



***Night-time obstruction lighting  
for offshore (and onshore) wind farms  
and birds: demands from different  
interest groups***

**Development of concepts  
for the marking of offshore wind farms**

**Sub-project: Ecological effects and nature conservation**

**11<sup>th</sup> European Symposium for the  
Protection of the Night Sky  
6<sup>th</sup> - 8<sup>th</sup> October, 2011, Osnabrück, Germany**

**EKKO** - Development of concepts for the marking of offshore wind farms

**Project time:** 2 years (01.01.2010 - 31.12.2011)

**Funding:** ~ 70% Federal Ministry for the Environment,  
Nature Conservation and Nuclear Safety (BMU)  
~ 30% third-party funds of energy companies

**Project coordination:** SSC-Montage GmbH

**Project partners / subcontractors:**

Kuhbier Rechtsanwälte – approval regulations, project consulting

Germanischer Lloyd AG – maritime traffic

Institut für Luft- und Raumfahrt der TU Berlin – aviation and legal aspects

BioConsult SH – ecology and nature conservation

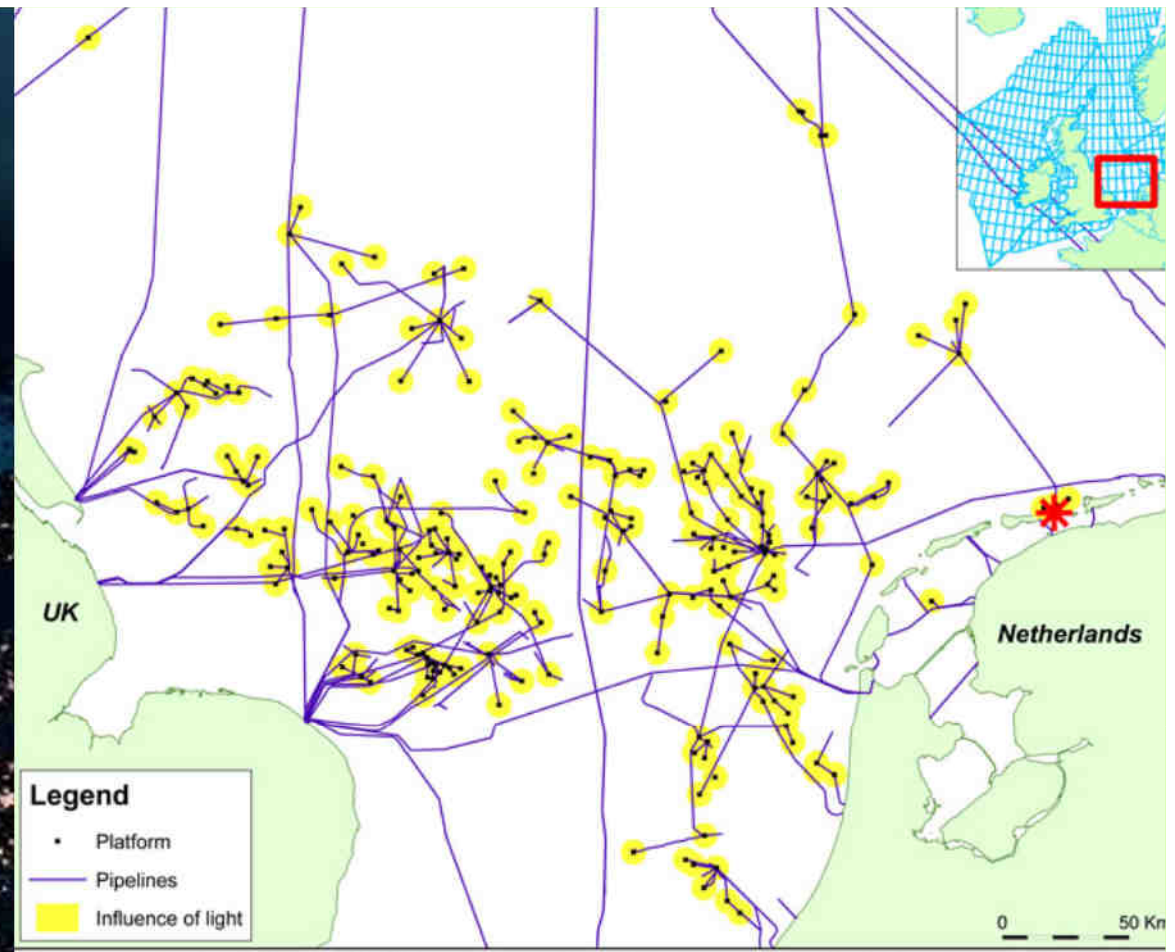
Hamburg Port Training Institute – nautics, navigation

Anwaltskanzlei Lebuhn & Puchta – marine law

Deutscher Wetterdienst Uni Paderborn - meteorology

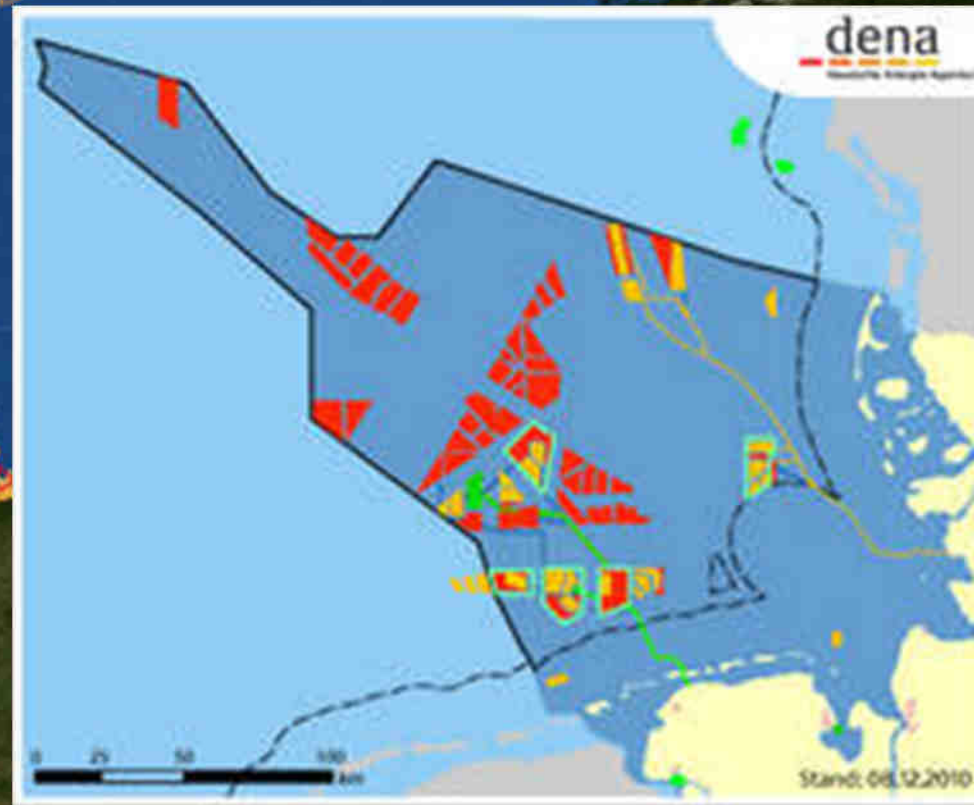


**Offshore structures,  
– more lights in the sea...**



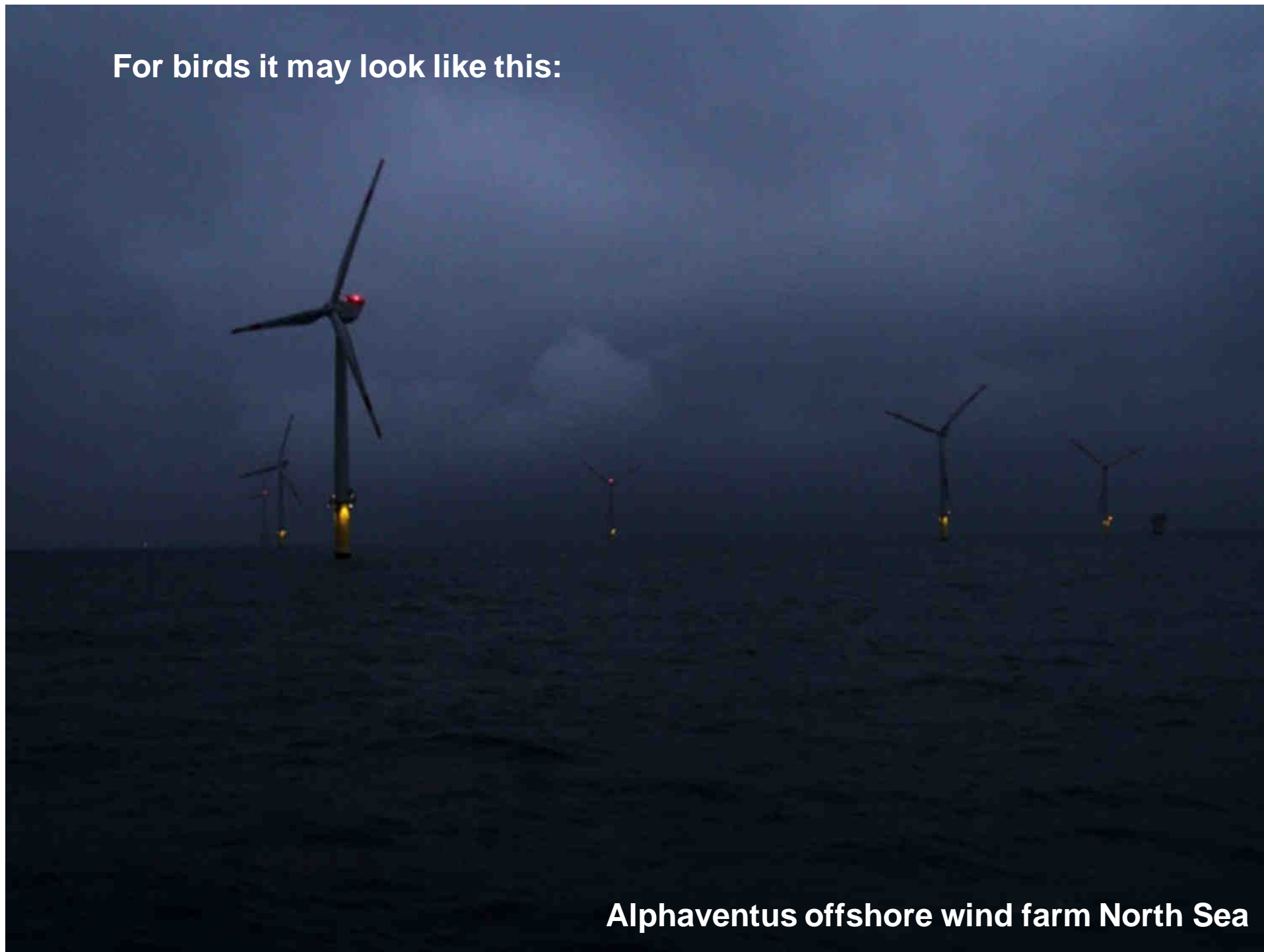
**Production platforms in 2007 incl.  
5 km circle (Poot et al. 2008)**

Proposed offshore wind farm areas in Europe; database: [www.4coffshore.com](http://www.4coffshore.com)



**German EEZ: 26 permitted and 62 proposed  
each with 40- 100 wind turbines (Status 2010)**

**For birds it may look like this:**



**Alphaventus offshore wind farm North Sea**

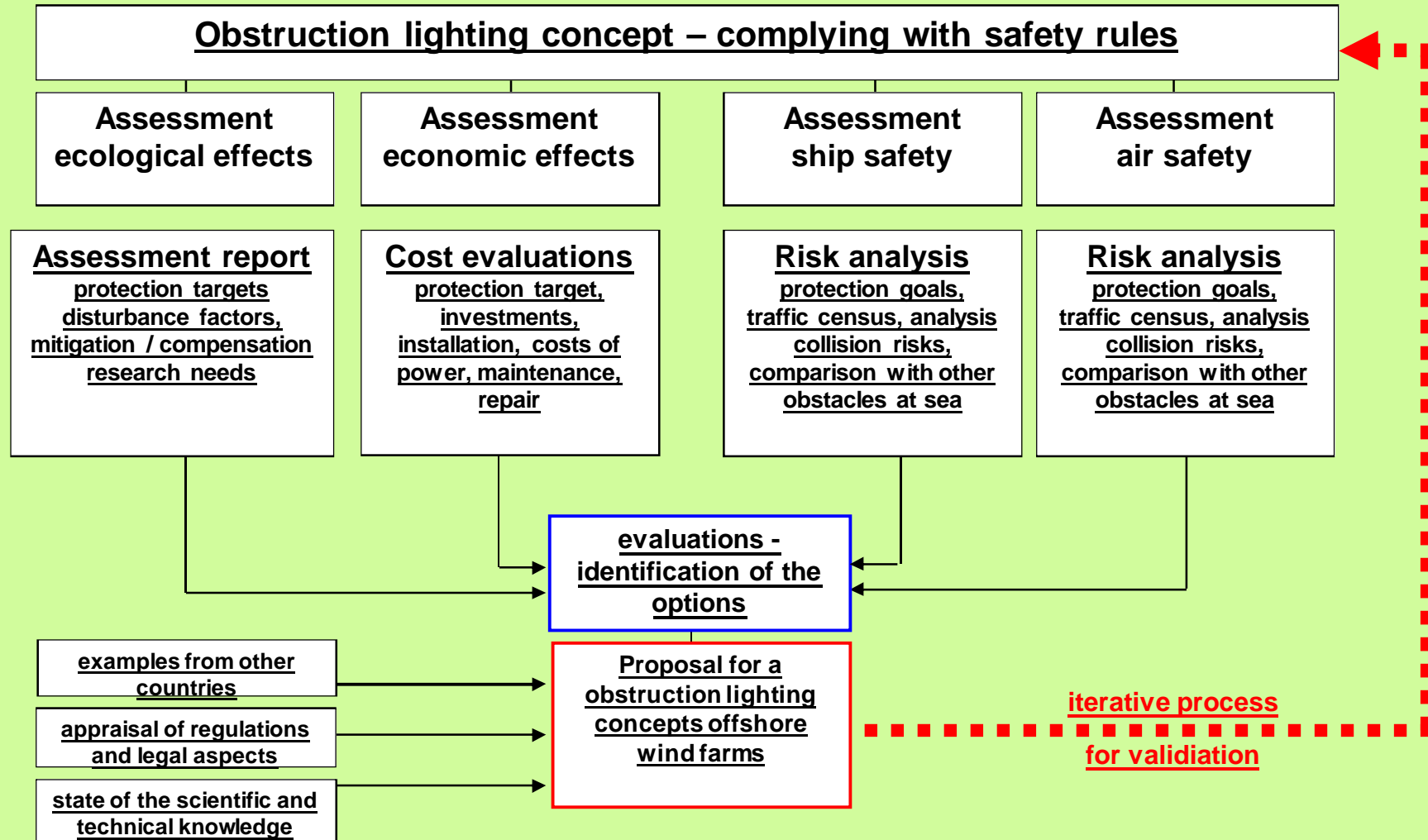
... or more like this?

in a formerly pitch dark environment ...



... we simply don't know!

# Development of concepts for the marking of offshore wind farms



Windturbines will be marked,

- onshore with aviation lighting only
- offshore with lighting for airplanes and ships.

## WEA > 150m

- **Schifffahrt**

- Gelber Turm (min. HAT + 15m)
- 3 x Erkennungsmarkierung am Turm (Schriftgröße 1 Meter)
- Nacht-Nahbereichskennzeichnung
  - a. 3 x Anstrahlung der Erkennungsmarkierung
  - b. 3 x LED-Leuchttafeln
- Periphere WEA: 5-Seemeilenfeuer

- **Luftfahrt**

- 2 x w, Rot auf der Gondel
- 4 x Hindernisfeuer am Turm
- 2 x 6 Meter rote Streifen am Rotor
- Erkennungsmarkierung auf der Gondel
- Roter Streifen am Turm
- Roter Streifen an der Gondel



SSC Montage



SSC Windenergy  
Service

## Safety shipping traffic - IALA (International Civil Aviation Organization)

- yellow lights - blinking – corner, periphery (5 nm)
- yellow markings / paint plus light (near)

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Gondel  
am Turm  
Leuchten am Rotor  
Markierung auf der Gondel  
Turm  
er Gondel

Windenergy  
Service



## Safety air traffic - ICAO (International Association of Marine Aids to Navigation and Lighthouse Authorities)

- red light on nacell ,
- more red lights depending on turbine height:  
red lights at the tower and at the blade tips (upper 120°)

WEA > 150m



### • Luftfahrt

- 2 x w, Rot auf der Gondel
- 4 x Hindernisfeuer am Turm
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- Erkennungsmarkierung auf der Gondel
- Roter Streifen am Turm
- Roter Streifen an der Gondel

Schrifthöhe 1 Meter)

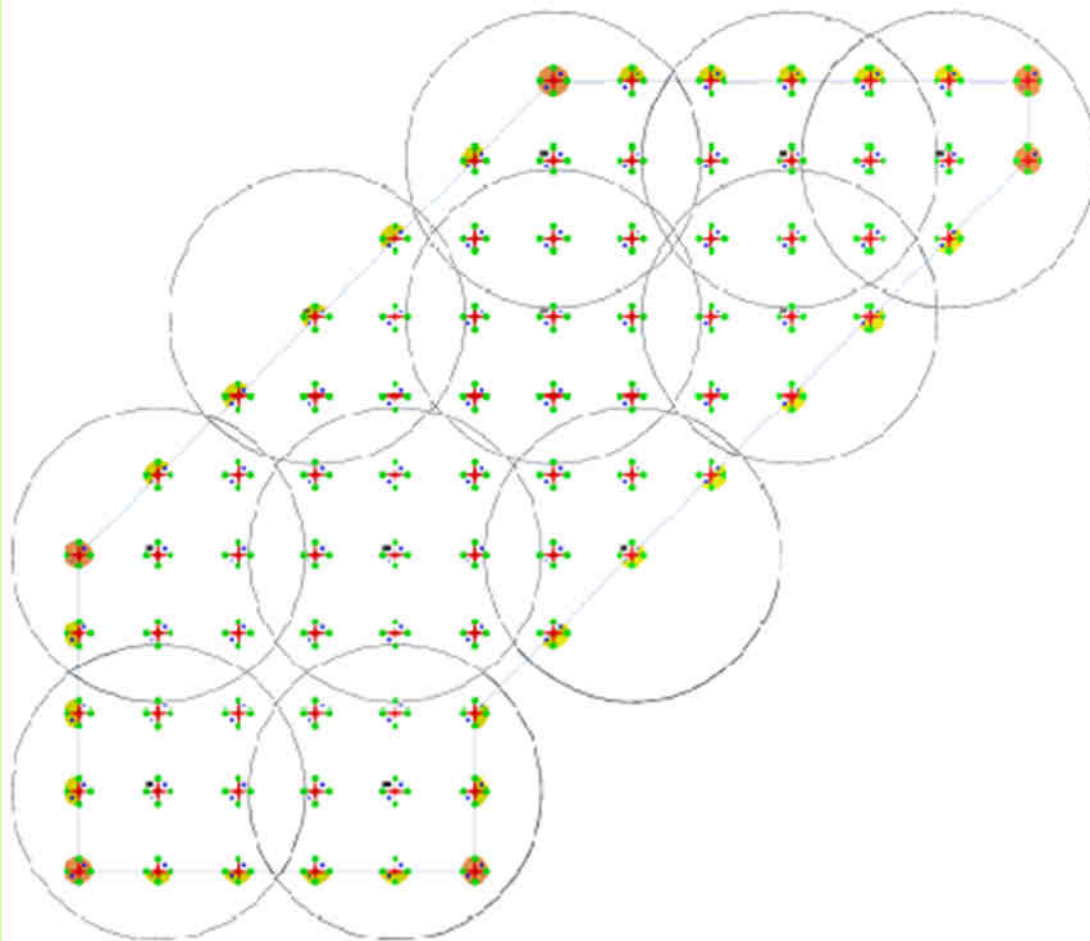
smarkierung



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- ✚ Offshore Windenergieanlage
- ✚ 2 x w, Rot auf der Gondel
- ✚ 4 x Hindernisfeuer (Festfeuer) am Turm
- ✚ 5-Seemeilenfeuer 360° auf der Plattform, Kennung: Ubr(3) gelb (16s)
- ✚ 5-Seemeilenfeuer nach außen gerichtet auf der Plattform, Kennung: Blz. gelb (4s)
- \* Sichtweitenmessgerät auf der Gondel
- Peripherlinie
- / 1500m Radius

**Offshore scenario**

**77 turbines**

**> 150 m high**

## **Nature conservation protection targets**

Impact by obstruction lighting of offshore wind farms means, that individual birds are

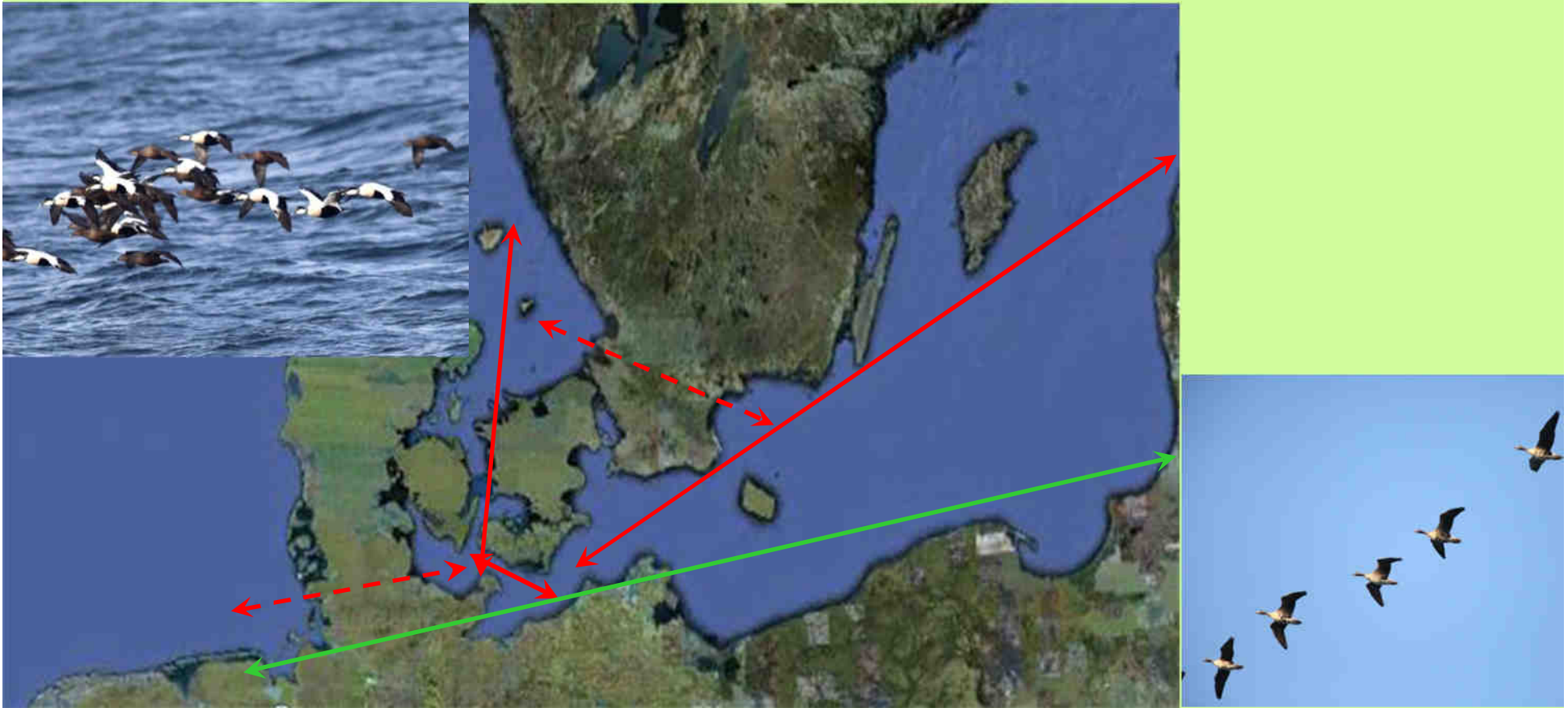
- killed due to markings / lighting (collision, exhaustion) or
- disturbed (desorientation, distraction, loosing fitness).

### **Goal:**

It shall be avoided, that additional mortality by obstruction lighting will negatively affect the population status.

## Where are migrating birds flying?

- **waterbirds like seaducks, divers, auks: preferably over water**
- **other waterbirds: over water, but long-distance straight lines**

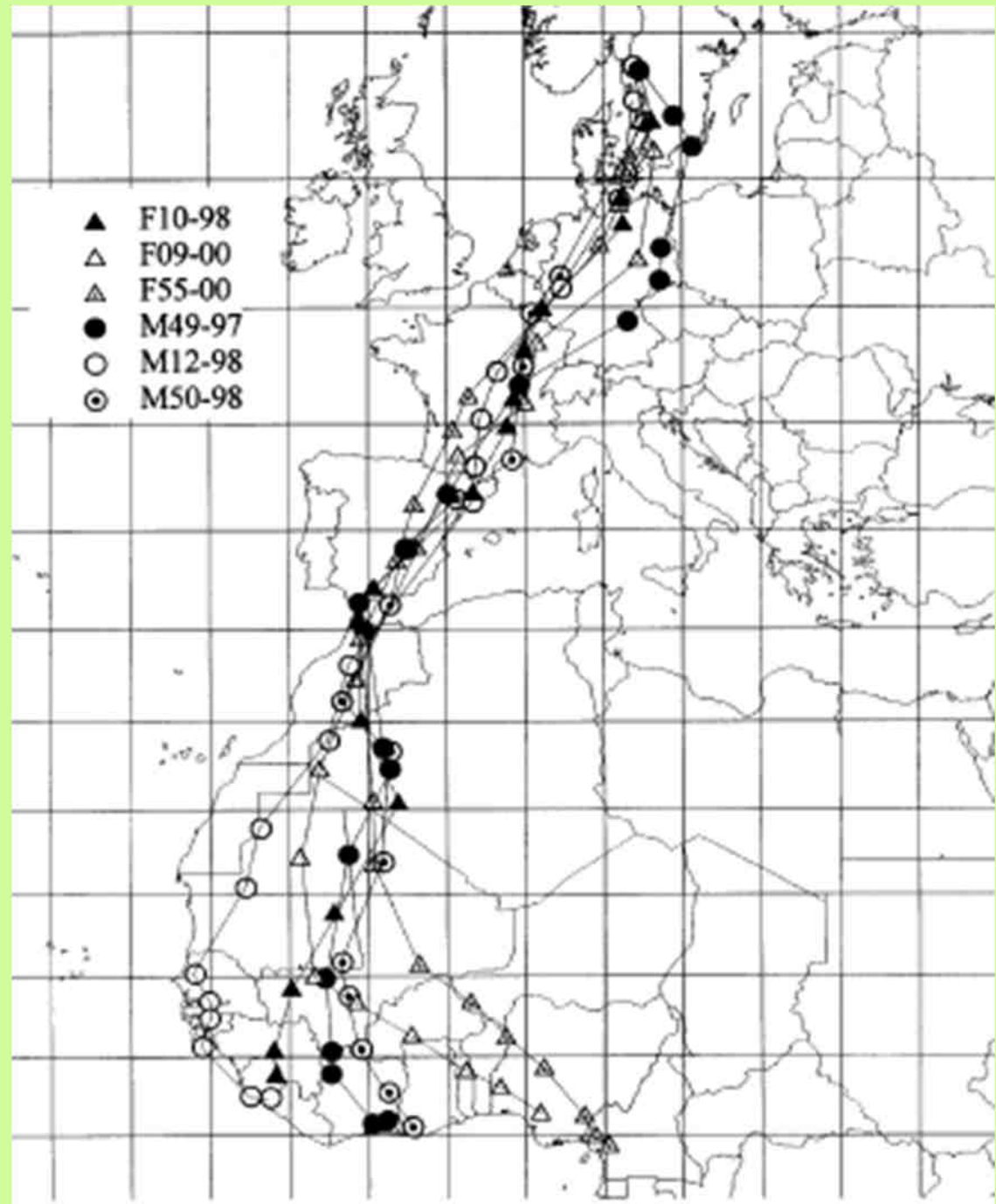




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## Where are birds flying?

- daytime migrants
- here long-distance migrant Honeybuzzard (Hake et al., 2003)
- same routes apply to songbirds



## Where are migrating birds flying?

- **daytime migrants – birds of prey, other soaring birds, some species of songbirds**
  - narrow front migration guided by topographic features;
  - cross large waterbodies at shortest distance

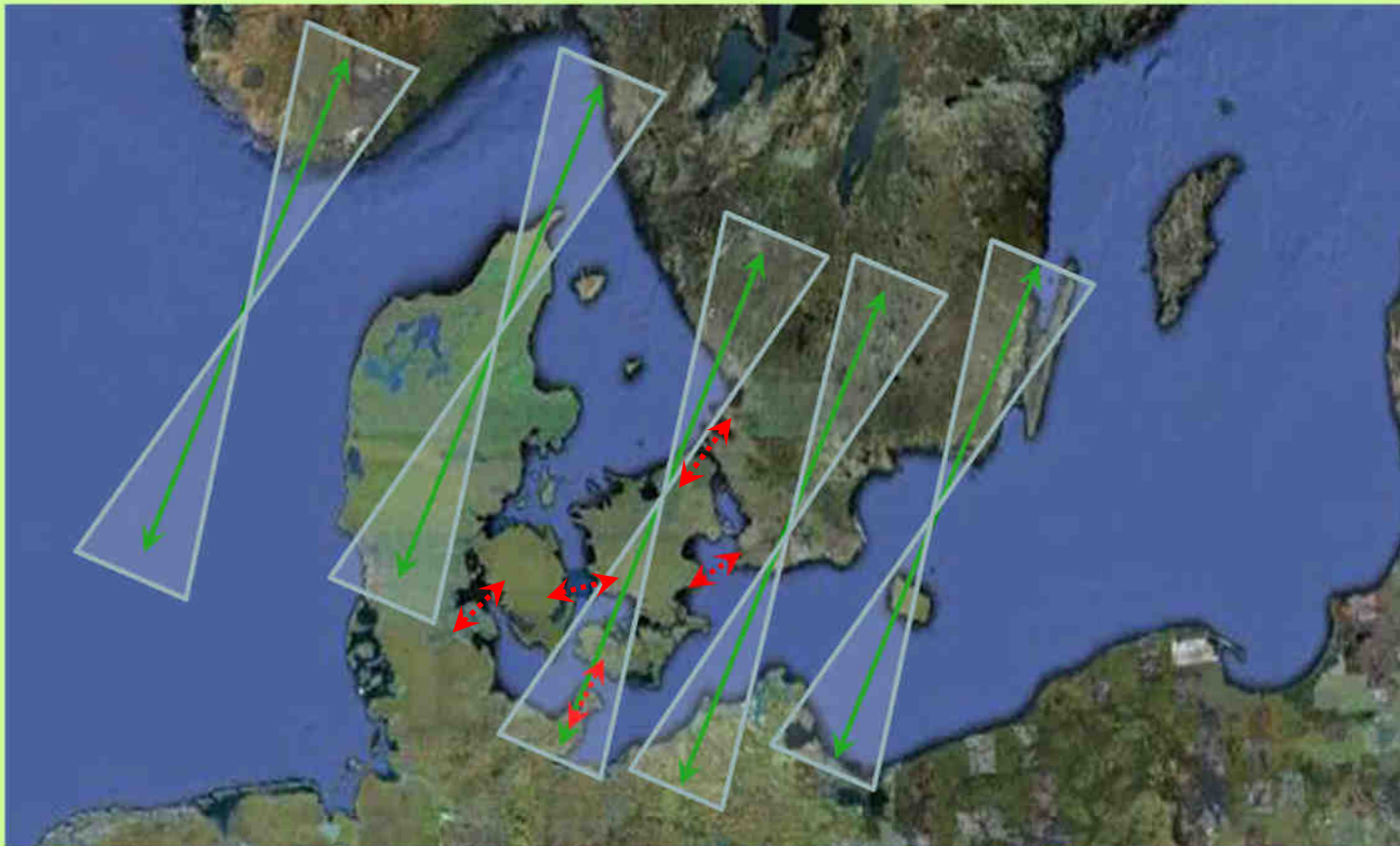


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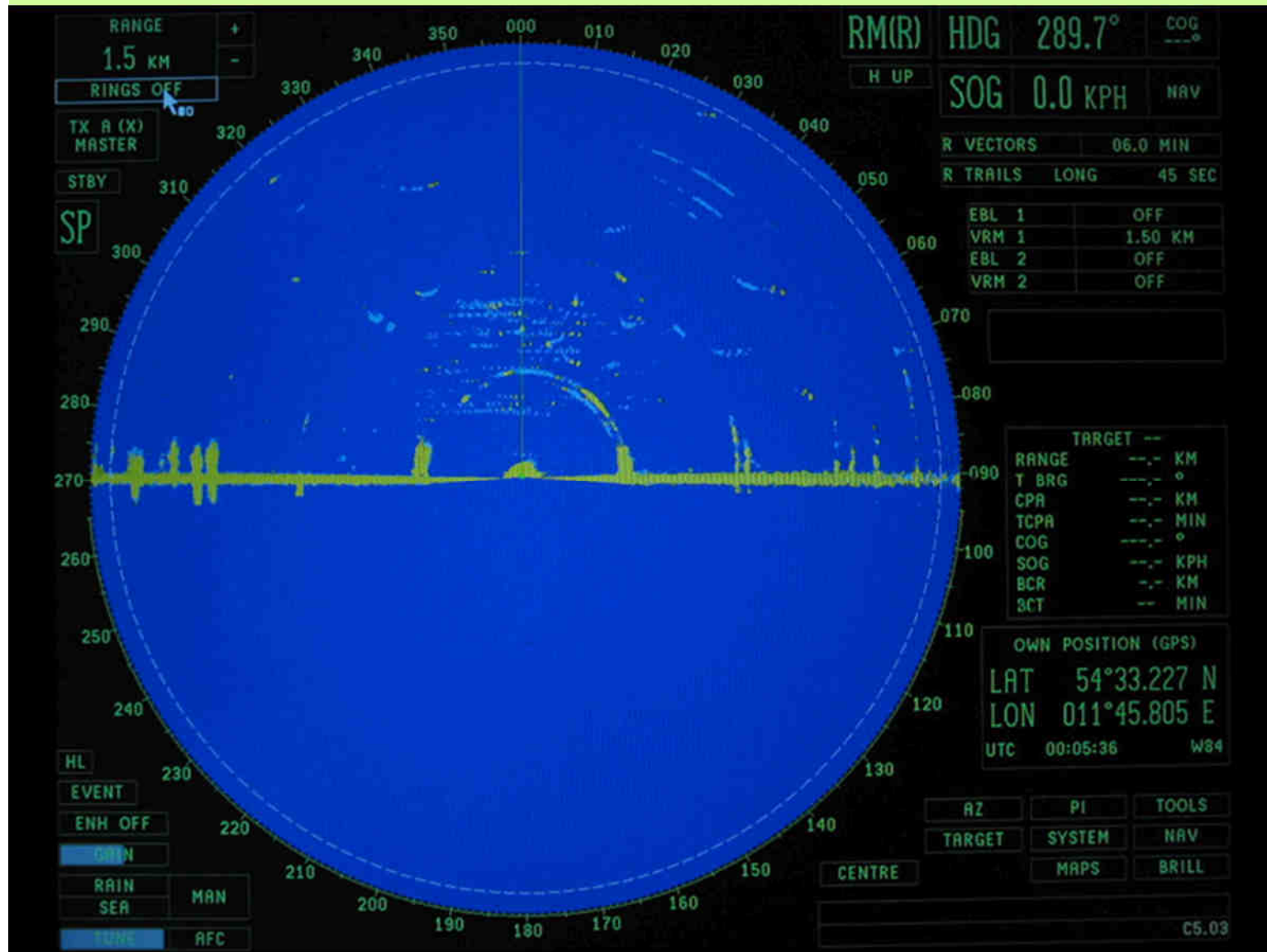
## Where are migrating birds flying?

- **night-time migrants – mainly songbirds, some waders and other waterbirds**  
**broad-front migration at all altitudes, limited leading line effects**



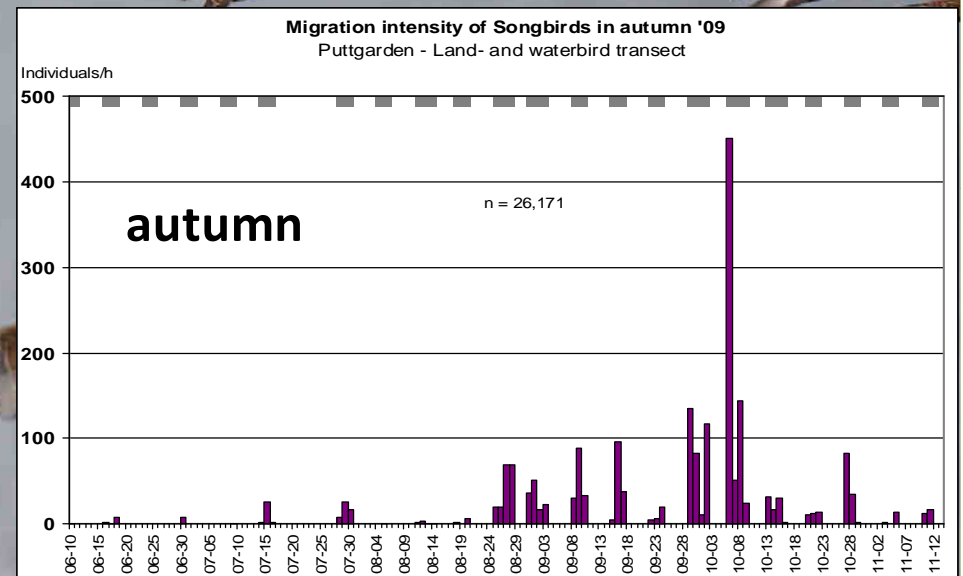
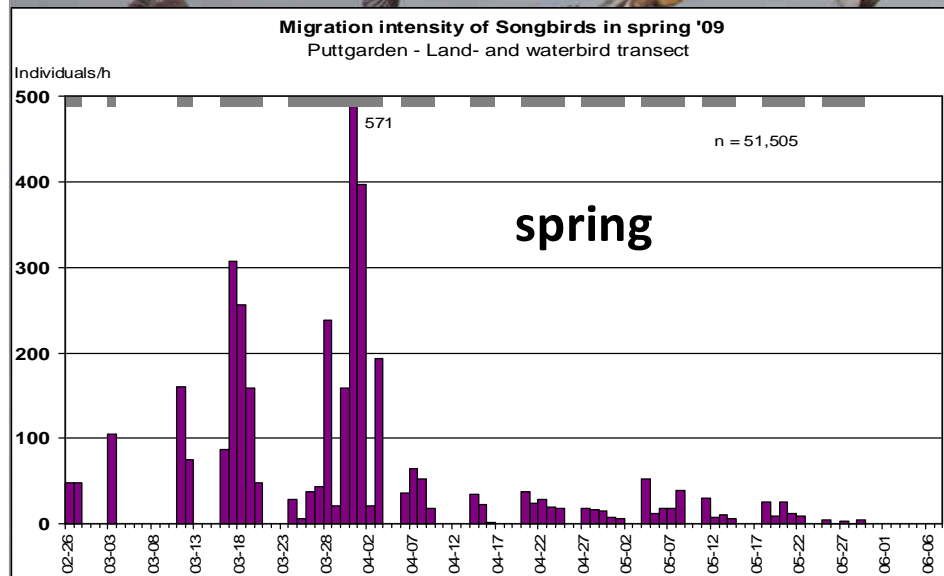
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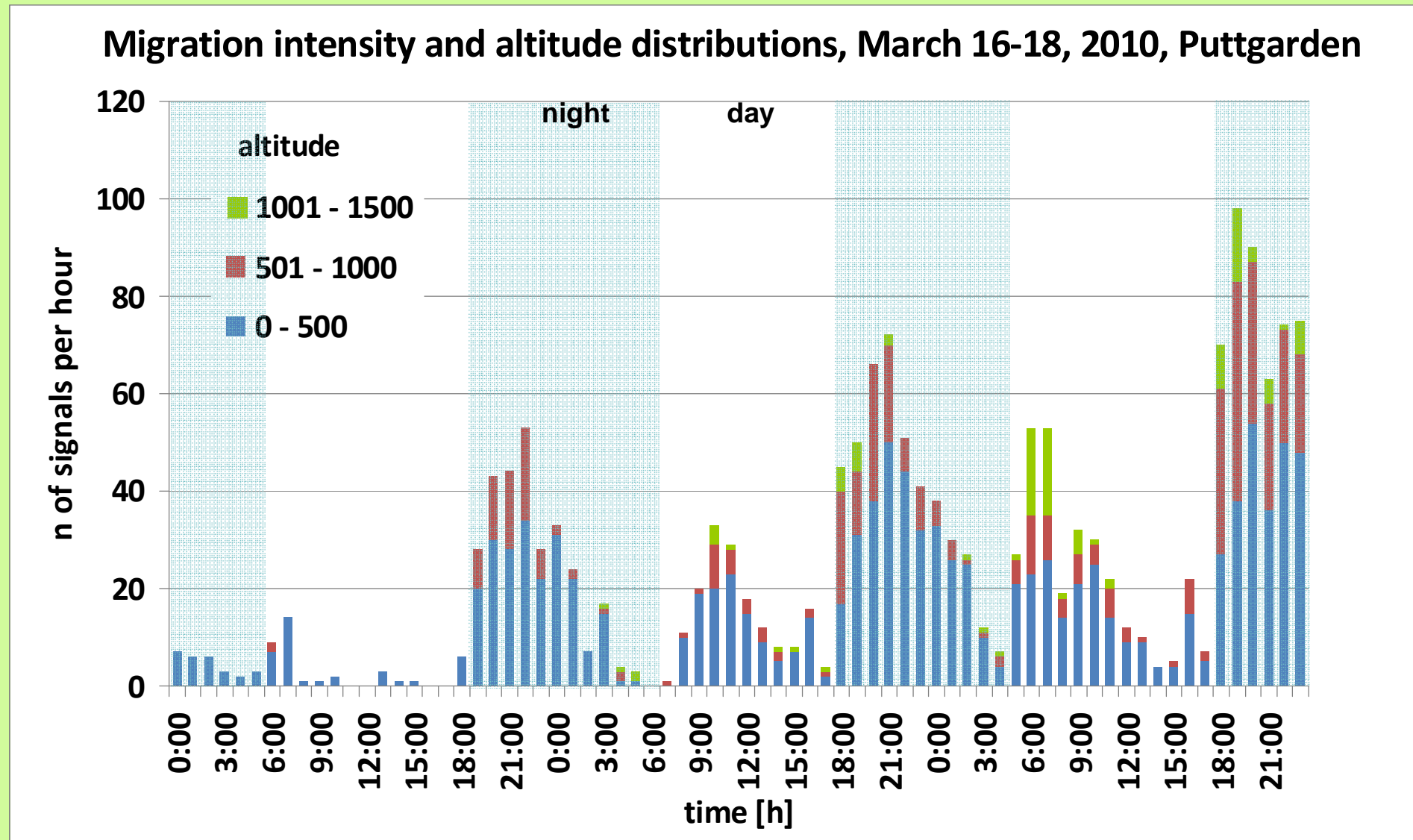
# When are they in the air?

## Migration intensities per season (Fehmarn 2009)



## When are they in the air?

### Migration intensities per day and night, altitude (Fehmarn 2010)



## How many are there?

- Night migration:  
e.g. breeding populations Sweden and Finland (incl. both partners plus 2 young per pair) –  
~ 400 Mio, mostly songbirds;
- Day migration:  
e.g. waterbirds > 10 Mio individuals from a much larger region  
plus other day migrants

**MANY!**

Do they collide?

They do!



Abb. 4: Illuminierter Post-Tower von der Ostseite. Das weiße Licht dringt auch nach Beendigung der Illumination während der gesamten Nacht nach außen. Foto aus 2008 mit ausgeschalteter Lichtkranz.

*Fig. 4: East side of the illuminated Post Tower. The white lights shine out of the building during the entire night even after the illumination period. Photo from 2008 with roof lights switched off.*



Abb. 18: Tote Rotkehlchen zweier aufeinander folgender Nächte (auf den 02. und den 03.10.07) mit starker Anlockwirkung durch den Turm. Von Mitte September bis Mitte Oktober, wenn Tiere aus nördlichen Regionen durchziehen, traten Rotkehlchen am Turm zahlreicher in Erscheinung. Mit 46 Rotkehlchen und 73 Vögeln insgesamt lockte das Licht in der Nacht auf den 03.10.07 soviel Vögel wie in keiner anderen Nacht während der Untersuchung an den Turm.

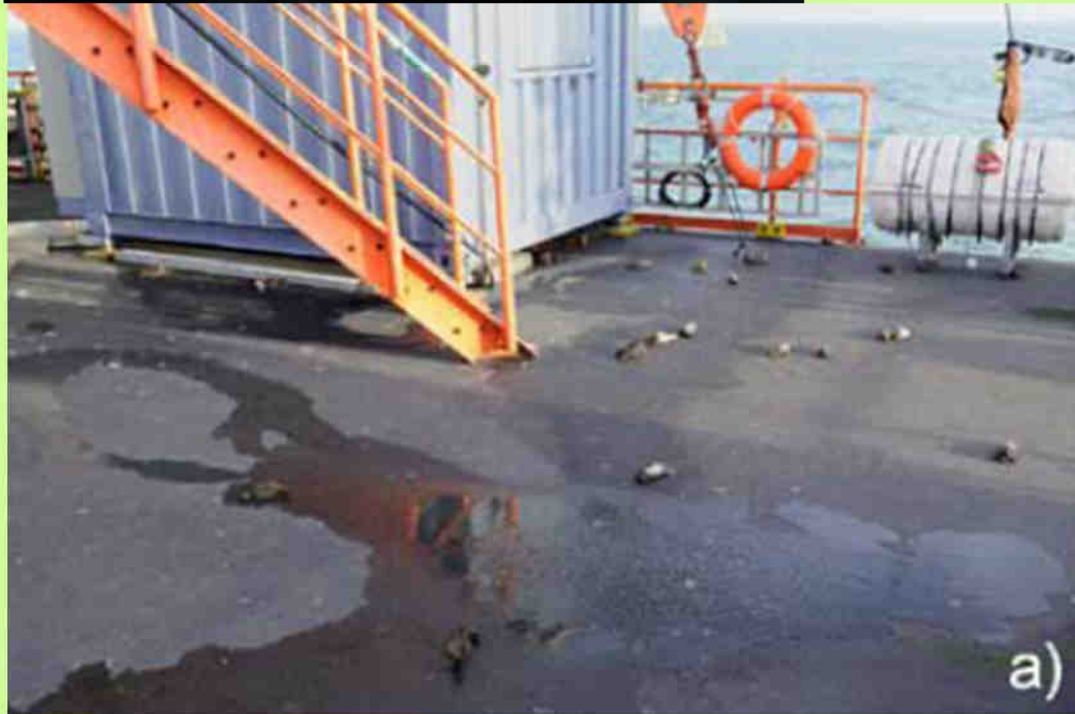
onshore: Bonn Post-Tower (Haupt 2009)

**Do they collide?**



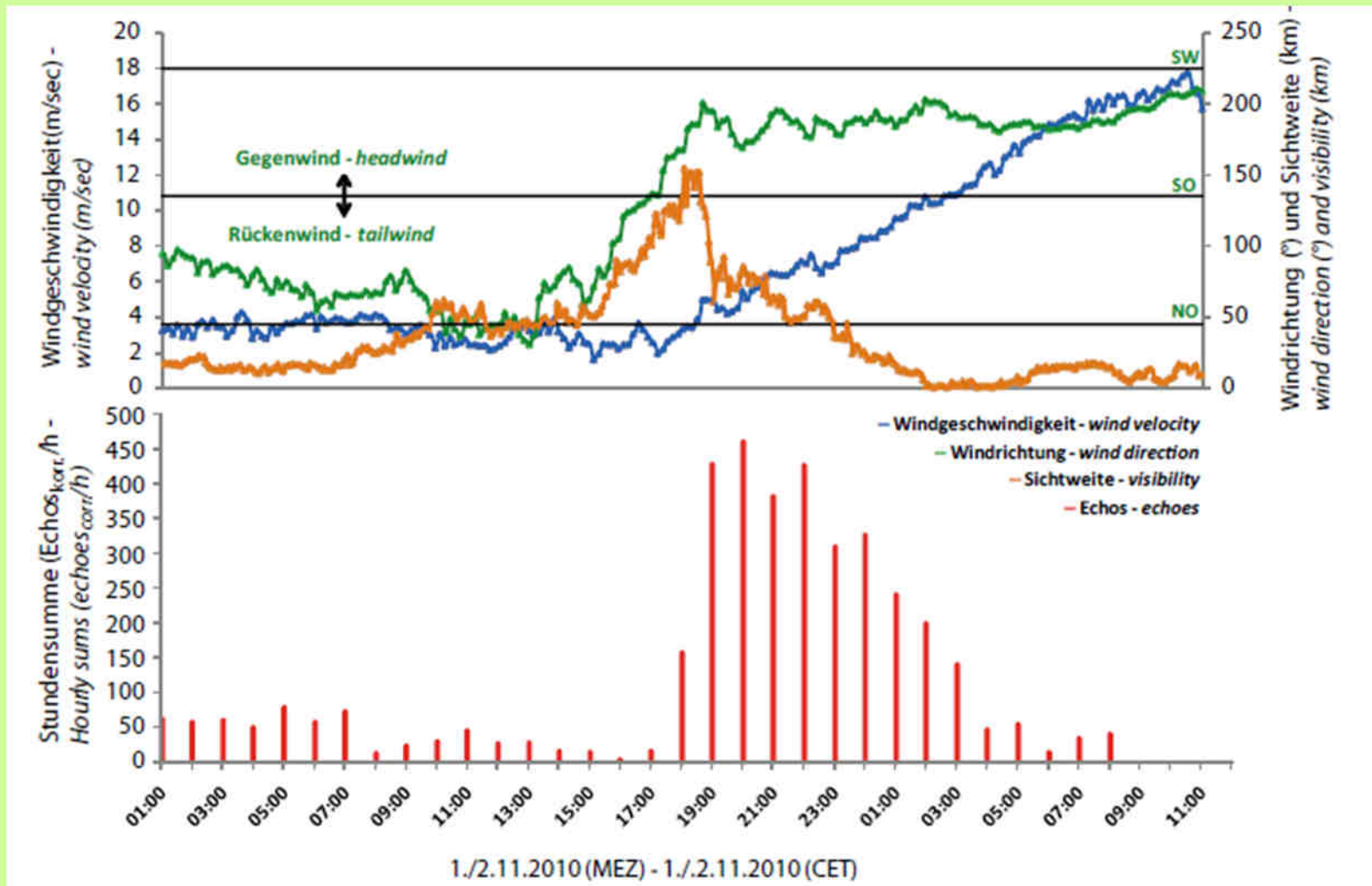
**They do!**

**Offshore: Fino 1 (Aumüller et al., 2011)**



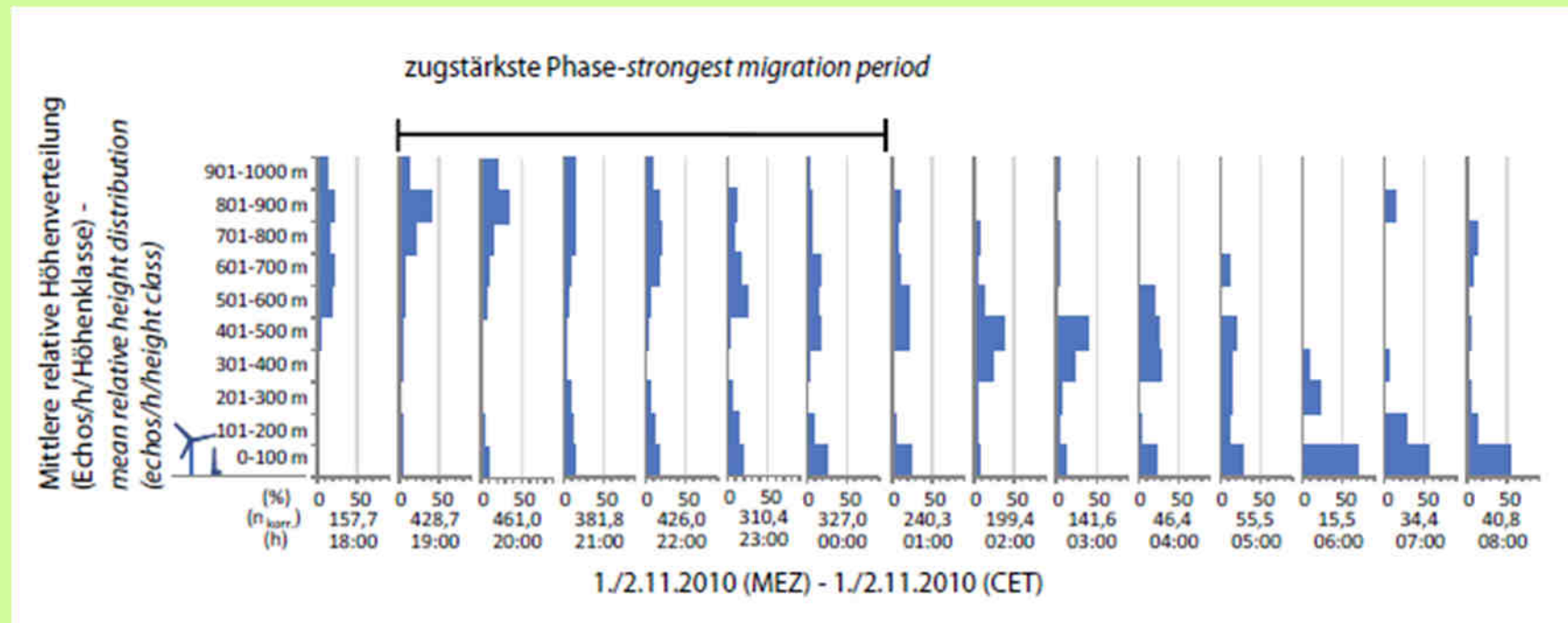
## We know, when collision rates are high

- An example:  
Good migration conditions in Scandinavia – tailwind;  
turning bad over the North Sea – headwind, low visibility



## We know, when collision rates are high

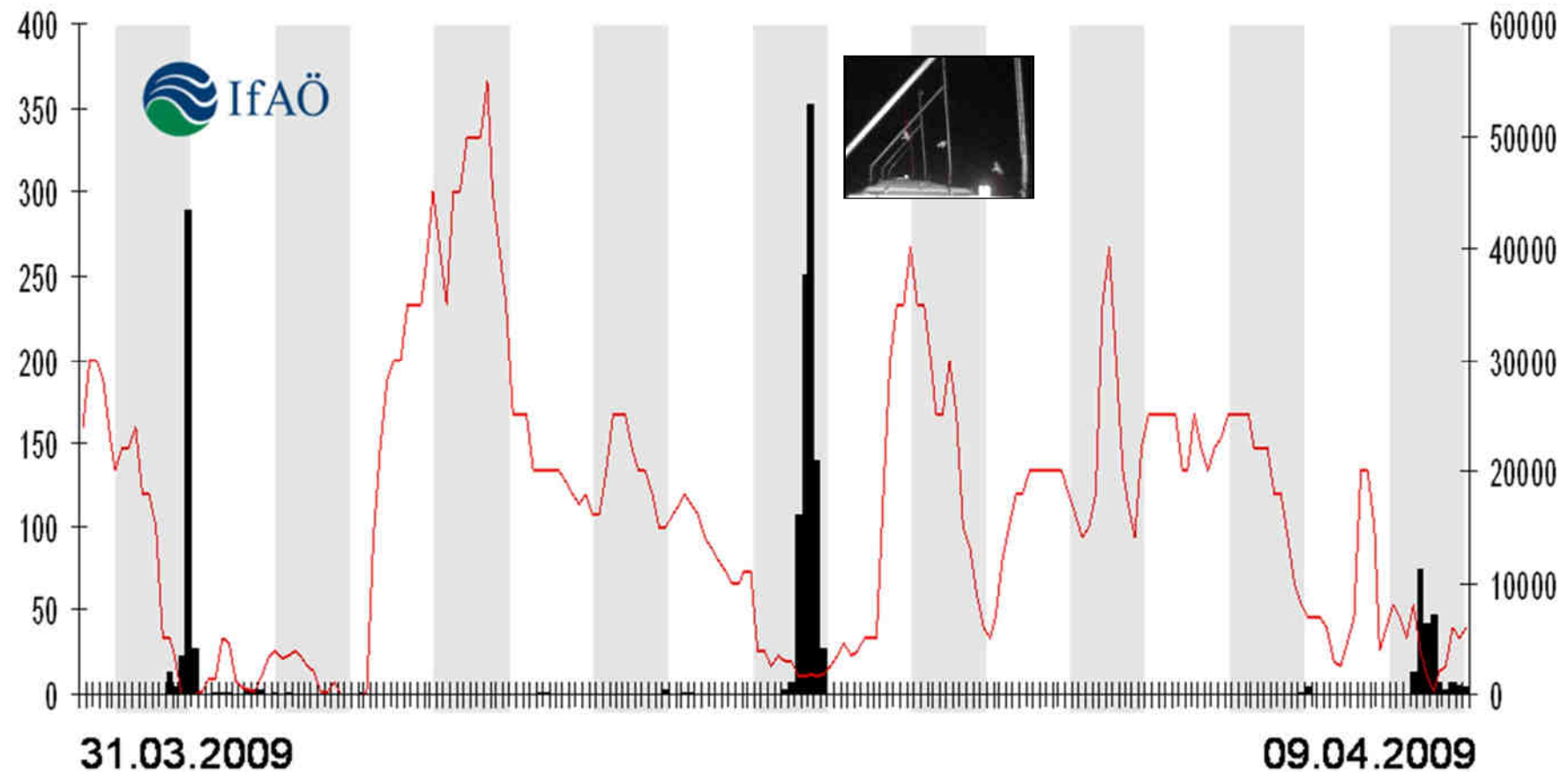
- An example:  
Good migration conditions in Scandinavia – tailwind;  
turning bad over the North Sea – headwind, low visibility
- birds come down, are attracted by lights, collide



## Attraction depends on visibility

Anzahl Vogelereignisse pro Stunde (Nachtsichtkamera VARS)

Sicht (m)



Federal Ministry for the  
Environment, Nature Conservation  
and Nuclear Safety



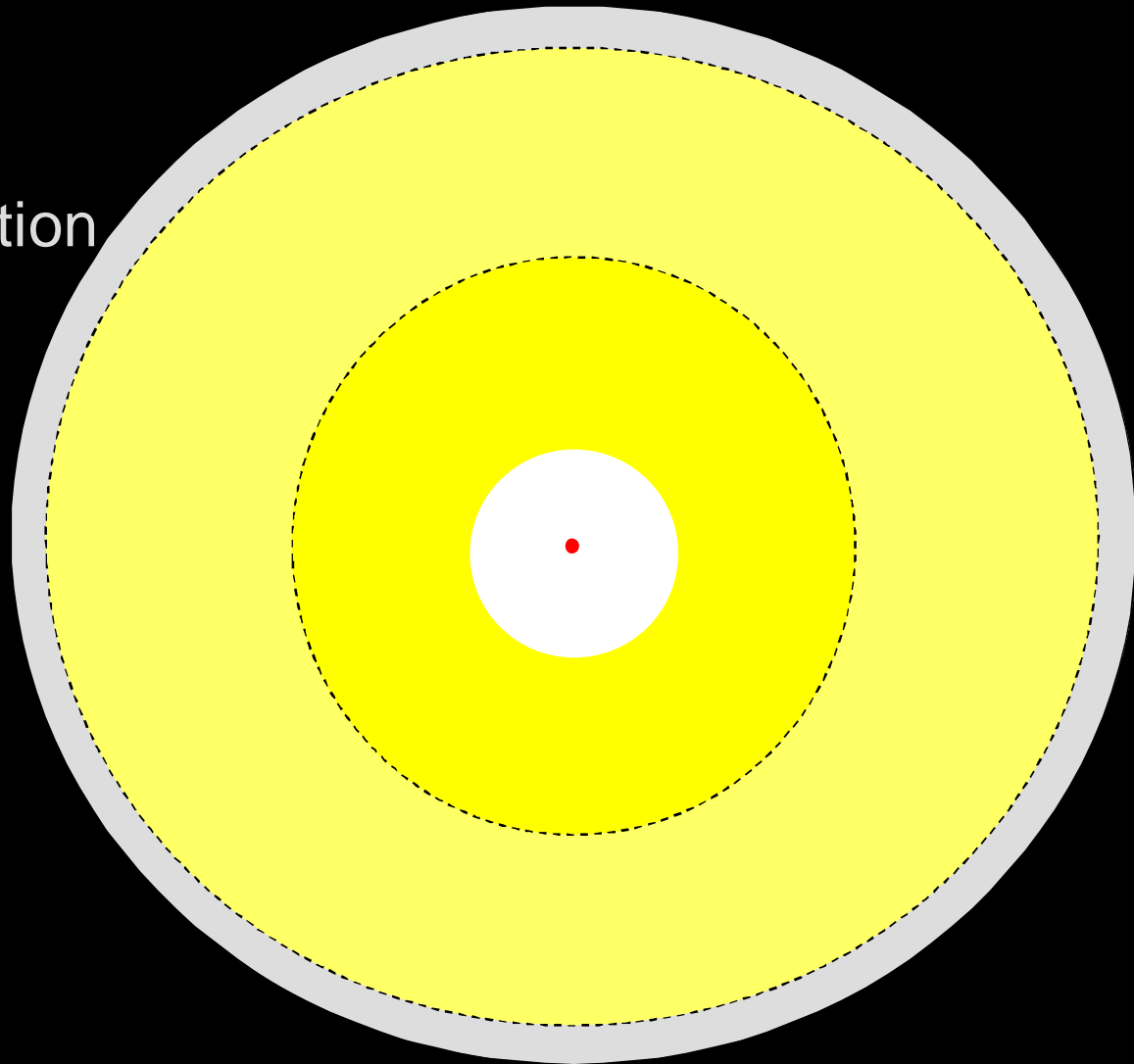
Schulz A, Kulemeyer C, Röhrbein V, Coppack T (2011)  
The extent of phototactic attraction of night-migrating  
birds passing an illuminated mast in the western Baltic  
Sea. NINA Report 693:102

What about light?    How it could be...

detection / perception

reaction

desorientation  
*„trapping“*



## What exactly do we know about light and bird migration?

- light intensity – the less, the better



e.g. Marquenie & Laar 2004 NL Shell

Lighthouse studies etc.

## What exactly do we know about light and bird migration?

- light colour – results are contradicting
  - red is found to attract and cause desorientation (NL, Poot et al., 2008)
  - green is found to attract (USA, Evans et al., 2007)



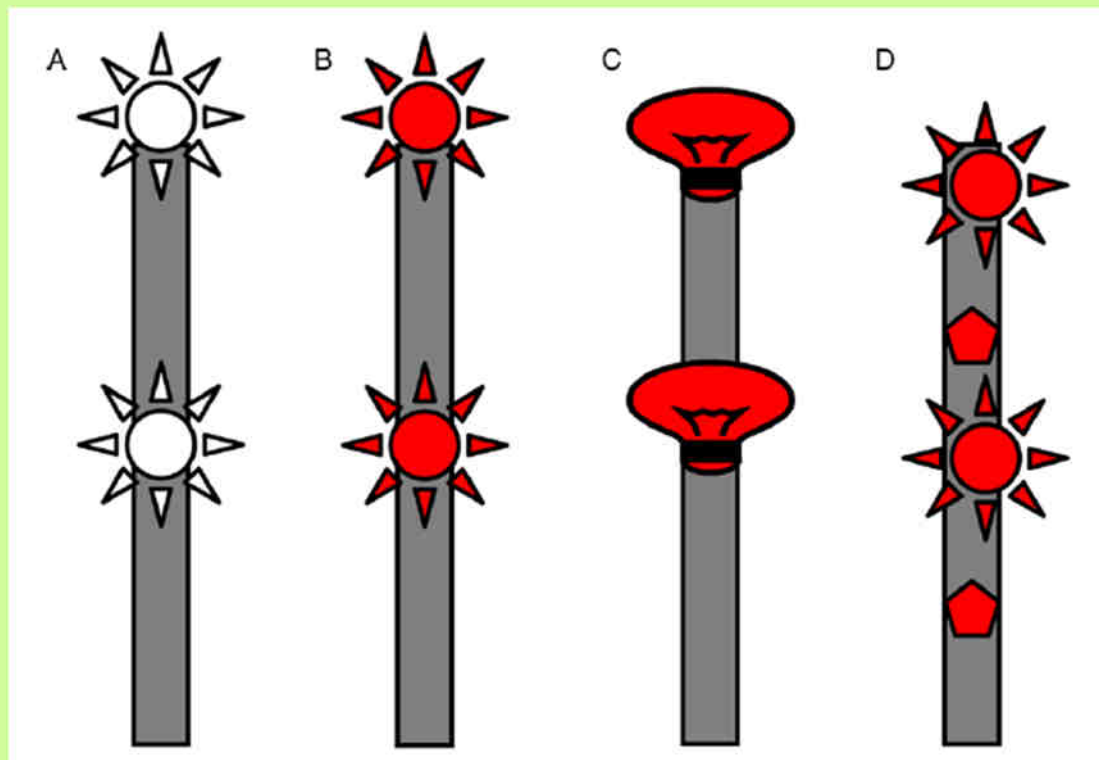
Marquenie et al., 2006 – NL, Shell

## What exactly do we know about light and bird migration?

- flashing / steady (colour)

Studies at USA comm. towers 100 – 300 m (Gehring et al., 2009)

Avoiding steady light can reduce collisions by 50-70%.



- A) strobe white
- B) strobe red
- C) flashing red
- D) flashing plus non-flashing

## **Birds as collision victims due to light: What do we know, *what is missing*?**

- birds are attracted by lights – and collide;
- „trapping effects“ – increase the collision risk;
- flashing is preferred;
- estimated collision numbers:
  - onshore: 2 to 60 per turbine and year  
(data from Germany and USA)
  - *offshore: nocturnal migrating songbirds:  
100 to 1,000 per turbine and year  
(calculated, Bellebaum et al., 2010)*

## **Birds as collision victims due to light: What do we know, *what is missing?***

*Missing are:*

- *quantitative results on avoidance behaviour, attraction effects, true collision rates;*
- *altitude distributions and migration depending on regional and local weather*
- *colour effects*

## **What have we learned from each other?**

Regulations are not binding, there is room for flexibility.

e.g. no additional lights for turbines above 150 m;

e.g. for self-reflective ID markings instead of lit areas;

e.g. transponder techniques (for turning lights on).

A compromise can be found between

safety issues and a „dark sky“ = less bird collisions.

**Thank you!**

Thomas W. Johansen

