

Seabird sensitivity to offshore wind farms: an individual-based modelling approach

Lila Buckingham (she/they)

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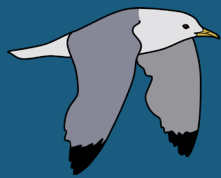




Lethal

Easier to quantify
(dead)

Collision



Barrier effects



Displacement



Sub-lethal

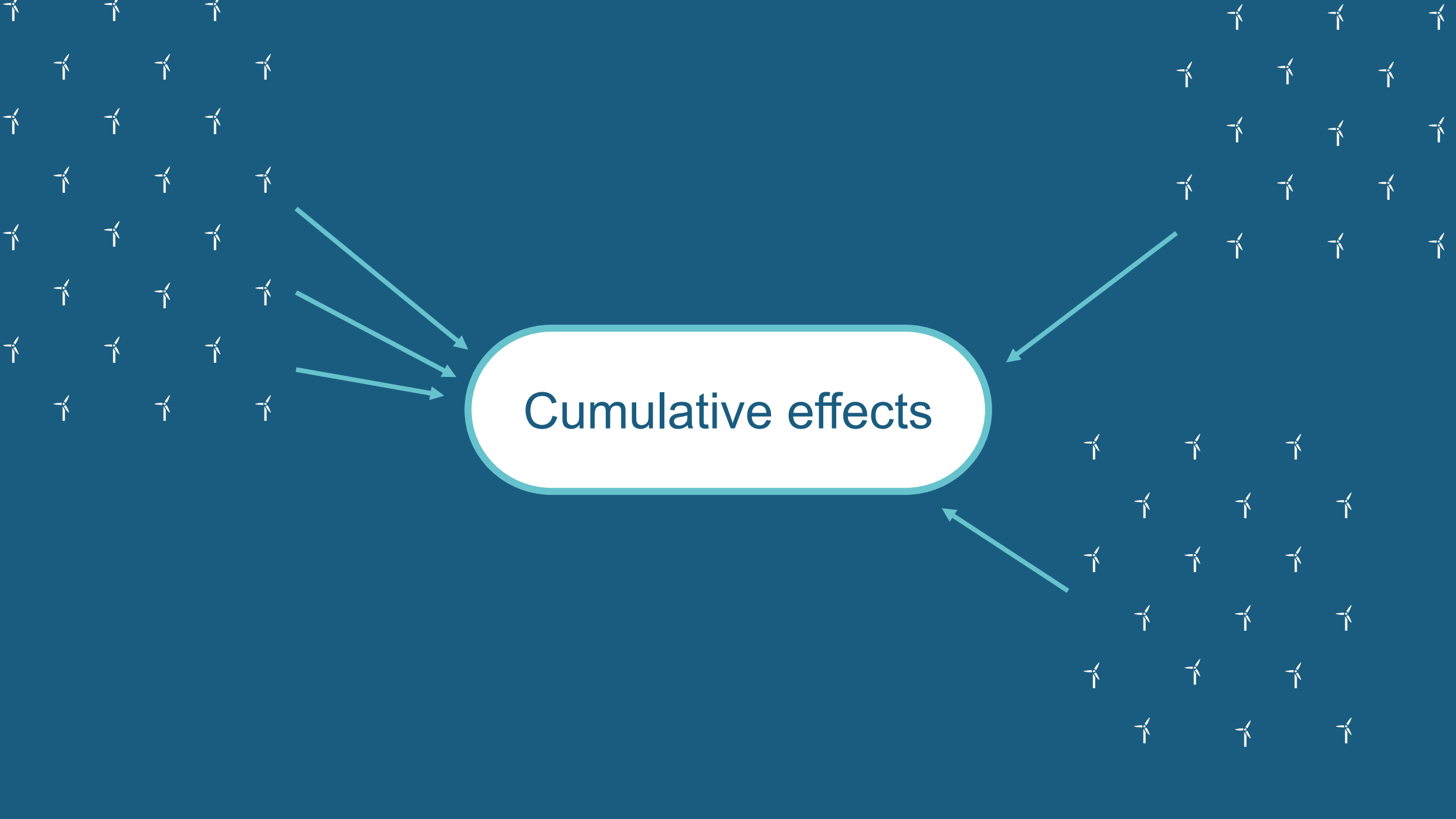
Energetic
consequences

Survival

Breeding success

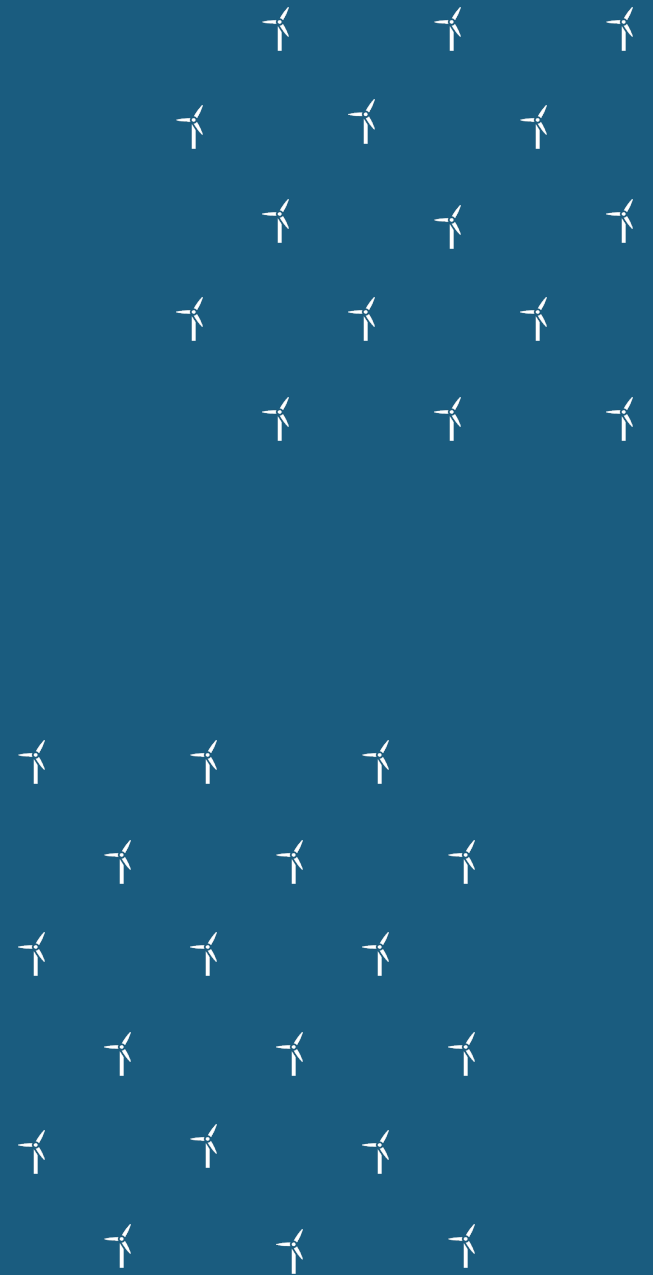


Cumulative effects



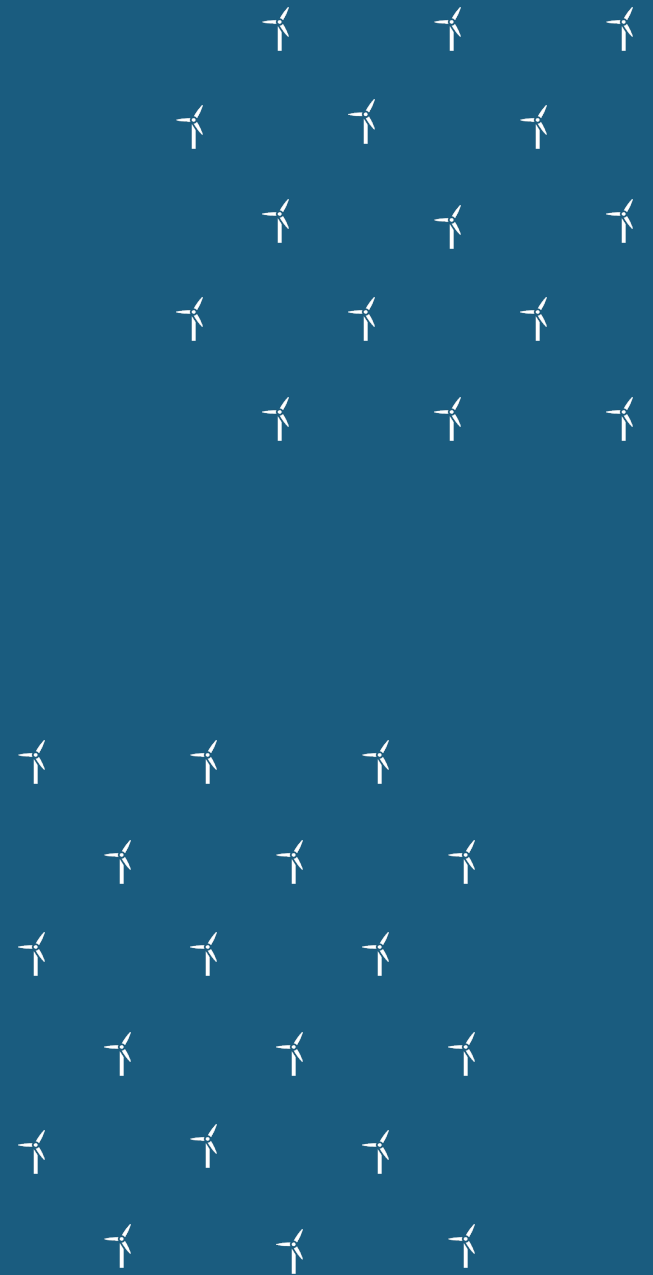


Aim:
Model individual responses to
OWFs to quantify cumulative
impacts



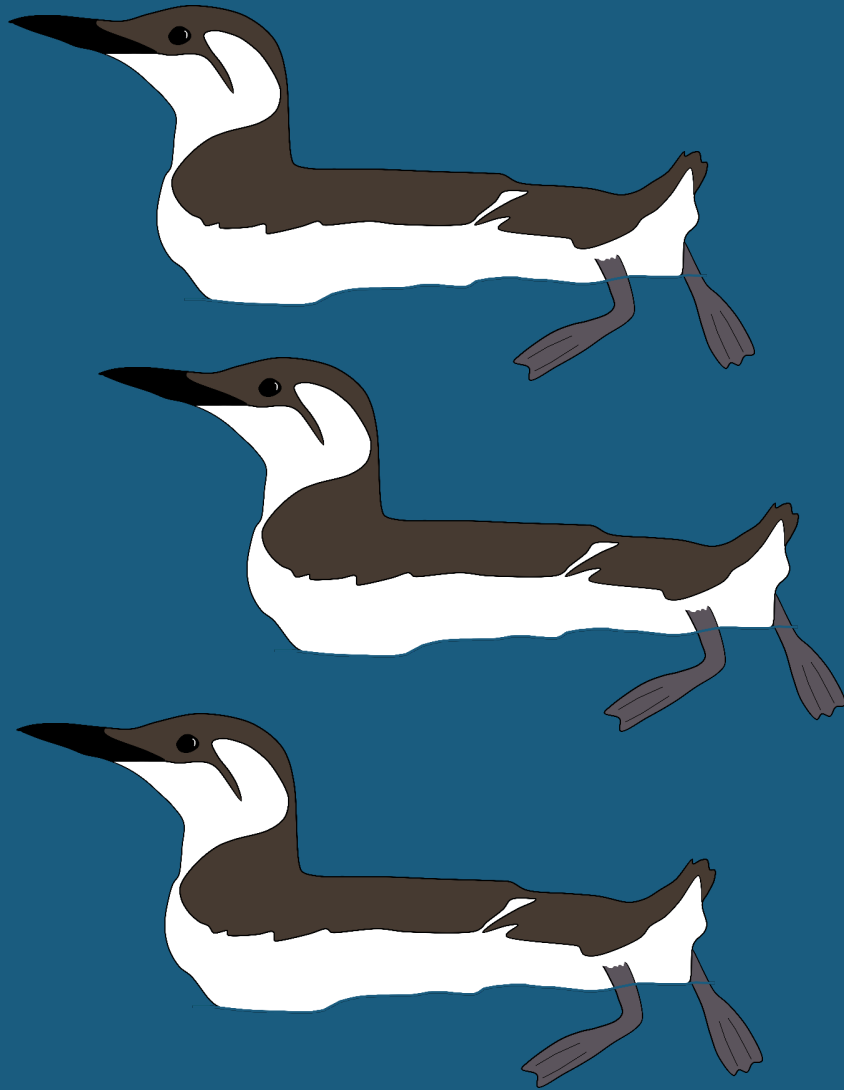


Approach:
Individual-based model

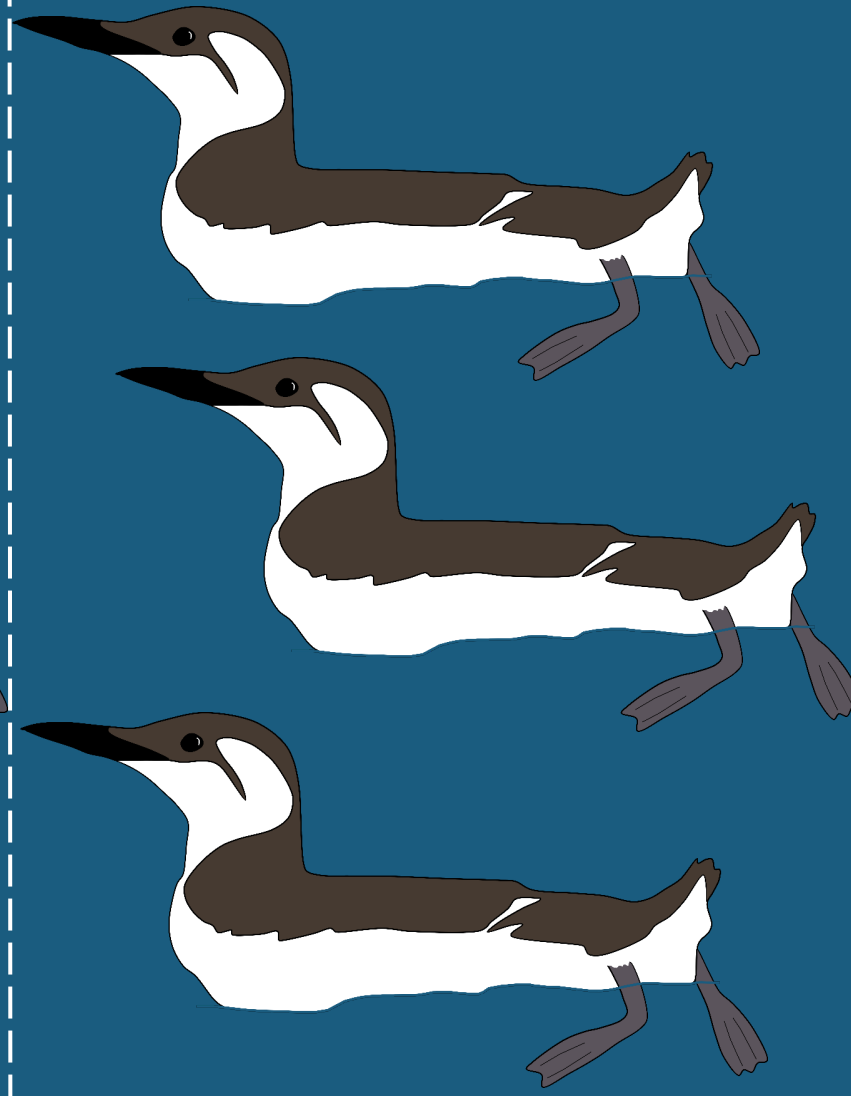


Day: 1

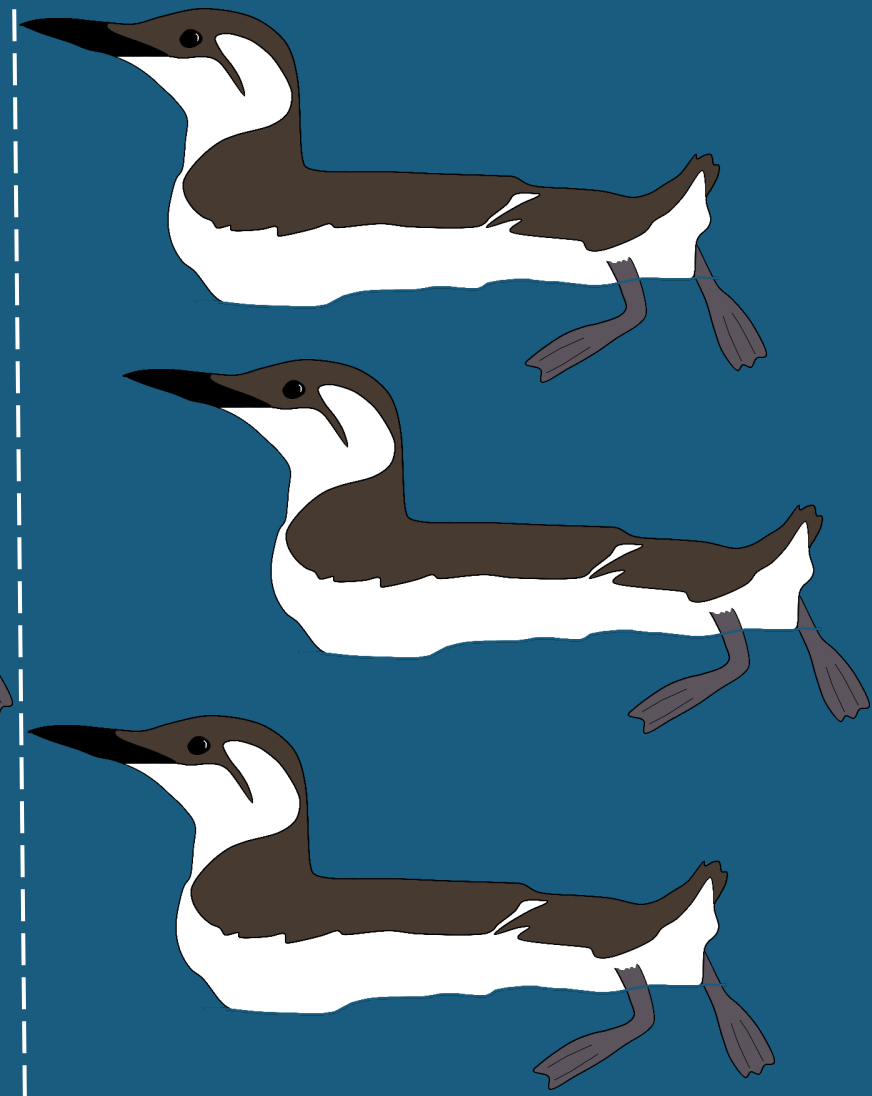
Many OWFs



Some OWFs

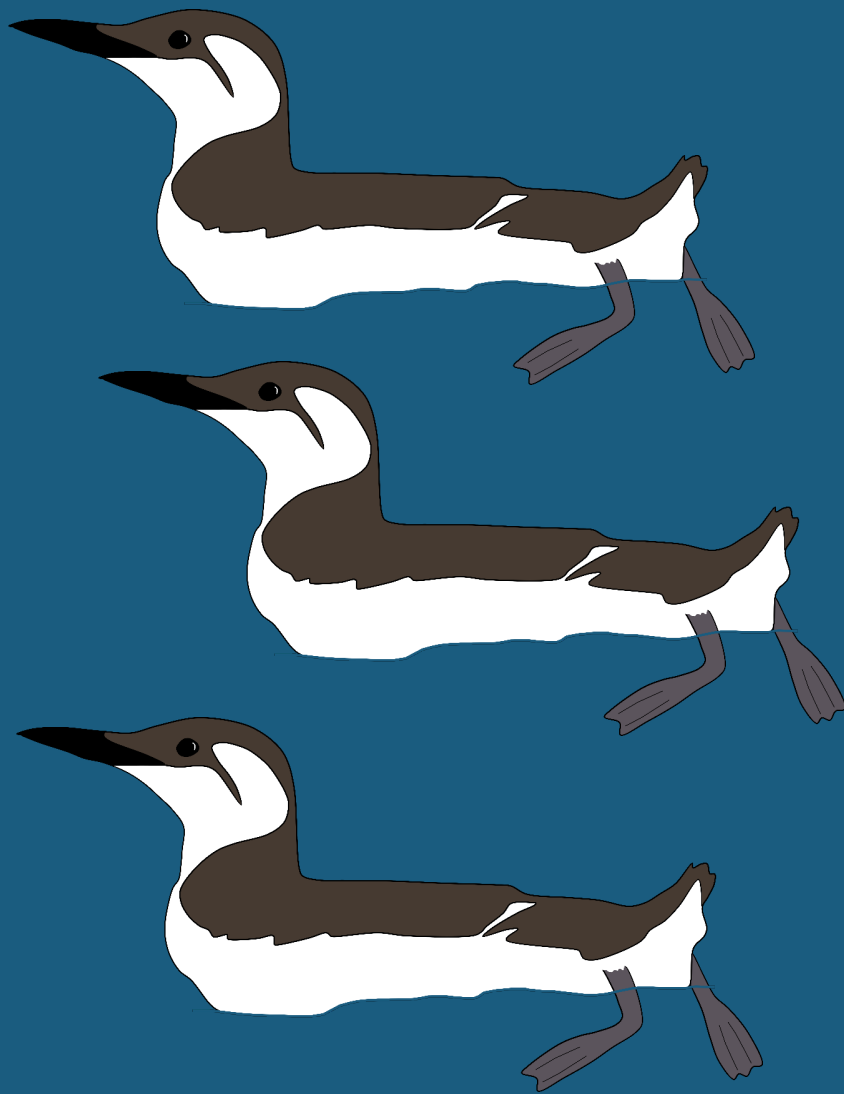


Few OWFs

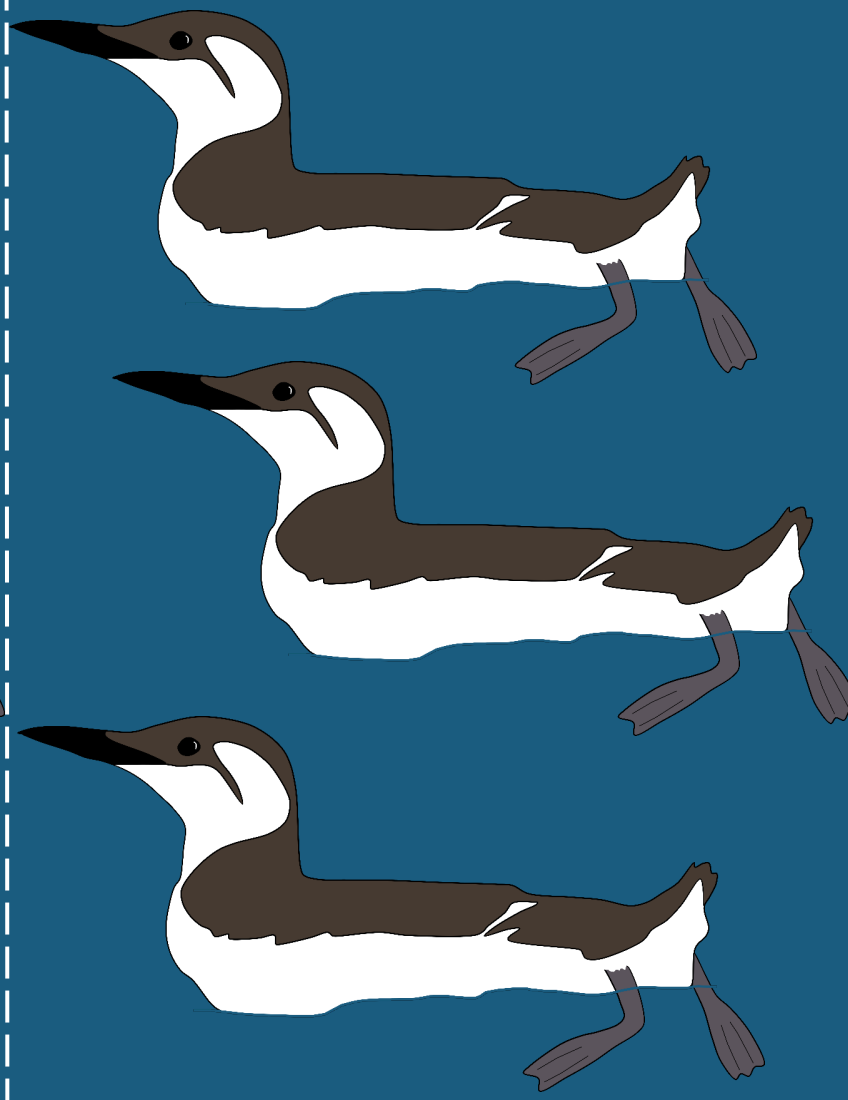


Day: 10

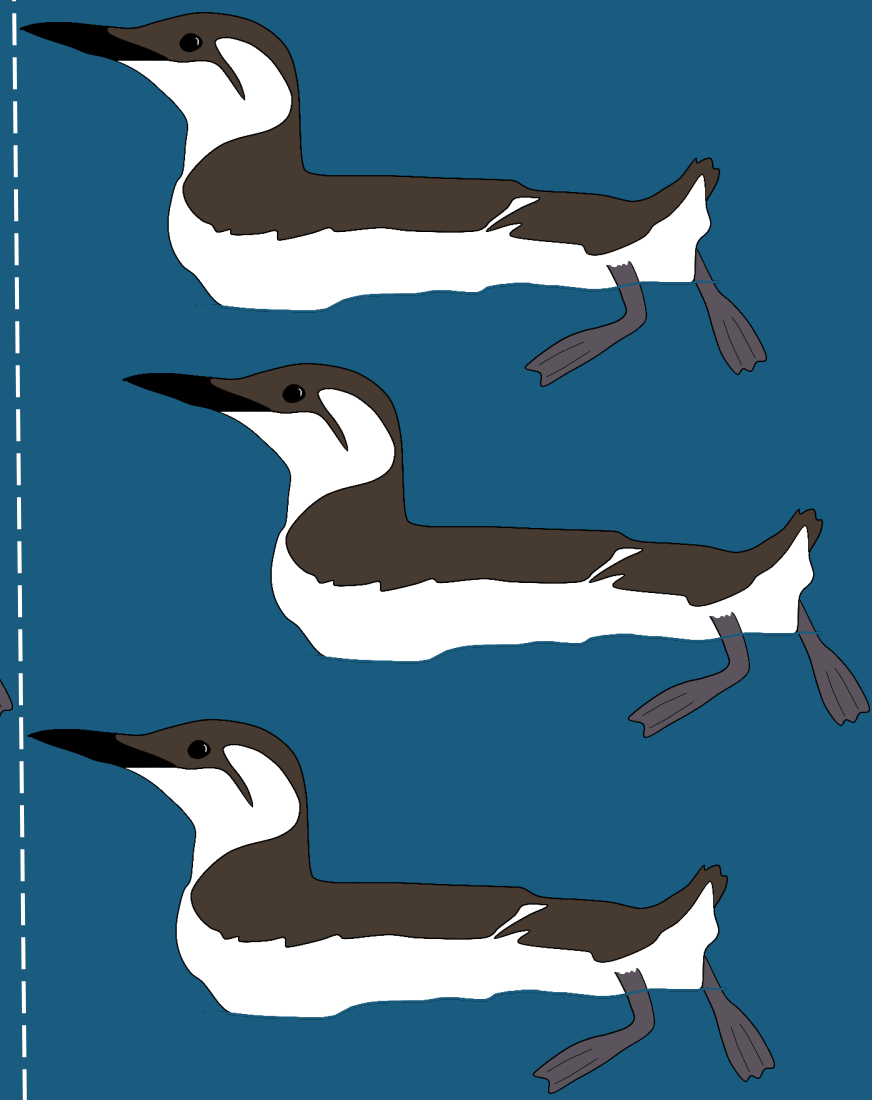
Many OWFs



Some OWFs

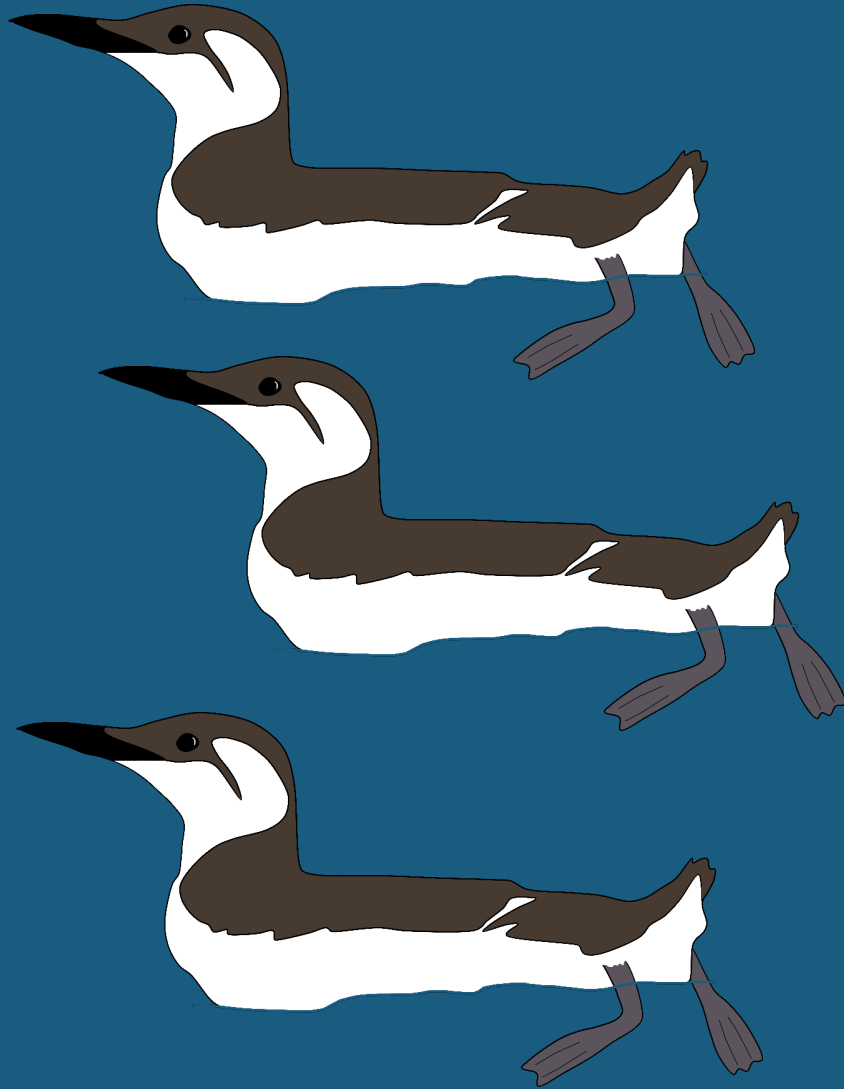


Few OWFs

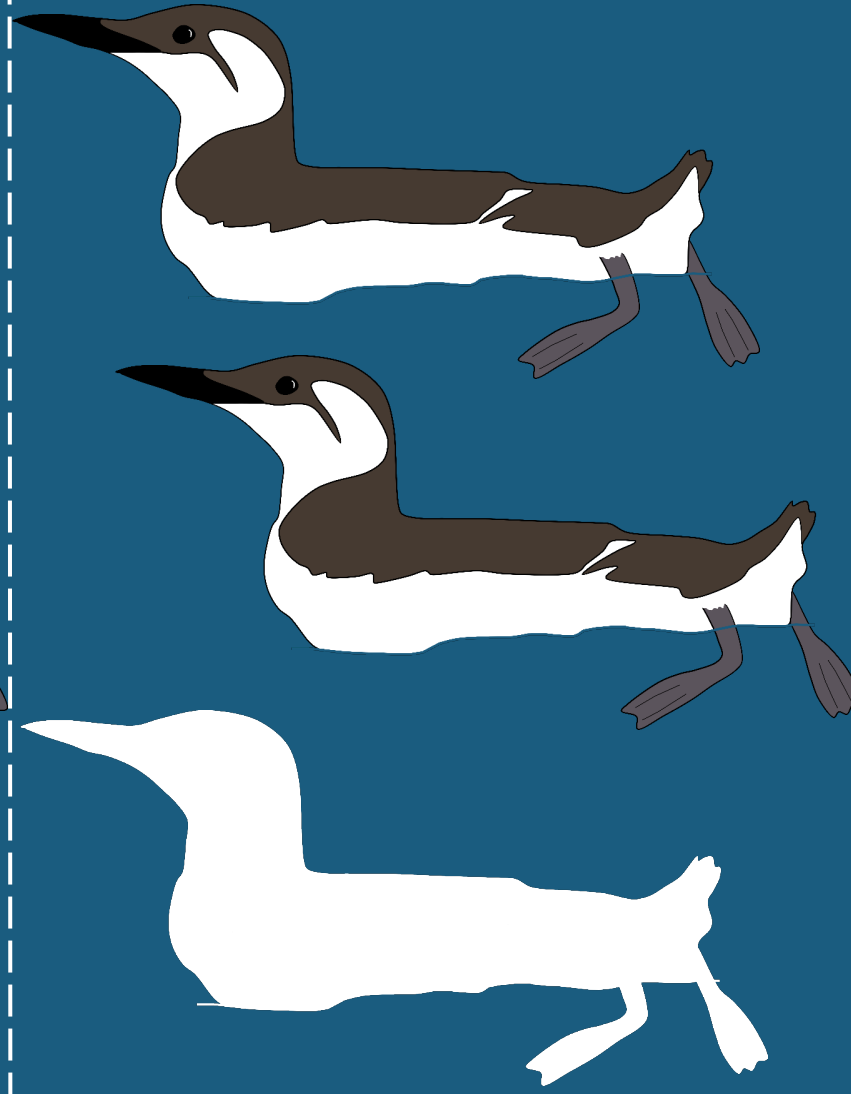


Day: 20

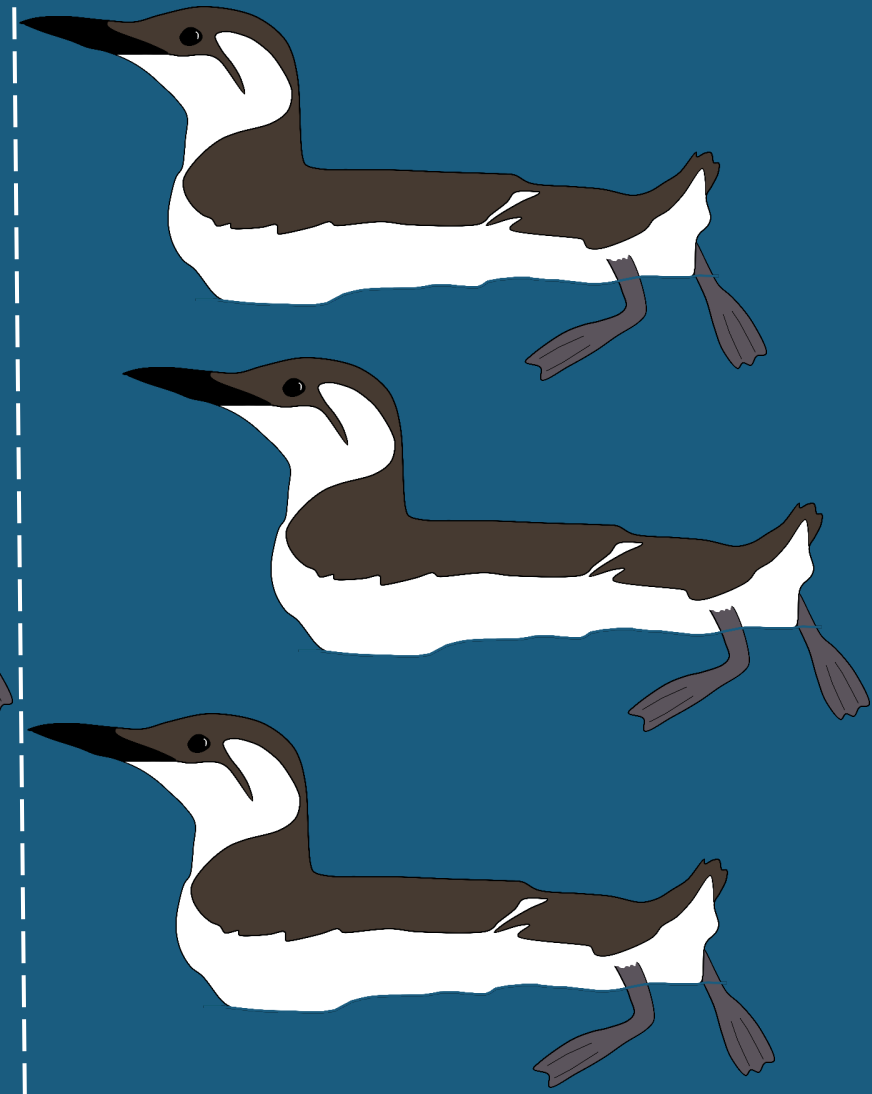
Many OWFs



Some OWFs

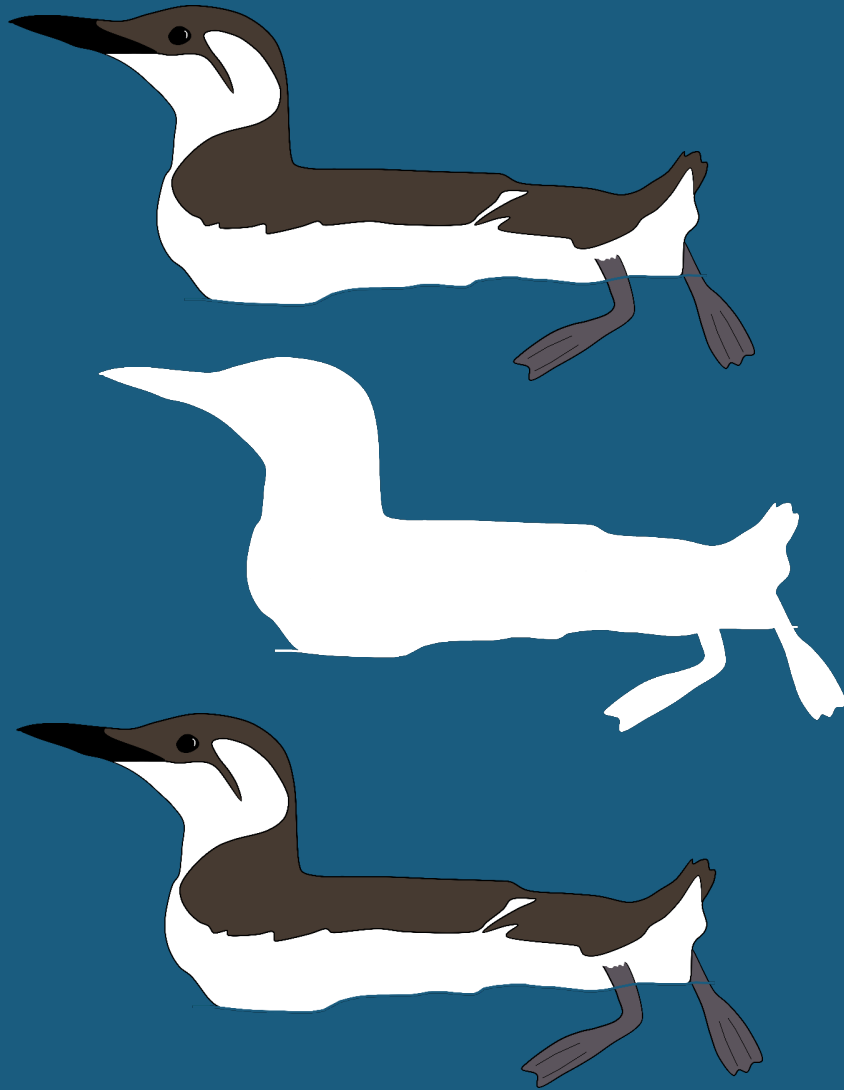


Few OWFs

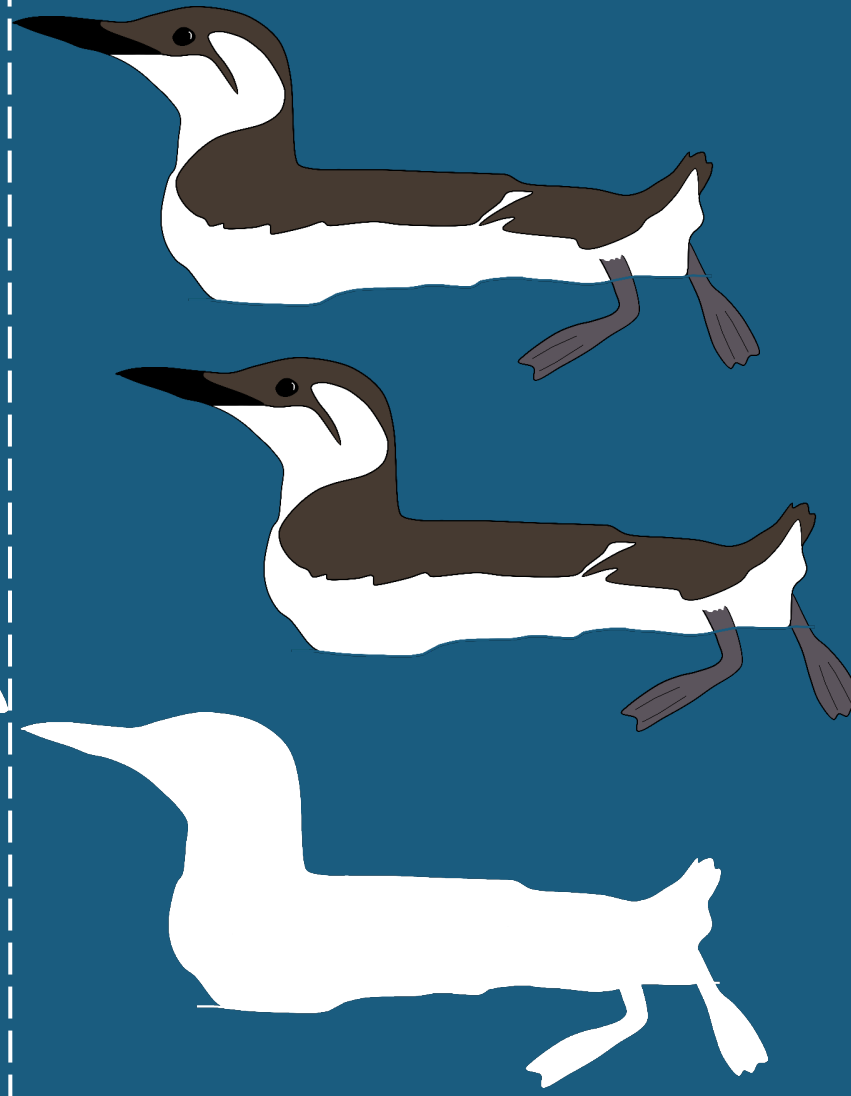


Day: 30

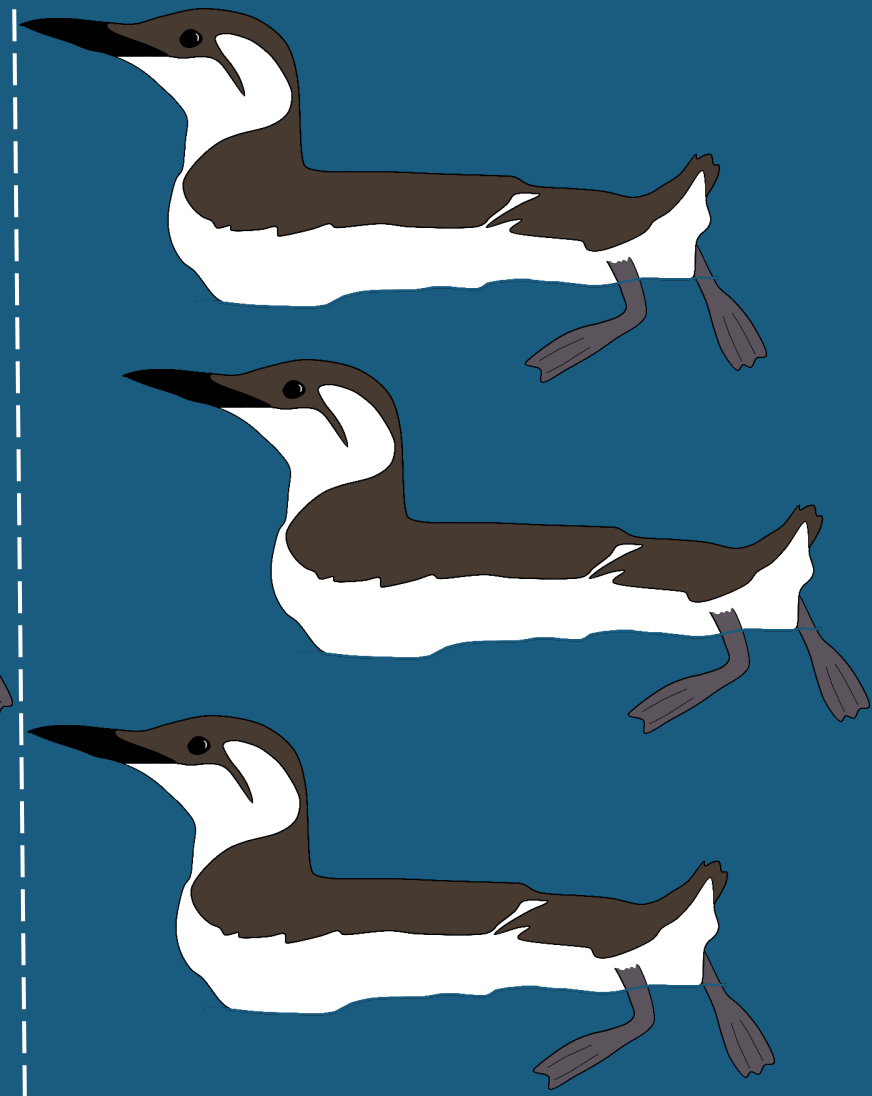
Many OWFs



Some OWFs

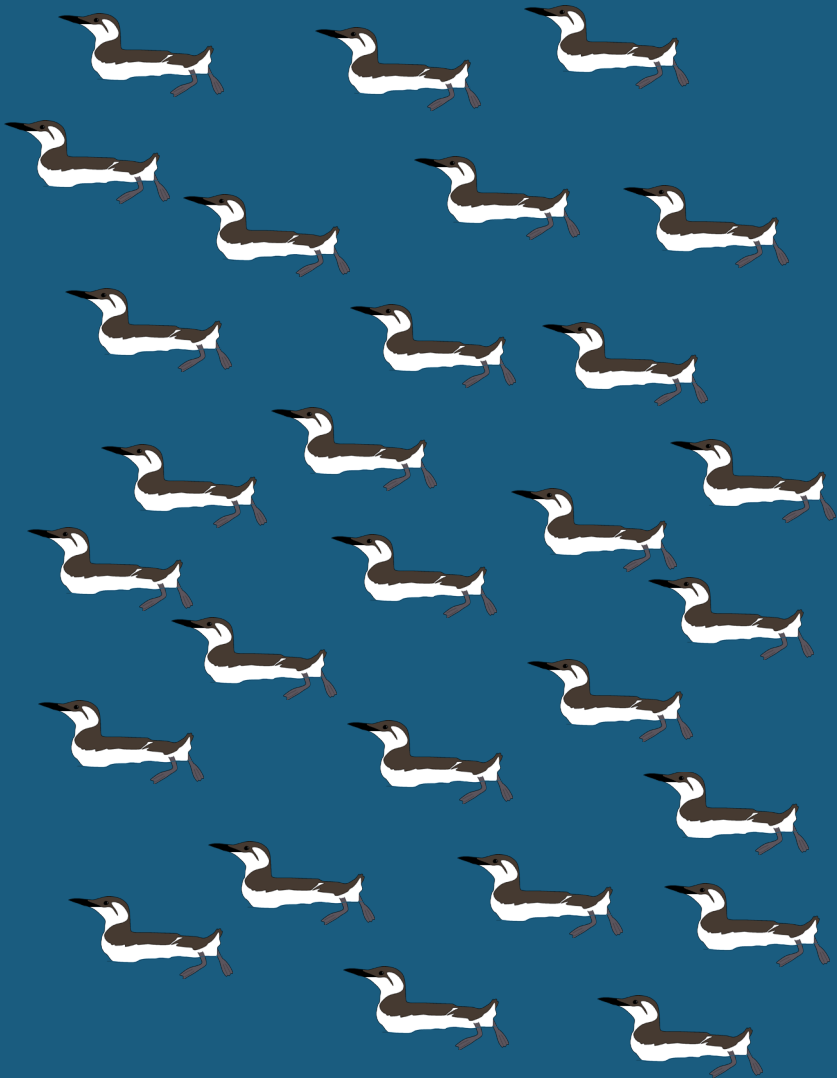


Few OWFs

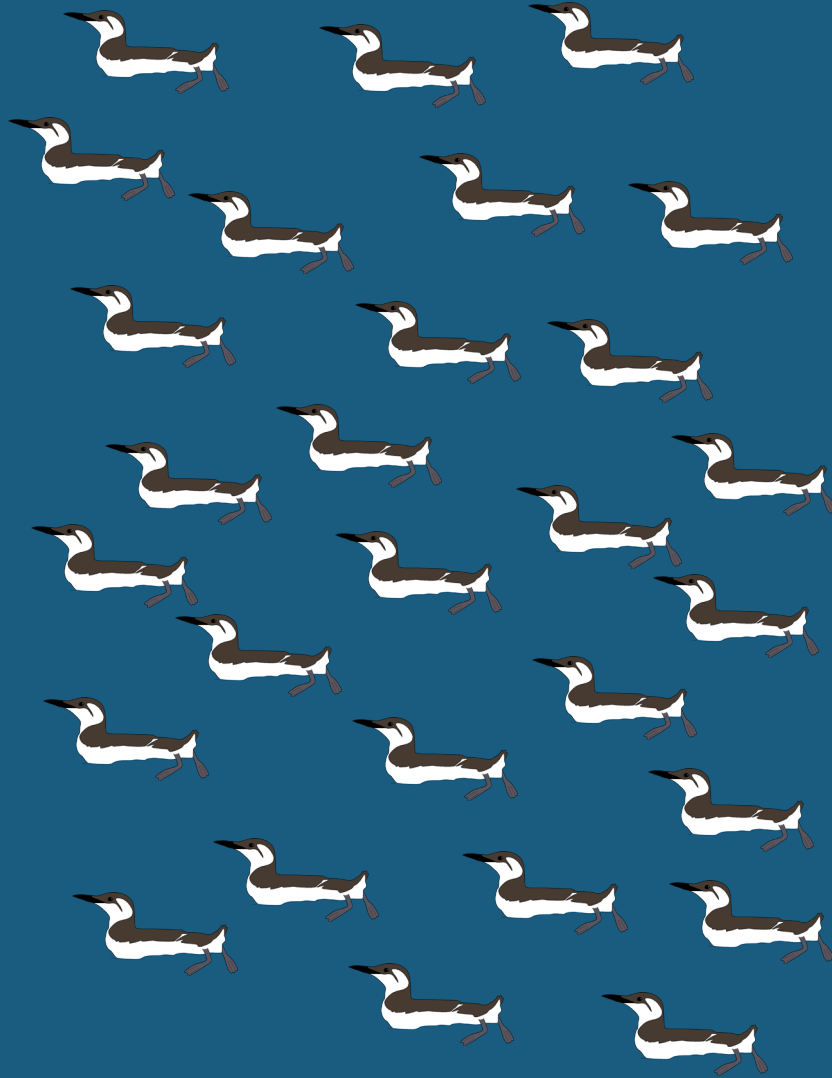


Start of season

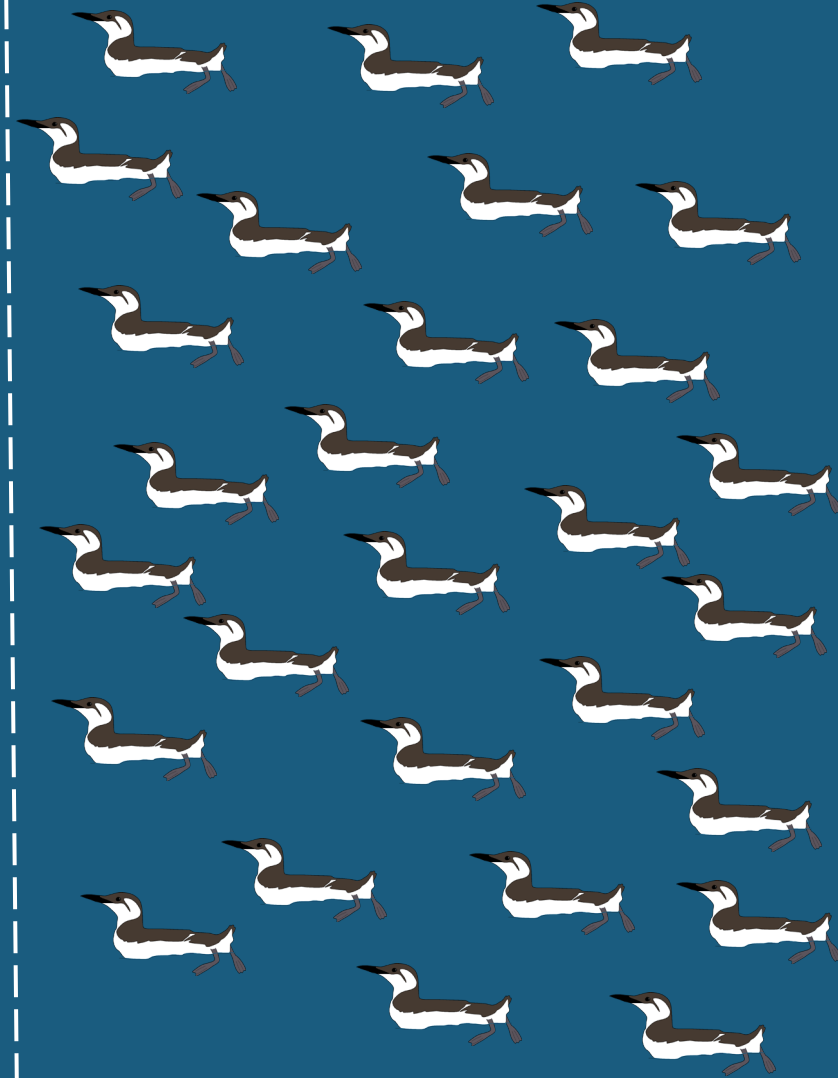
Many OWFs



Some OWFs

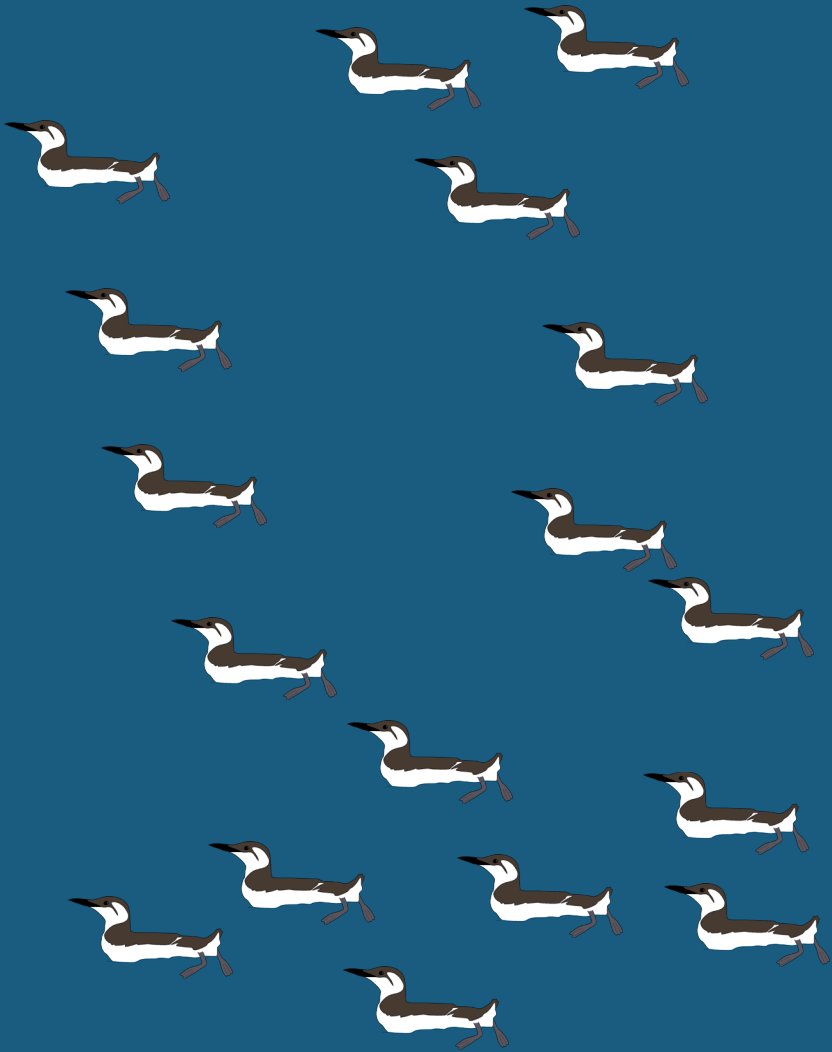


Few OWFs

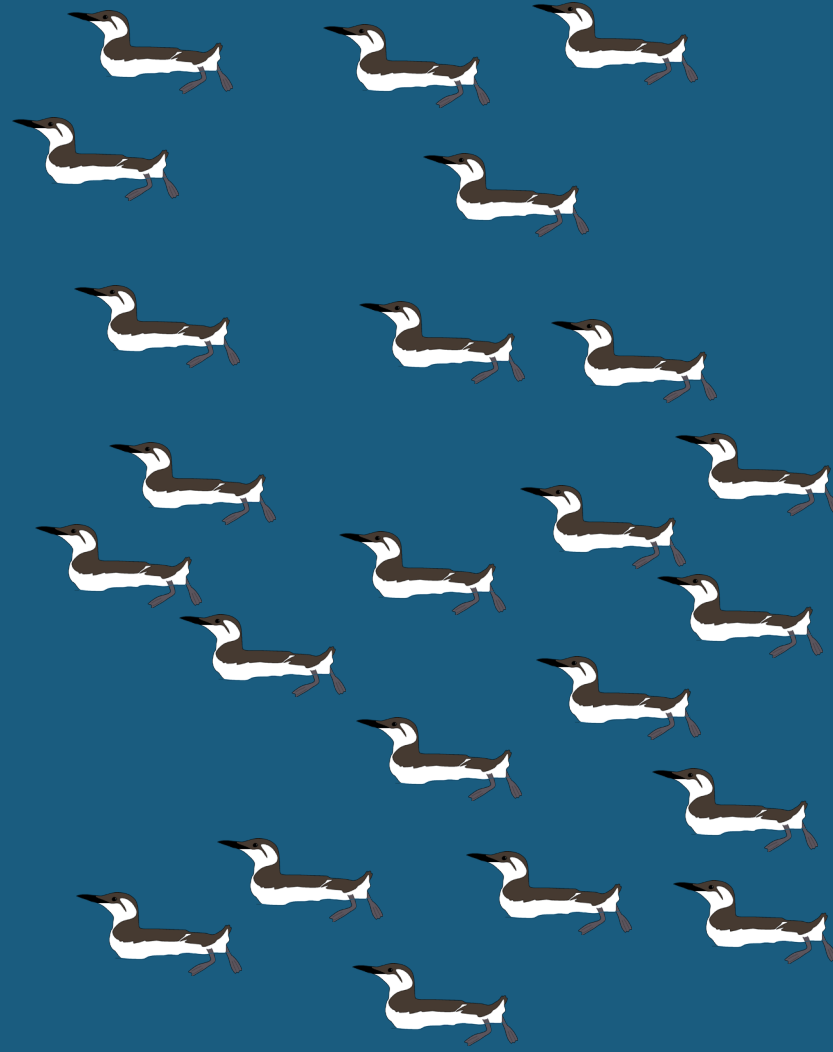


End of season

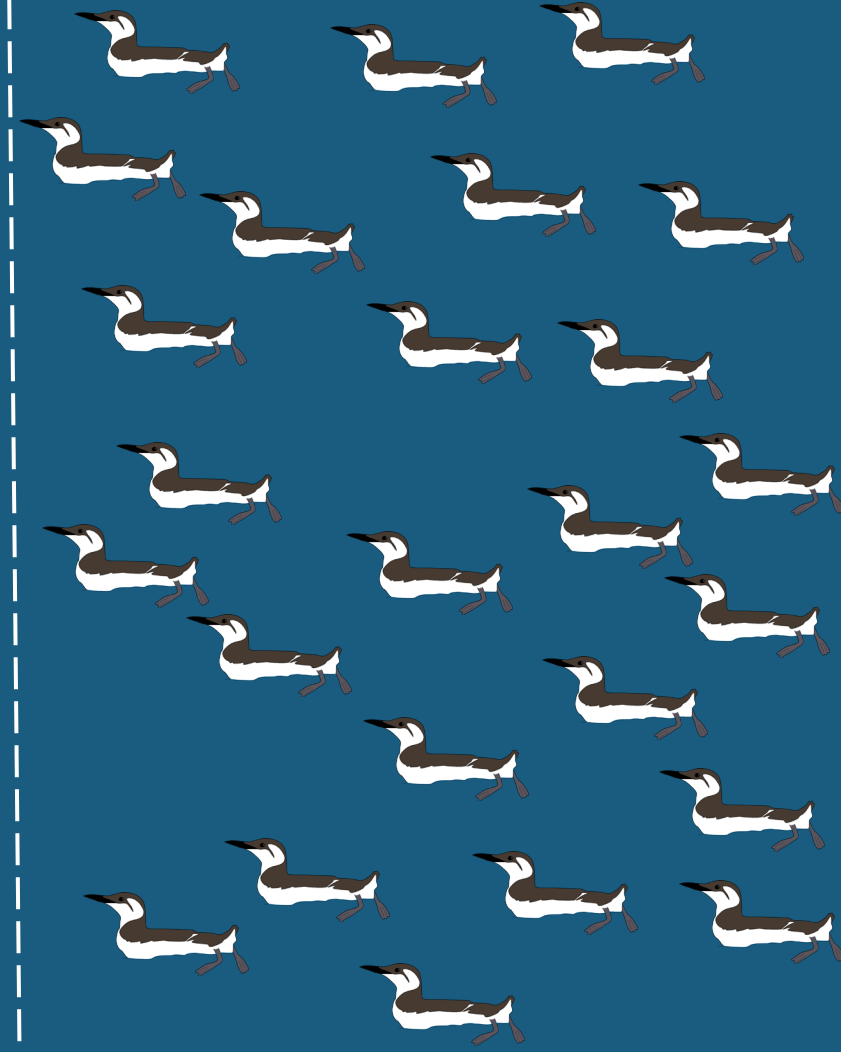
Many OWFs



Some OWFs

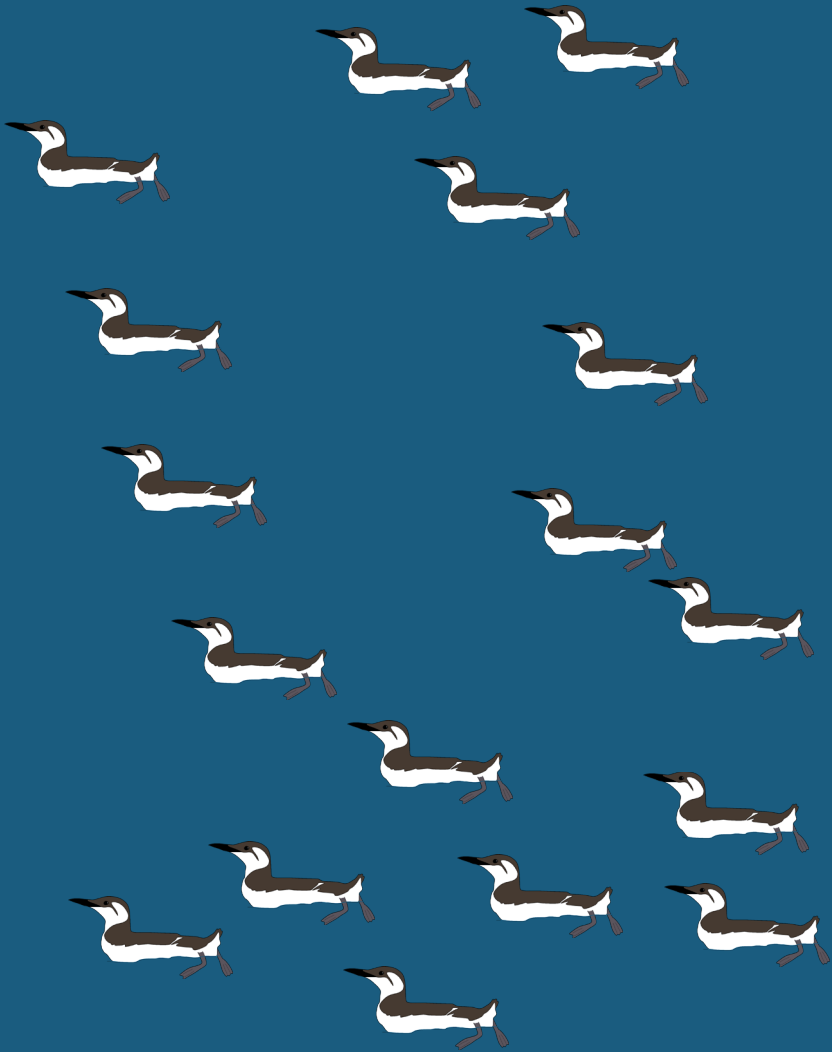


Few OWFs



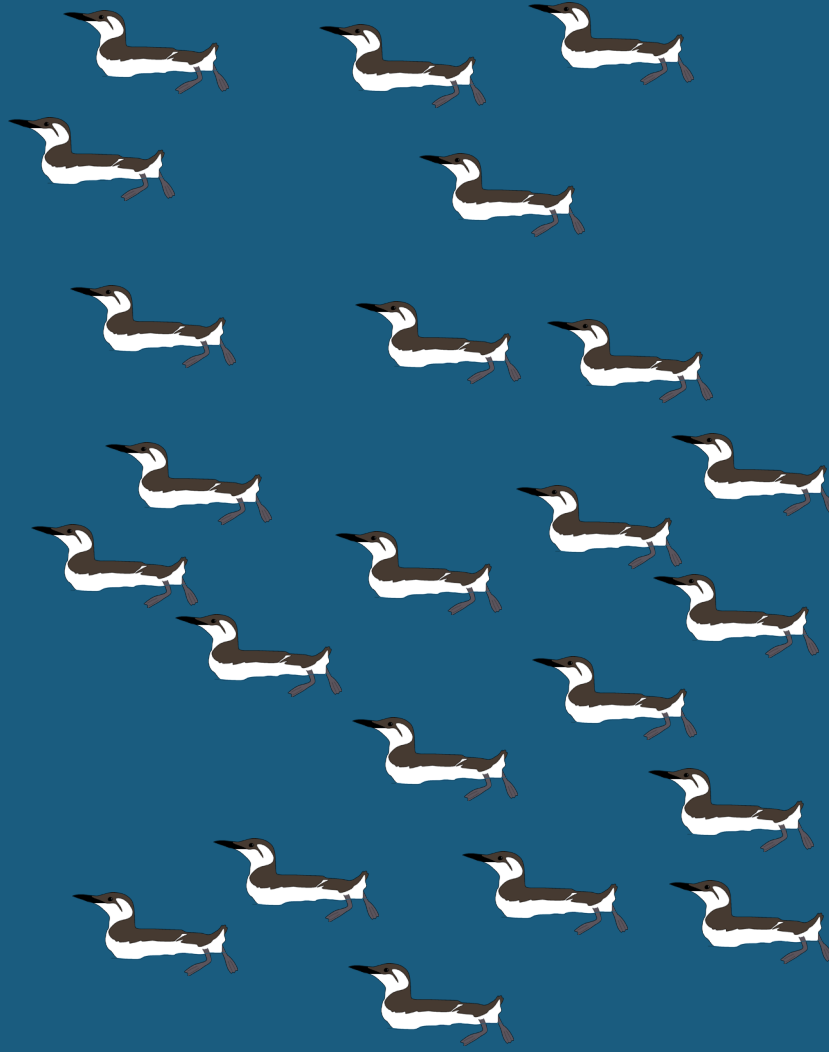
60%
survival

Many OWFs



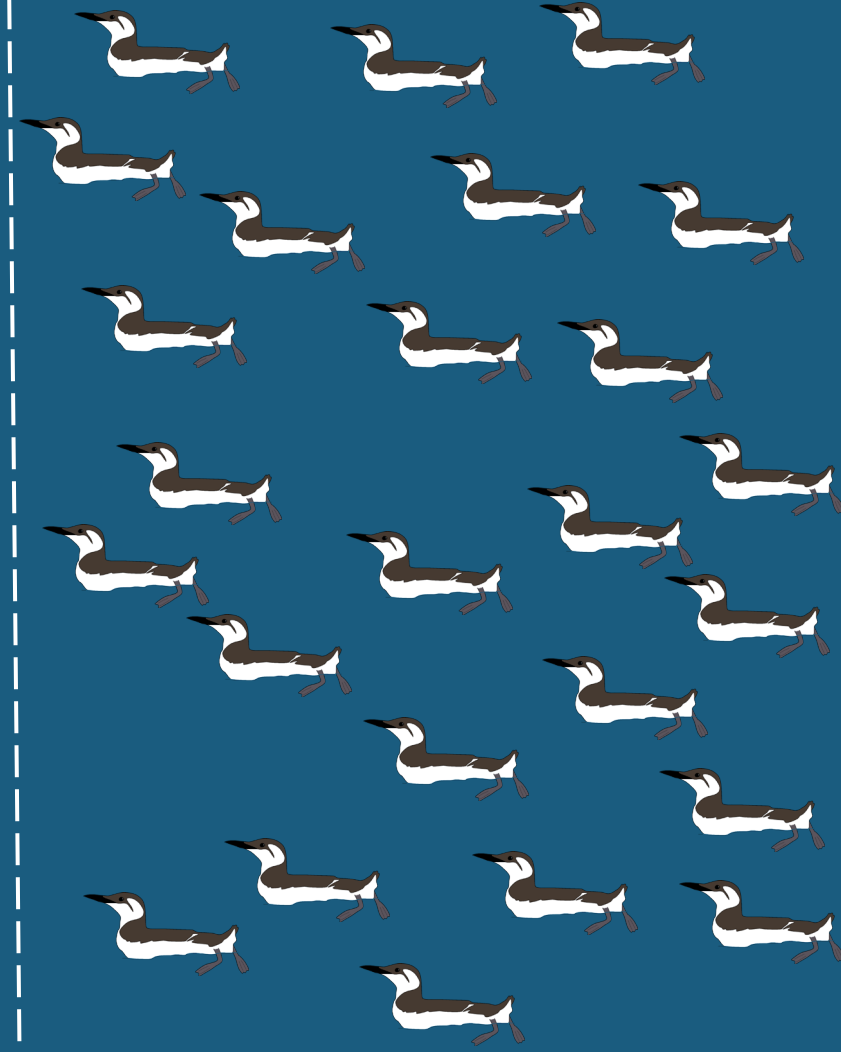
80%
survival

Some OWFs



90%
survival

Few OWFs

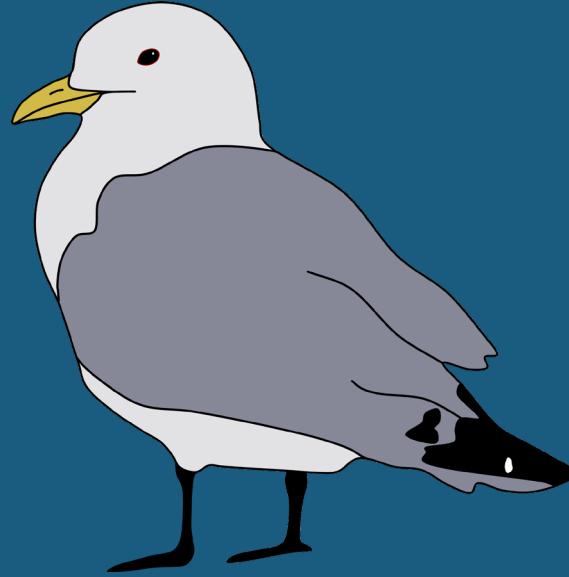


Model overview

- 1) Movement
- 2) Energetics

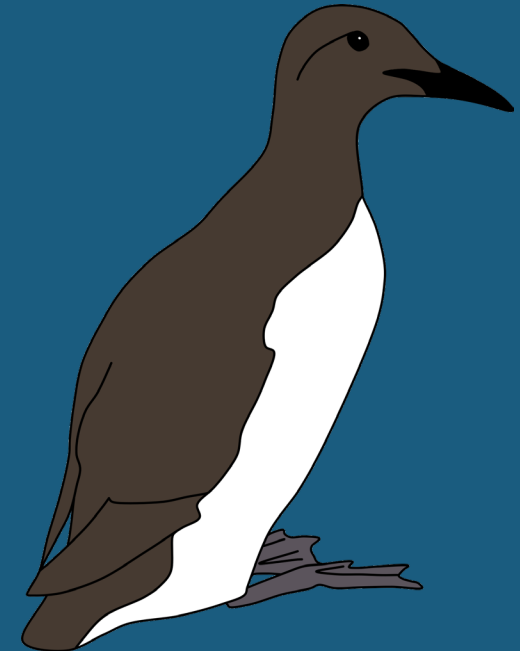
Case study:

The impacts of one offshore wind farm on two species of seabirds



Black-legged kittiwake
Rissa tridactyla
Collision

Common guillemot
Uria aalge
Displacement



Model parameters

Geolocation-immersion data



Credit: Andrew Carter

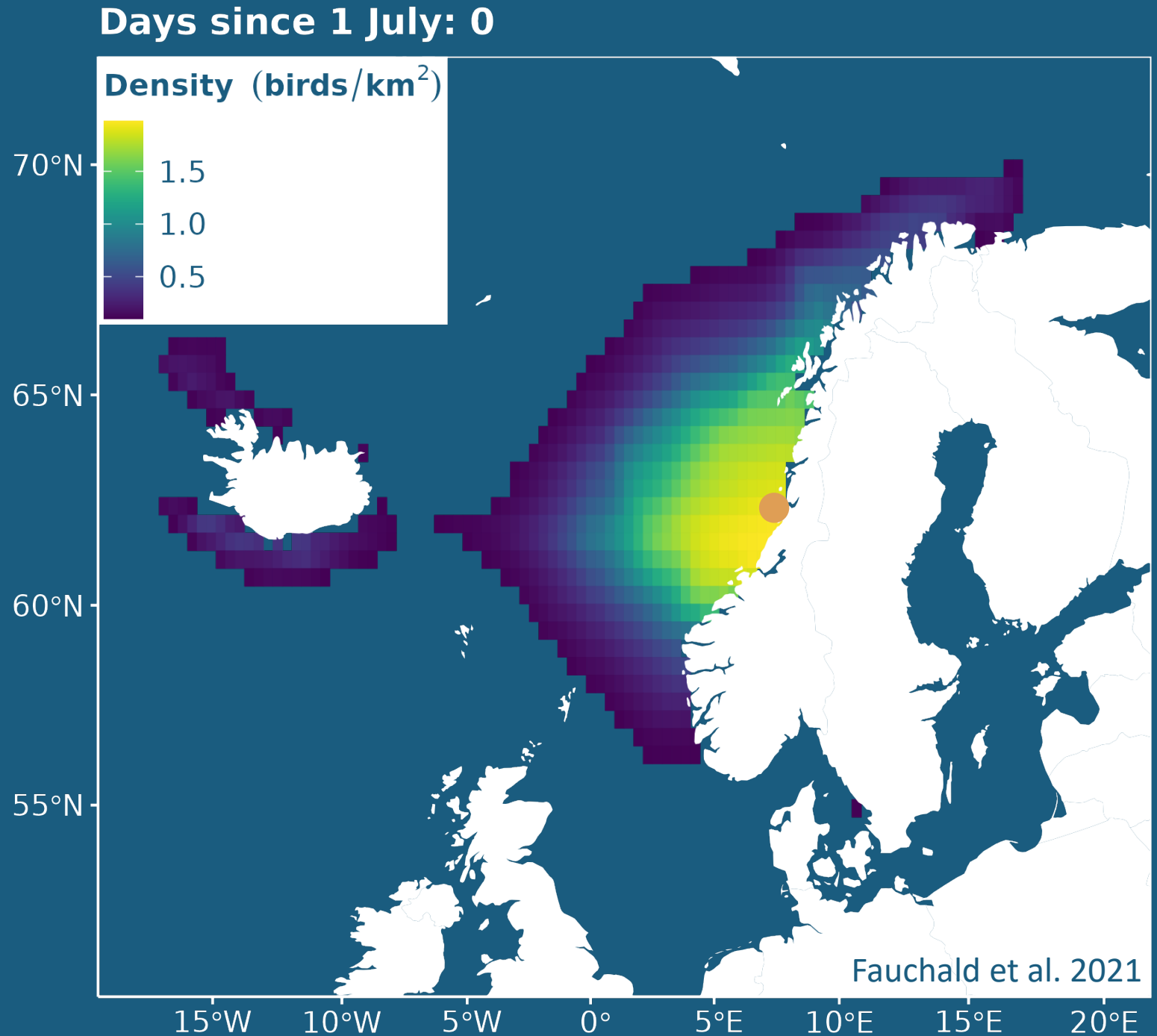
Model parameters

Geolocation-immersion data

Estimated population-level:

- distribution

For each day of the non-breeding season



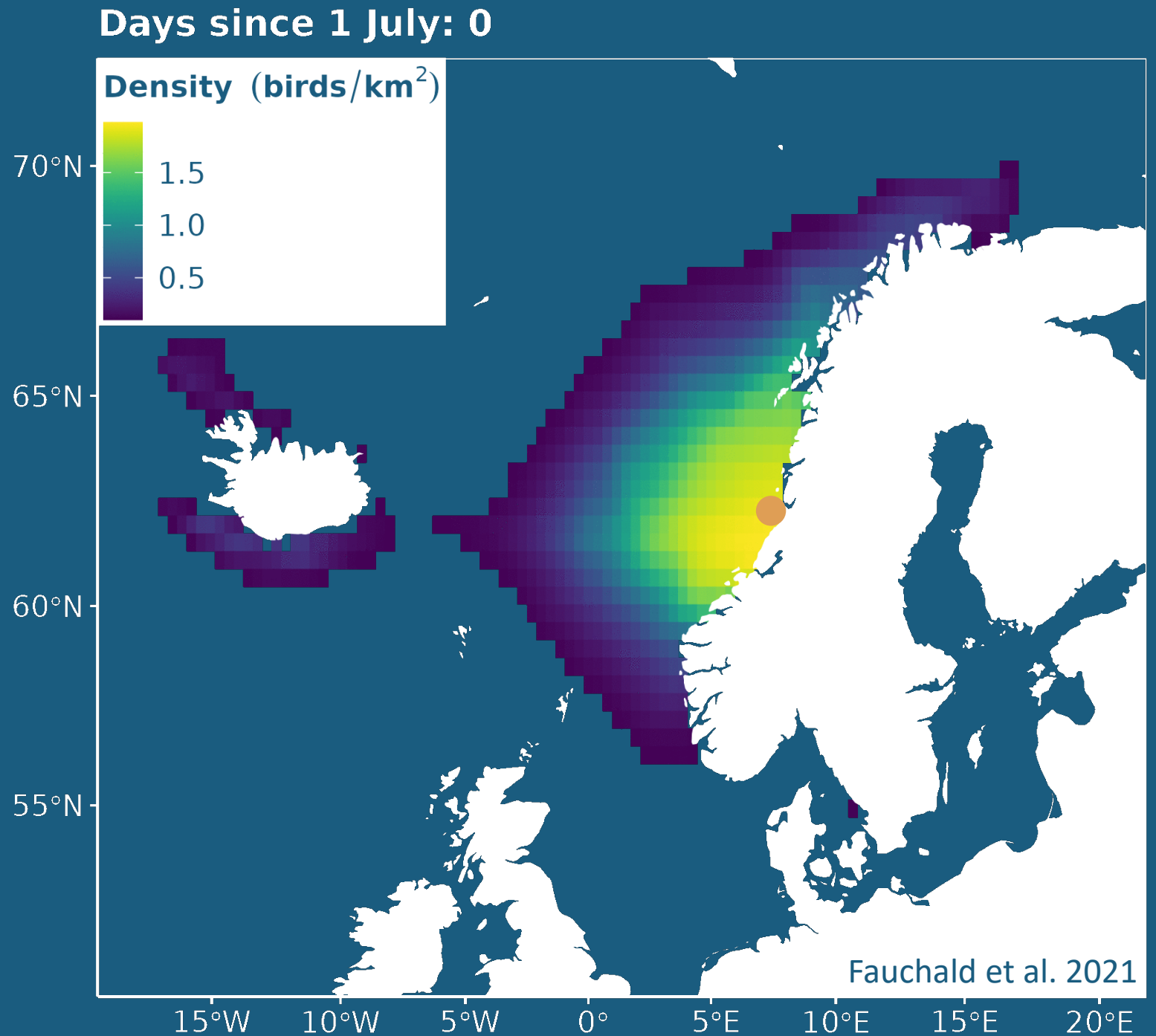
Model parameters

Geolocation-immersion data

Estimated population-level:

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For each day of the non-breeding season



Model parameters

Geolocation-immersion data

Estimated population-level:

- distribution
- activity budgets

For each day of the non-breeding season



Model parameters

Geolocation-immersion data

Estimated population-level:

- distribution
- activity budgets

For each day of the non-breeding season



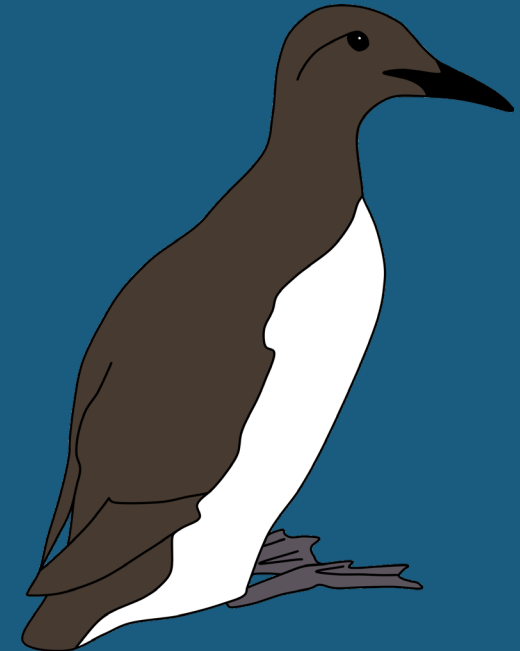
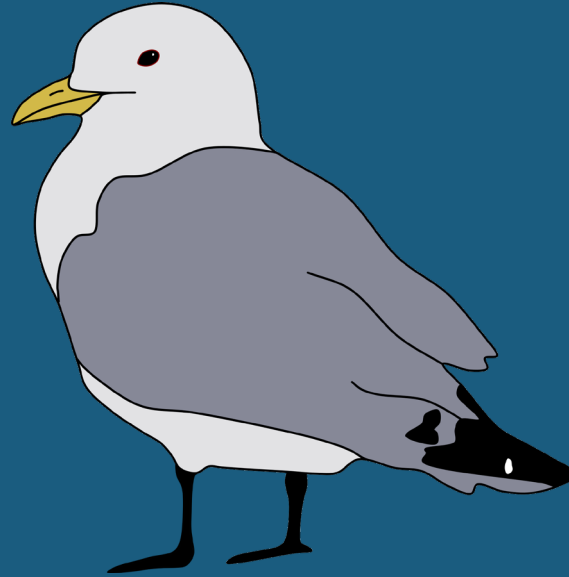
Model parameters

Collision risk

- Modelled using the stochastic Collision Risk Model (sCRM; Band 2012; Masden 2015, McGregor et al. 2018)
- Collision → death

Displacement

- Modelled using values of displacement probability (Peschko et al. 2020)
- Added an energetic cost of displacement equivalent to +30 minutes flight



Simulations



For each individual:

1) daily movement

- yesterday's location
- today's distribution
- time flying/swimming → max distance travelled

Simulations

For each individual:

1) daily movement

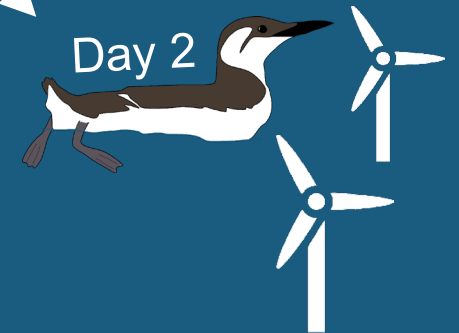
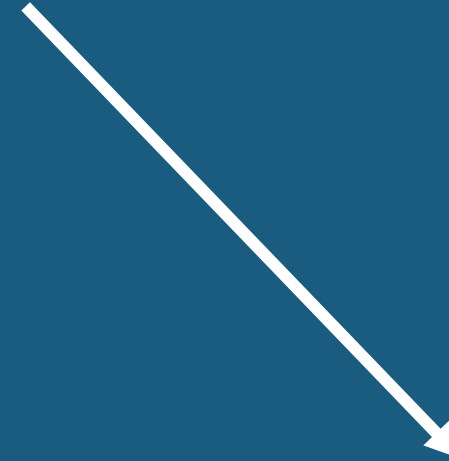
- yesterday's location
- today's distribution
- time flying/swimming → max distance travelled

2) OWF interaction

- kittiwake: collision → death
- guillemot: displacement → energetic cost

3) OWF impact

- kittiwake: mortality due to collision
- guillemot:
 - energy expenditure
 - end of season mass



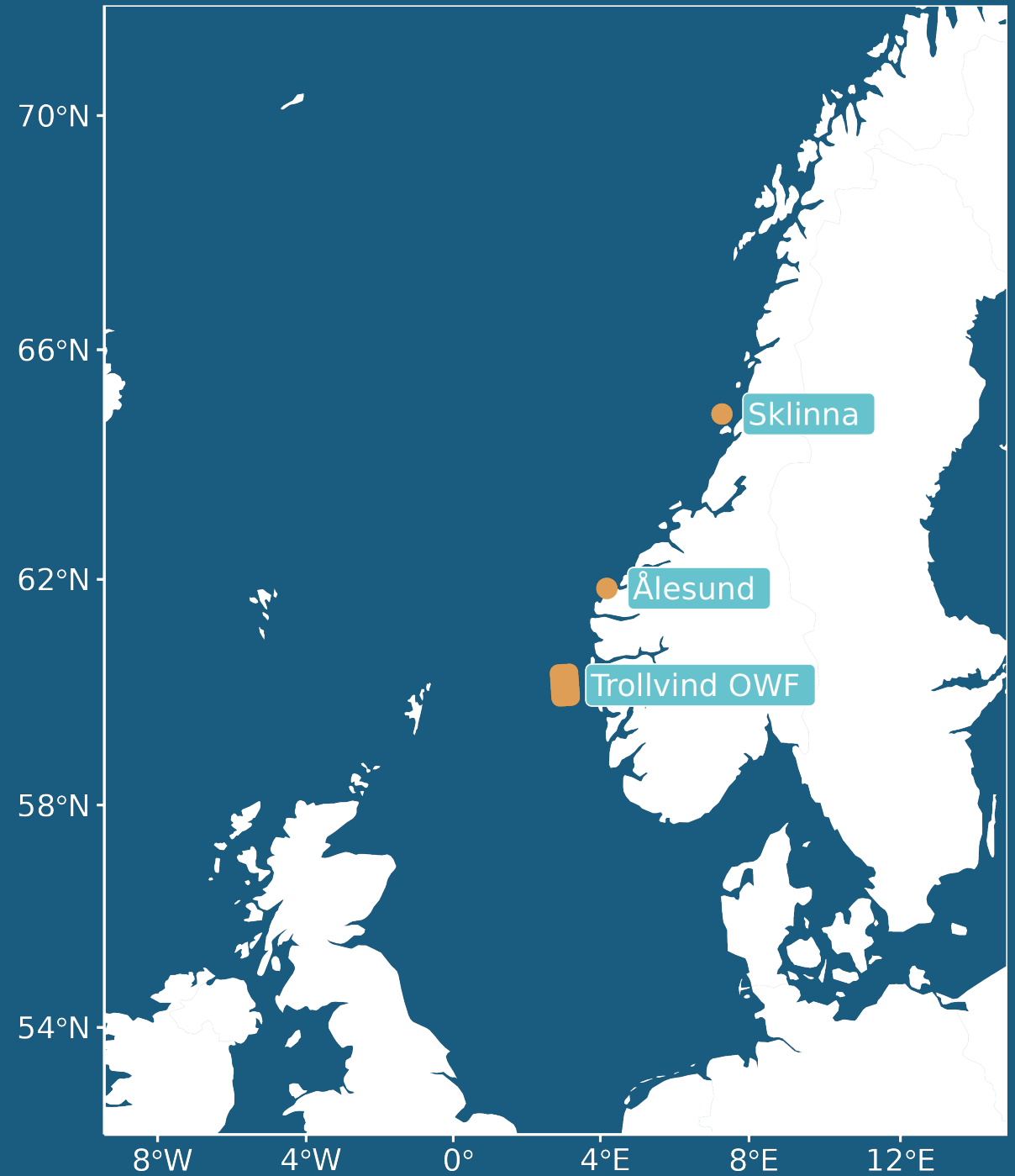
Output:
Change in mortality or
mass due to OWF

Case study

Guillemots – Sklinna

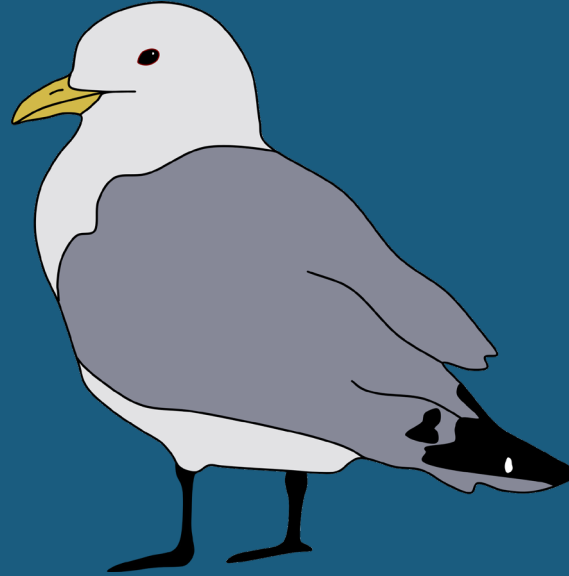
Kittiwakes – Ålesund

Trollvind offshore wind farm



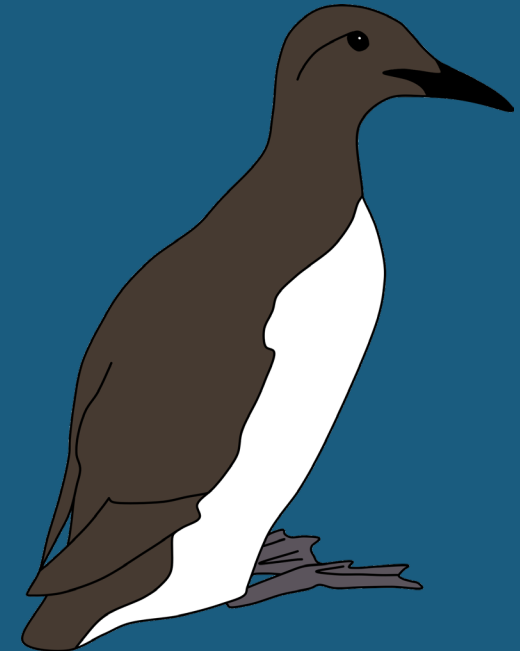
Case study

- 22.7% overlapped with footprint at least once
 - sCRM predicted a very low collision probability ($< 0.001\%$)
- very low collision rate



Case study

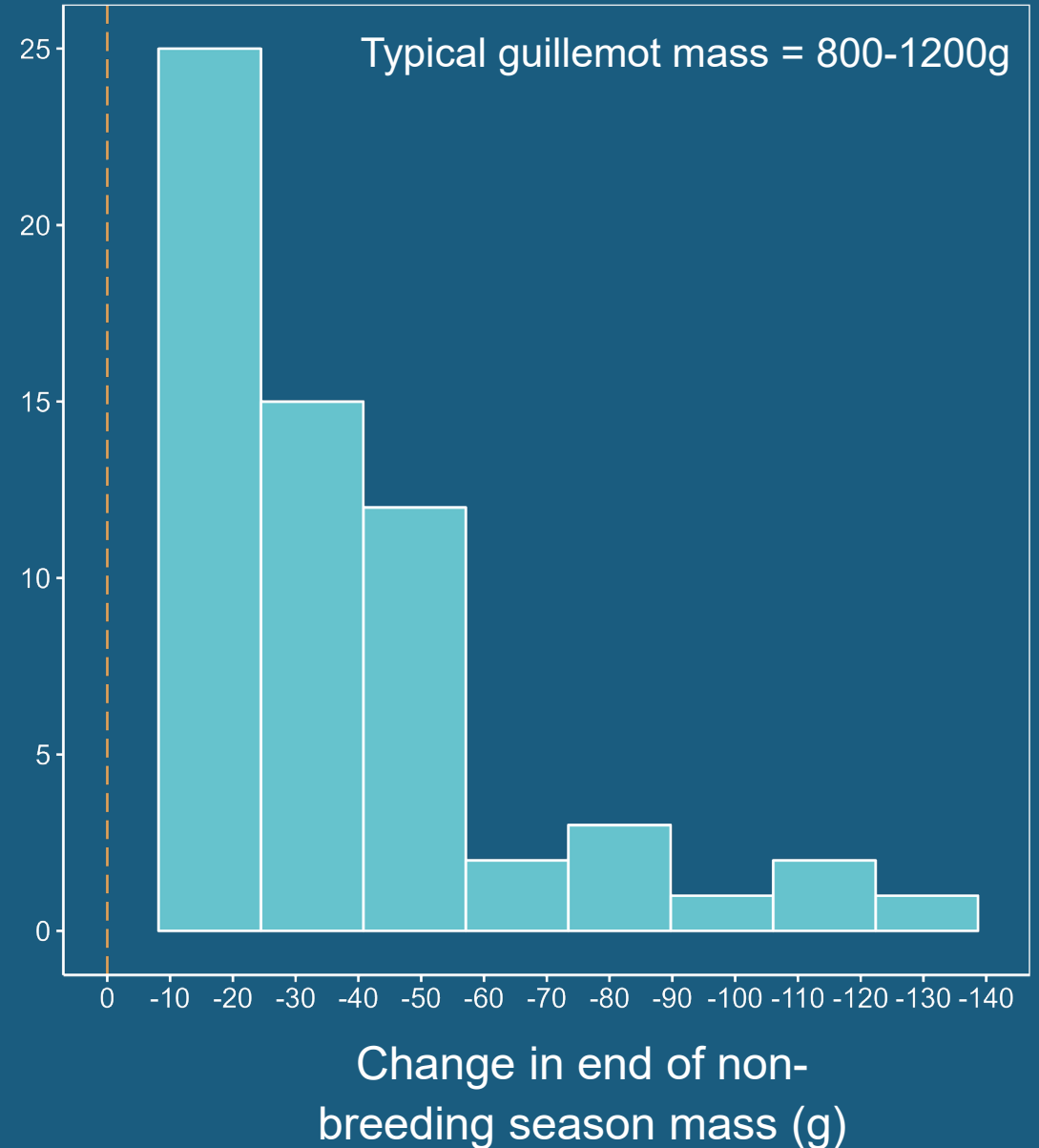
- 7.1% overlapped with footprint at least once
- Displacement effects for 6.1% of population
- Negligible mean change in mass
 - mean = -2.33g
 - standard deviation = 11.4
- But potentially significant individual-level impacts



Case study

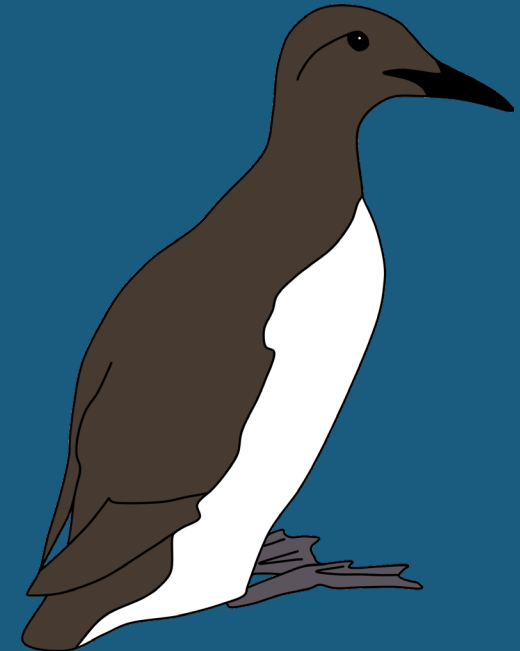
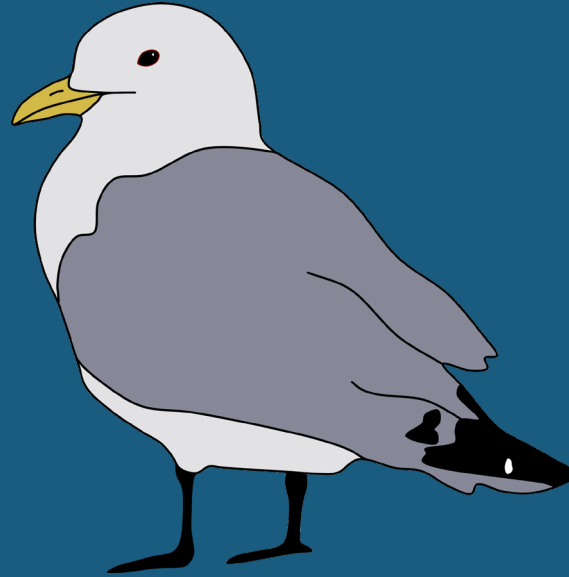
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Number of individuals



Case study

- Negligible impact on Ålesund kittiwakes
- Individual-level effects on Sklinna guillemots
→breeding/survival?

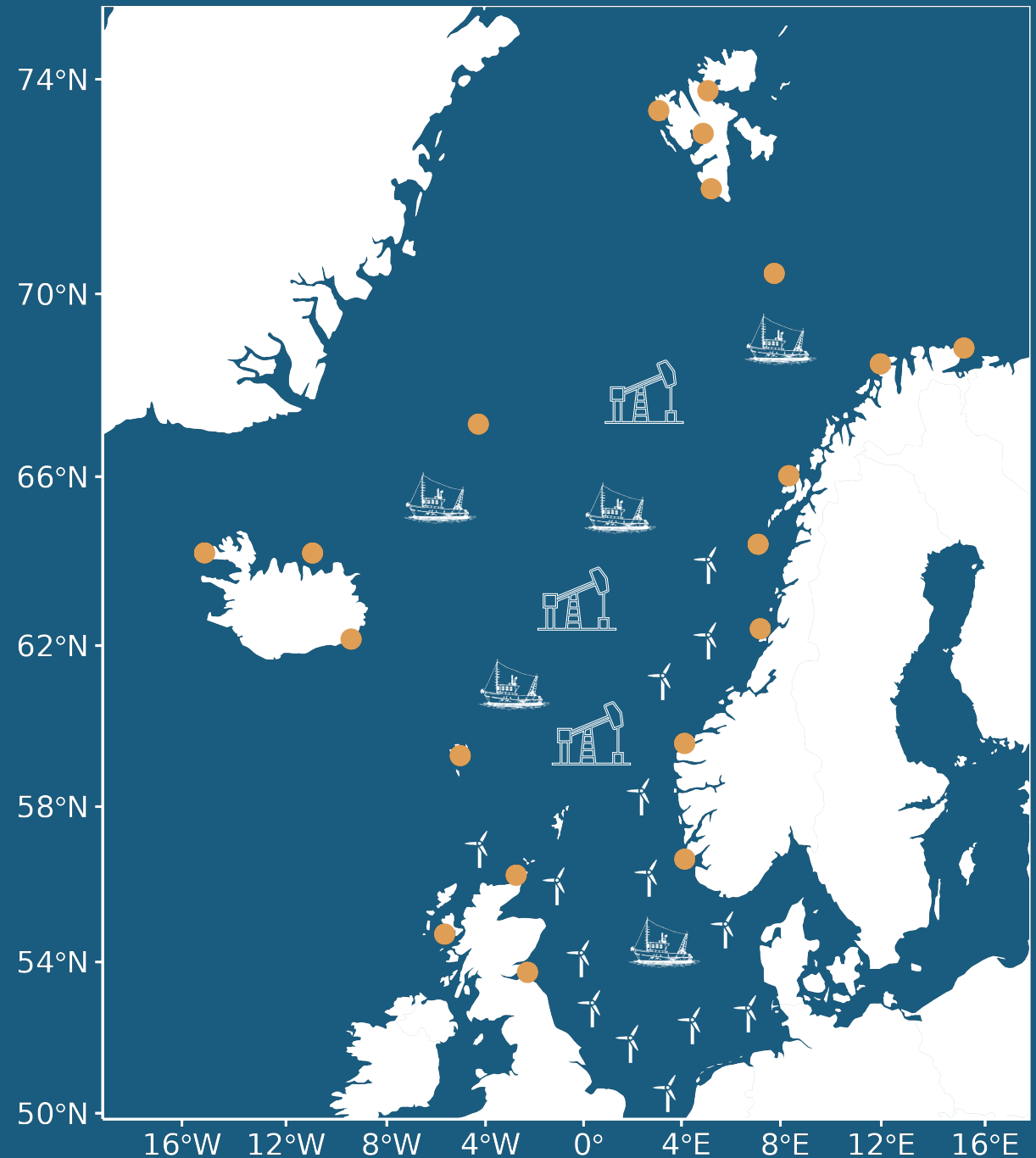


Next steps

Created a spatially-explicit IBM for assessing OWF impacts on seabirds in the non-breeding season

- 1) Other populations
- 2) Multiple OWFs and other stressors
- 3) Other species

Energetic consequences of displacement?



Thank you to all our collaborators:



NORGES FISKARLAG



NTNU



KYSTVERKET



FISKERIDIREKTORATET



Passion for Salmon



Rogaland fylkeskommune



University of Reading

MARCIS is a collaborative research project between research institutes, industry, management authorities, NGOs and interest groups. The project will contribute to ecosystem-based management of marine spatial use and provide a decision support tool for balancing interests and conflicts in planning processes.

Read the report:

Layton-Matthews et al. 2023. *Development of a Cumulative Impact Assessment tool for birds in Norwegian Offshore Waters: Trollvind OWF as a case study.*



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