Environmental Impacts of Offshore Wind Farms

High Resolution Digital Stills for Aerial Survey: Seabirds & Marine Mammals

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Lab No. 4441*

building reputation through excellence

Welcome

Today's presentation will cover:

- **Use by Government Agencies & Regulators**
- **Use by industry**
- **Methods - Capturing the data**

  - Image interpretation & QA

  - Statistical analysis
- **Value of information**
- **Conclusions & Future**

UK Regulator Acceptance

Outer Thames Estuary Special Protected Area (Natura 2000)

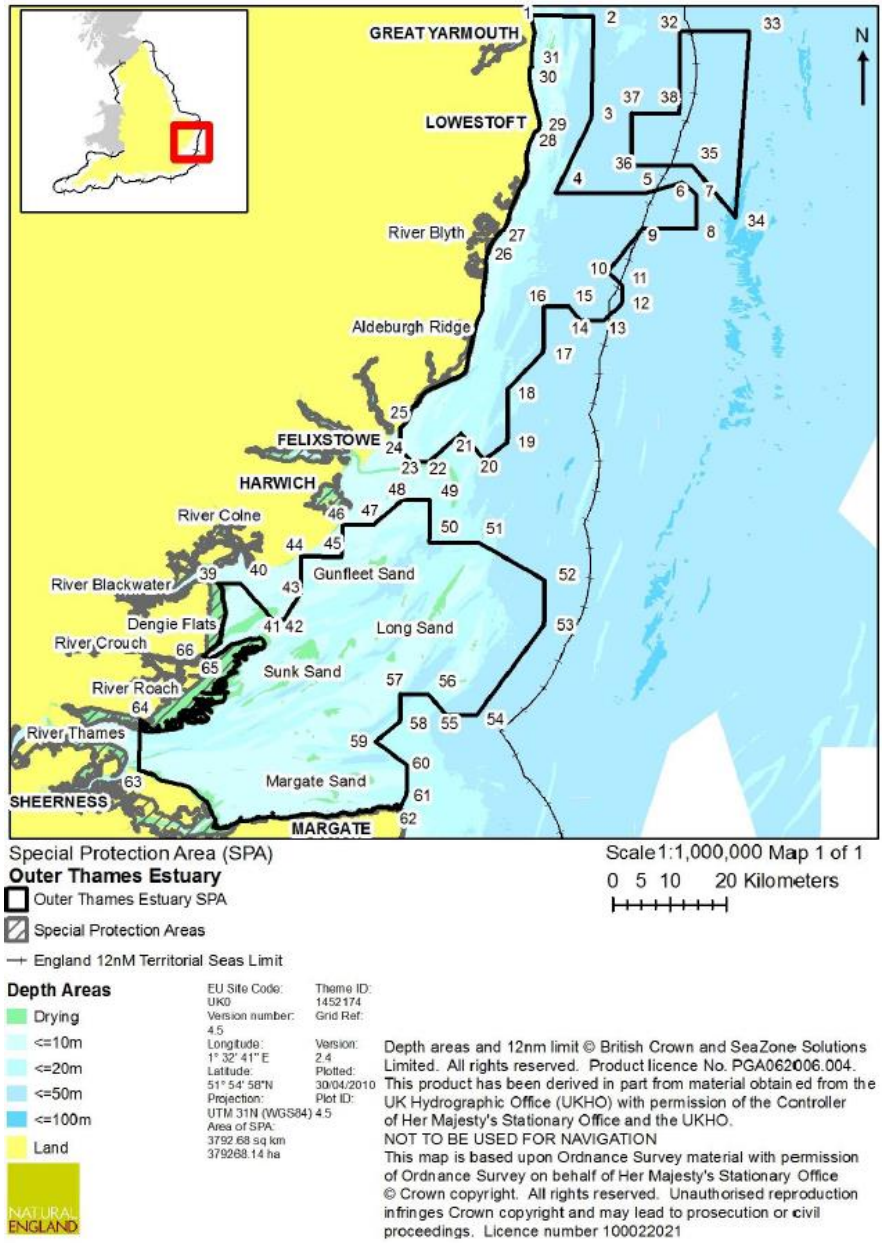
- Monitoring of red-throated diver
- Highest count of divers in Europe
- Contracted by Natural England

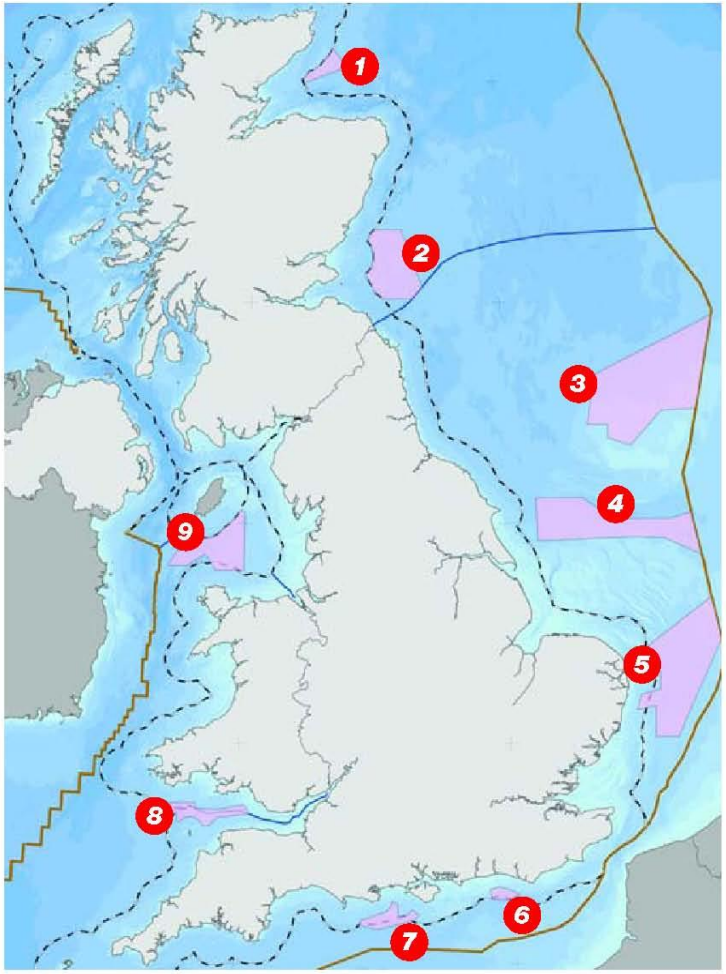
Carmarthen Bay SPA / N2K

- Monitoring of common scoters
- Contracted by Countryside Council for Wales (now Natural Resources Wales)

Pentland Firth Area

- Strategic assessment of wave and tidal lease areas
- Multiple Special Protected Areas within the vicinity
- Contracted by Marine Scotland





Wind farm licences: who got what

1. The Moray Firth zone
EDP Renováveis and SeaEnergy Renewables. Potential yield: 1.3GW

2. Firth of Forth zone
SSE Renewables and Fluor. Potential yield: 3.5GW

3. Dogger Bank zone
SSE Renewables, RWE npower renewables, Statoil and Statkraft. Potential yield: 9GW

4. Hornsea zone
Mainstream Renewable Power and Siemens Project Ventures, and also involving Hochtief Construction. Potential yield: 4GW

5. Norfolk Bank zone
ScottishPower Renewables and Vattenfall. Potential yield: 7.2GW

6. Hastings zone
E.ON Climate and Renewables UK. Potential yield: 0.6GW

7. Isle of Wight zone
Eneco New Energy. Potential yield: 0.9GW

8. Bristol Channel zone
RWE npower renewables. Potential yield: 1.5GW

9. Irish Sea zone
Centrica Energy. Potential yield: 4.2GW

Industry Support

United Kingdom

- All UK Round 3 Offshore Wind Farm projects surveyed fully or in part by aerial digital methods
- >30GW of renewable projects have been surveyed since 2009 (wind, wave, tidal)
- East Anglia ONE first project seeking consent using aerial data as the primary data source
- Acceptance by UK Statutory Nature Conservation Agencies and Regulators
- Used for strategic and project impact assessments

Germany

- New StUK+ standard environmental investigation programme of BSH requires aerial digital survey

USA

- Maryland &Texas windfarms use digital methods

Rest of the World

- To follow.....

Methods: capturing the data (I)

- **Flight conditions & planning**
  - **Flight height to meet objectives (*eg* 1000-1200 feet under cloud)**
  - **Chose good weather days(!)**
  - **Avoid sea state > 5 as birds difficult to see in breaking waves**
  - **Avoid midday sun that causes glare/glint in images (software)**
  - **Have surveyed > 300 km from land**
- **Camera systems**
  - **Expensive: APEM has 500 000 € bespoke systems (60 Megapixels with forward motion compensation on 2 axes for accuracy)**
  - **Multispectral (RGB, NIR bands) & high resolution (2 cm standard)**

Methods: capturing the data (I)

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Methods: capturing the data (II)

- **Survey design**
  - **Special for each survey depending on site, species & questions**
  - **Chose the best resolution: normally 5 cm, 3 cm or 2 cm**

Effect of image resolution on identification

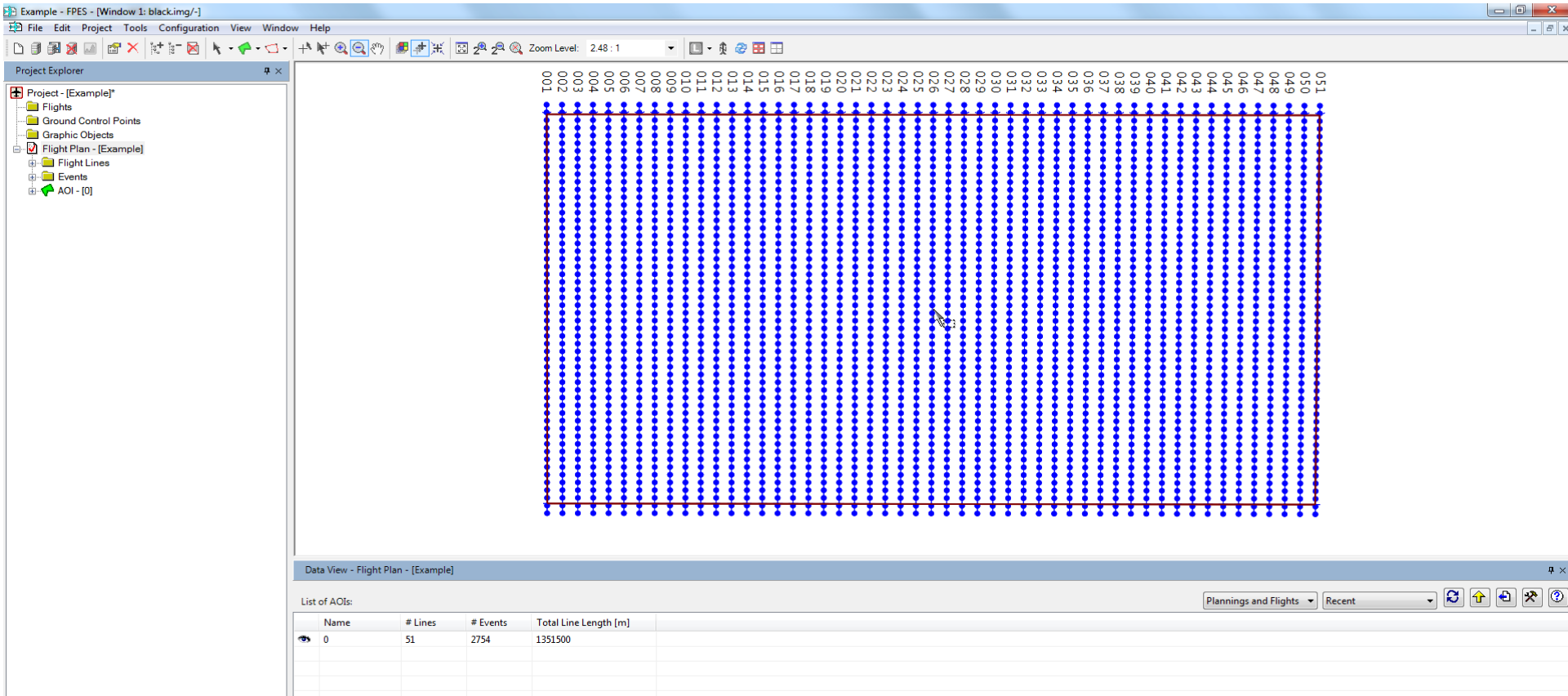
Bird group / species	Latin name	Image resolution		
		5 cm	3 cm	2 cm
Geese	*Anser* spp.	X	✓	✓
Ducks	*eg Melanitta , Clangula* spp.	X	✓	✓
Divers	*Gavia* spp.	X	✓	✓
Northern Fulmar	*Fulmarus glacialis*	X	✓	✓
Shearwaters	*eg Puffinus* spp .	X	✓	✓
Petrels	*eg Hydrobates* spp.	X	✓	✓
Northern Gannet	*Morus bassanus*	✓	✓	✓
Cormorant / Shag spp.	*Phalacrocorax* spp.	✓	✓	✓
Grebe Species	*Podiceps* spp.	X	✓	✓
Skuas	*Stercorarius* spp.	X	✓	✓
Small gulls	*eg Rissa tridactyla, Larus canus*	X	✓	✓
Large gulls	*eg Larus fuscus, L.argentus*	X	✓	✓
Terns	*eg Sterna* spp.	X	✓	✓
Auks	*eg Uria aalge, Alca torda*	X	✓	✓
Seals	*eg Halichoerus grypus, Phoca vitulina*	X	✓	✓
Harbour porpoise	*Phocoena phocoena*	✓	✓	✓
Dolphins	*eg Delphinus delphis, Tursiops truncatus*	X	✓	✓

✓ > 80% individuals identified to species

✓ > 50% individuals identified to species

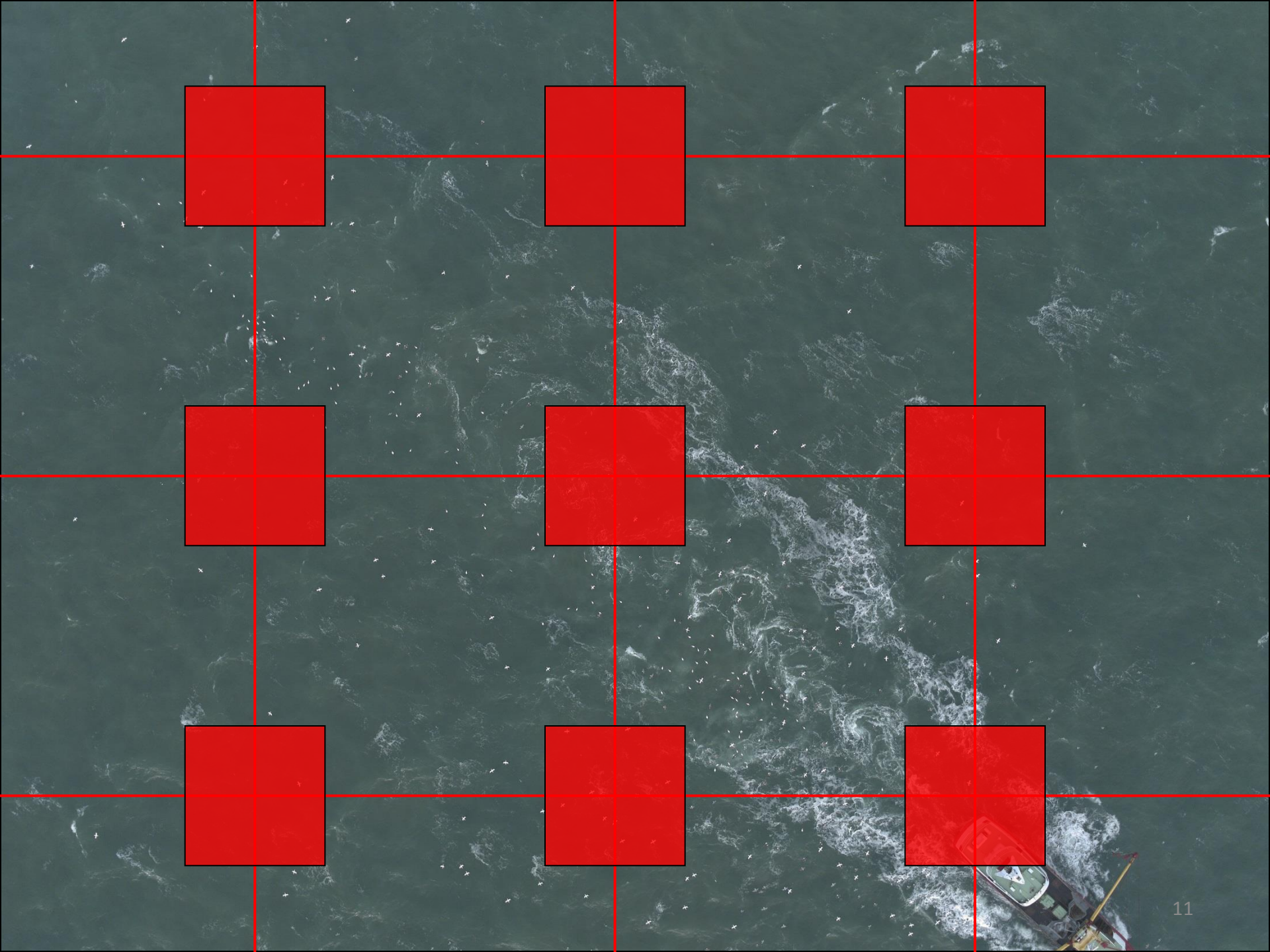
Methods: capturing the data (II)

- **Survey design**
  - **Special for each survey depending on site, species & questions**
  - **Chose the best resolution – normally 2, 3 or 5 cm**
  - **Choose Grid or Transect**
  - **Specialist software plots flight lines & nodes**
  - **Camera only fires when target location reached**



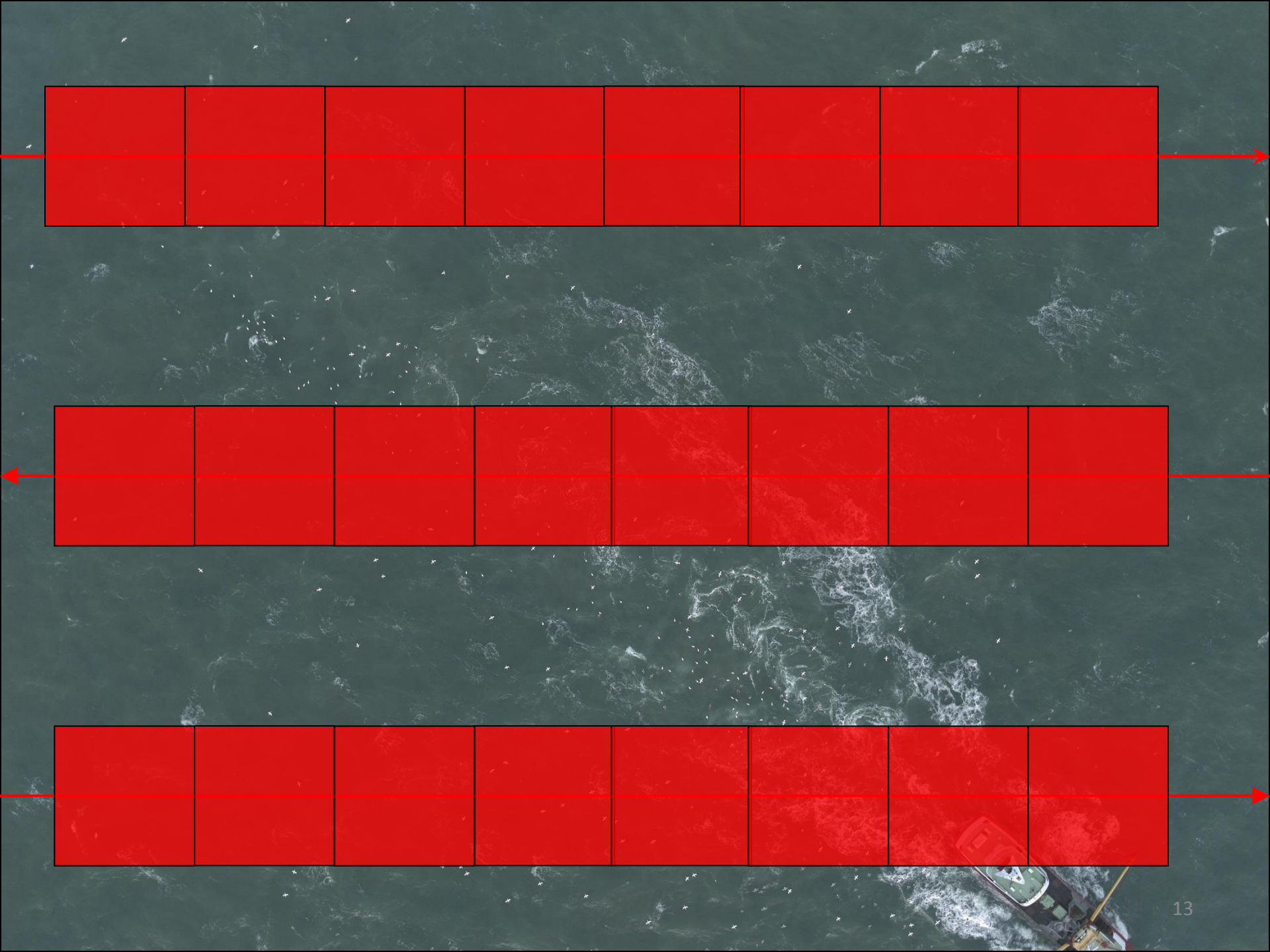
Methods: Grid-based surveys

- **Back to first principles**
- **Classic design – quadrat style**
- **Independent samples of population – statistically preferable**
- **Grids make no *a priori* assumption about environmental variables**
- **Trade off between percentage coverage & processing cost**



Methods: Transect-based survey

- Strips of abutting imagery
- Maximum percentage survey coverage in short space of time
- Direct comparison to boat survey transects



Methods: capturing the data (III)

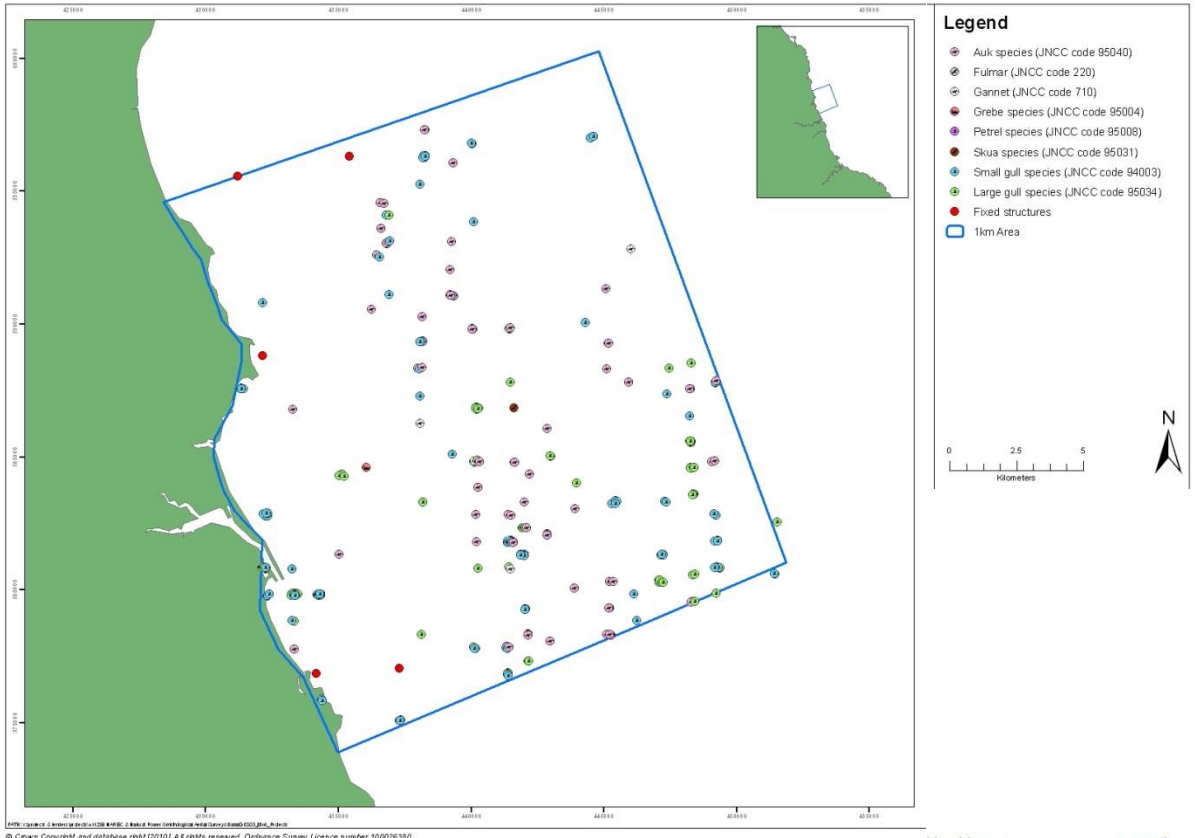
- **Data flow summary**
  - Data downloaded when plane lands
  - Raw data & GPS logs backed up on to hard drives kept in two places
  - Quality Control to ensure data of suitable quality & correct transects
  - Each image file geo-referenced from GPS log
  - Run through detection algorithm to identify possible birds / mammals
  - Images sent to analysts

Methods: capturing the data (IV)

- Automated Object Recognition
- Bird wing span and body length
- Bird flight direction
- Bird flight height

Methods: capturing the data (IV)

- **Image Analysis & Quality Assurance**
  - **Automated image analysis**
  - **Species identification**
  - **Bird parameters – location, flight height & flight direction**



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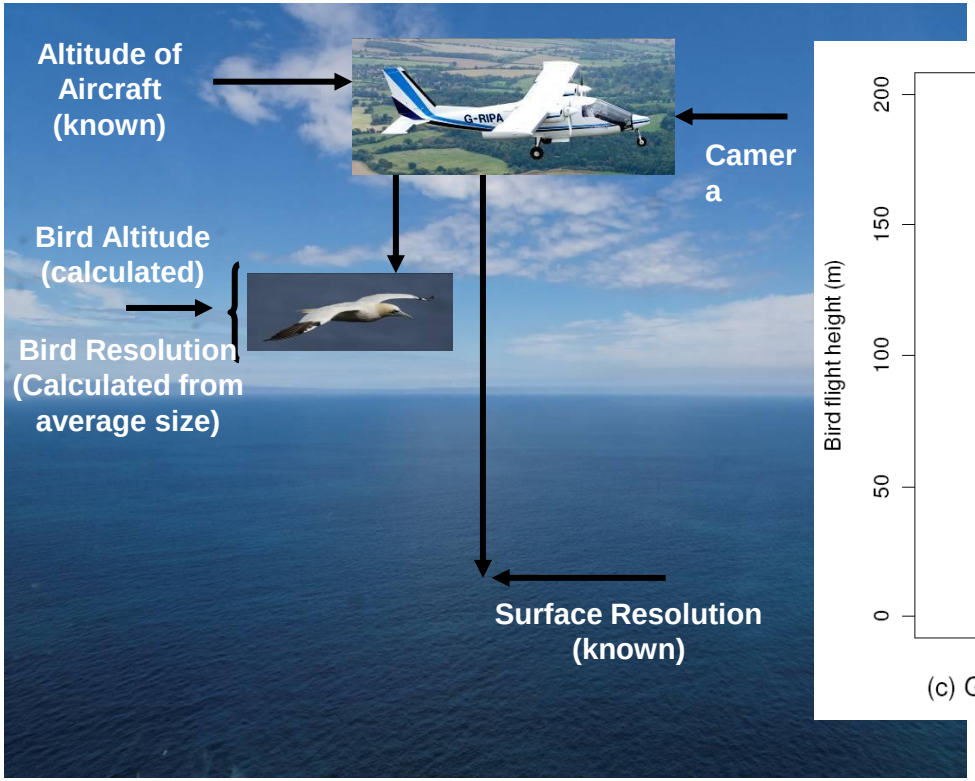
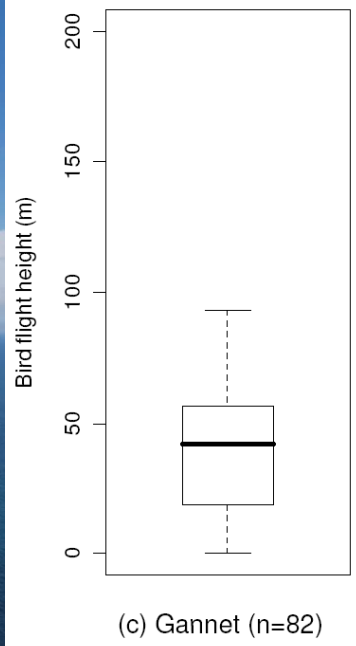
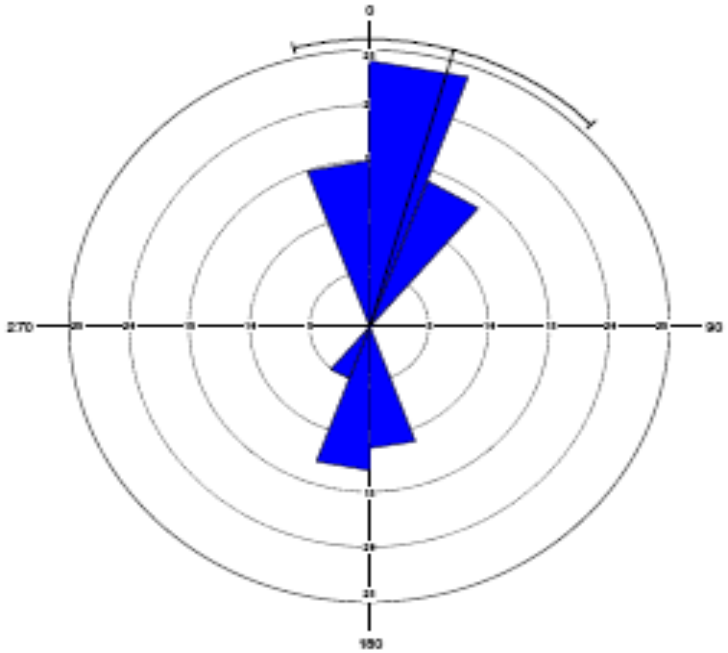




Methods: capturing the data (IV)

- **Image Analysis & Quality Assurance**
  - **Automated image analysis**
  - **Species identification**
  - **Bird parameters – location, flight height & flight direction**



Rose diagrams of flight directions

Methods: capturing the data (V)

- **Image Analysis**
  - Automated image analysis
  - Species identification
  - Bird parameters – location, flight height & flight direction

- **Quality Assurance procedures**
  - Internal checking
  - External independent checking

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BTO Looking out for birds

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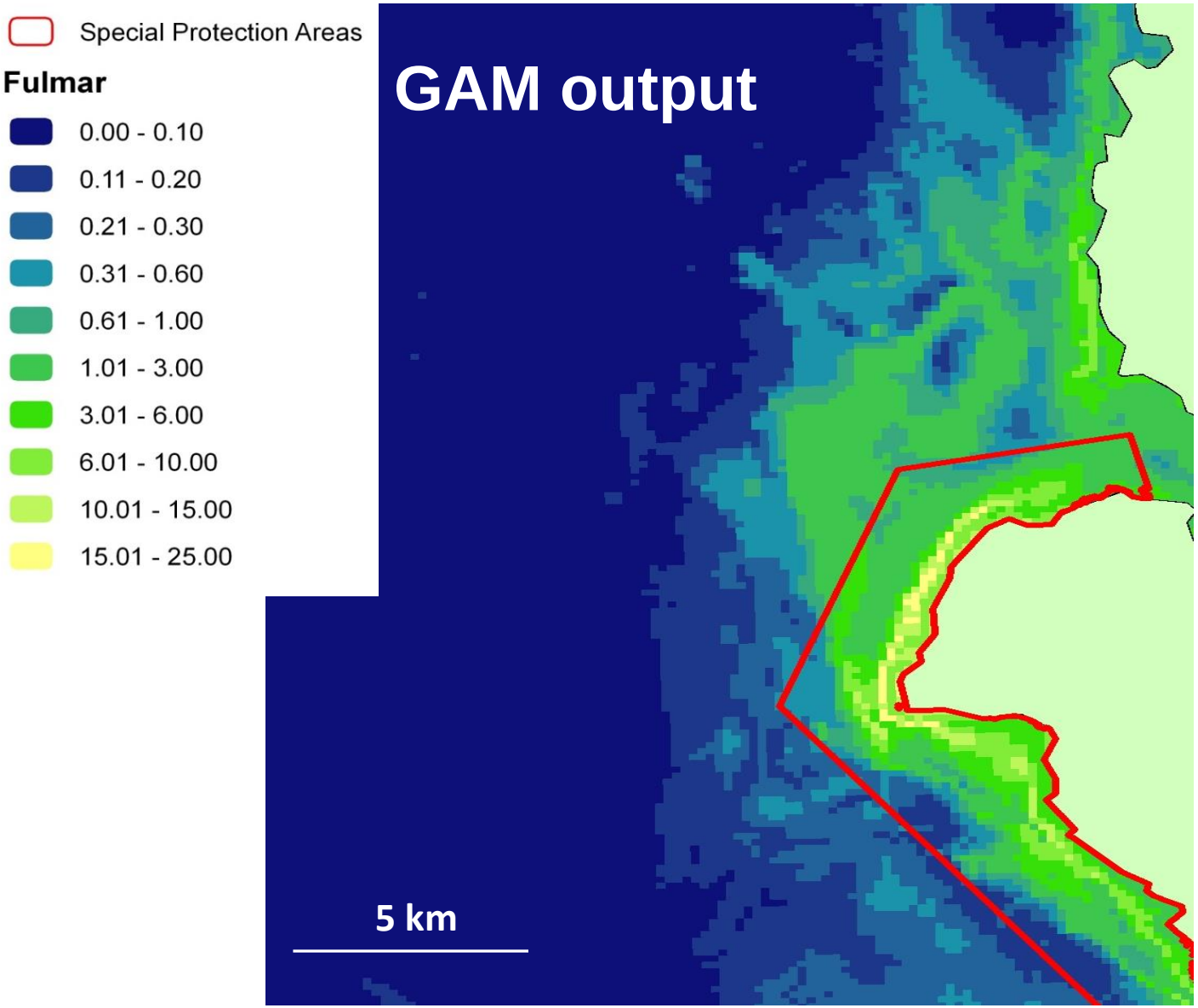
Statistical Analysis & Support Tools

Too much to describe in the time available, *eg*

- **Availability bias**
- **Design-based modelling**
- **Generalized Additive Modelling (GAM)**
- **Migration Models**
- **Population Viability Analysis**
- ***etc*.**

Statistical Analysis & Support Tools

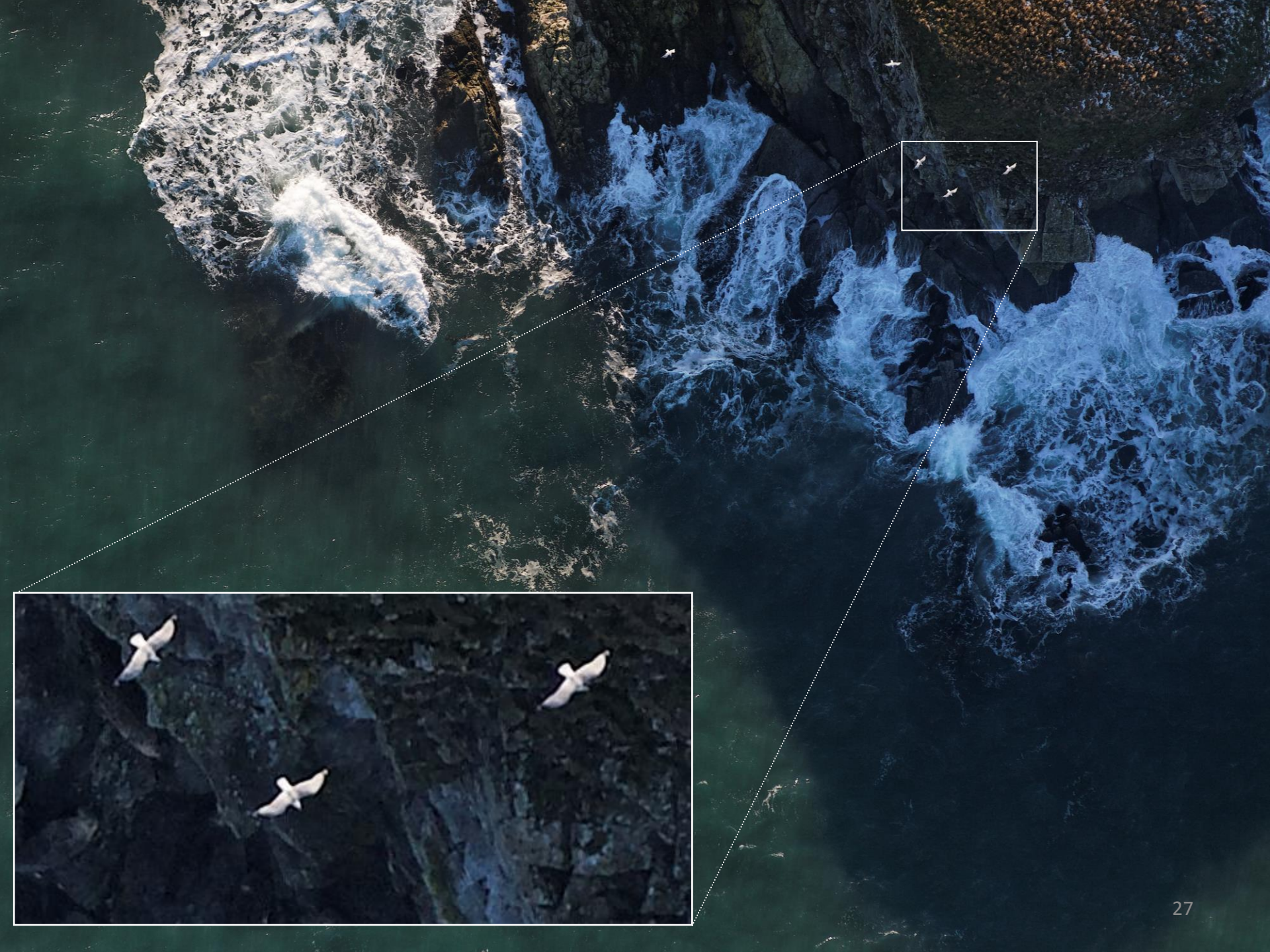


Example high-resolution snags

Species ID from high-resolution imagery

Species ID from high-resolution imagery

Puffin Island seals



Information provided by aerial survey

- **Rapid and cost effective surveys of large marine areas**
- **Population estimates *eg* wintering red-throated divers**
- **Identification of potential MPAs / *Natura 2000* sites**
- **MPA condition monitoring *eg* O. Thames & Carmarthen Bay SPAs**
- **Information for offshore Environmental Impact Assessments (EIAs)**
- **Information for offshore Before-After-Control-Impact (BACI) studies**
- **Information for scientific research**

High Resolution Digital Still Images: Conclusions

- Human error of boat and aerial visual surveys reduced
- Reliable - no monthly surveys in North Sea missed for 3 years
- Little or no disturbance to animals due to >300 m flight height
- Geo-referencing accurate & precise
- Images Quality Assured
- Images are a permanent record
- Images available for statistical (re-)analysis or to answer future questions of biological interest
- Always improving – in 5 years from 5 cm to 2 cm pixel resolution, from auk to wintering guillemot or razorbill
- Can we survey birds accurately at night?

Thank you for listening.

Any questions?

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