



Model development for birds and offshore wind farms

Quantifying impacts requires more than just one model

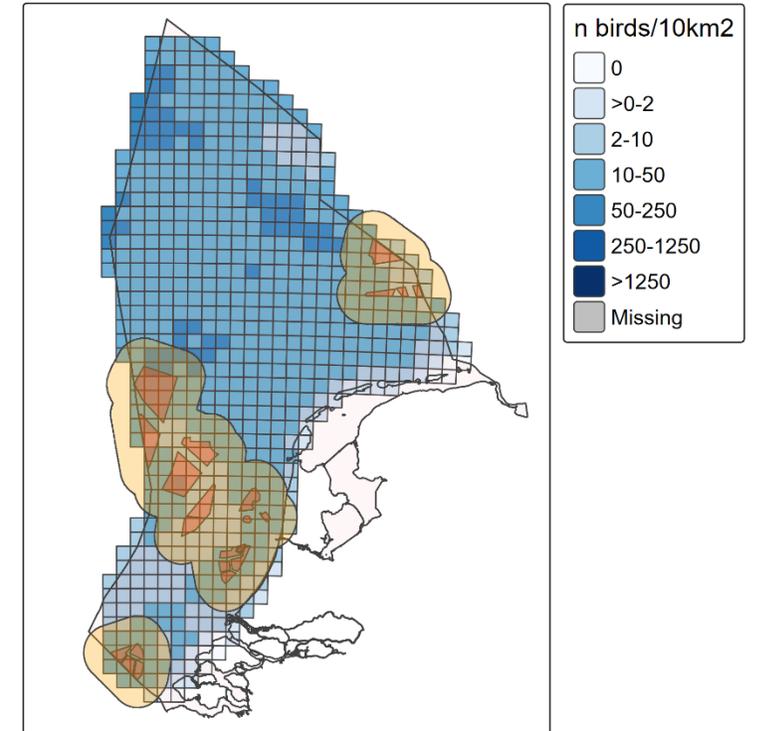
17 March 2026 | Silke van Daalen & Gerben IJntema

Marine birds and offshore wind farm impacts

How do we quantify the impacts?

In KEC, birds considered as

- Vulnerable to collisions
- Vulnerable to habitat loss
- Maps of densities and offshore wind farms are combined
- To estimate the percentage of birds at risk of either impact
- This leaves out key elements of marine bird ecology

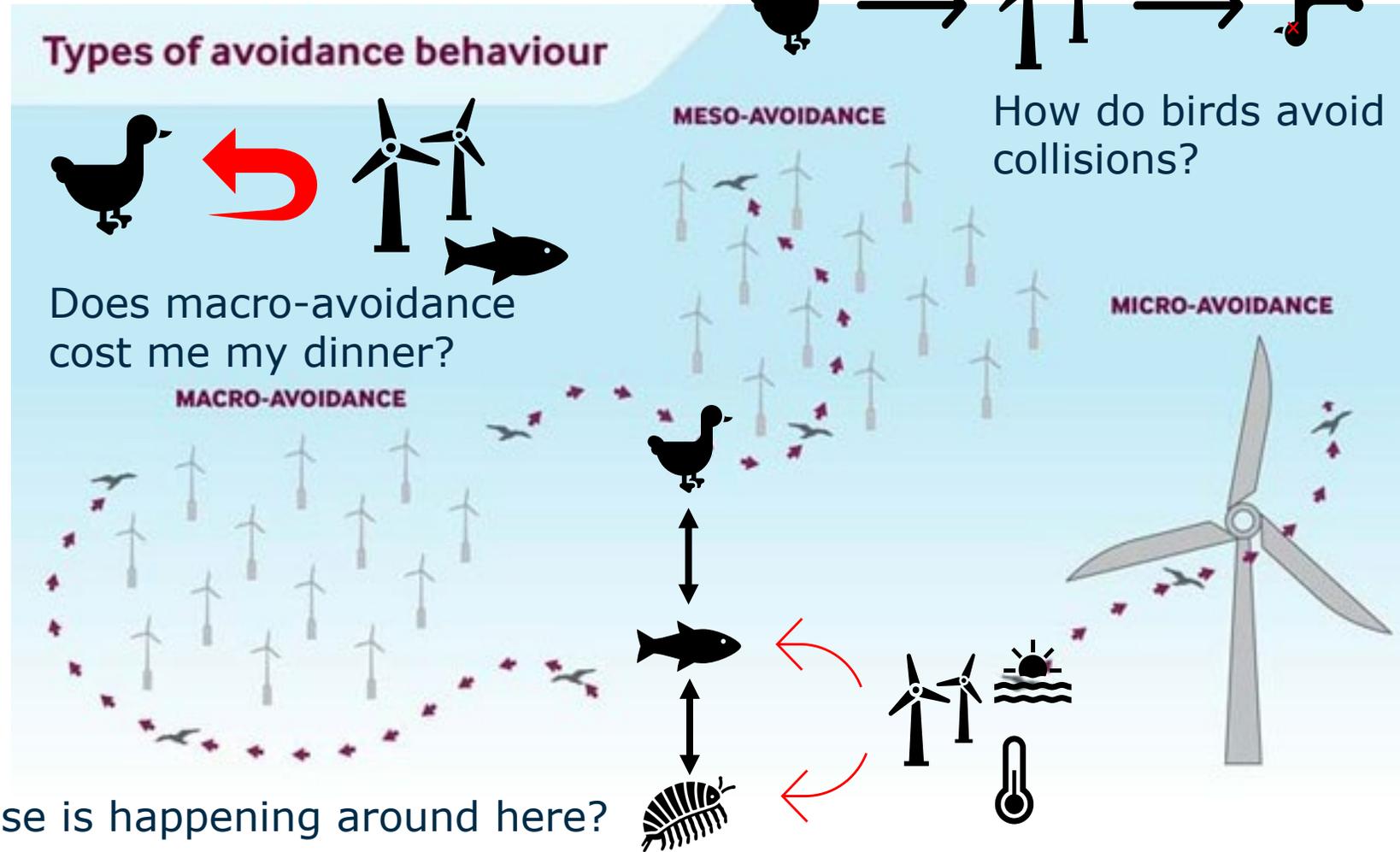


Marine birds and offshore wind farm impacts

Research objectives

Missing elements:

- Behavior
- Energetics
- Ecosystem effects
- Cumulation: how do we add it all up?
- MONS-Wozep project
- Year 2 of 5



What else is happening around here?

Why models?

We cannot run experiments on the entire North Sea

Models allow us to simplify and focus:

- What mechanisms determine where the birds are, in space, in time, how do they move, how do they feed, how do they survive and how do they breed?
- Based on a set of simple rules (model assumptions) we can explore what-if scenarios:
 - If the birds move like a flux of particles through the landscape, X% of them will collide with wind turbines
 - If the birds avoid wind farms and have less space to successfully forage for food, X% will starve over the winter

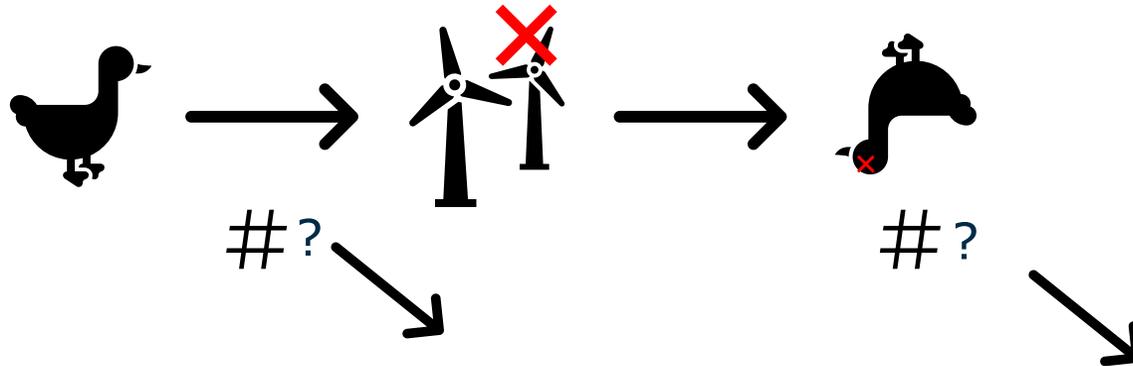
Behold, a wind turbine!



Collisions



How are collisions currently modelled?



1. How many birds are exposed to risk of collision

How to determine the number of flights through a windfarm?

2. How many birds end up colliding

How to determine the number of flights **colliding** with a turbine?

Cook *et al.* 2025

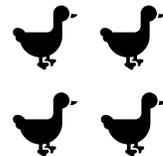


Stochastic Collision Risk Model (sCRM)

Caneco *et al.* 2022



Better usage of current data



Modelling # birds at risk



Modelling # birds colliding

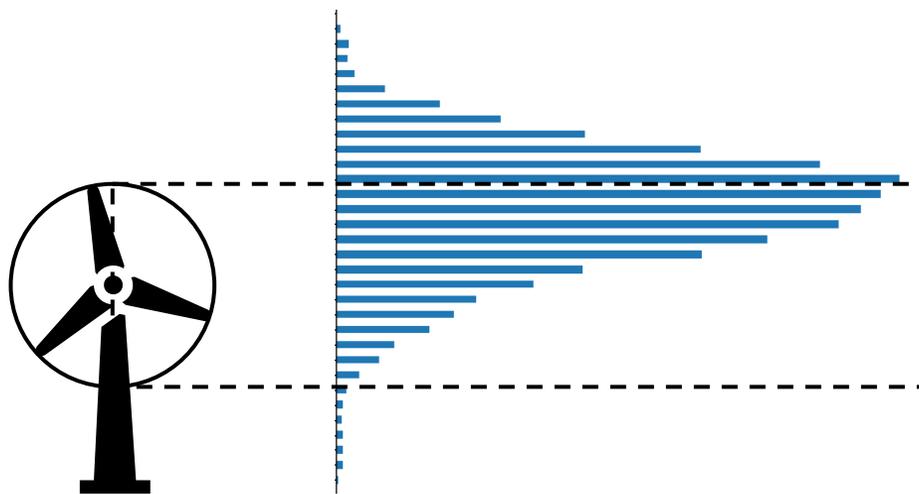


Usage of future data

Introducing two key parameters

Flight Height Distributions & Macro-avoidance

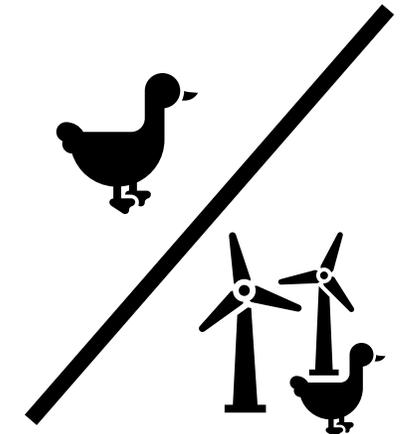
What is the chance we find a bird at a certain height?



How often does a flight path not go through a windfarm?



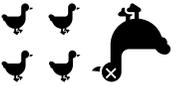
How much more likely am I to find a bird in or outside a wind farm?



Collision models – What have we achieved?

International Workshop: what is the ideal model to predict collisions?

Model measured collisions rather than based on assumptions



Is the current Flight Height Distribution resolution feasible?

Data is not suitable to hold 1 meter resolution bands



How is (macro-)avoidance currently used in the models?

The difference between macro-avoidance and displacement factors is blurry

Modifications of the macro-avoidance rates can be implemented relatively easily



Collision models – What's next? (1 of 2)

How is (macro-)avoidance currently used in the models?

What is the underlying data of the currently used avoidance rates



Can the current model use different resolution flight height distributions?

Adapt the scripts used to accommodate different resolution flight height distributions



Collision models – What's next? (2 of 2)

How do different measures for numbers of birds relate to each other?

Relationship measured density and flux

Additional measures from the same data



What data on measured collisions is or will be available in the future?

Reviewing the literature on the usability of measured collision and other data obtained at the time of collision



Can we model collisions differently?

brainstorming phase leading to a conceptual approach



Habitat loss

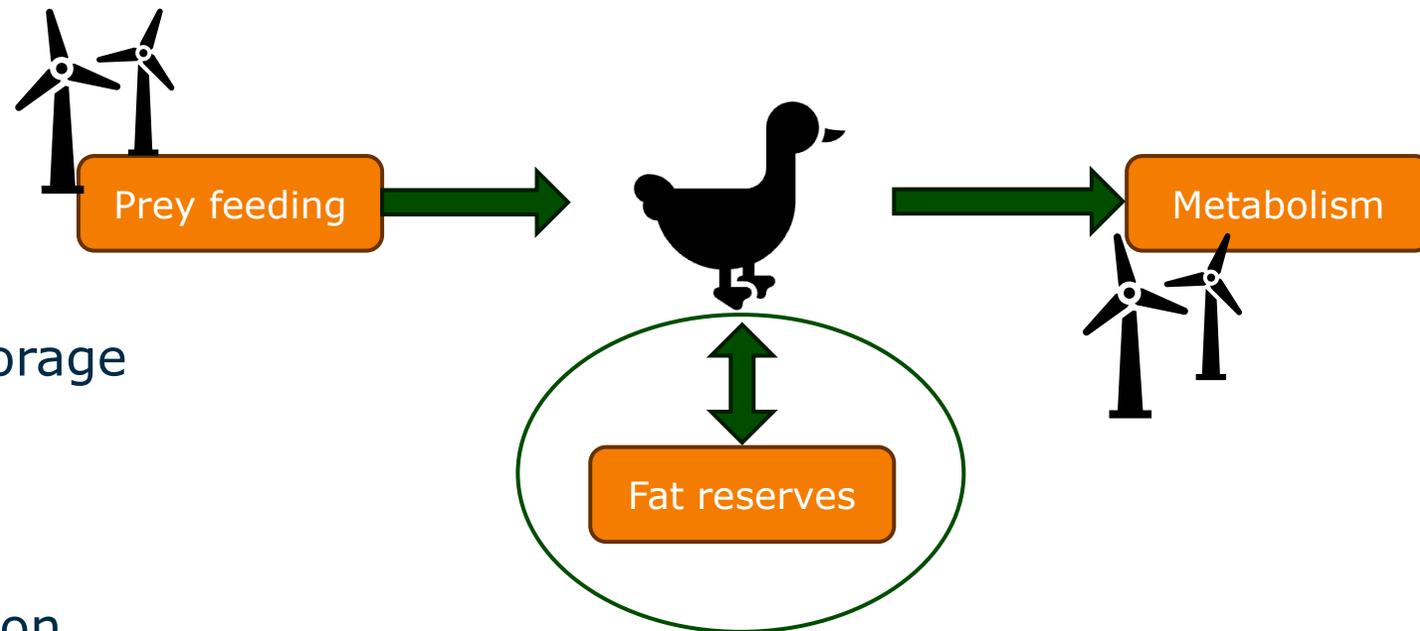


How is habitat loss modelled?

What happens when a bird is displaced by OWF?

From an energetics perspective:

- Prey availability might change
- Leading to less energy for the bird
- More distance traveled to forage
- More effort needed to successfully forage
- Leading to higher energy spending
- Fat reserves as a measure of condition

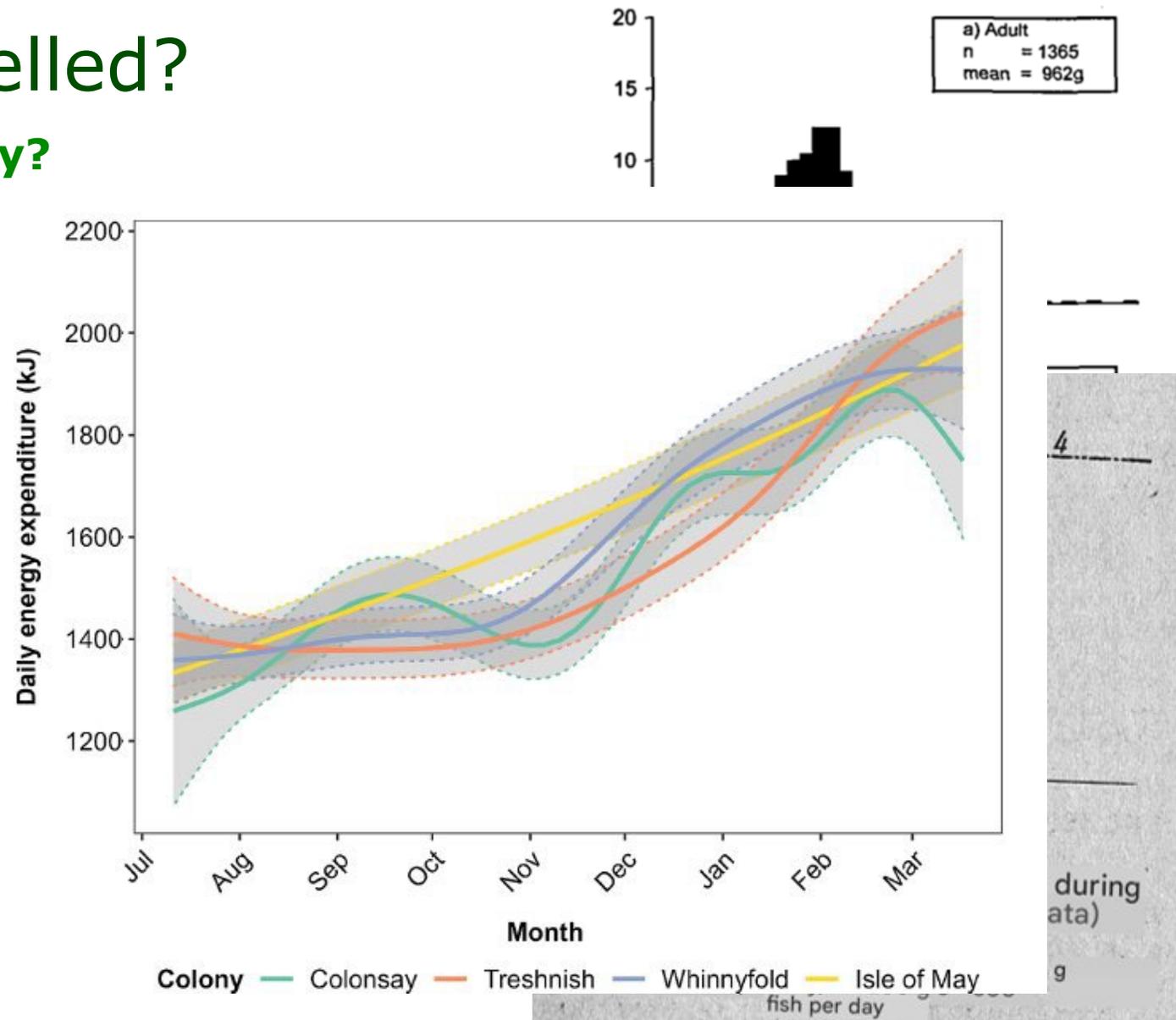


How is habitat loss modelled?

How do guillemots work energetically?

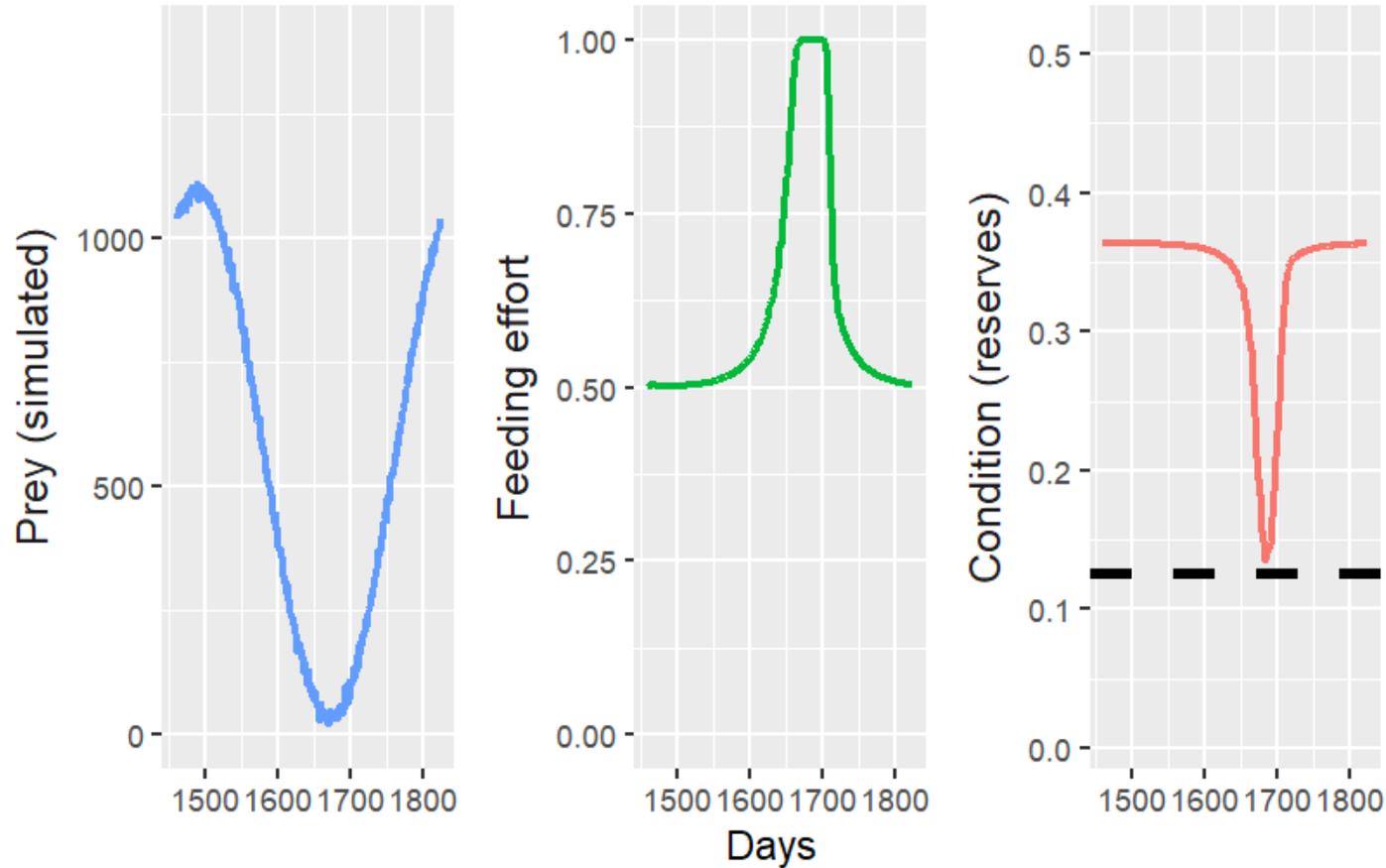
Model parameterized from data:

- Typical weight (Harris et al., 2000; pers. comm. Leopold)
- Russian starvation study (Golovkin, 1963)
- Metabolic rates (Buckingham et al., 2023)



Habitat loss models – What have we achieved?

Energetic model for the common guillemot



Habitat loss models – what's next?

Guillemot model:

- Improve model link to data on food landscape

Northern gannet model:

- Finish model parameterization
- Model analysis

For both species:

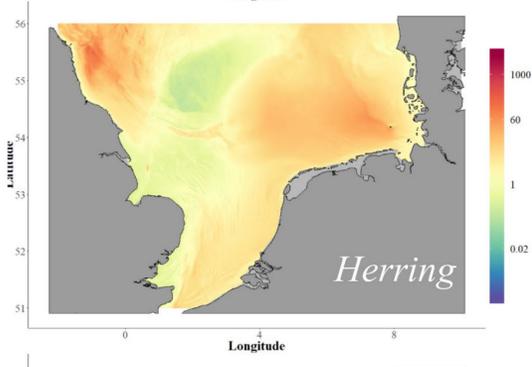
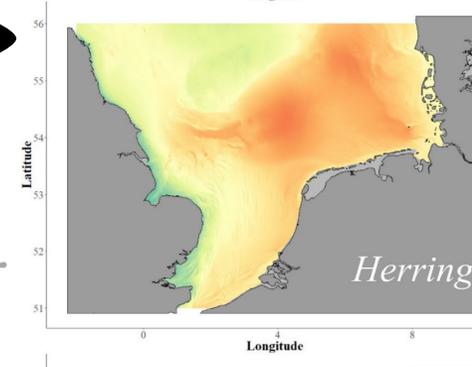
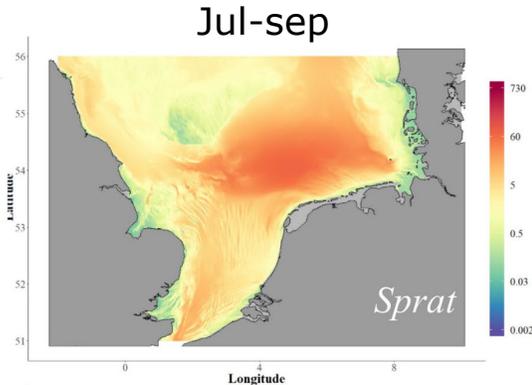
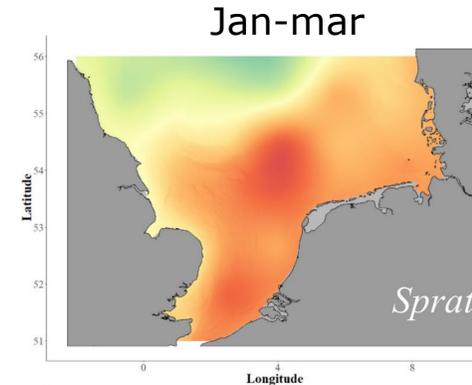
- Translate individual-level effects to population
- Investigate application scenarios



Ecosystem-level understanding

Linking the bird to its ecosystem through its energetics

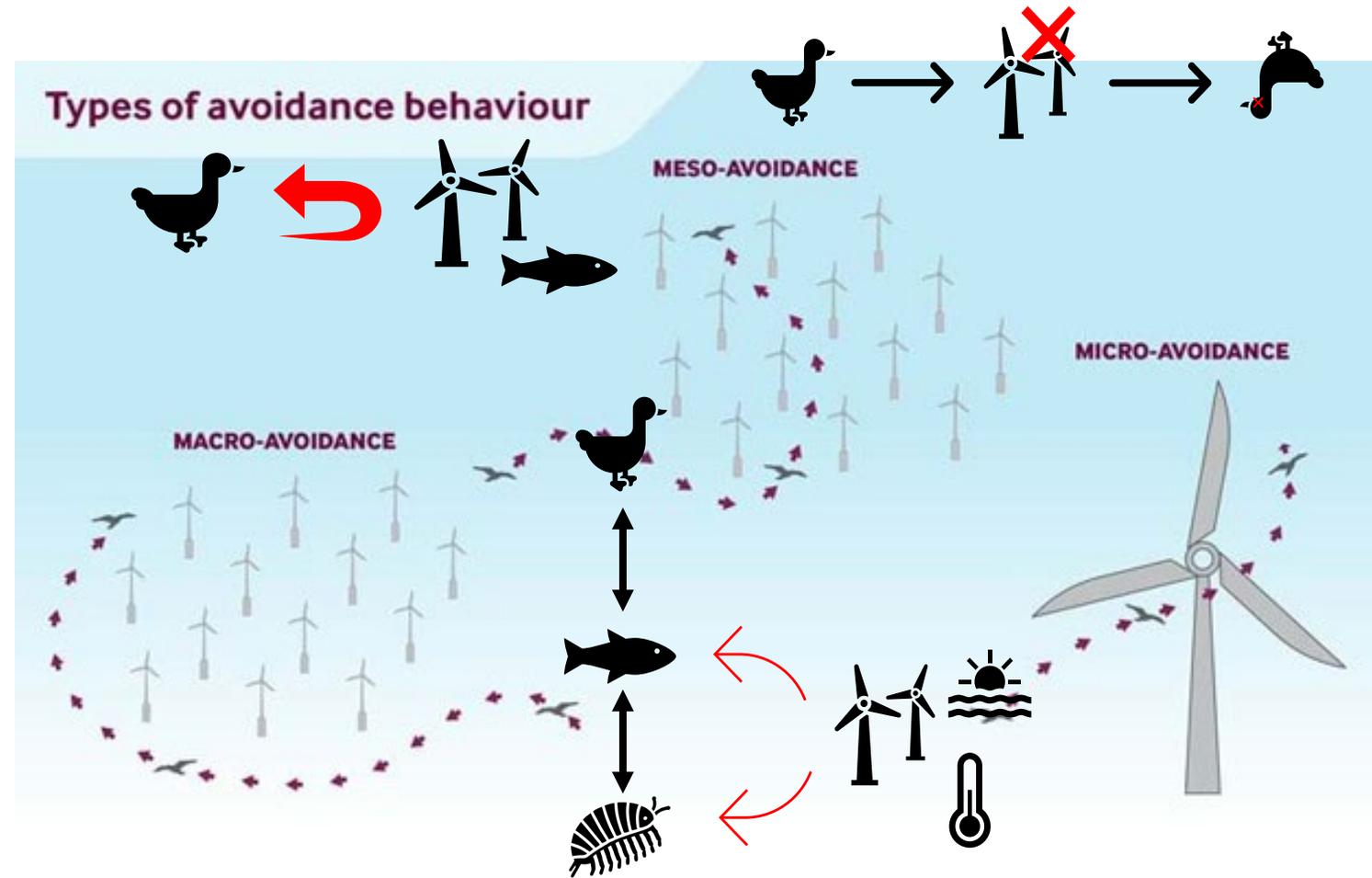
- Seasonal signal of prey
- Data exists and more maps are being made
- Goal is to get energy landscapes for multiple seabirds (& other top predators)
- Hydrodynamic changes might:
 - Impact primary production
 - Therefore entire food web
 - Change visibility and foraging conditions



We are working to add it all up

Definitions, estimations, interpretations, oh my!

- A bird that gets displaced is not at risk of collision, but...
- Avoidance rate in CRM is estimated from displacement sometimes? Definition issue.
- If behavior is our starting point, we need to know:
- How long do birds spend in OWF?
- How often does a bird enter OWF?



Next steps for the whole project



- Energetics model: include full life histories, temperature dependence, seasonality in greater detail
- Better use of current and better future data to improve collision models
- Cumulation approach that starts from the behavior of birds
- How do impacts from OWF compare to other impacts (bird flu, climate change)
- Keeping people informed, and staying informed on model developments elsewhere

Questions?

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