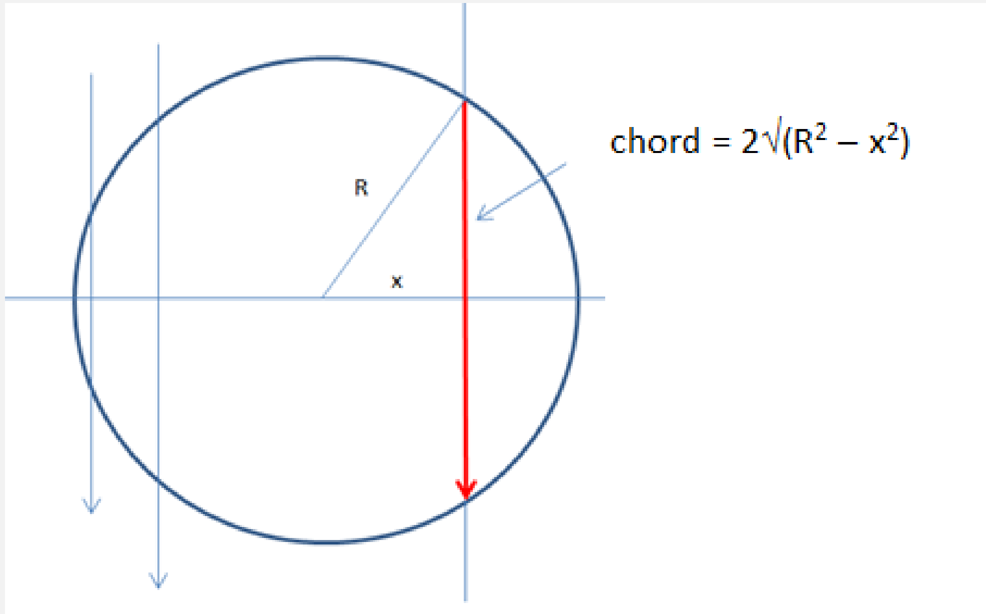


Box 2 – Calculation of mean track length within the rotor swept zone

Total track length = No of data points in swept area x πR/2

Area = π R^2

Track length per unit area = no of data points in swept area x πR/2 / π R^2



$$\text{Mean chord} = \int_{-R}^{R} 2\sqrt{(R2 - x2)}\,dx \;/\; 2R$$

$$= \pi R/2$$

Sample size

Radar tracks

Species	SCANTER radar (turbine G01)	LAWR radar (turbine G05)	Total
Northern gannet	**585**	**185**	**770**
Black-legged kittiwake	**75**	**49**	**124**
Lesser black-backed gull	**138**	**29**	**167**
Herring gull	**187**	**36**	**223**
Great black-backed gull	**220**	**51**	**271**
Black-headed gull	11	1	12
Black-throated diver	1	4	5
Brent goose	16	1	17
Common guillemot	36	3	39
Common gull	50	7	57
Common house martin	0	1	1
Common scoter	14	1	15
Common starling	22	0	22
Common tern	4	0	4
Cormorant	23	3	26
Goldfinch	1	0	1
Great skua	3	0	3
Grey heron	1	1	2
Greylag goose	1	1	2
Little gull	0	1	1
Northern fulmar	3	4	7
Pink-footed goose	1	4	5
Razorbill	12	42	54
Red-throated diver	61	21	82
Redwing	4	0	4
Sandwich tern	24	5	29
Shelduck	2	2	4
Unidentified auk	24	41	65
Unidentified bird	49	1	50
Unidentified diver	3	0	3
Unidentified goose	1	1	2
Unidentified gull	47	26	73
Unidentified tern	0	3	3
Wigeon	1	0	1
Total	**1,620**	**524**	**2,144**

Sample size

Rangefinder tracks

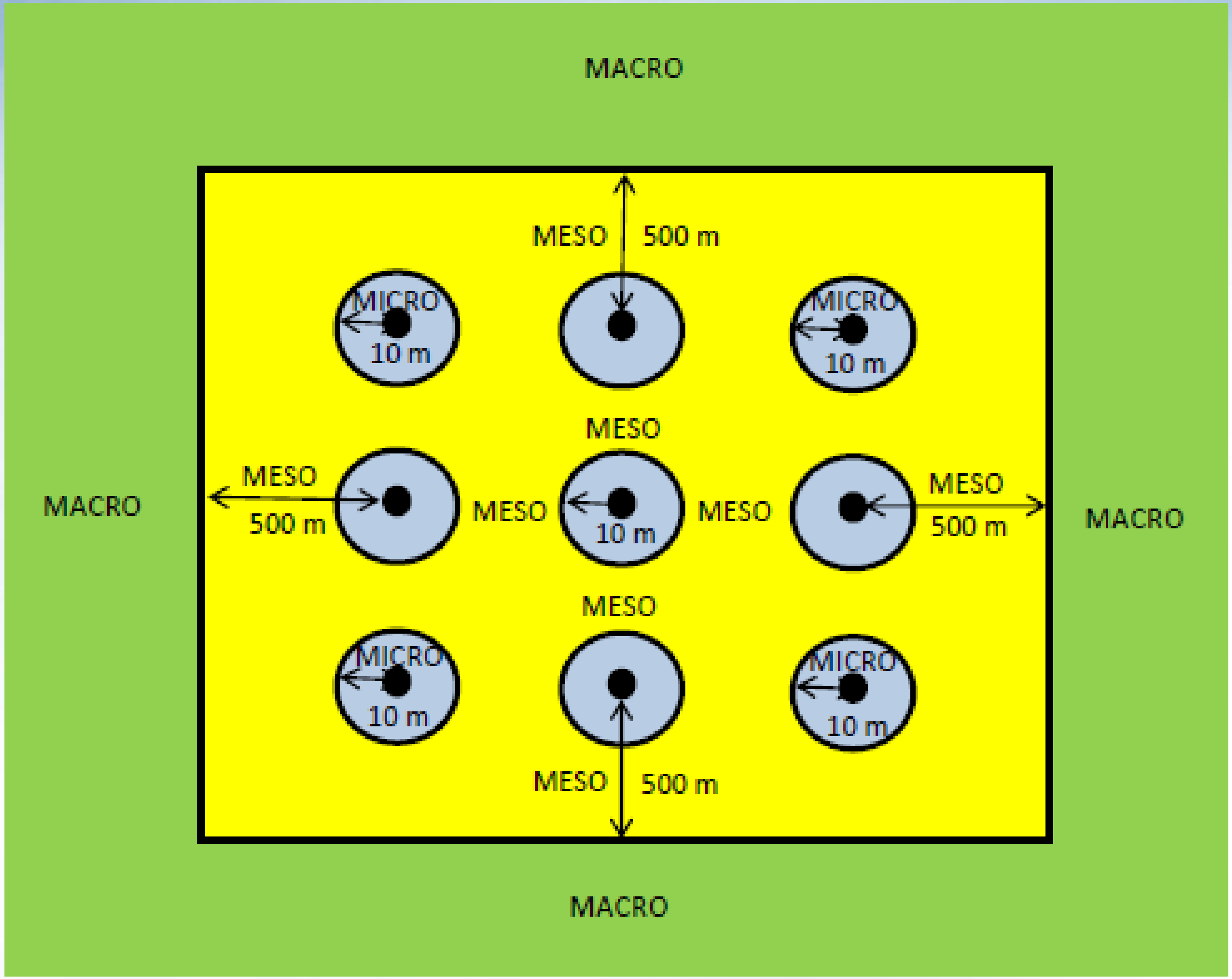
Species	Turbine G01	Turbine G05	Total
Northern Gannet	**428 (136)**	**278 (23)**	**706**
Black-legged Kittiwake	**135 (13)**	**161 (0)**	**296**
Lesser Black-backed Gull	**115 (35)**	**79 (1)**	**194**
Herring Gull	**154 (41)**	**148 (1)**	**302**
Great Black-backed Gull	**201 (28)**	**119 (1)**	**320**
Arctic Skua	2 (0)	1 (0)	3
Black-headed Gull	12 (4)	6 (0)	18
Brent goose	11 (6)	2 (1)	13
Common Guillemot	10 (0)	5 (0)	15
Common Gull	109 (12)	101 (0)	210
Common Scoter	3 (2)	0 (0)	3
Common Tern	17 (3)	0 (0)	17
Cormorant	13 (8)	7 (0)	20
Fulmar	6 (1)	3 (0)	9
Great Skua	5 (1)	1 (0)	6
Pink-footed goose	3 (1)	1 (1)	4
Razorbill	13 (0)	7 (3)	20
Red-throated Diver	37 (17)	12 (1)	49
Sandwich Tern	25 (8)	15 (0)	40
Shelduck	1 (1)	1 (0)	2
Unidentified auk	10 (5)	5 (0)	15
Unidentified gull	12 (1)	15 (1)	27
Unidentified tern	1 (0)	0 (0)	1
Wigeon	1 (1)	0 (0)	1
Total	**1,324**	**967**	**2,291**

Sample size

Videos in wind farm

Species	Turbine F04	Turbine D05	Total
Northern Gannet	**406**	**1,254**	**1,660**
Black-legged Kittiwake	**54**	**183**	**237**
Herring Gull	**131**	**177**	**308**
Lesser Black-backed Gull	**26**	**38**	**64**
Great Black-backed Gull	**106**	**230**	**336**
Lesser/Great Black-backed Gull	**267**	**572**	**839**
Arctic Skua	0	1	1
Common Crane	2	0	2
Common Eider	3	1	4
Common Gull	55	92	147
Common Scoter	5	6	11
Crow sp	1	0	1
Diver sp	1	0	1
Goose sp	0	1	1
Great Cormorant	0	2	2
Great Skua	0	1	1
Marsh Harrier	1	0	1
Northern Fulmar	1	3	4
Passerine sp	1	7	8
Pomarine Skua	1	0	1
Sandwich Tern	1	1	2
Seaduck sp	2	1	3
Swallow sp	0	1	1
Tern sp	13	2	15
Unidentified			
Bird sp	9	86	95
Large gull sp	**1,635**	**1,616**	**3,251**
Gull sp	1,387	2,315	3,702
Small gull sp	162	181	343
Seabird sp	471	1,111	1,582
Total	**4,741**	**7,882**	**12,623**

3 scales of avoidance rates: macro, meso and micro



Estimation of empirical avoidance rates

"Quantify avoidance behaviours of target seabird species at OWF"

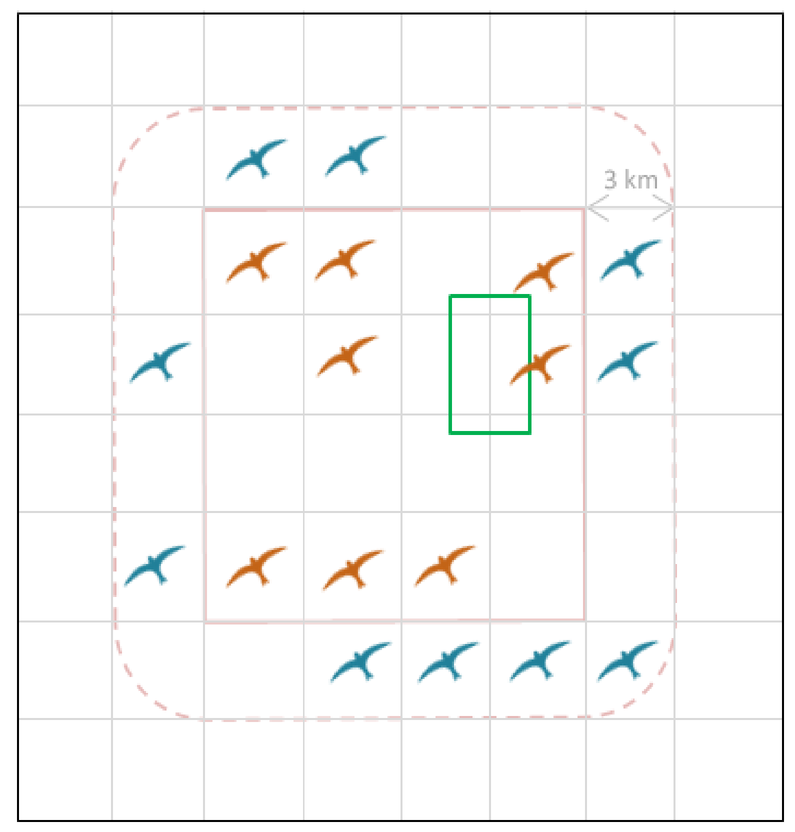
Overall EAR

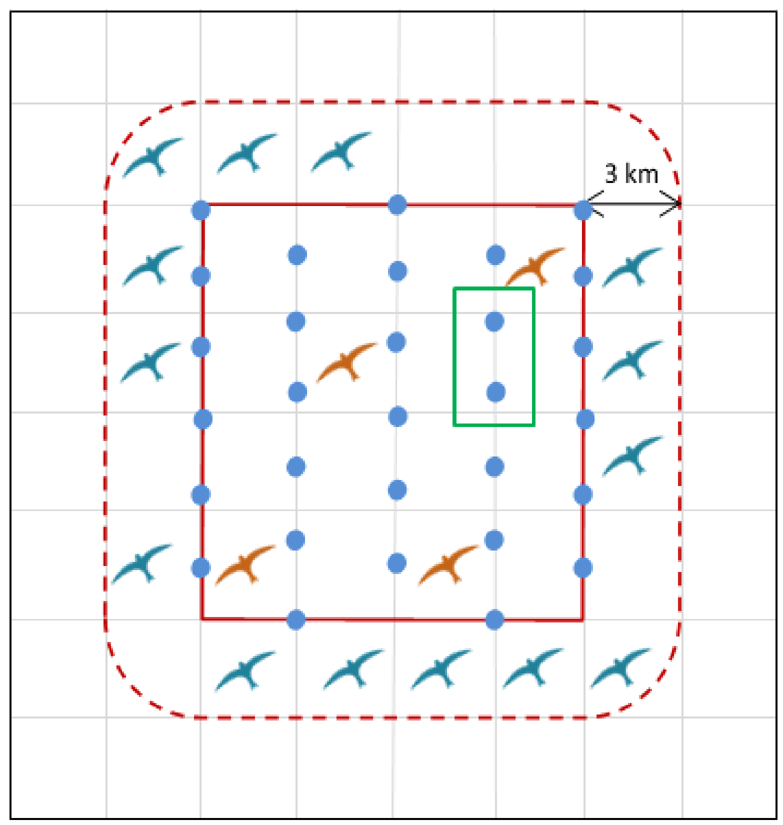
- Macro EAR
  - Mean value
    - SCANTER (G01) EAR
    - RF (G01) EAR
    - LAWR (G05) EAR
    - RF (G05) EAR
- Meso EAR
- Micro EAR

Overall EAR = 1-((1-macro)·(1-meso)·(1-micro))

+ Assessment of variability (SD / Confidence Intervals) (non-parametric bootstrap)

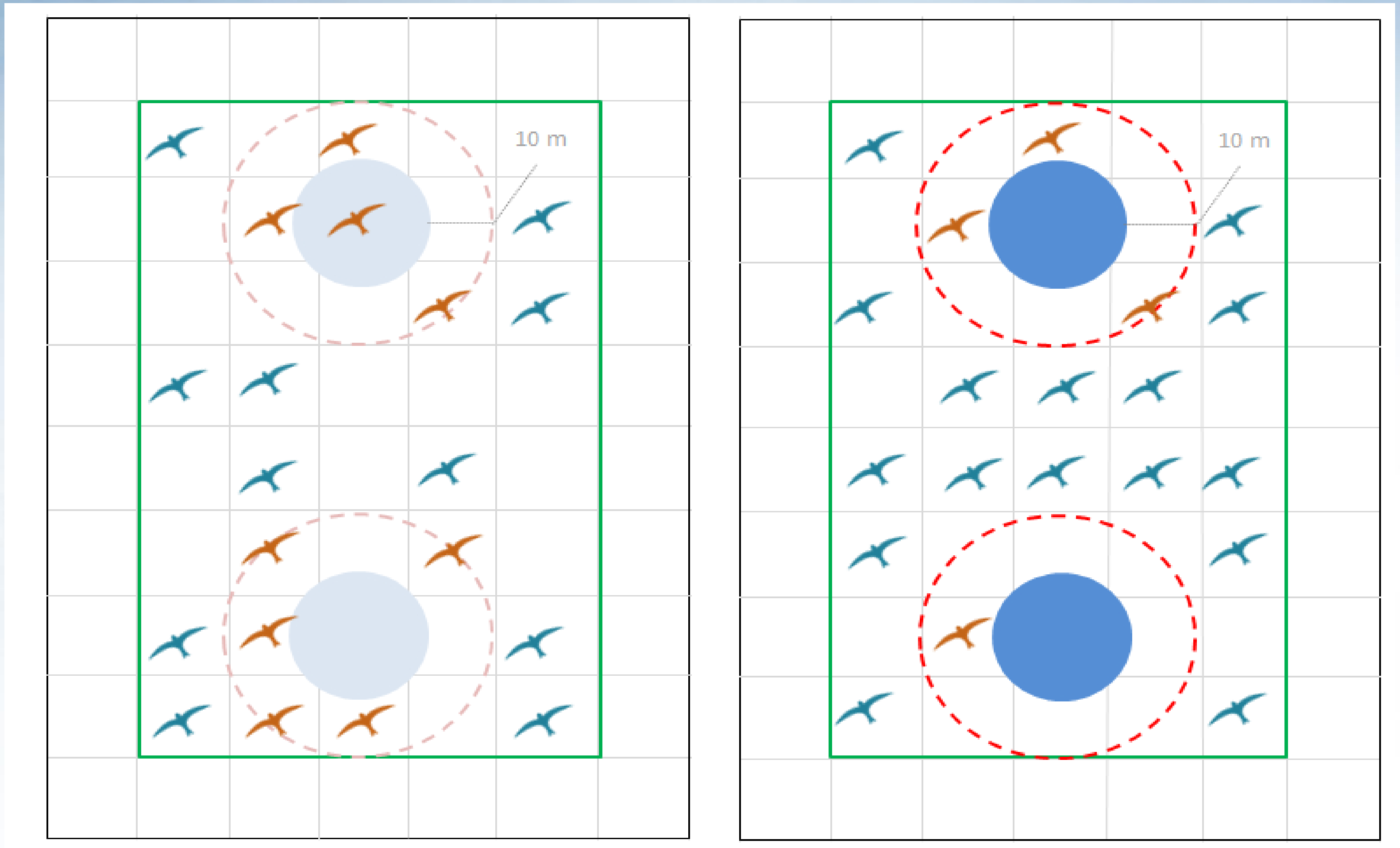
Empirical macro avoidance





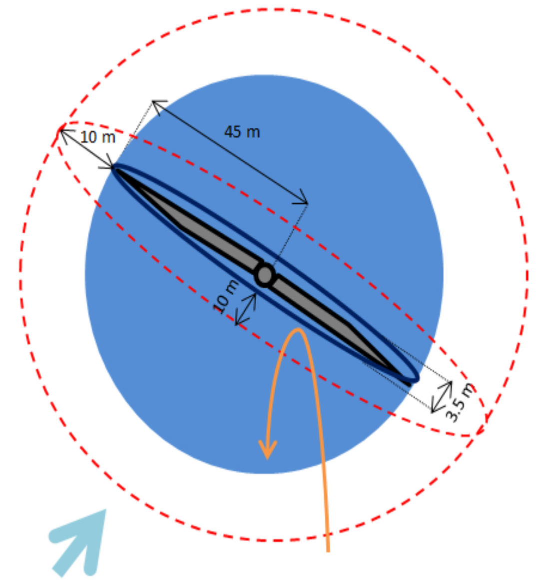
Overall Macro EAR = 1 - N_{in} / N_{ref}

Empirical meso avoidance

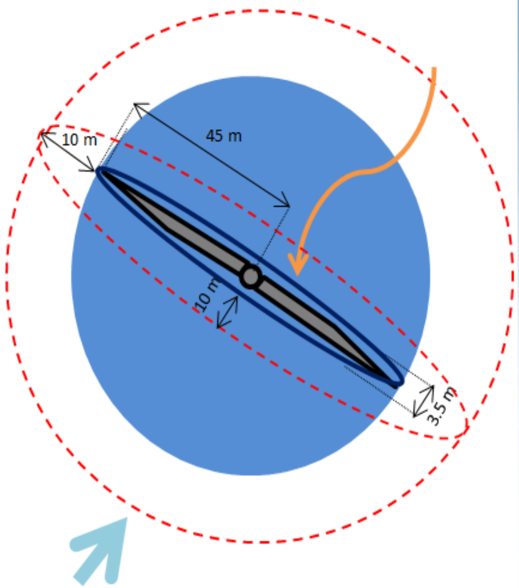


Overall Meso EAR = 1 - N_{in} / N_{ref}

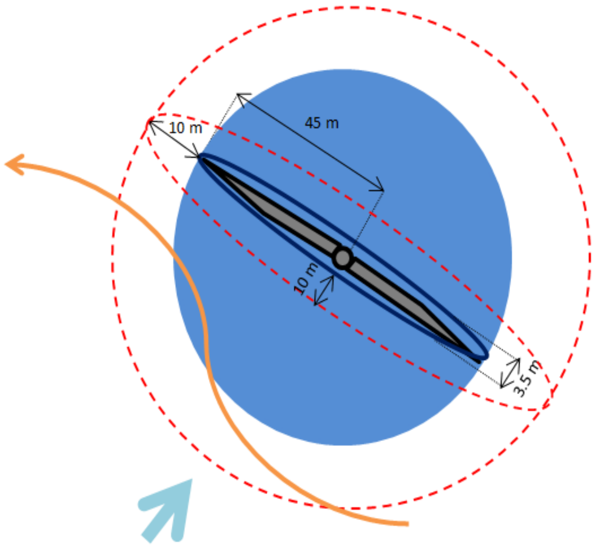
Empirical micro avoidance



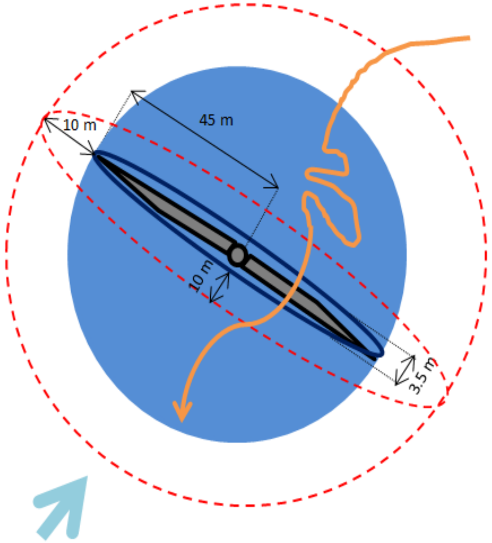
A – Adjusting – Returns before crossing the rotor, turning 180°



B – Adjusting – Stops before crossing the rotor

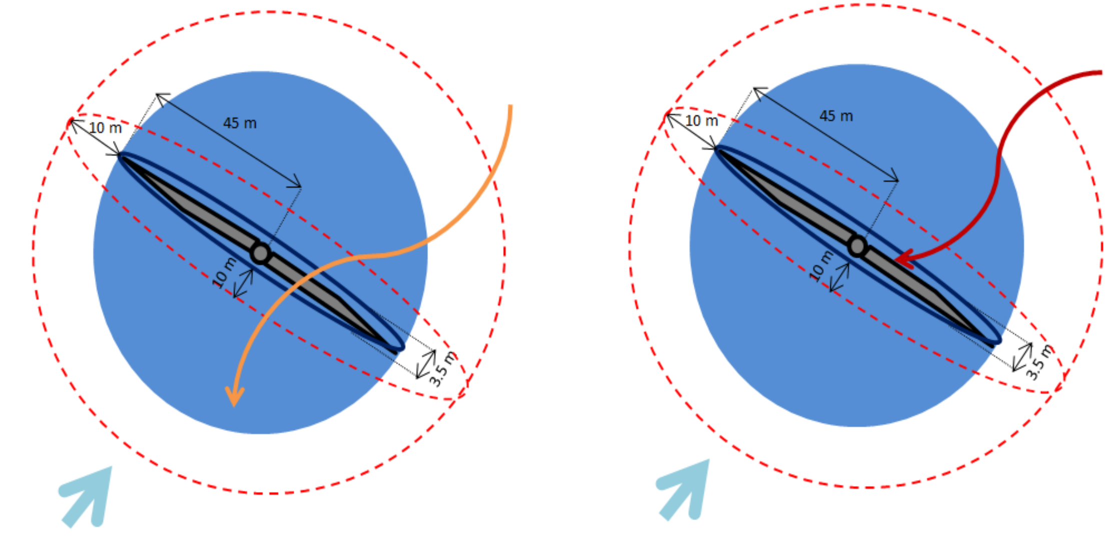


C – Adjusting – Flies along the rotor blades



D – Adjusting – Crosses the rotor with adjustments. Bird changes its path in front of rotor to cross between 2 blades. Also applicable in situations in which the rotor is not spinning

Empirical micro avoidance



E – Not Adjusting – Crosses the rotor without adjustments but survives **F – Collides**

$$\text{Overall micro EAR} = \frac{\text{N birds adjusting flight}}{(\text{N birds adjusting} + \text{N birds not adjusting} + \text{N birds colliding})}$$

Summary

The ORJIP study will provide important and enhanced input for CRM:

- Empirical avoidance behaviour at 3 spatial scales for five species of seabirds
- Species-specific data on flight speed and track speed → better estimation of fluxes
- Species-specific flight height data
- New data on nocturnal night activity of seabirds

The study collected the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm currently available.

The study developed a new sensor technology for automated monitoring of bird behaviour at offshore wind farms