# Multi-sensor bird detection system

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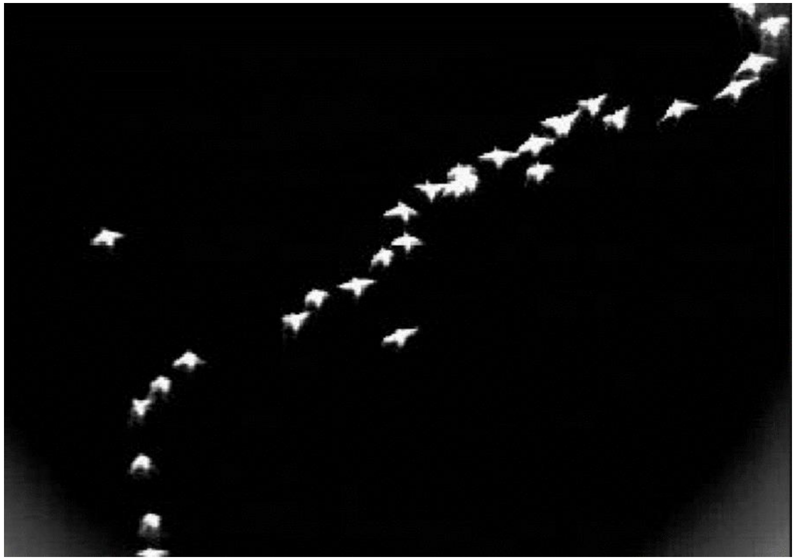
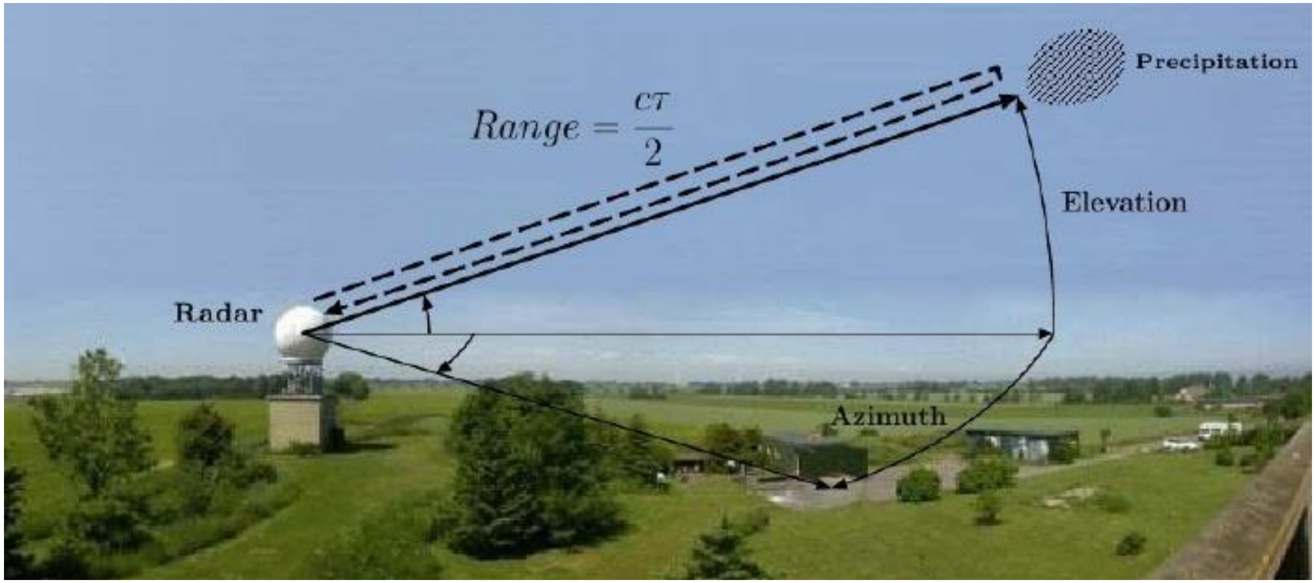
# DHI

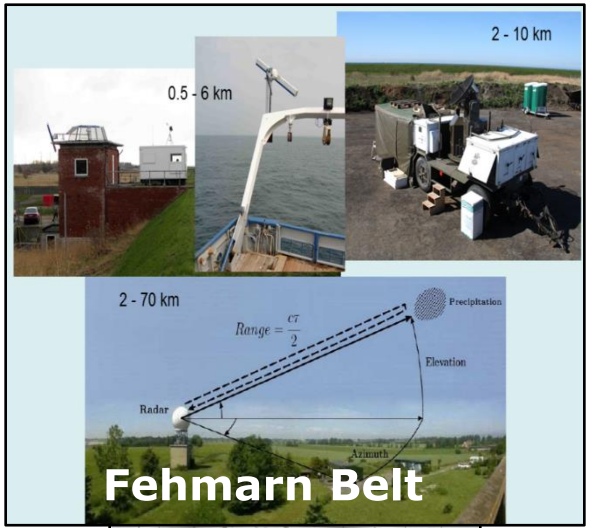

- Research-based (100 man years own R&D)
- 1100 staff (850 MSc/PhD)
- Turnover 100 mio. € (75% international)
- R&D core funding from Ministry of Science (5%)
- Offices in 25 countries (65 pct of staff)
- Representation in further 40 countries
- Private, no owners,  not-for-profit

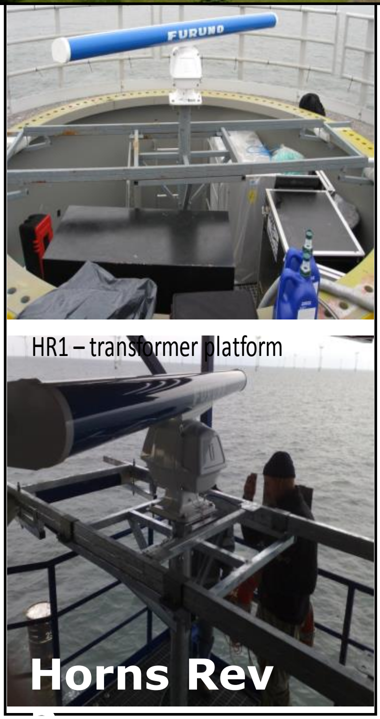
# DHI bird and bat detection systems





# DHI bird radar systems



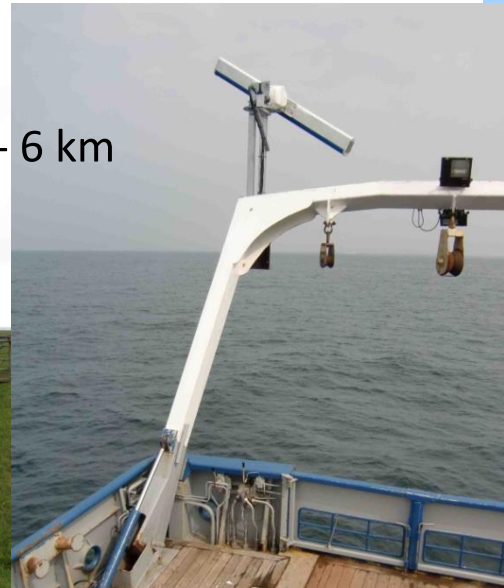


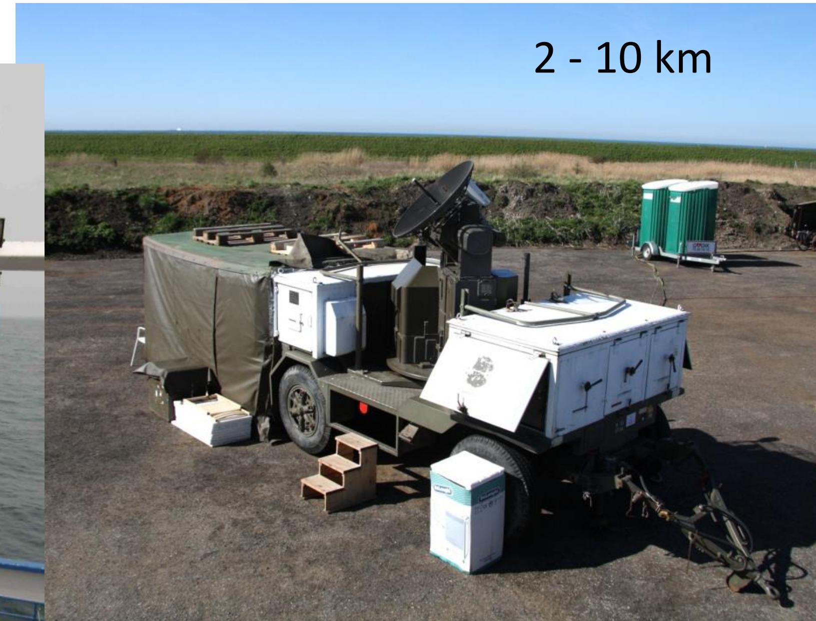


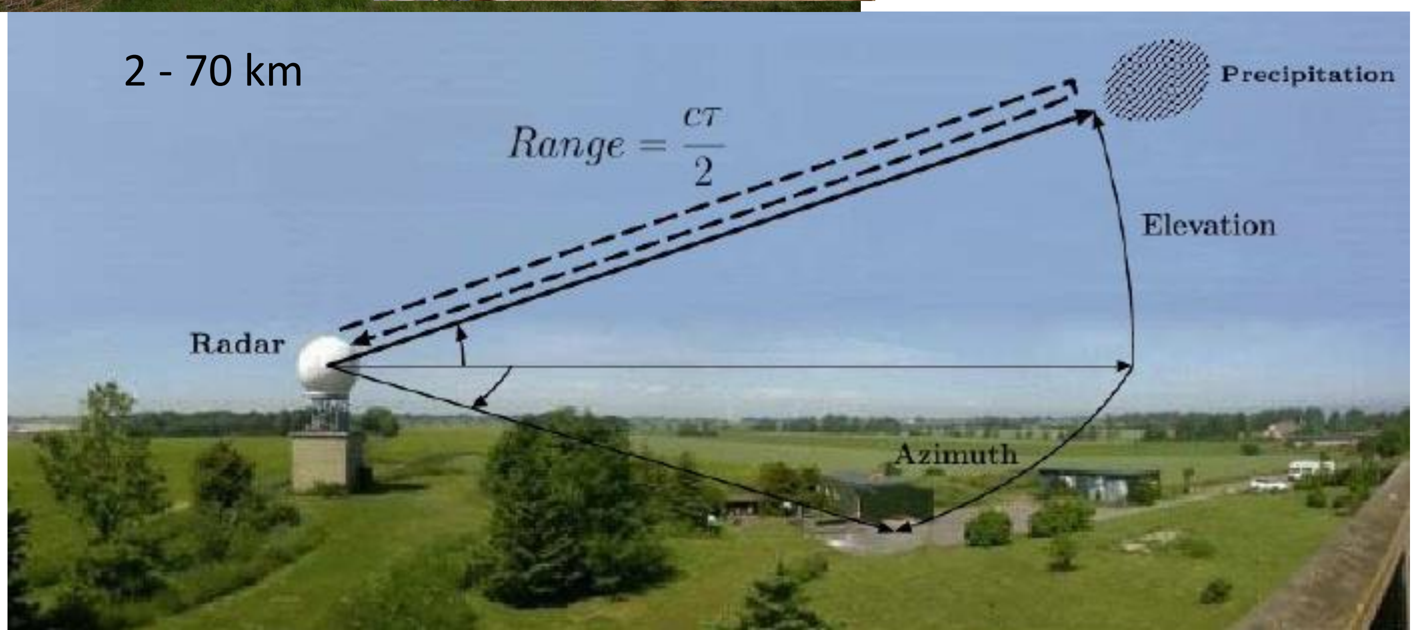


# Fehmarn Belt Fixed Link studies 2008 - 2015

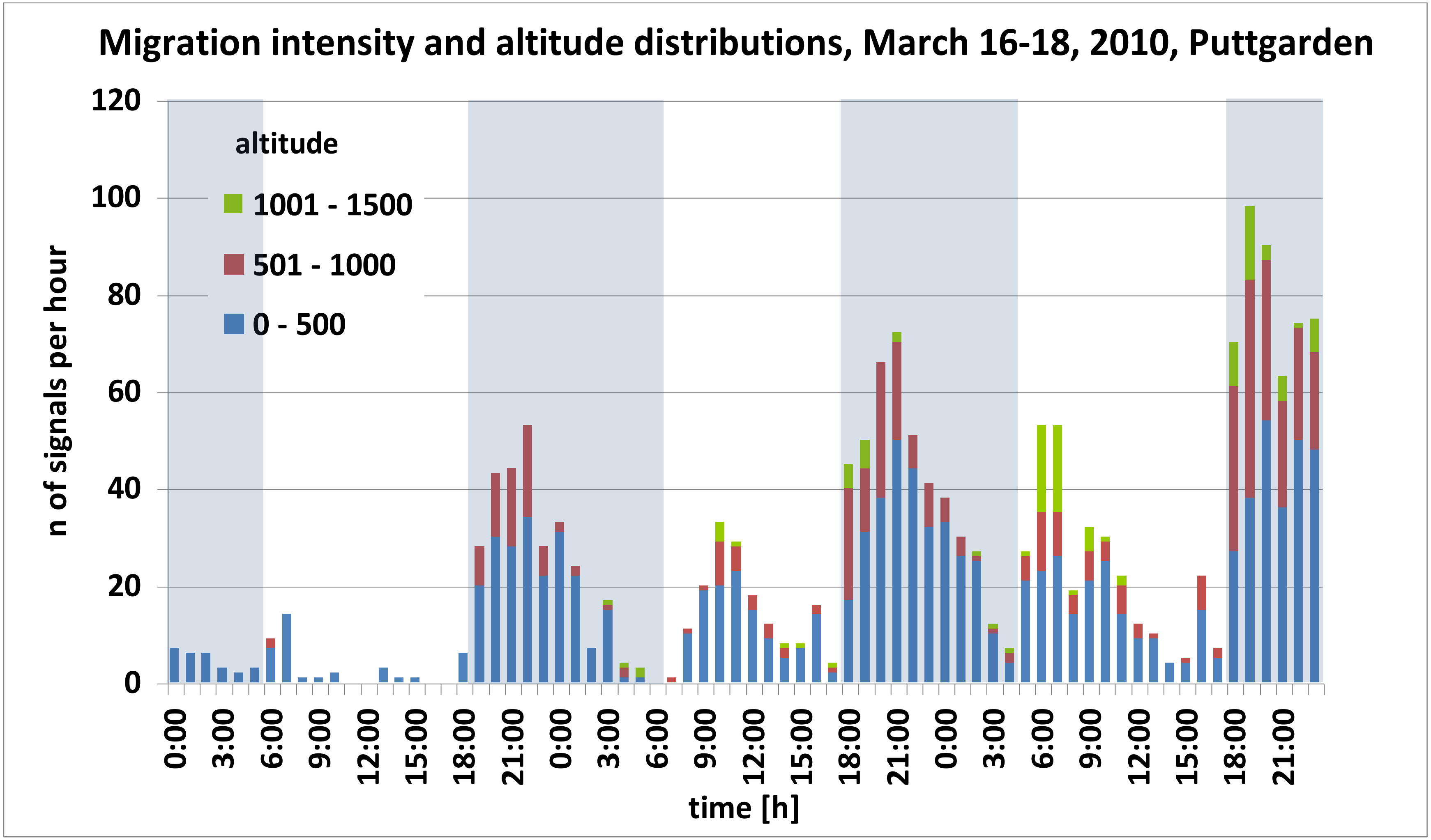
# Fehmarn Belt Fixed Link – tests of multiple radars

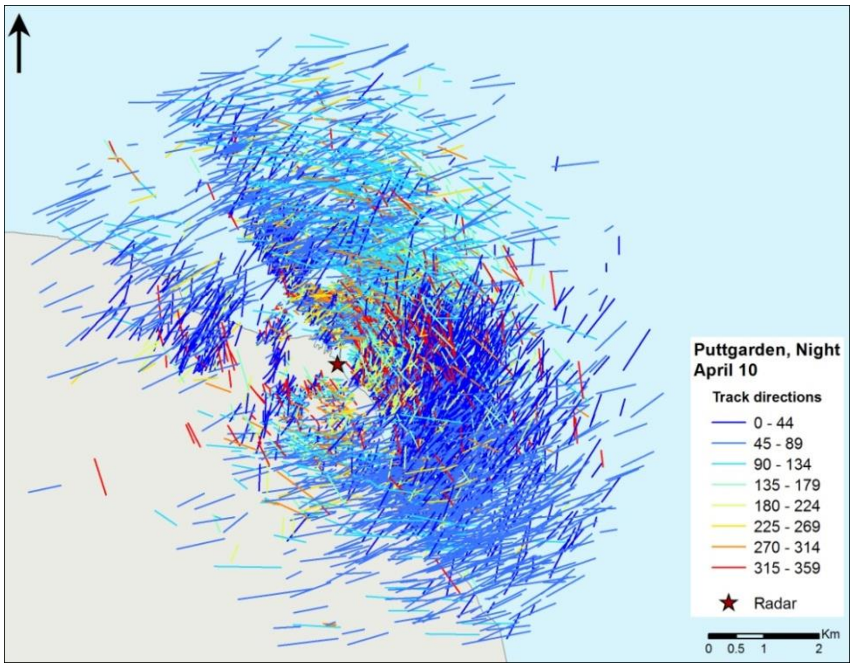


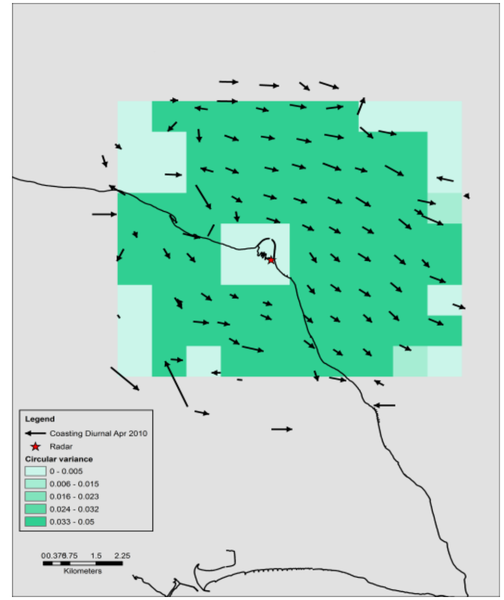



# Fehmarn Belt Fixed Link – flight altitudes

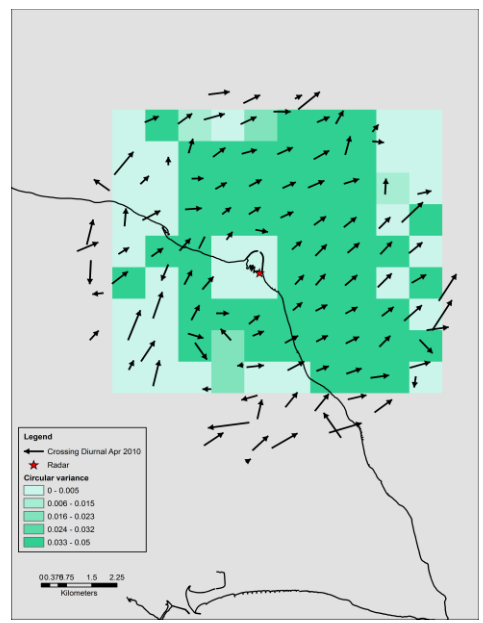


# Fehmarn Belt Fixed Link – flight patterns



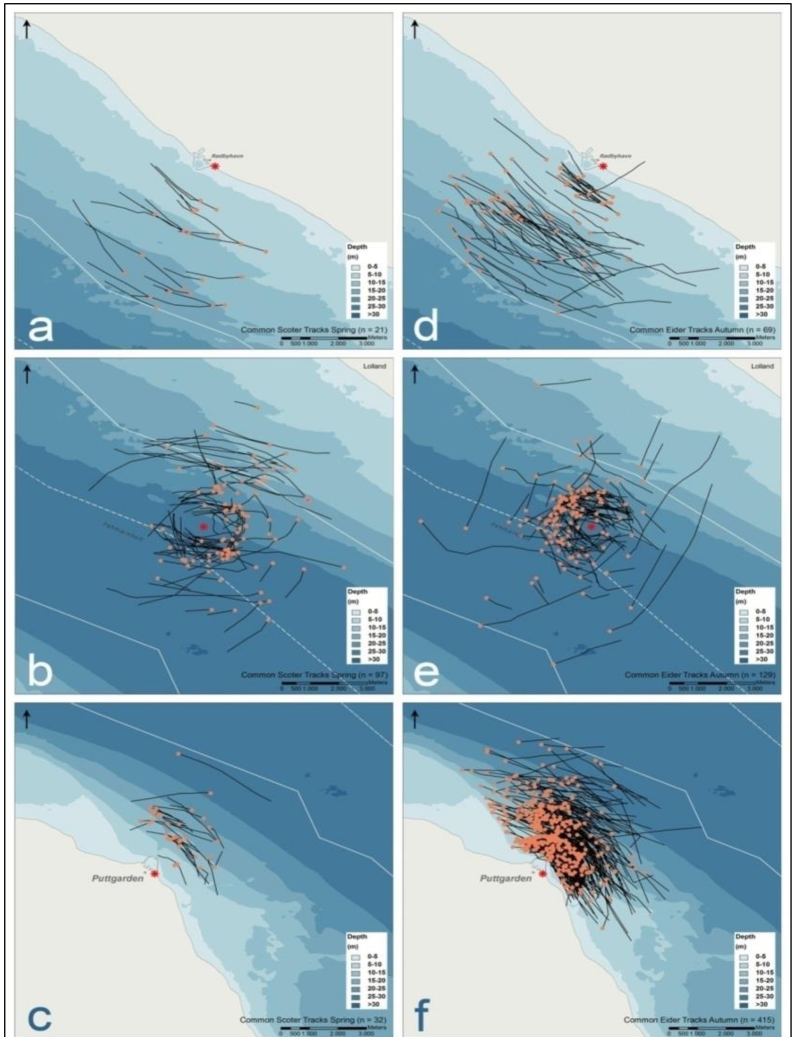

Coasting
Apr 2010



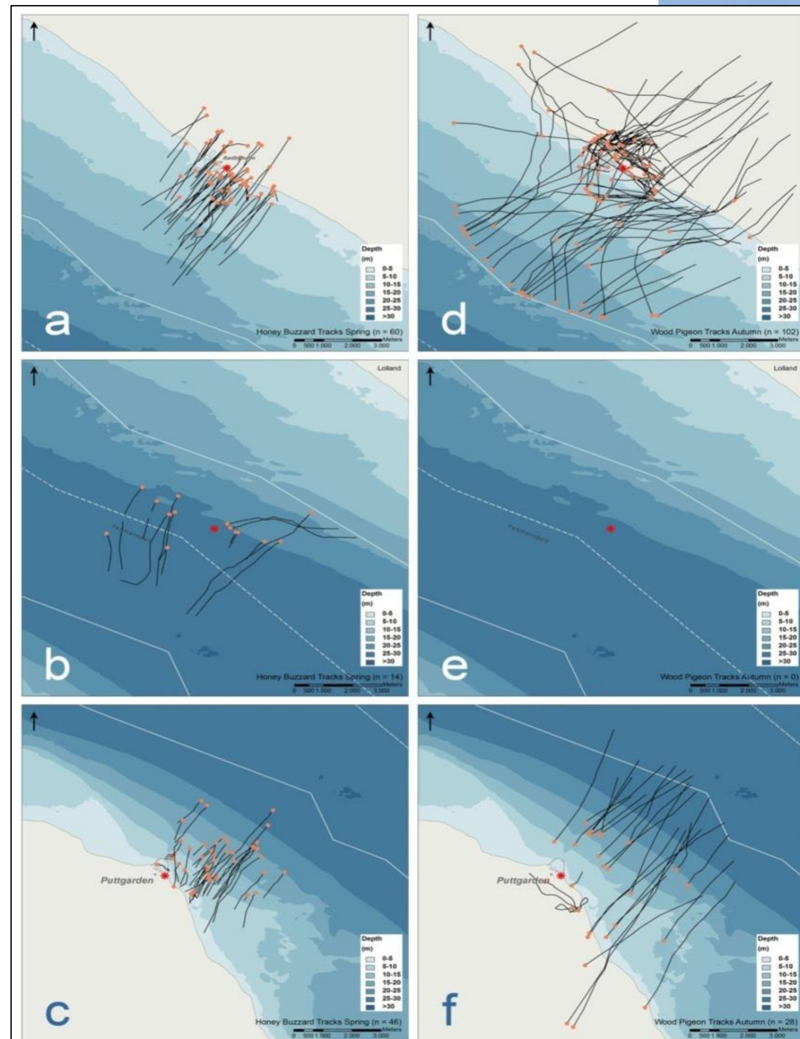

Crossing
Apr 2010

# Fehmarn Belt Fixed Link – species-specific tracks

**Common Eider**
**Common Scoter**

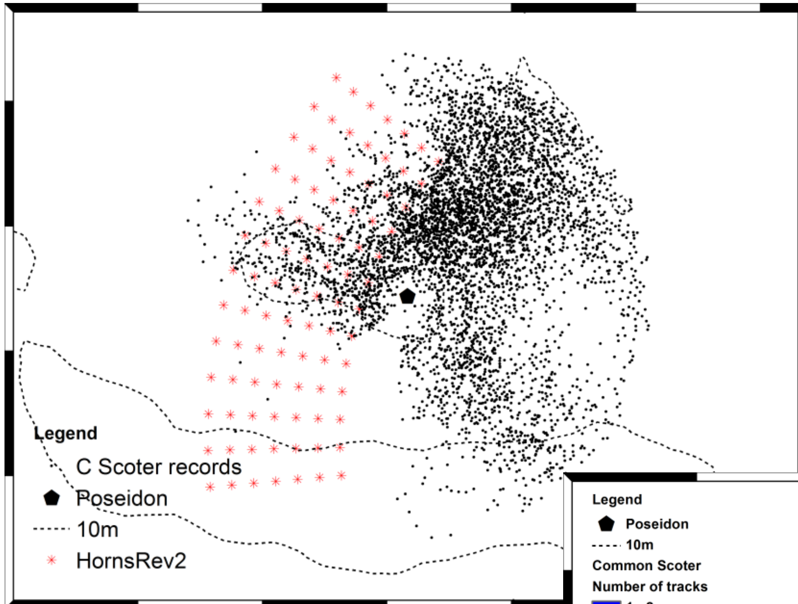


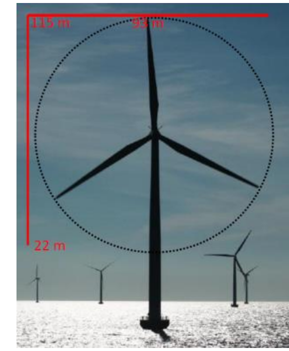

**Honey Buzzard**
**Wood Pigeon**

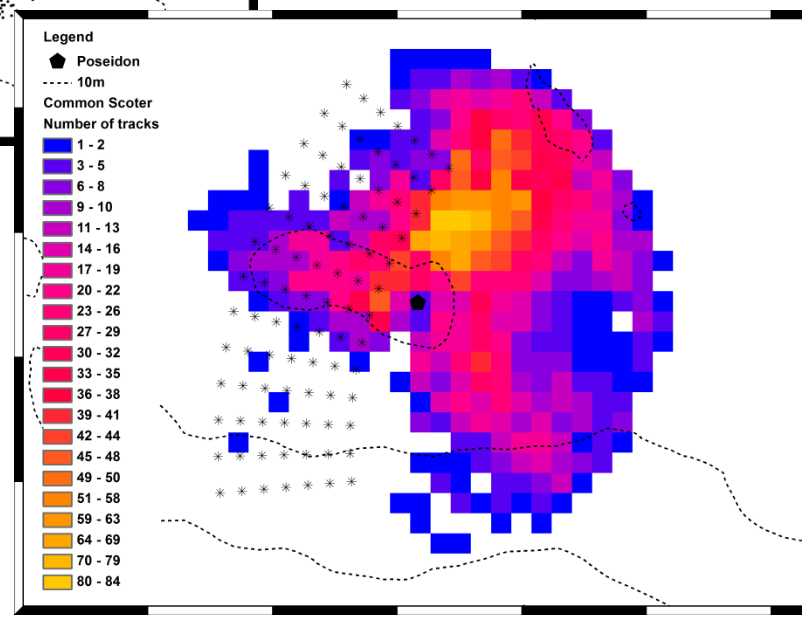


# Monitoring at offshore wind farms – collision risks

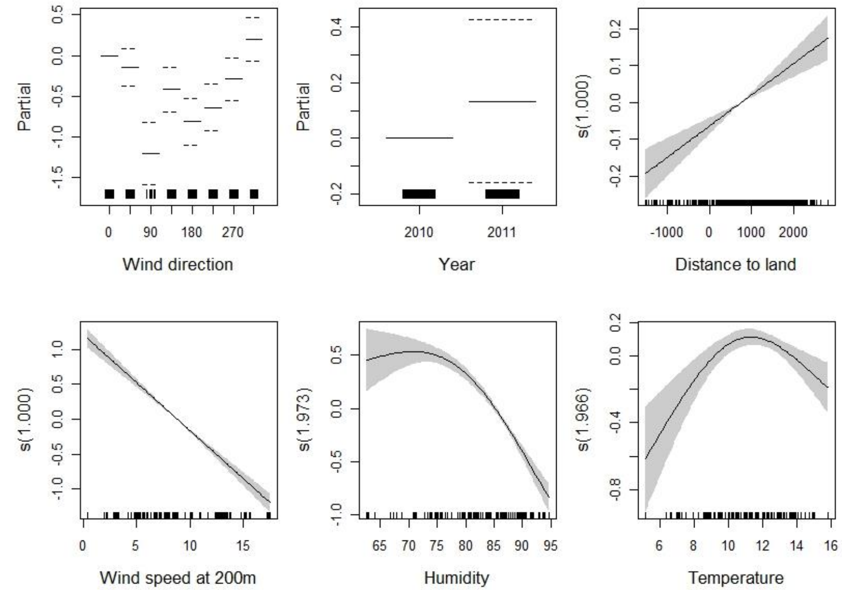
DHI



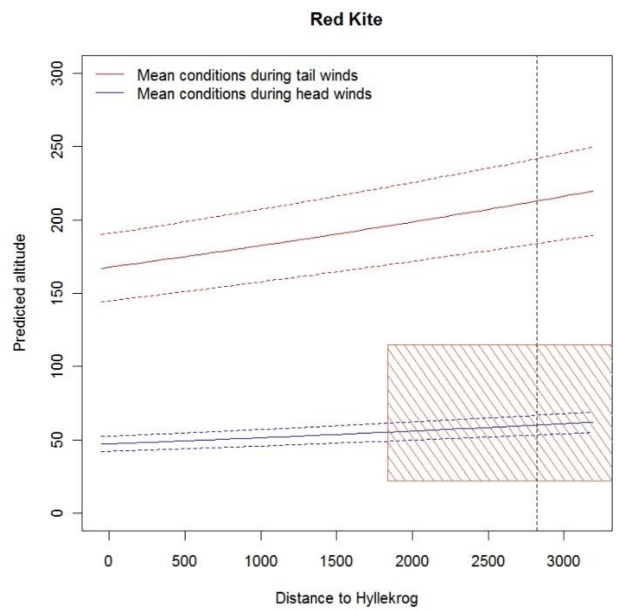



# Collision risks for protected species



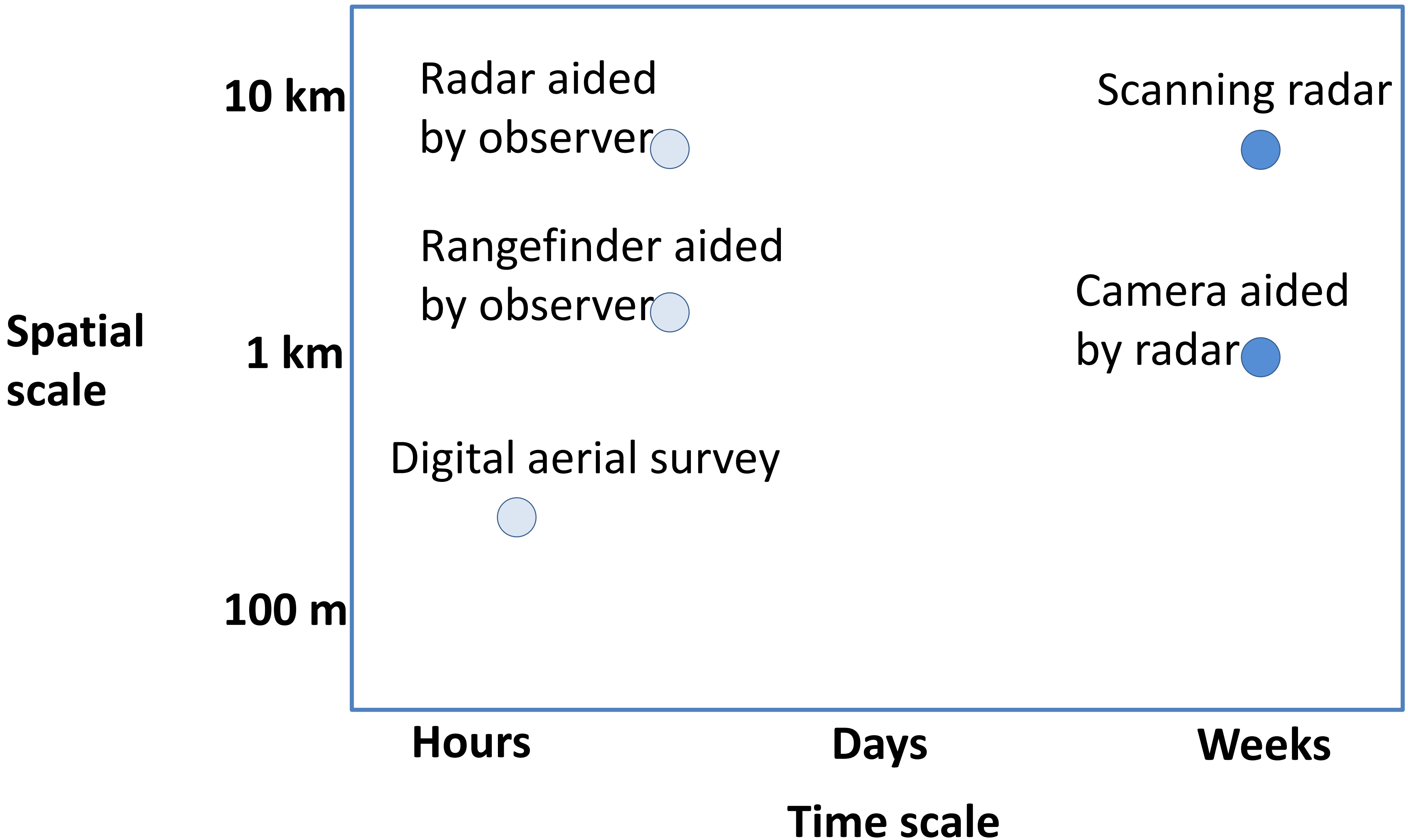




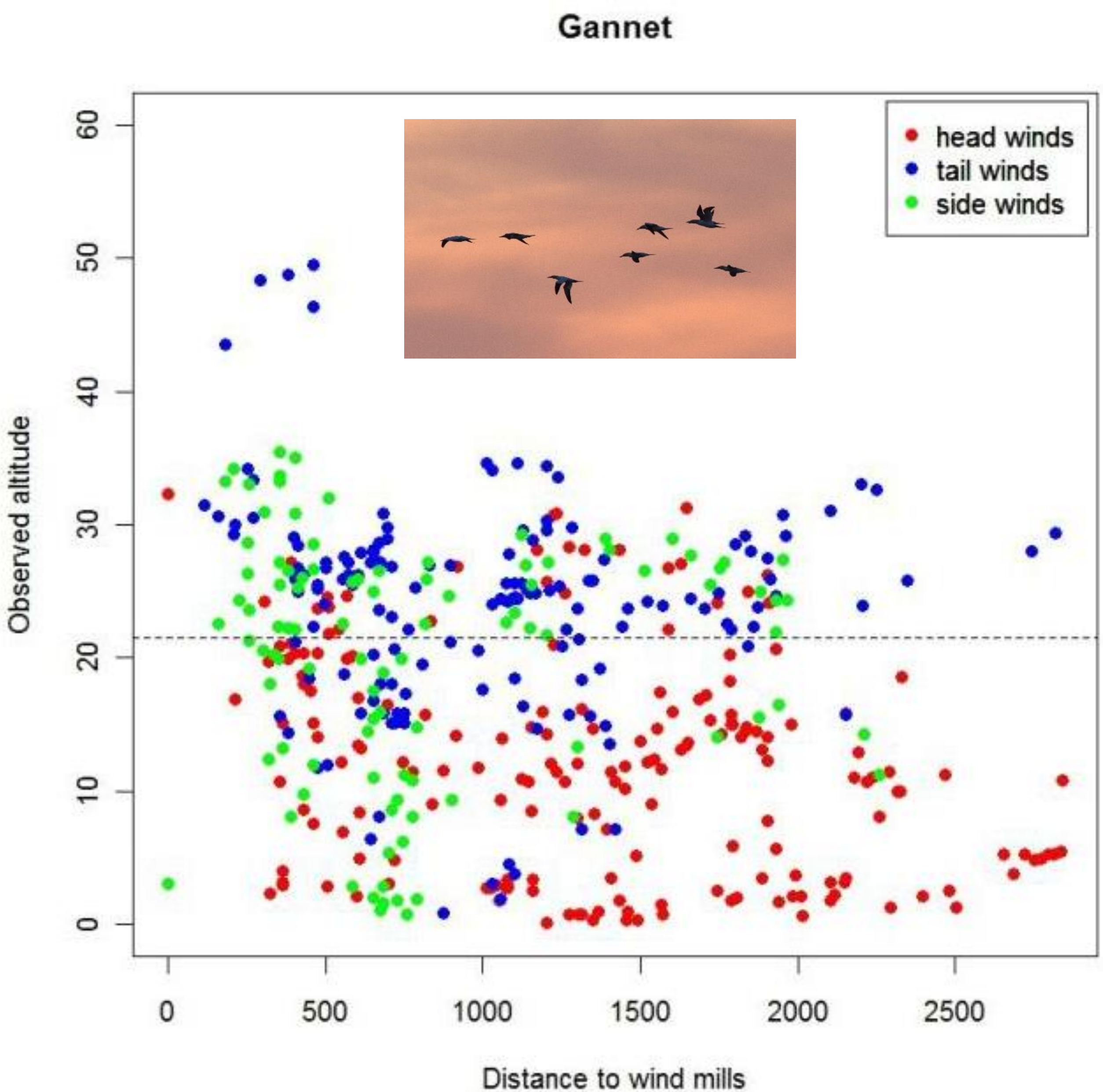


Source: Skov & Heinänen 2015; Predicting the weather-dependent collision risk for Birds at Wind Farms. Wind & Wildlife Proc. Springer Science

# Selection of sensor system



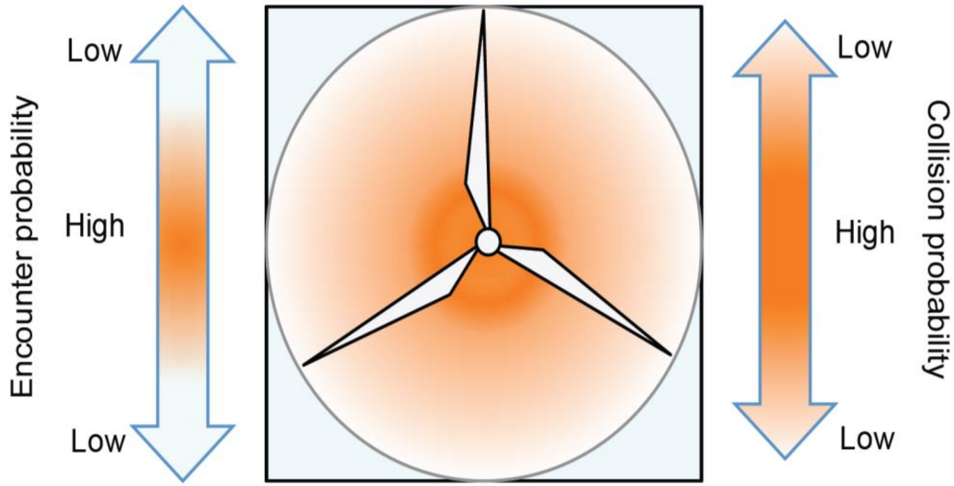
# Need for long-term deployment

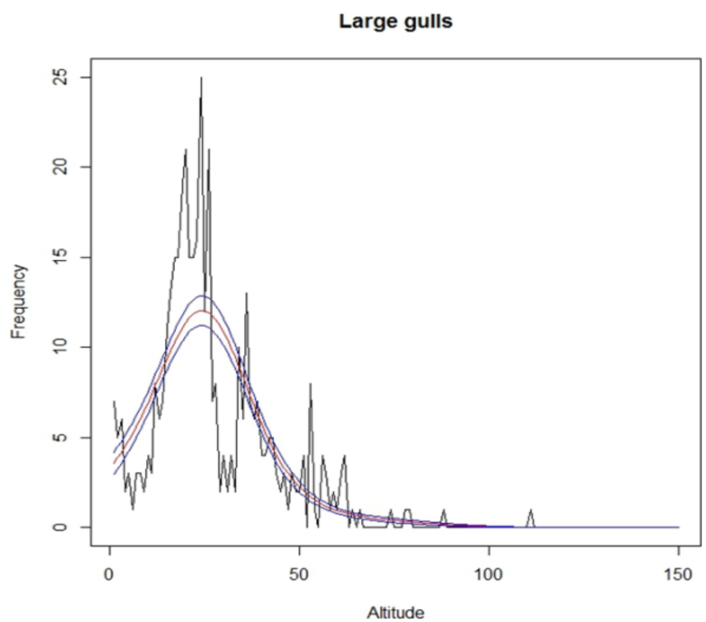



Data from Horns Rev 2 Offshore Wind Farm, North Sea

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

# Need for high-resolution 3D data



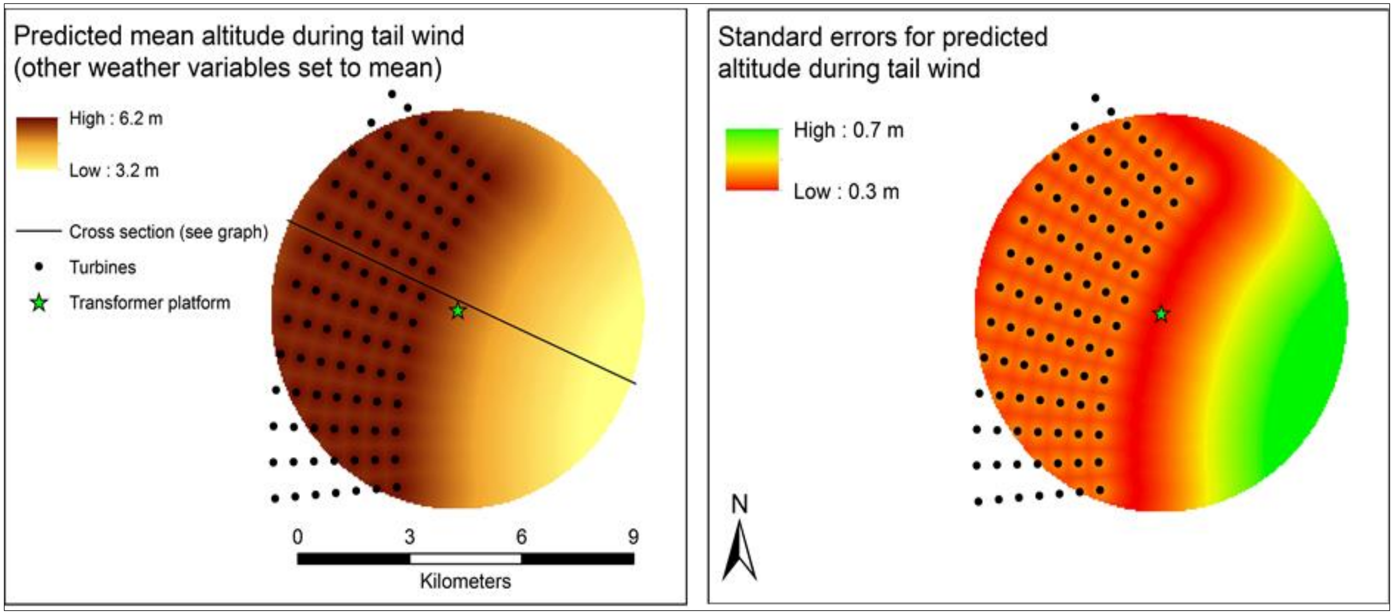

**Calculating the Collision rate**

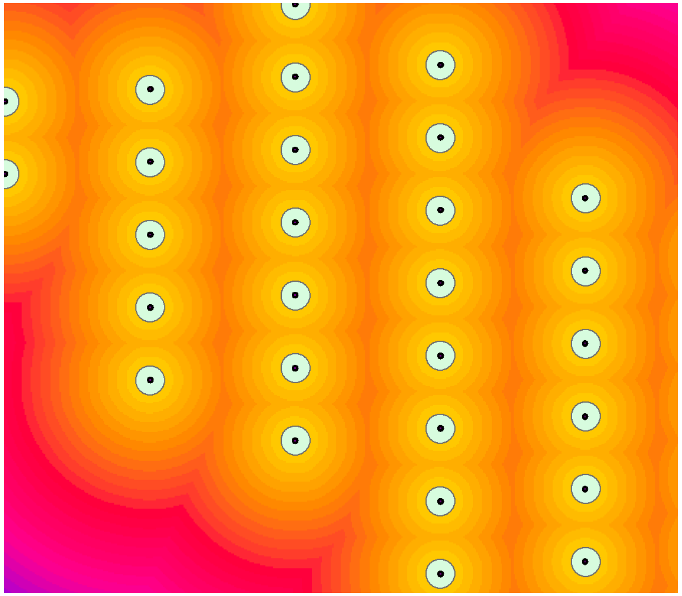
Collision risk = flux of birds flying through the rotor height × collision probability × proportion of wind farm operational time × avoidance rates

Extended Band Model (2012):

Detailed flux and collision probability calculated for different
parts of the rotor

# Need for data collection at multiple scales



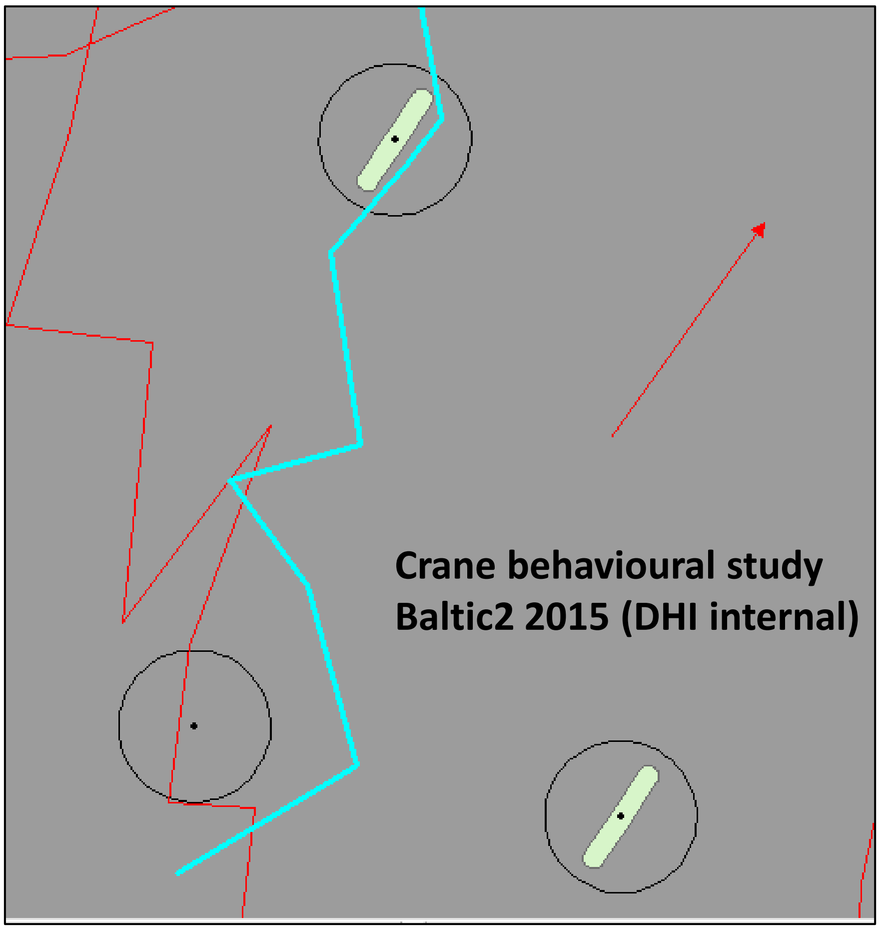



**Avoidance rate =**

**1 - (1-Macro) * (1-Meso) * (1-Micro)**

# Need for high-resolution tracks

**Judgement of meso and micro avoidance requires assessment of flight tracks *in situ* with orientation of rotor**



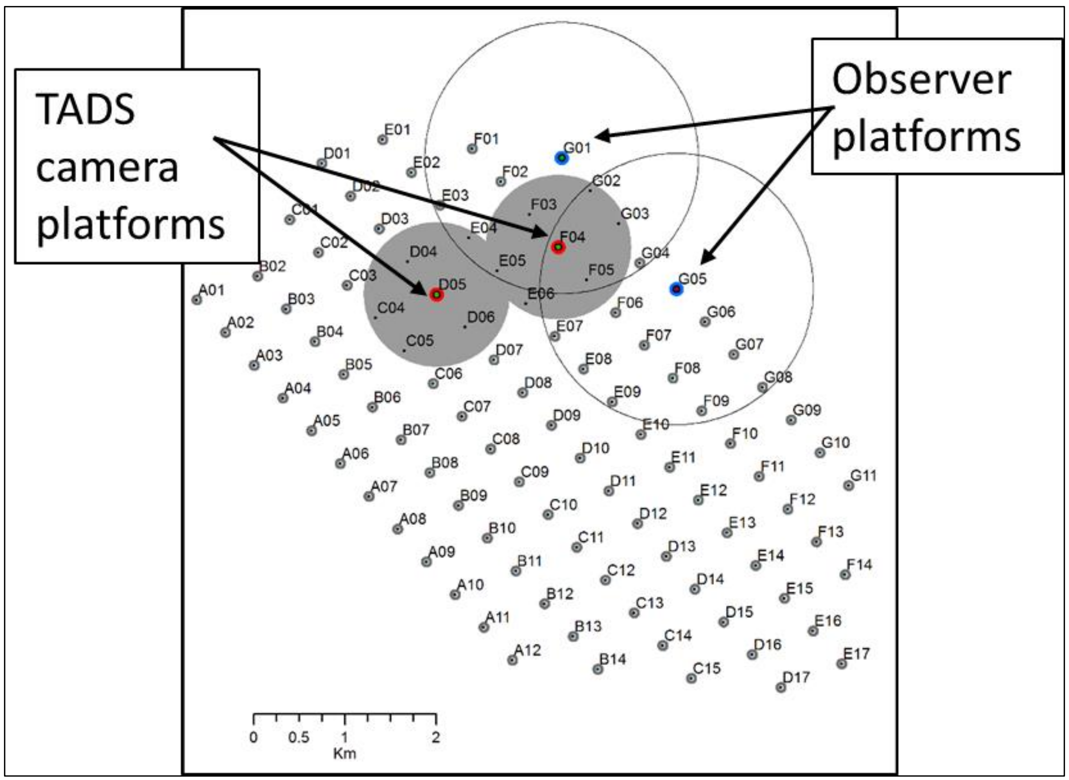

# ORJIP Bird collision avoidance study

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



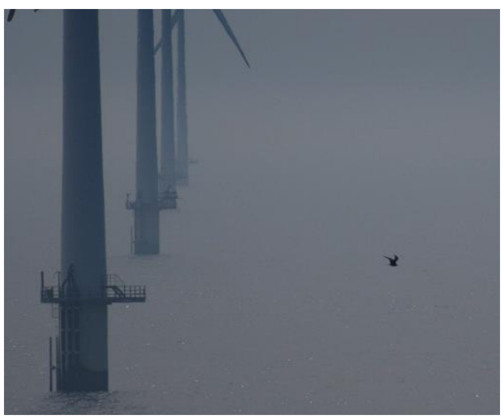


**Target species:**

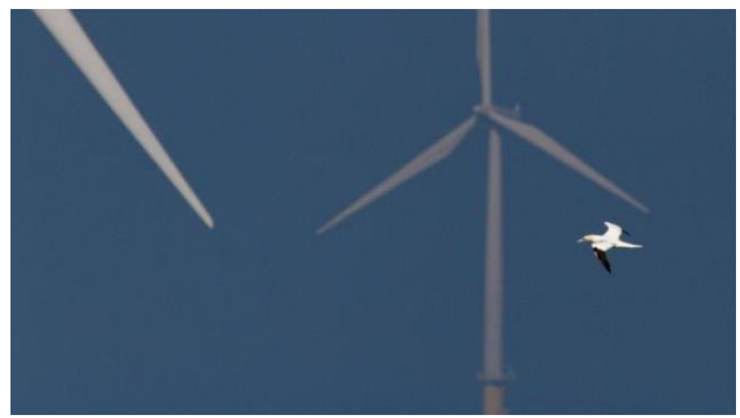
- Northern Gannet
- Lesser Black-backed Gull
- Herring Gull
- Great Black-backed Gull
- Black-legged Kittiwake

# Recording behavioural reactions of seabirds

| | Species identification | Macro avoidance | Horizontal meso avoidance | Vertical meso avoidance | Micro avoidance | Collision events |
|---|---|---|---|---|---|---|
| Observer | | | | | | |
| SCANTER 5000 radar | | | | | | |
| LAWR 35 radar | | | | | | |
| Laser rangefinder | | | | | | |
| TADS camera | | | | | | |



Horns Rev 2

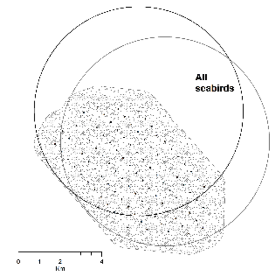


Horns Rev 2

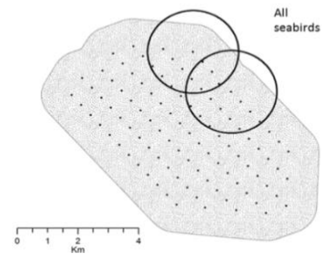
# Combination of detection ranges

*Detection*

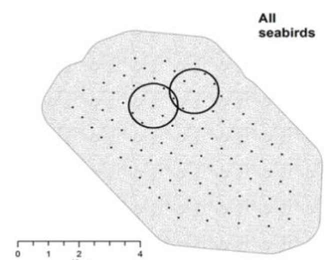
**Radar**




**Rangefinder**

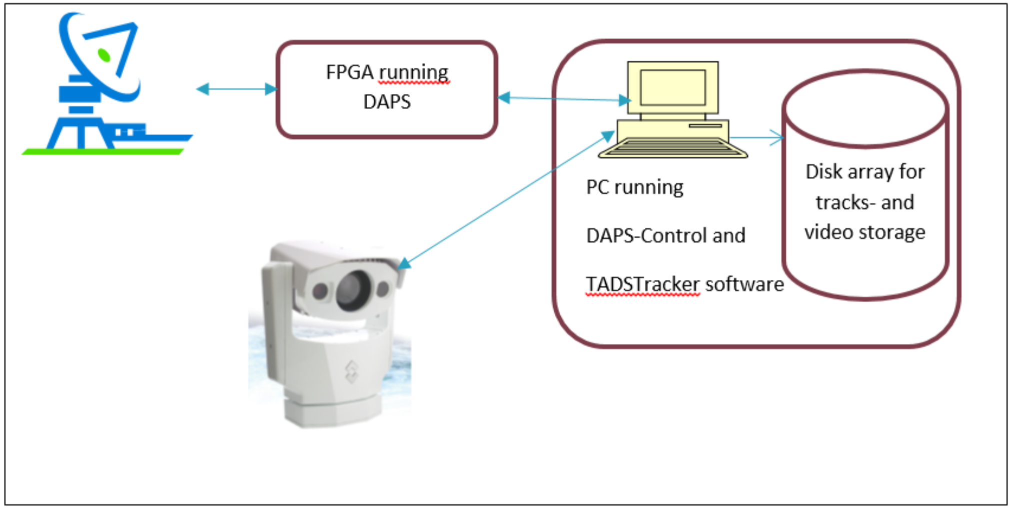



**Camera**



# Innovation: radar-camera integration

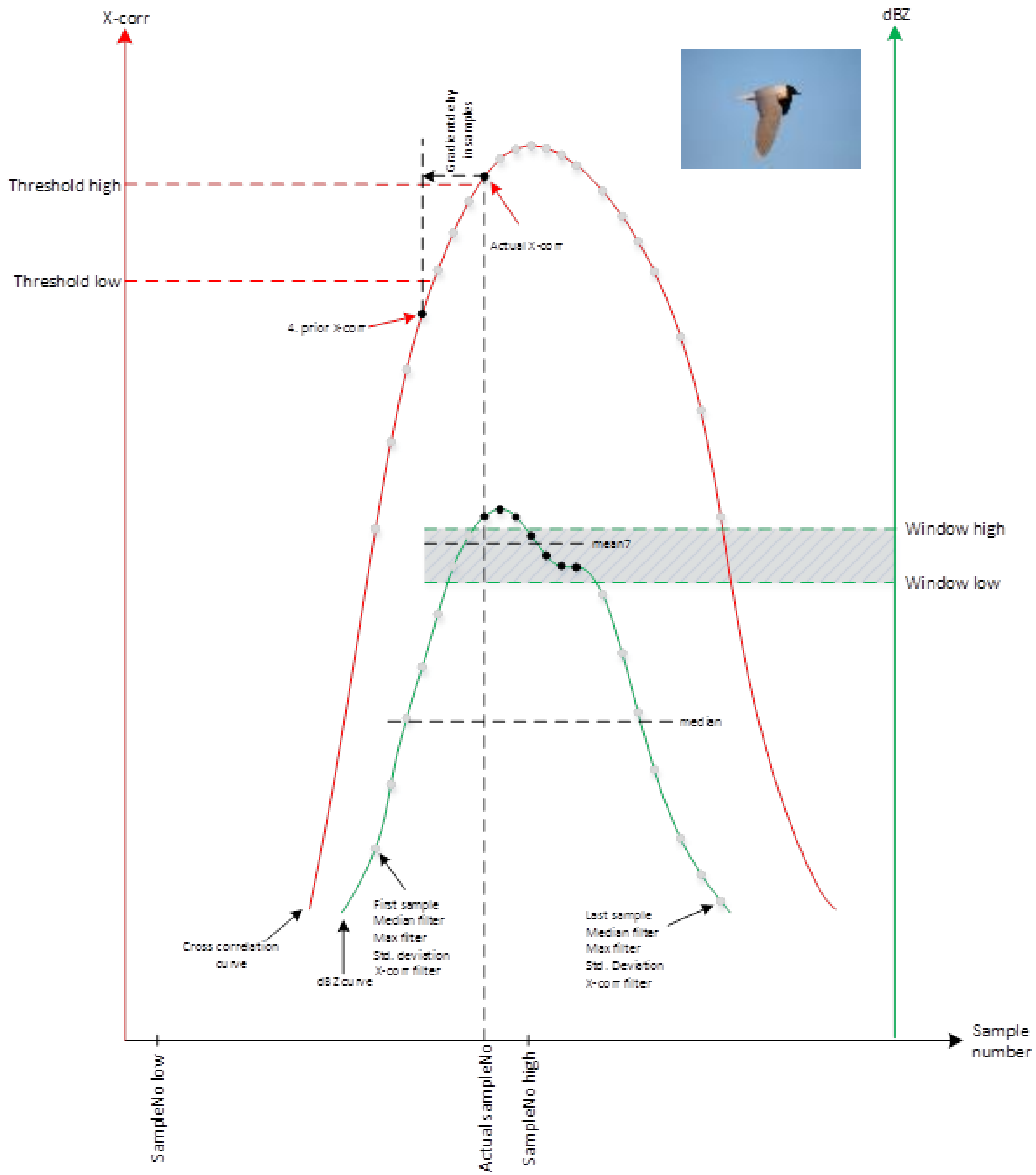
Digital integration of radar and thermal digital camera




TVADS (Thermal-Visual Animal-Detection-System)

FPGA-controlled Tracking unit

# Characterisation of bird signals



# TVADS camera

## Visual and thermal sensors

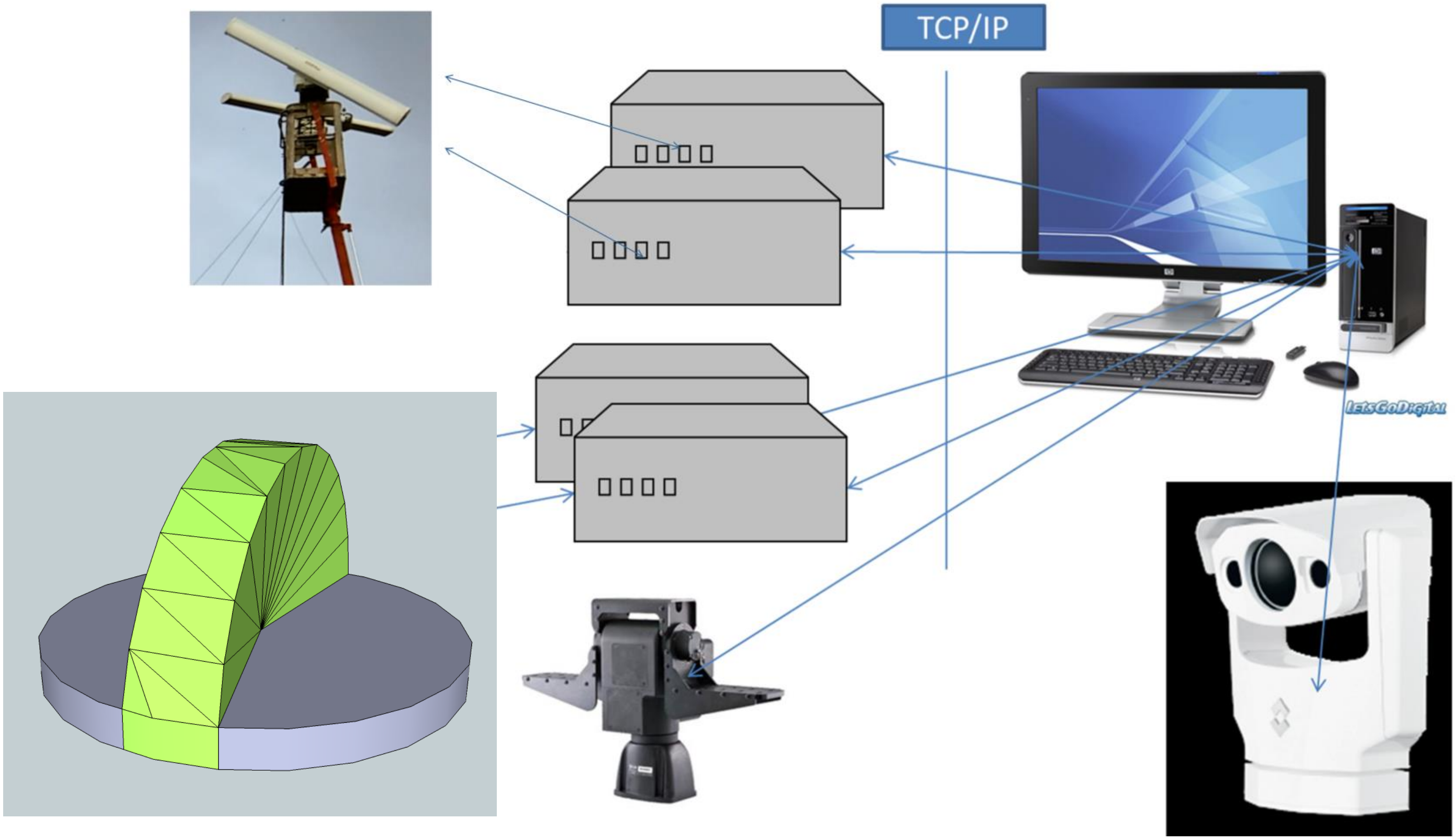
# TVADS species detection and identification

| | Thermal |
|---|---|
| Great Cormorant | 600m |
| Grey Heron | 600m |
| Swans | 600m |
| Seaducks | 450m |
| Oystercatcher | 350m |
| Common/Arctic Tern | 300m |
| Small gulls | 400m |
| Large gulls | 500m |
| Passerines | 100m |

| | Visual |
|---|---|
| Great Cormorant | 800m |
| Grey Heron | 800m |
| Mute Swan | 800m |
| Common Eider | 700m |
| Oystercatcher | 600m |
| Common/Arctic Tern | 500m |
| Black-headed Gull | 600m |
| Common Gull | 600m |
| Herring Gull | 700m |
| Great Black-backed Gull | 700m |
| Skylark | 300m |
| Barn Swallow | 300m |

# Next generation TVADS

## Horizontal and vertical coverage



# Thank you !