

# From Sea to Shore: The Hinterland model linking marine foraging habitat to seal distribution on land

Geert Aarts, Sophie Brasseur, Jessica Schop & Janneke Ransijn



Rijkswaterstaat  
*Ministerie van Infrastructuur en Waterstaat*



**Gefinancierd door  
de Europese Unie**



NOORDZEEOVERLEG



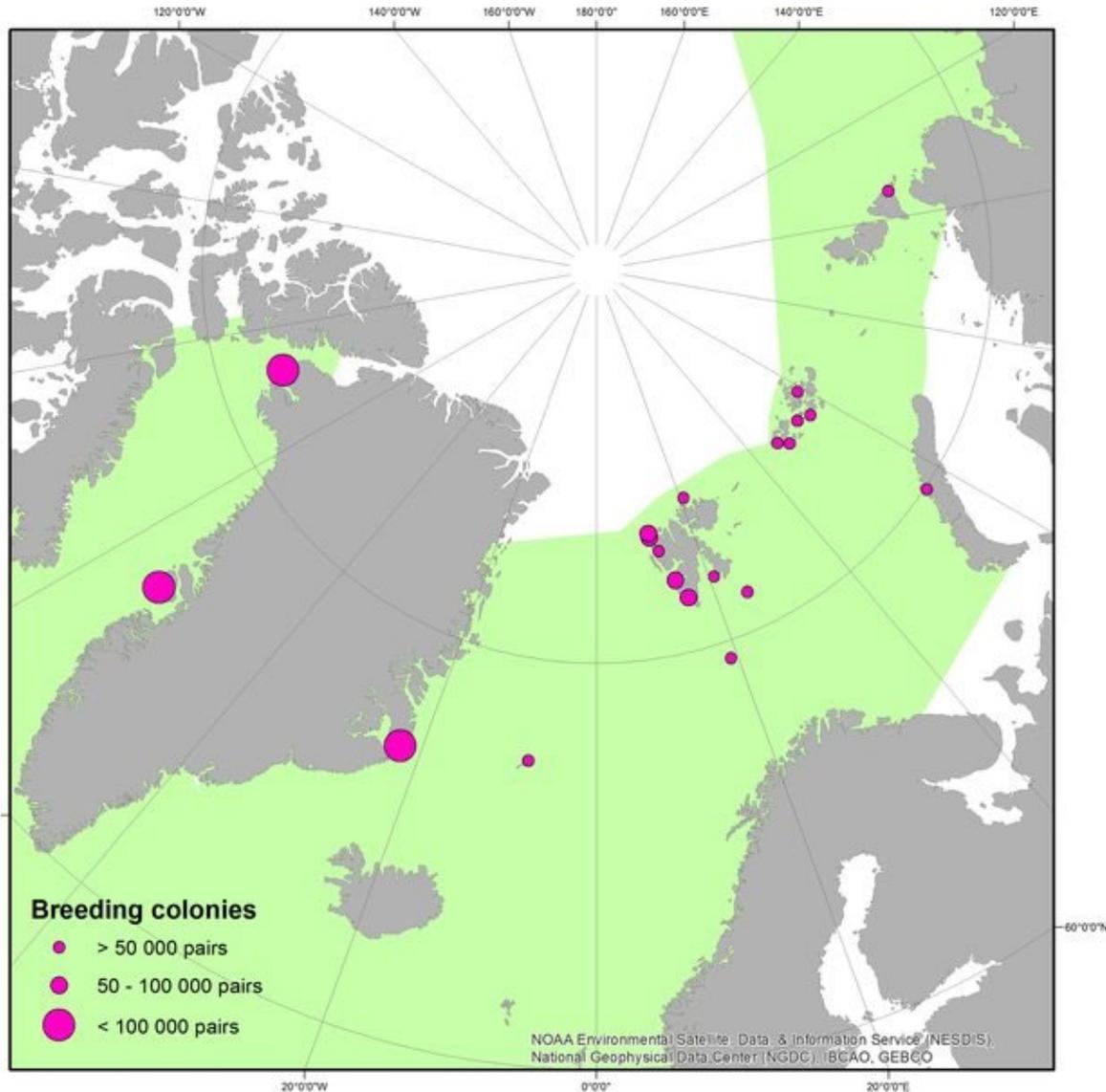
**WAGENINGEN**  
UNIVERSITY & RESEARCH



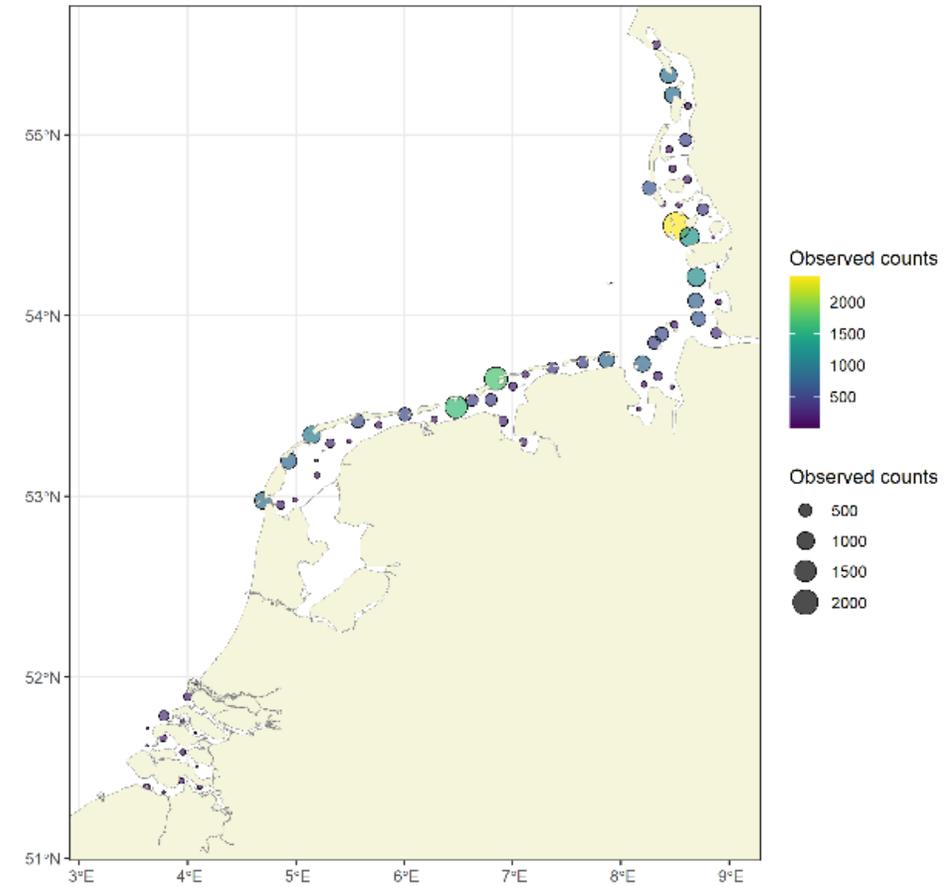
Many central place-foraging species

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# Is colony distribution influenced by surrounding seascape?



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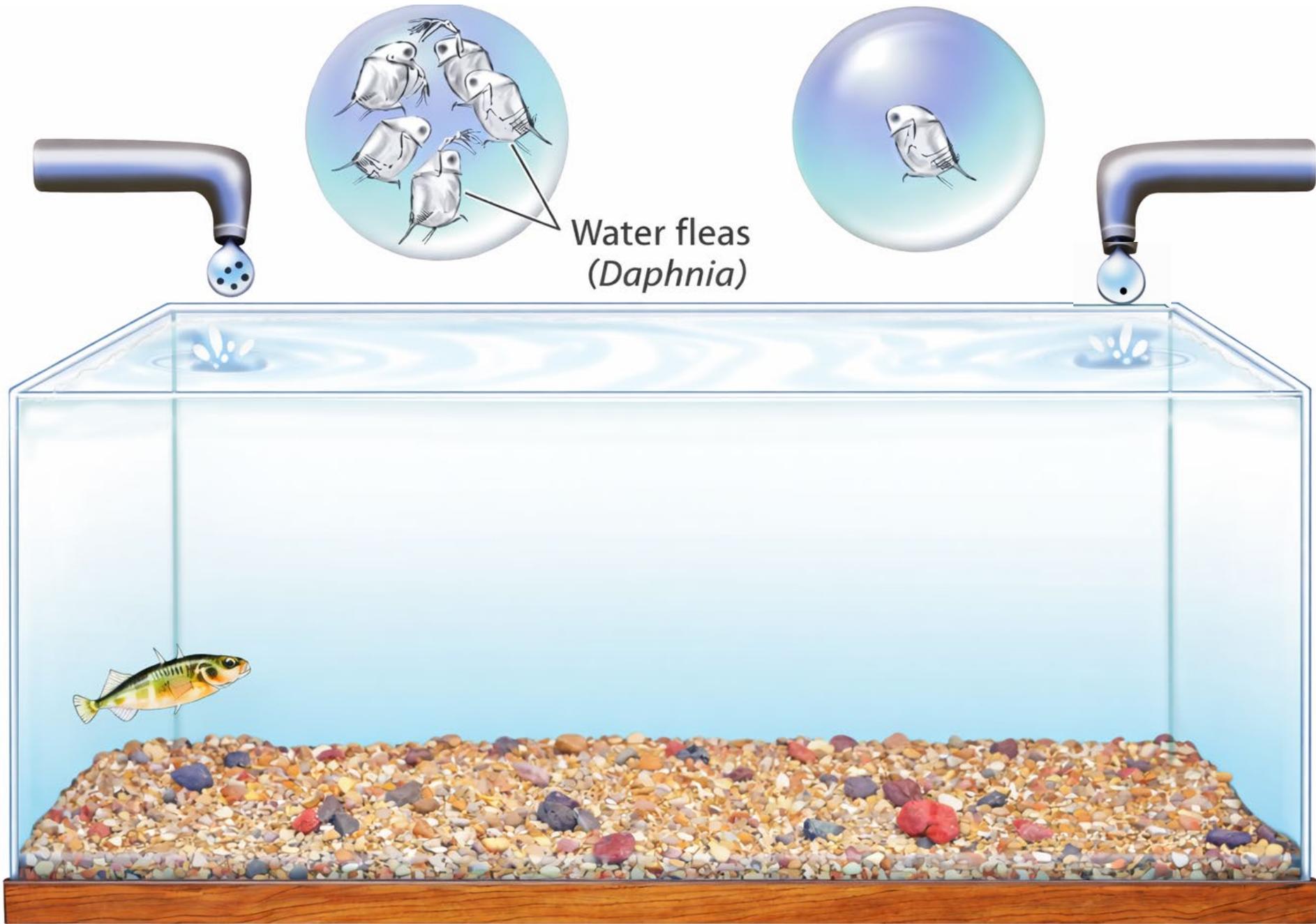


# Distribution = f(habitat quality)?

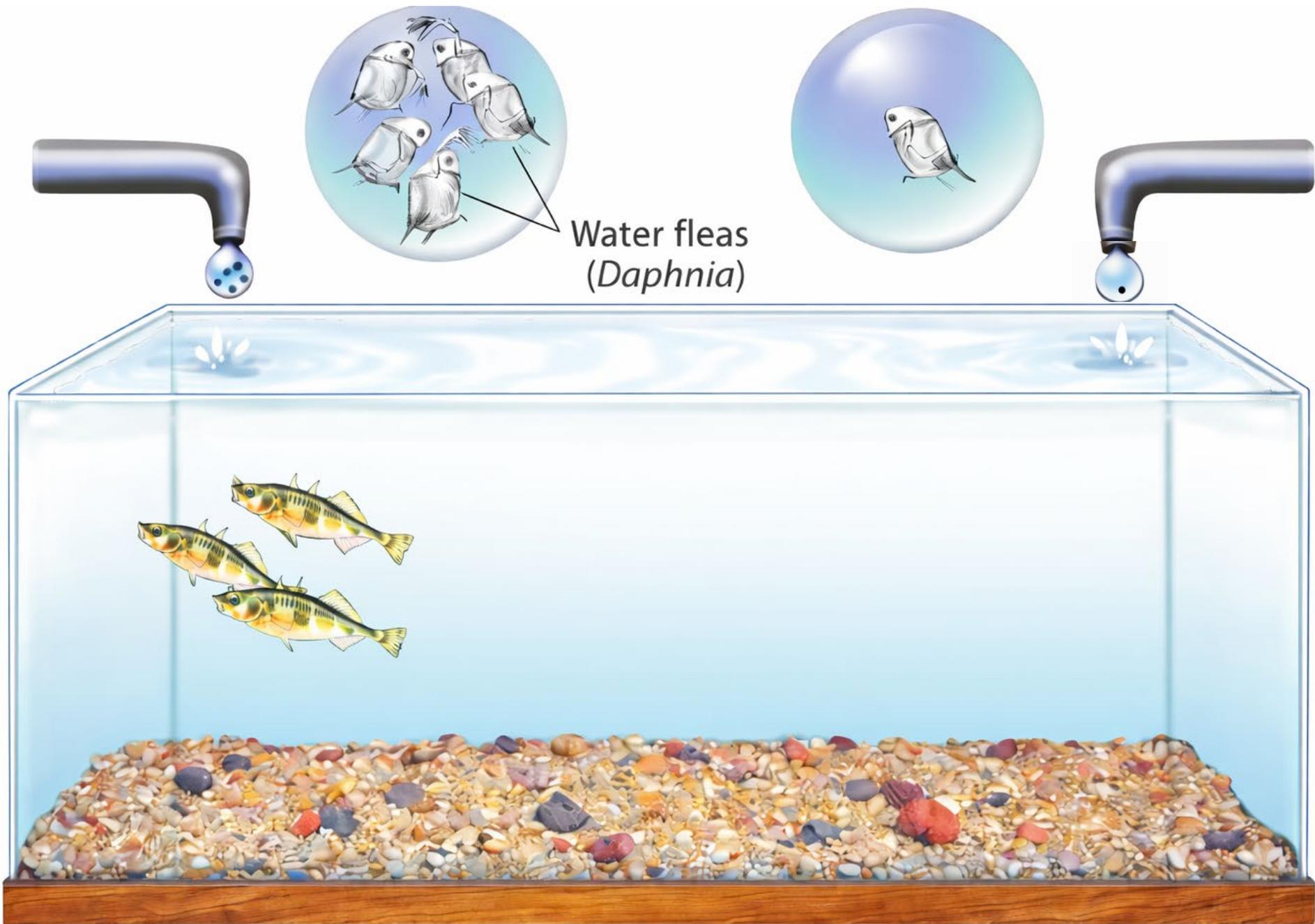
## Ideal-free distribution

**Ideal:** Individuals are aware of the current value of each patch and settle in the patch most suitable to them

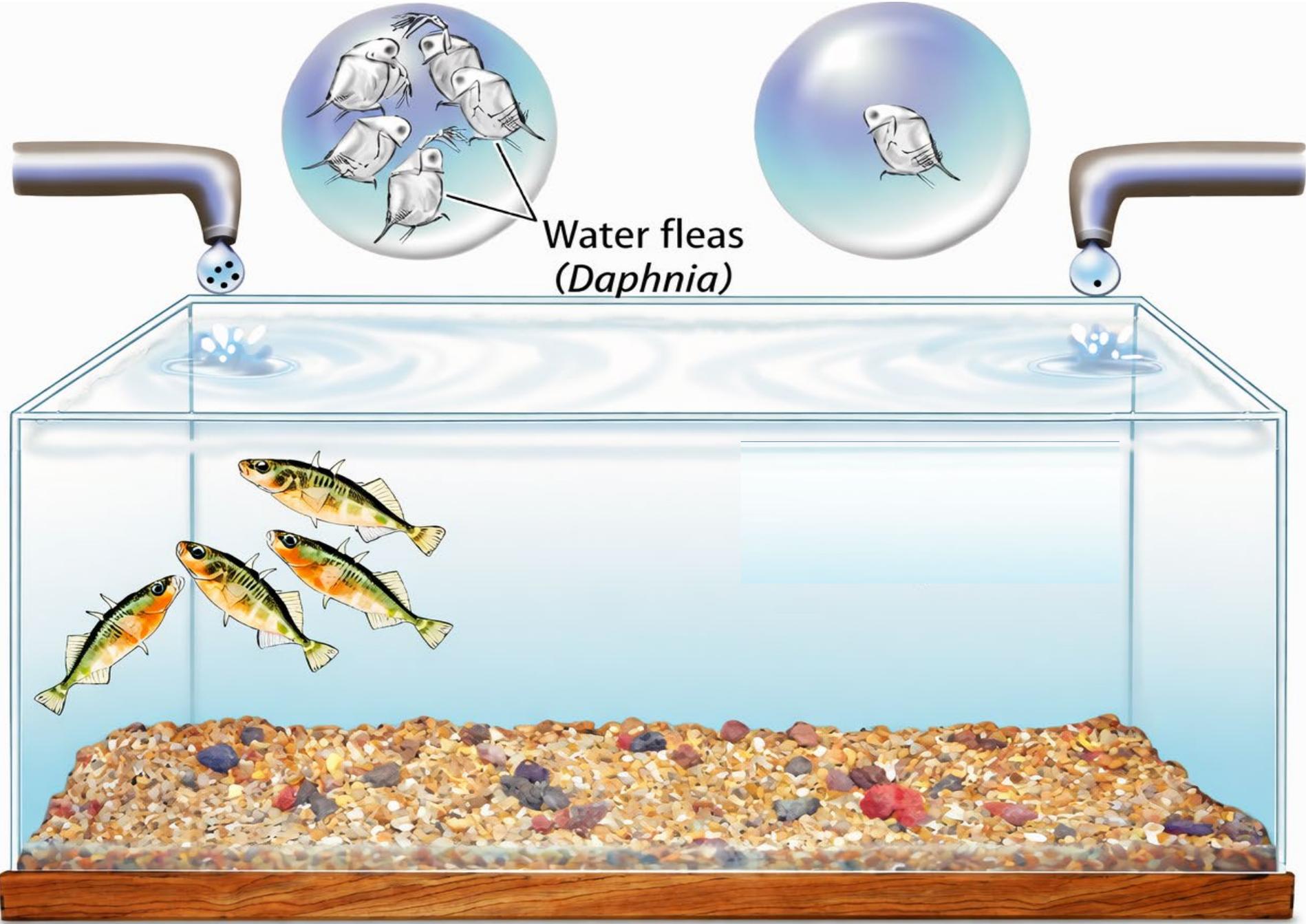
**Free:** All individuals are *free* to visit enter any patch



Water fleas  
(*Daphnia*)

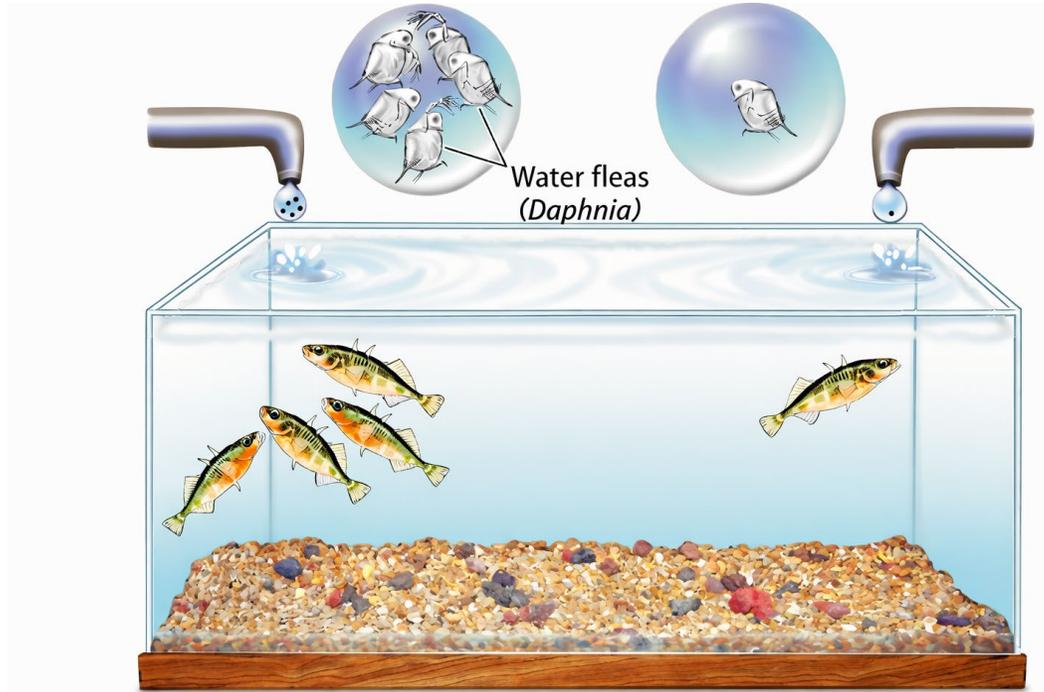
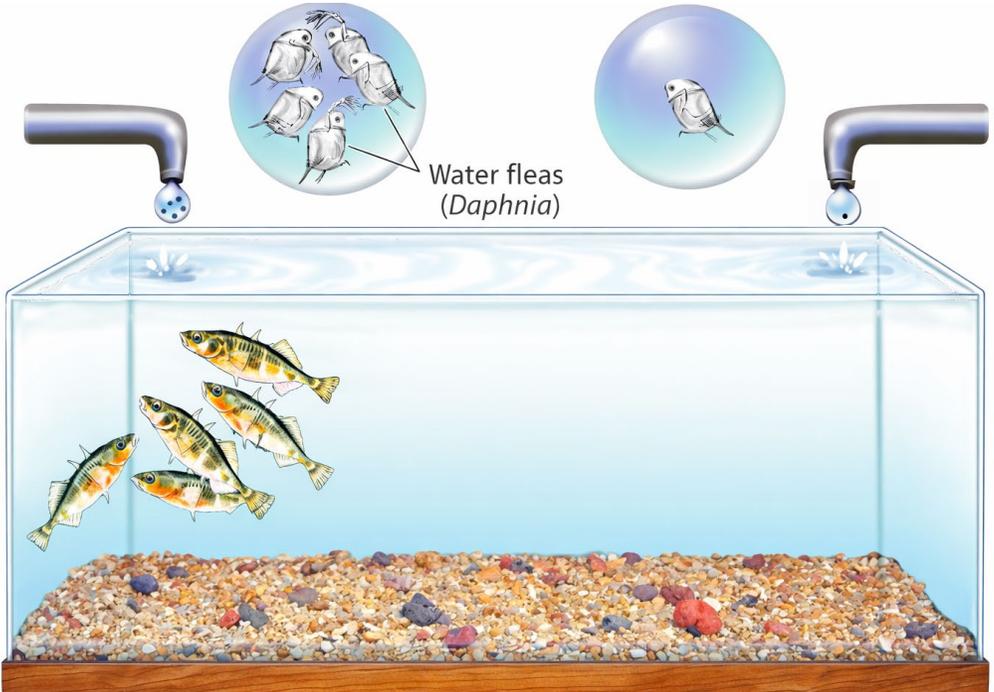


Water fleas  
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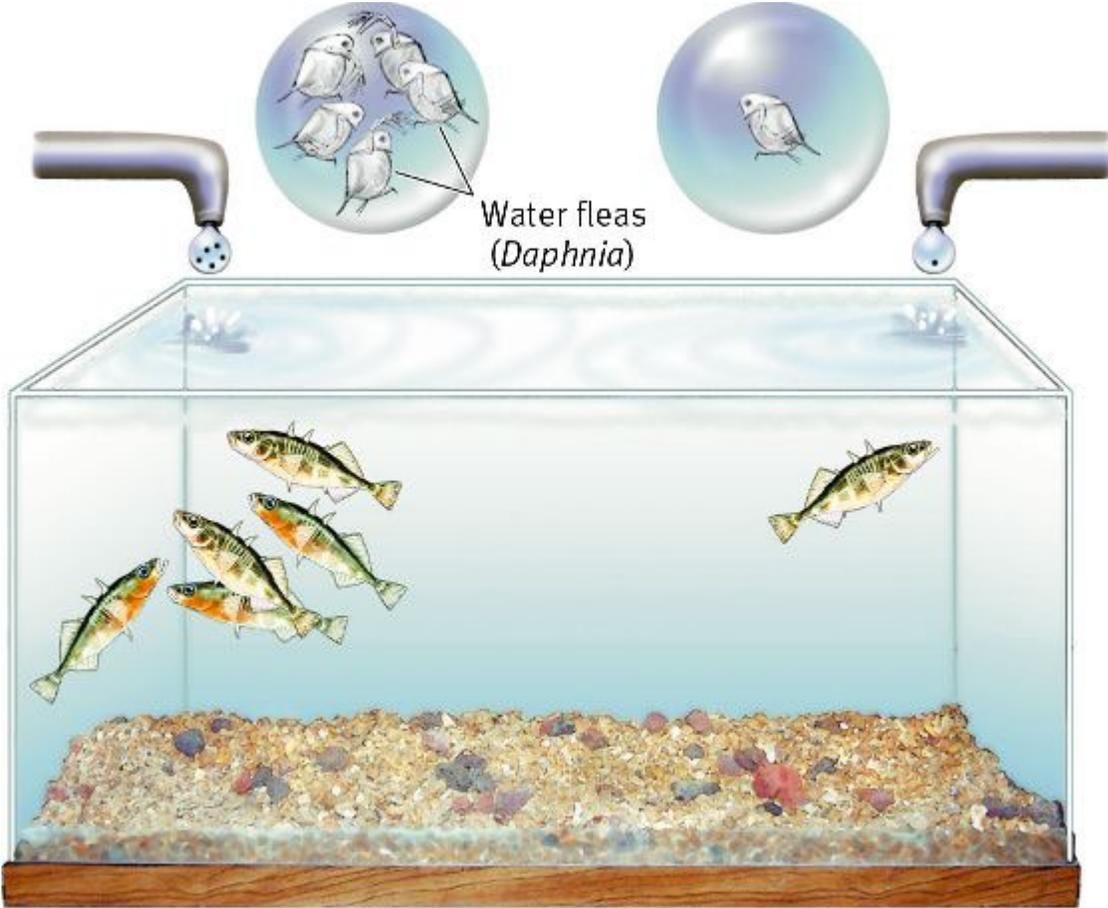


Water fleas  
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# Ideal-free distribution



# Ideal-free distribution

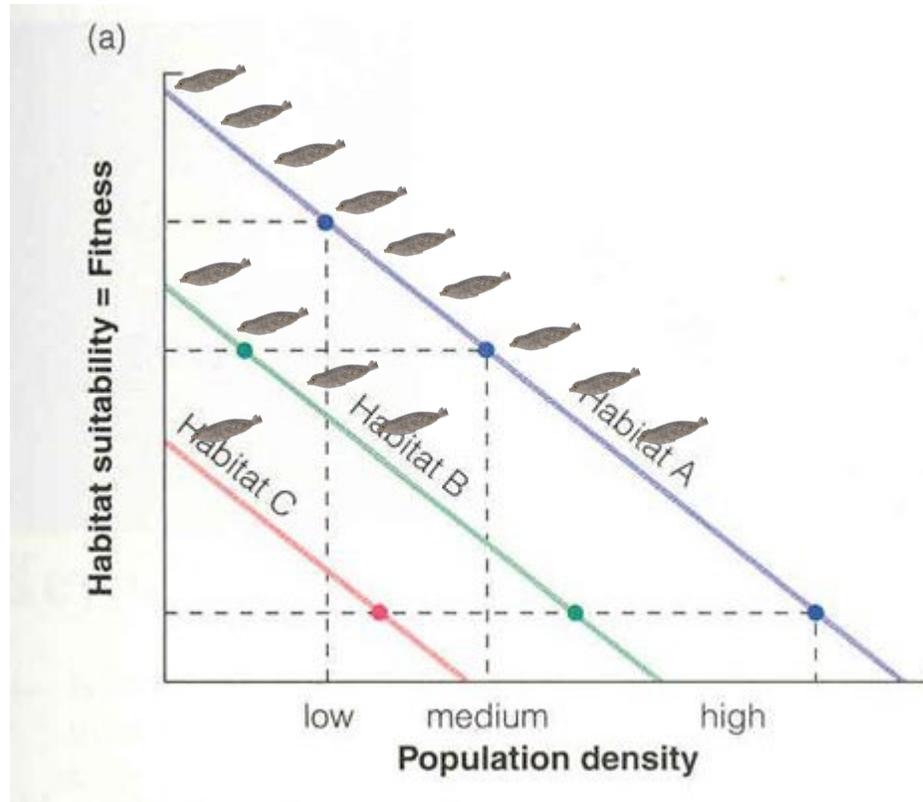


5 sticklebacks

1 stickleback

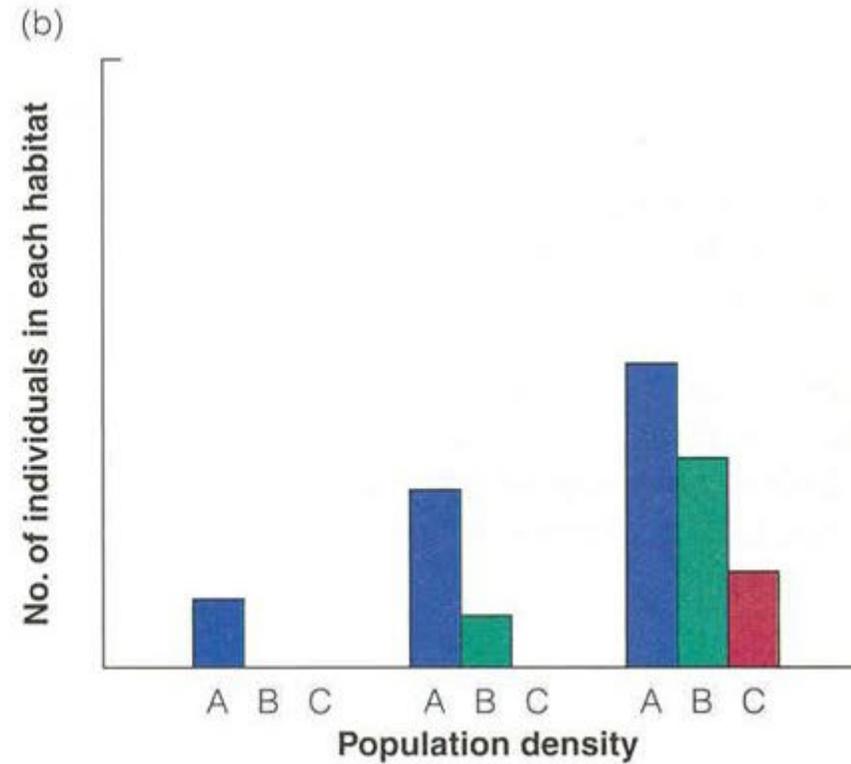
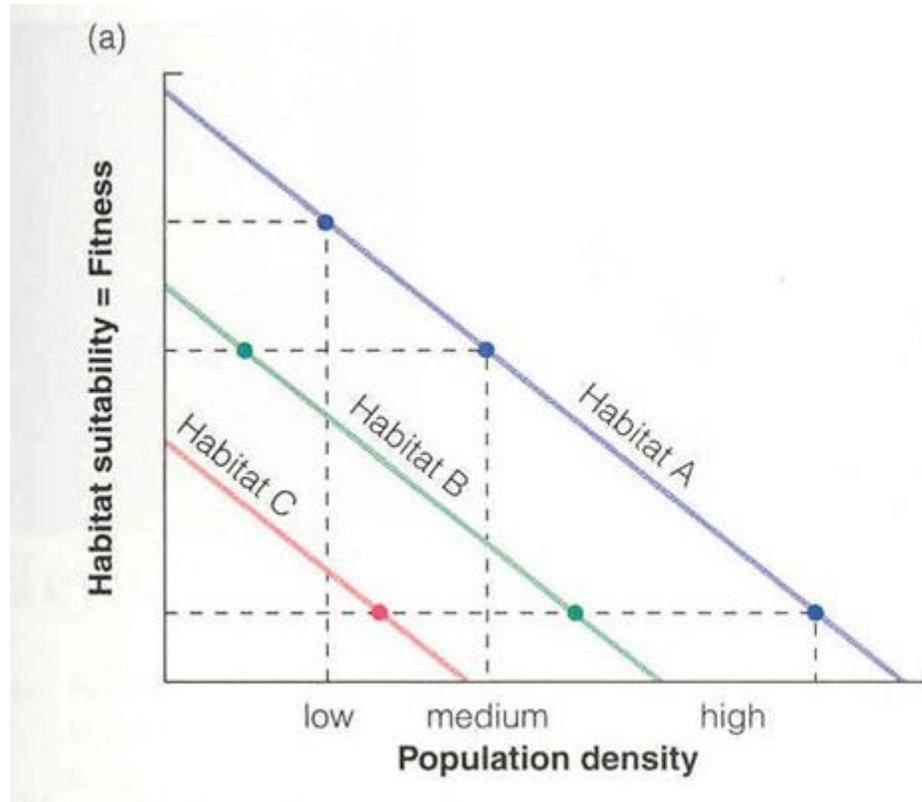
# Distribution = f(habitat quality)?

Ideal-free distribution

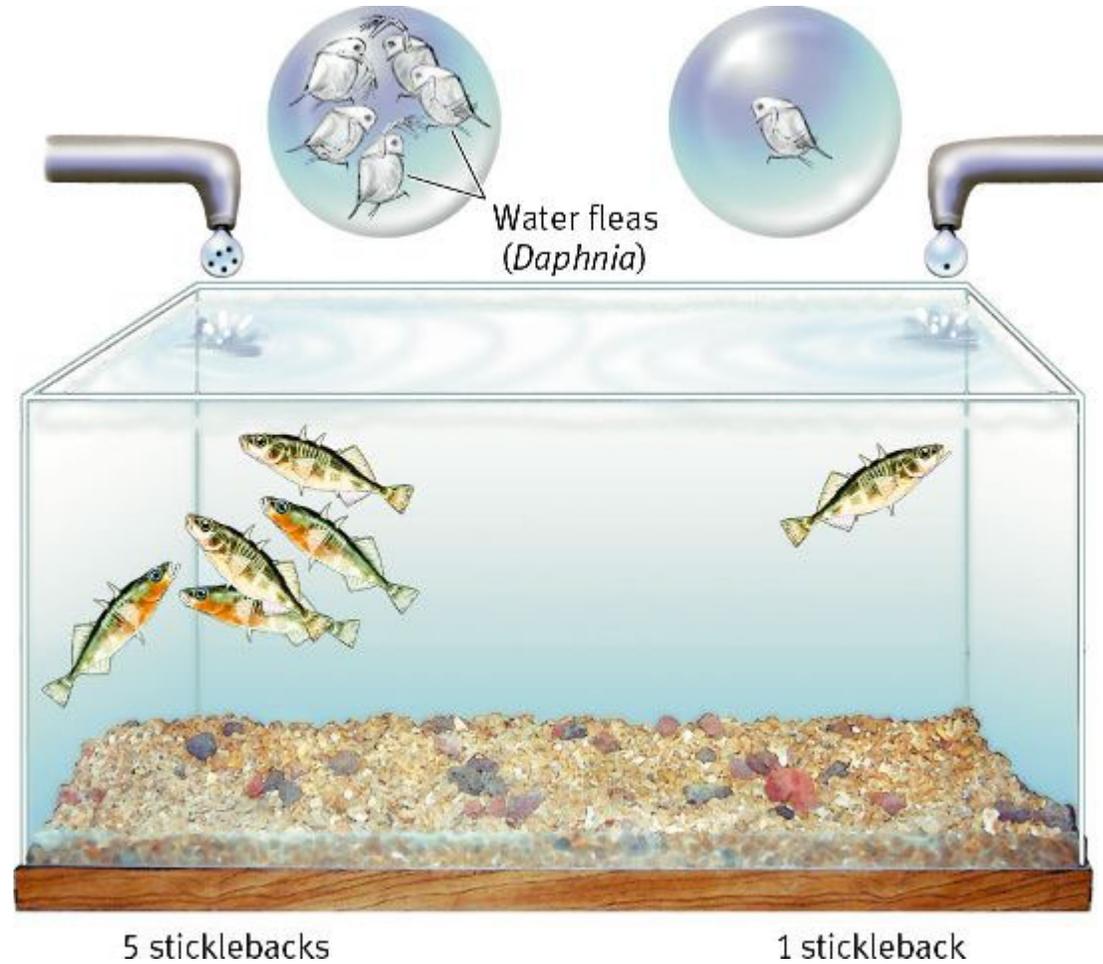


# Distribution = f(habitat quality)?

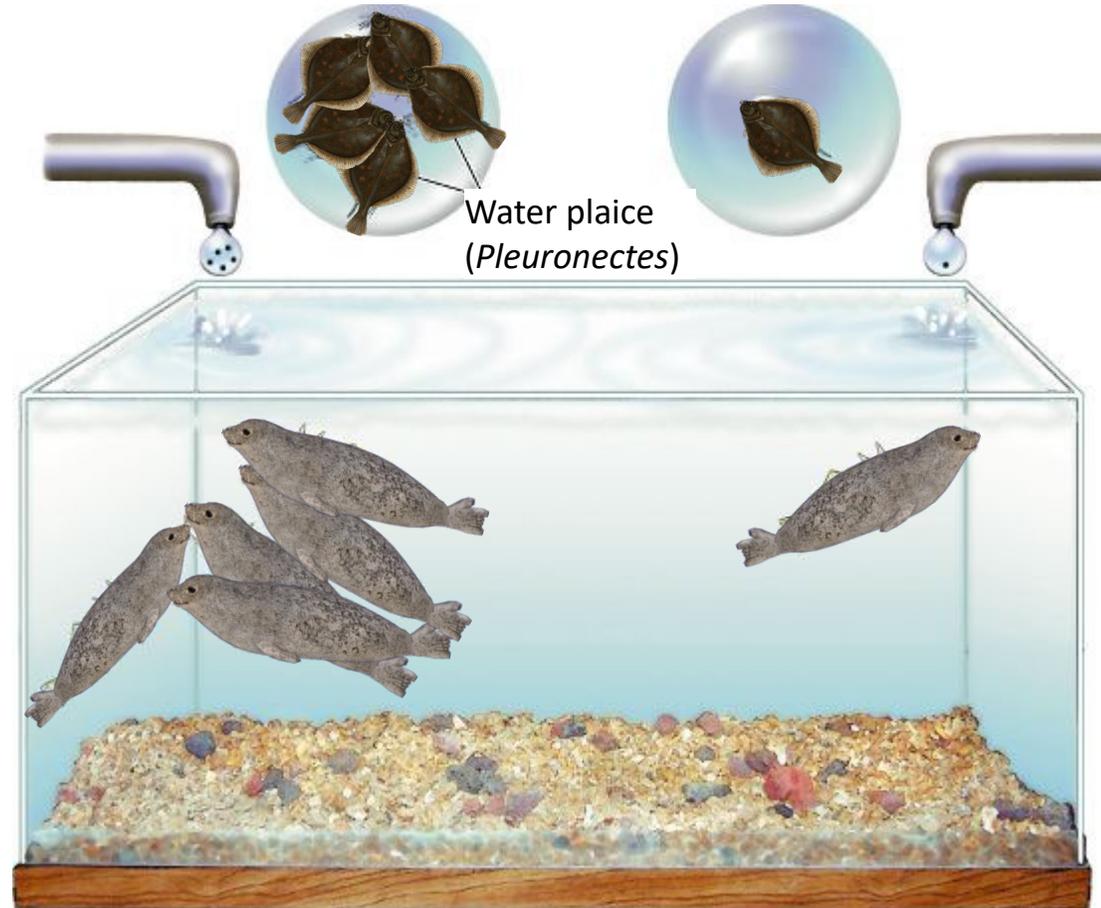
Ideal-free distribution



# Ideal-free distribution



Distribution = f(habitat quality)?



5 stickleseals

1 stickleseal

Distribution = f(habitat quality)?



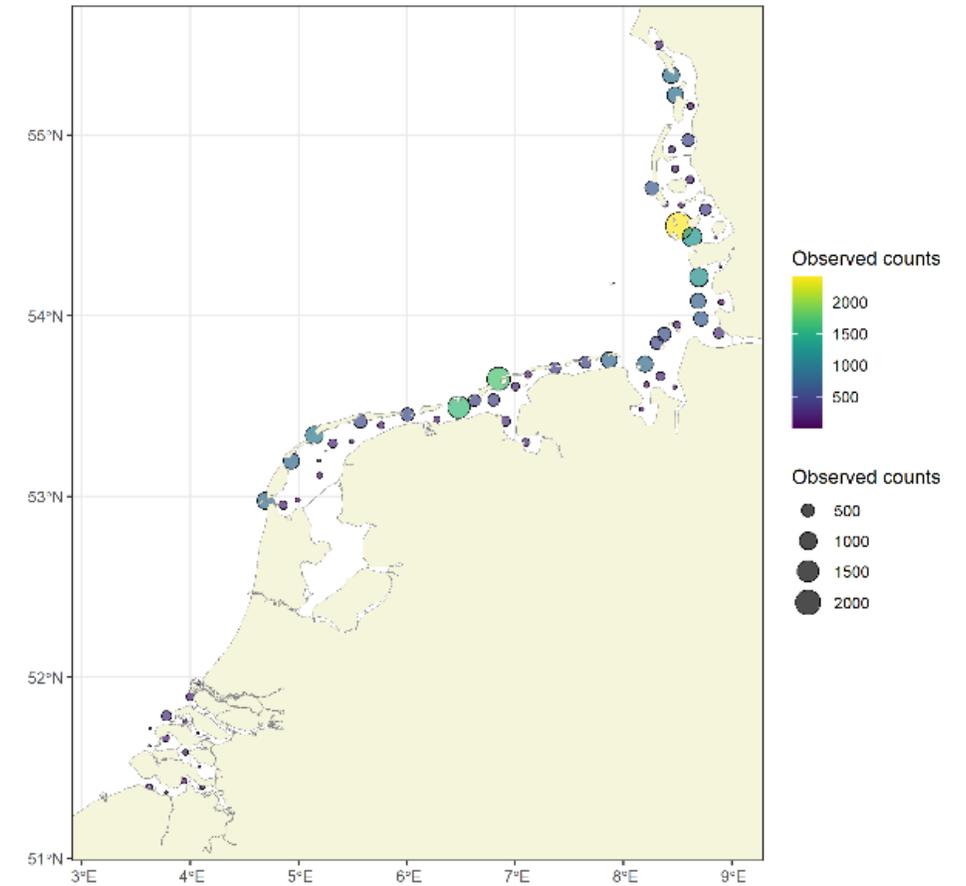
5 stickleseals

1 stickleseal

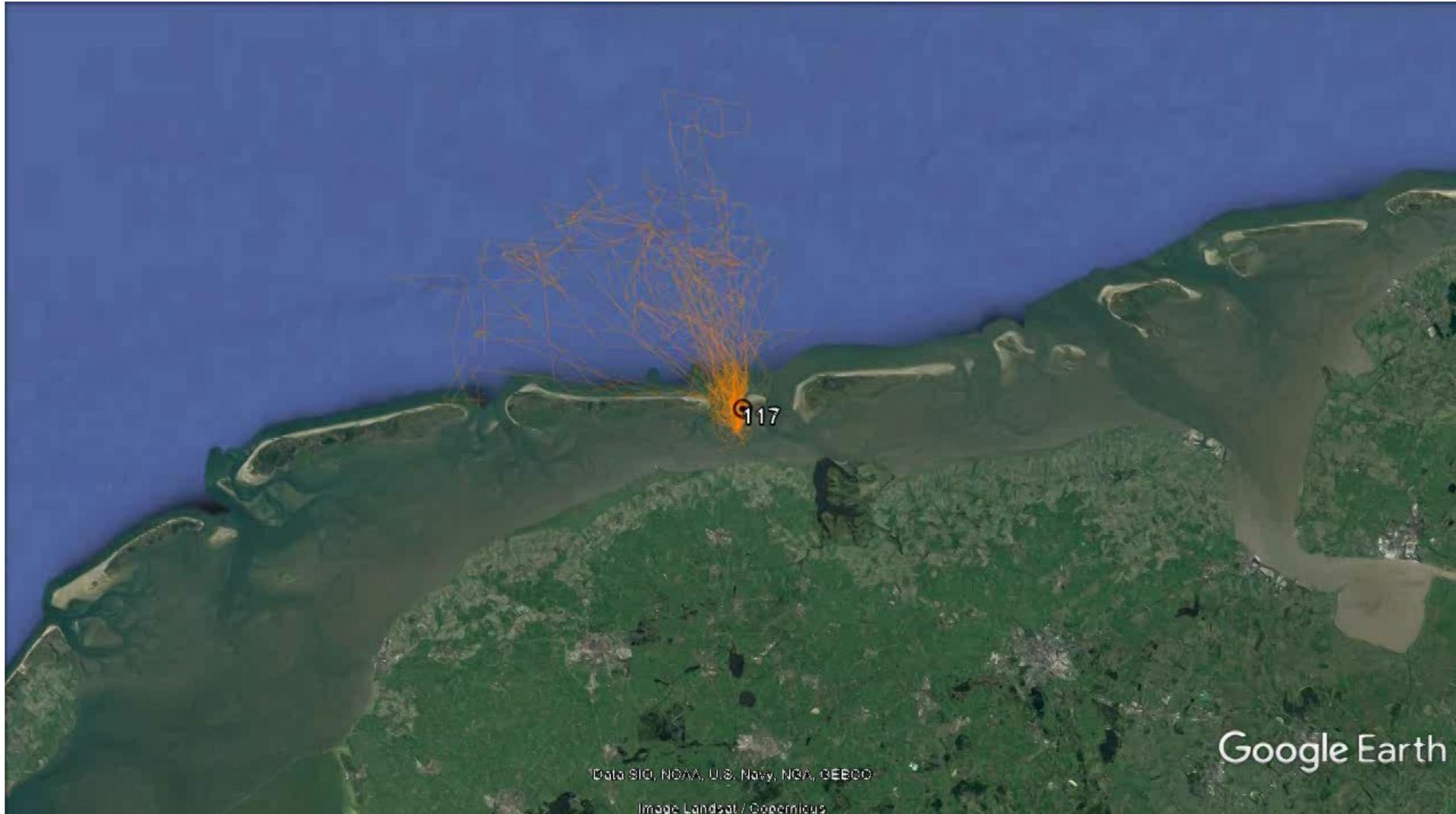
# Is the onshore distribution of harbour seals regulated by offshore habitat quality?



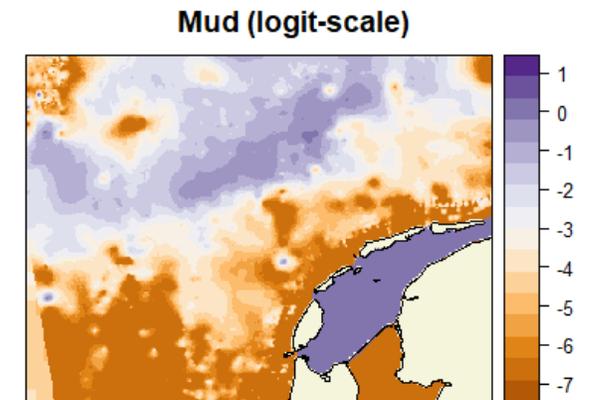
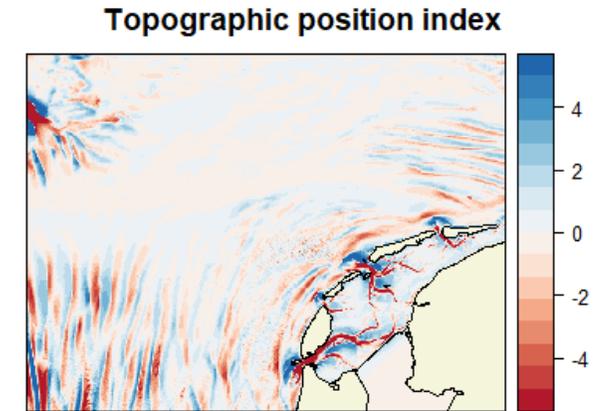
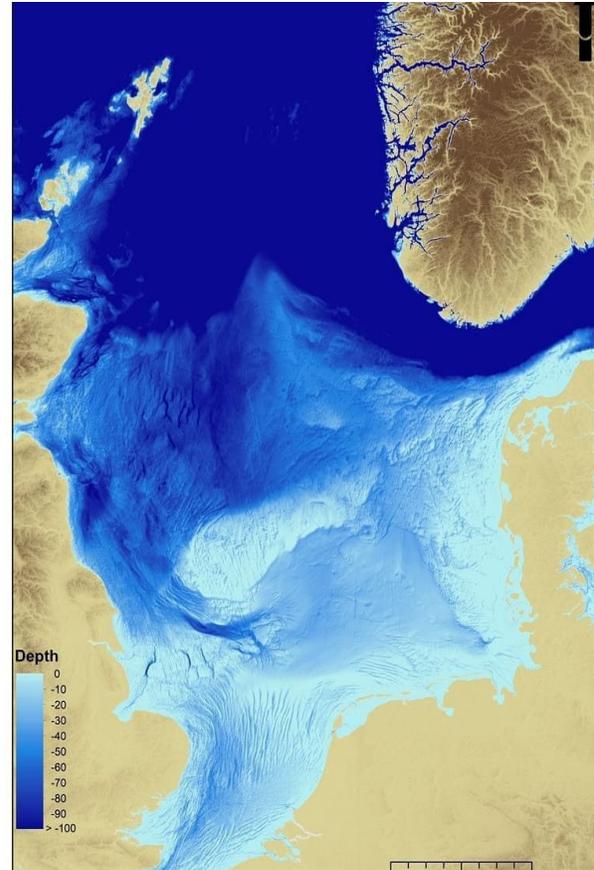
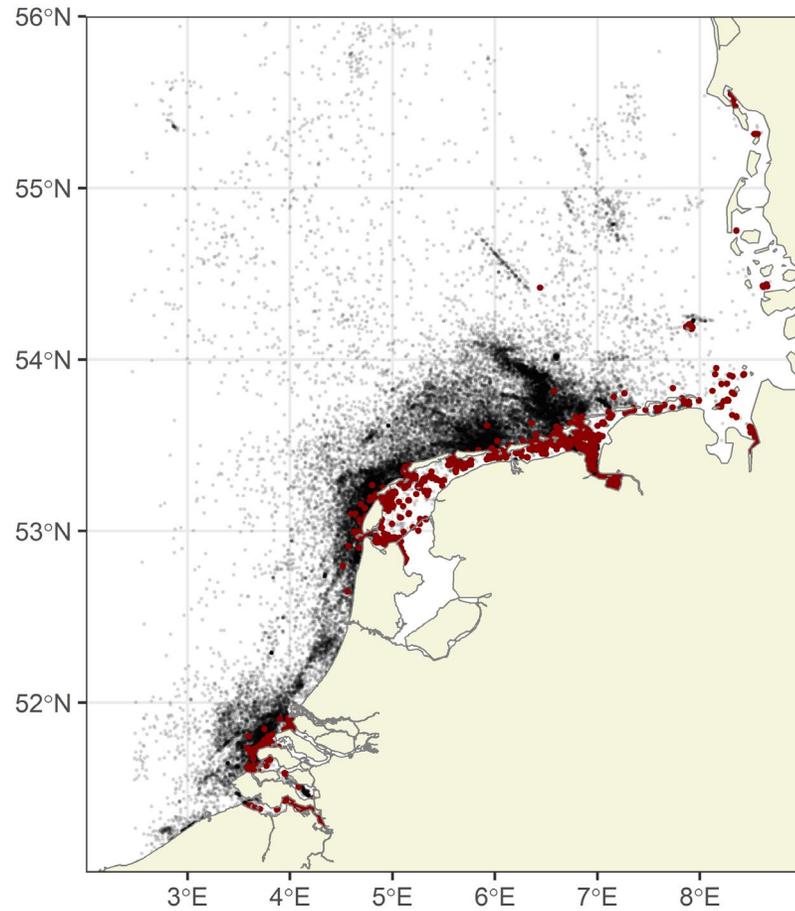
# Onshore distribution and population size



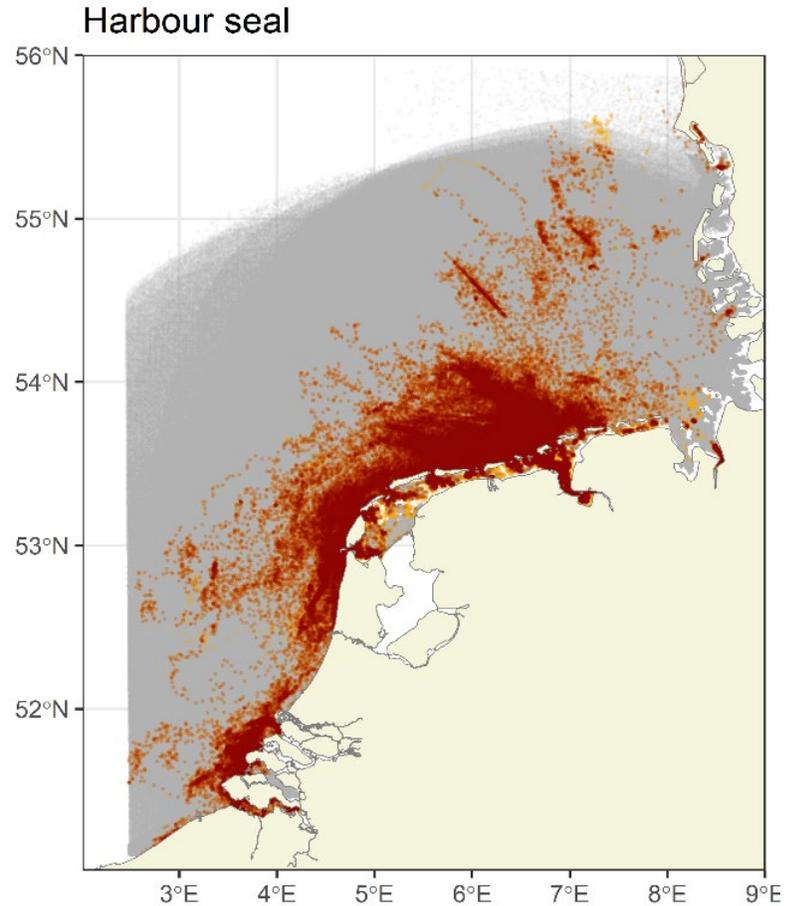
# Offshore foraging distribution



# Habitat analysis: Key features



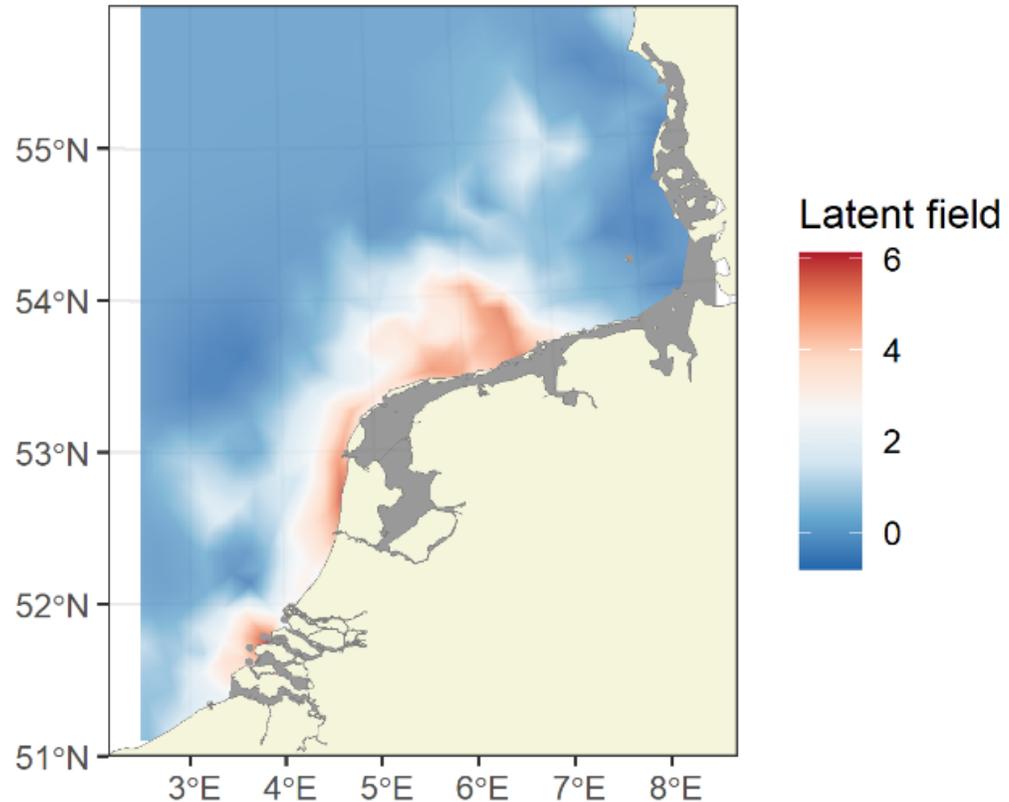
# Habitat analysis: Key features



- Use-availability design by haul-out using IPP likelihood

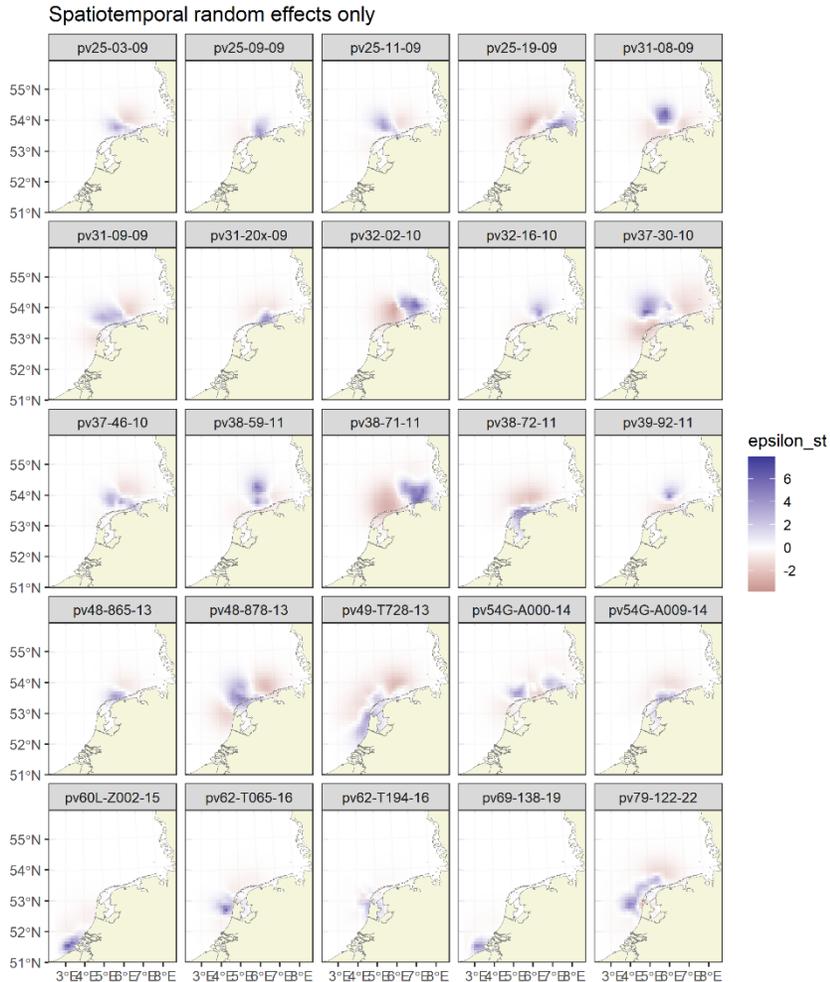
# Habitat analysis: Key features

Spatial Latent Field



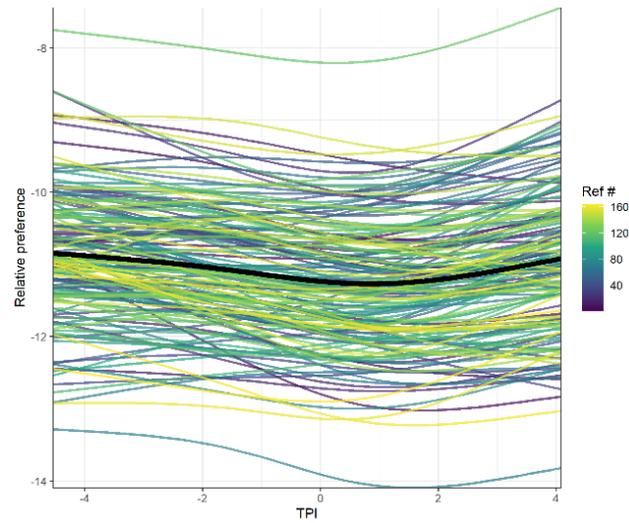
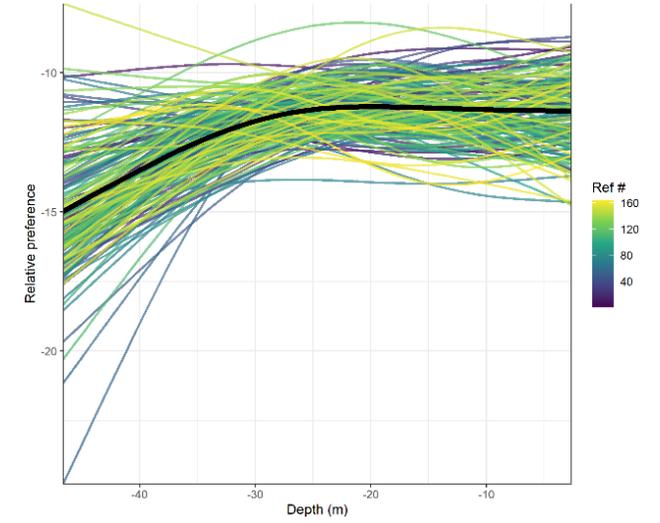
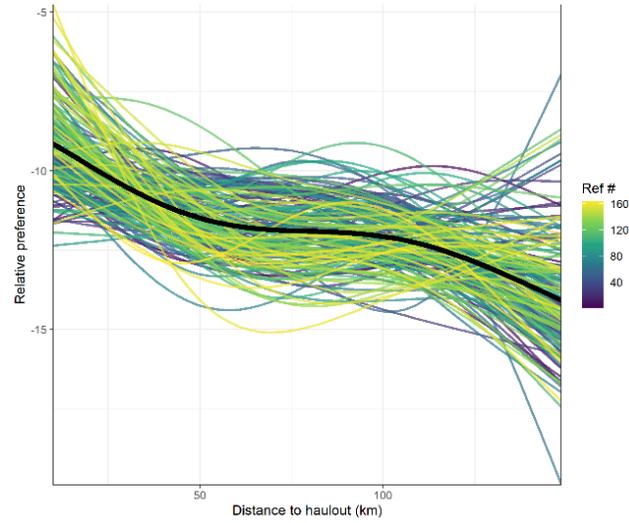
- Use-availability design by haul-out using IPP likelihood
- Individual-specific random slope coefficients (GAMM)
- Spatial latent field (missing covariates and spatial-autocorrelation)
  - Global
  - Individual-specific

# Habitat analysis: Key features

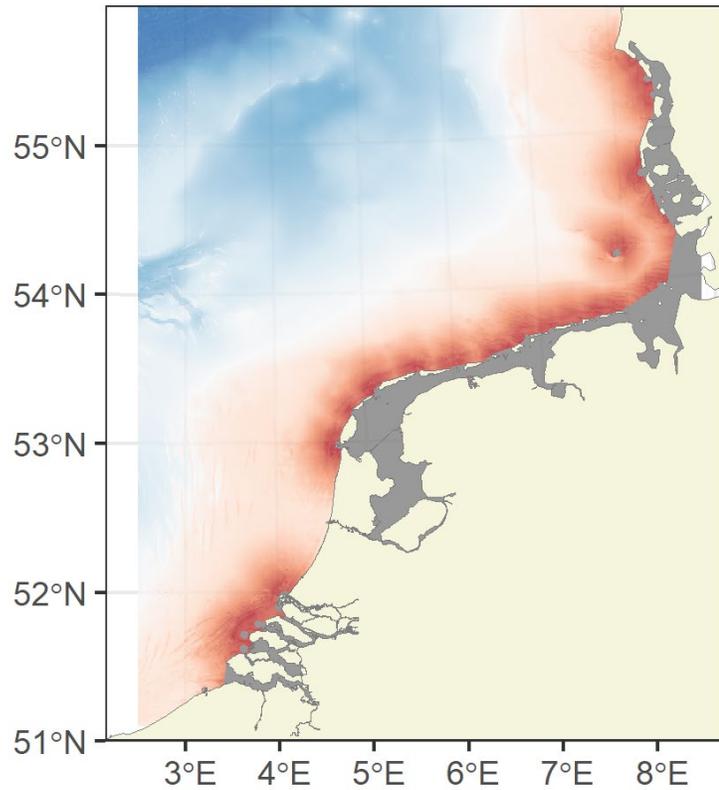


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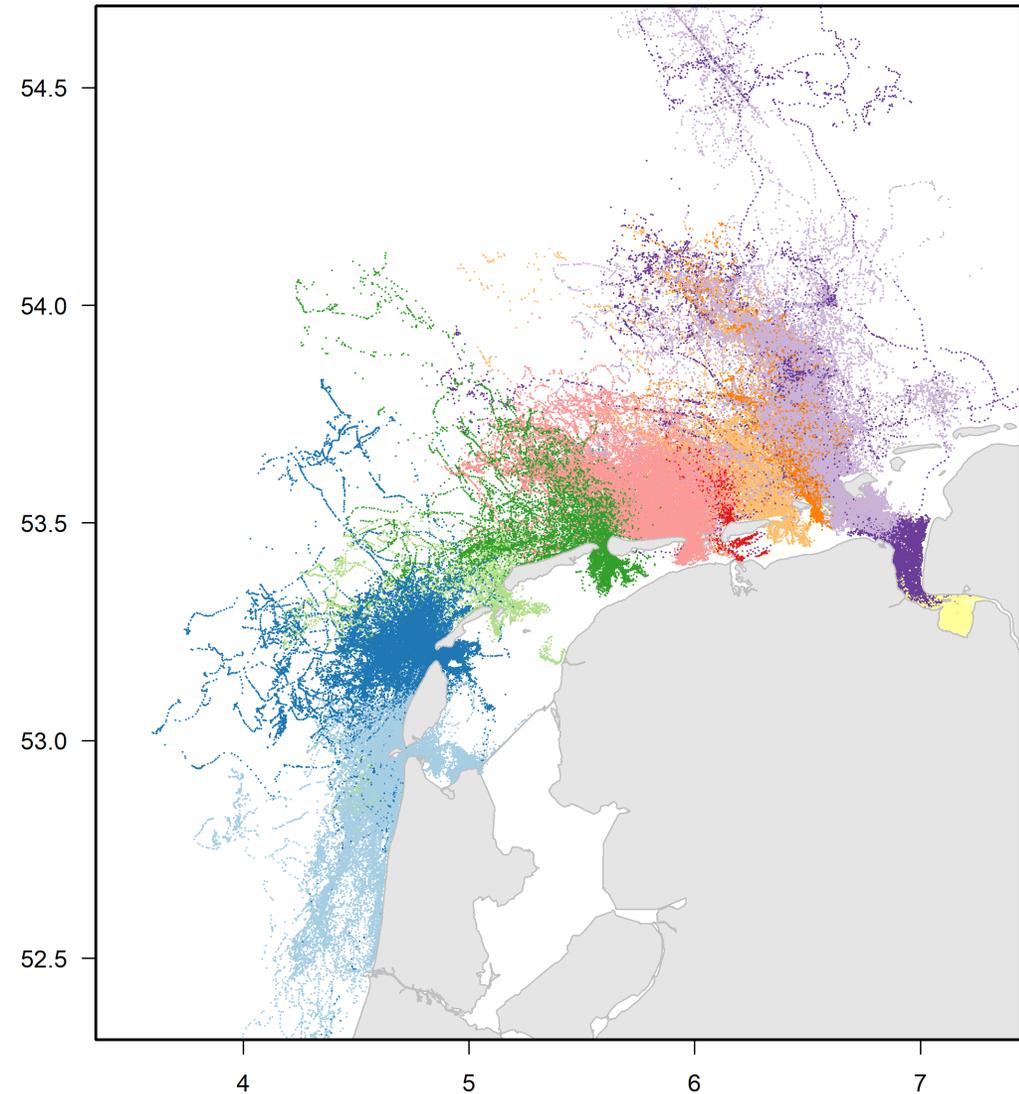
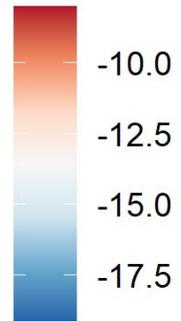
# Results: effects covariates



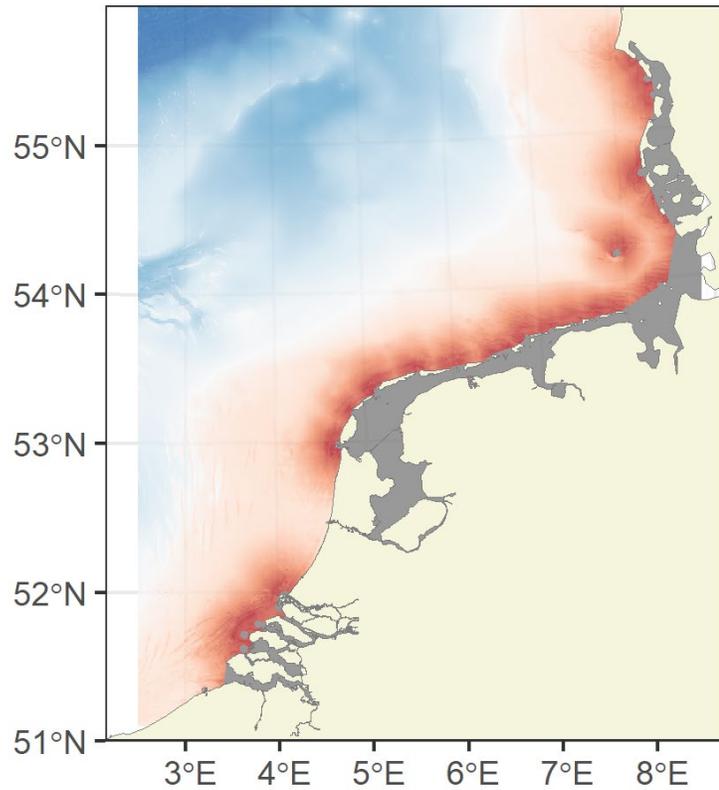
# Translocating seals from sea to land



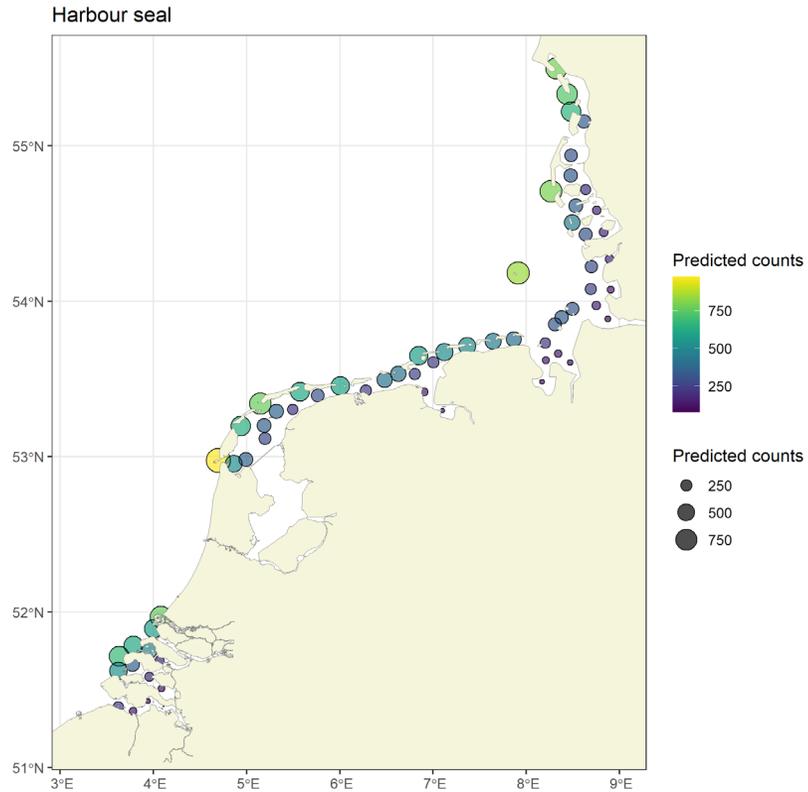
Log density



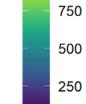
# Translocating seals from sea to land



Log density



Predicted counts



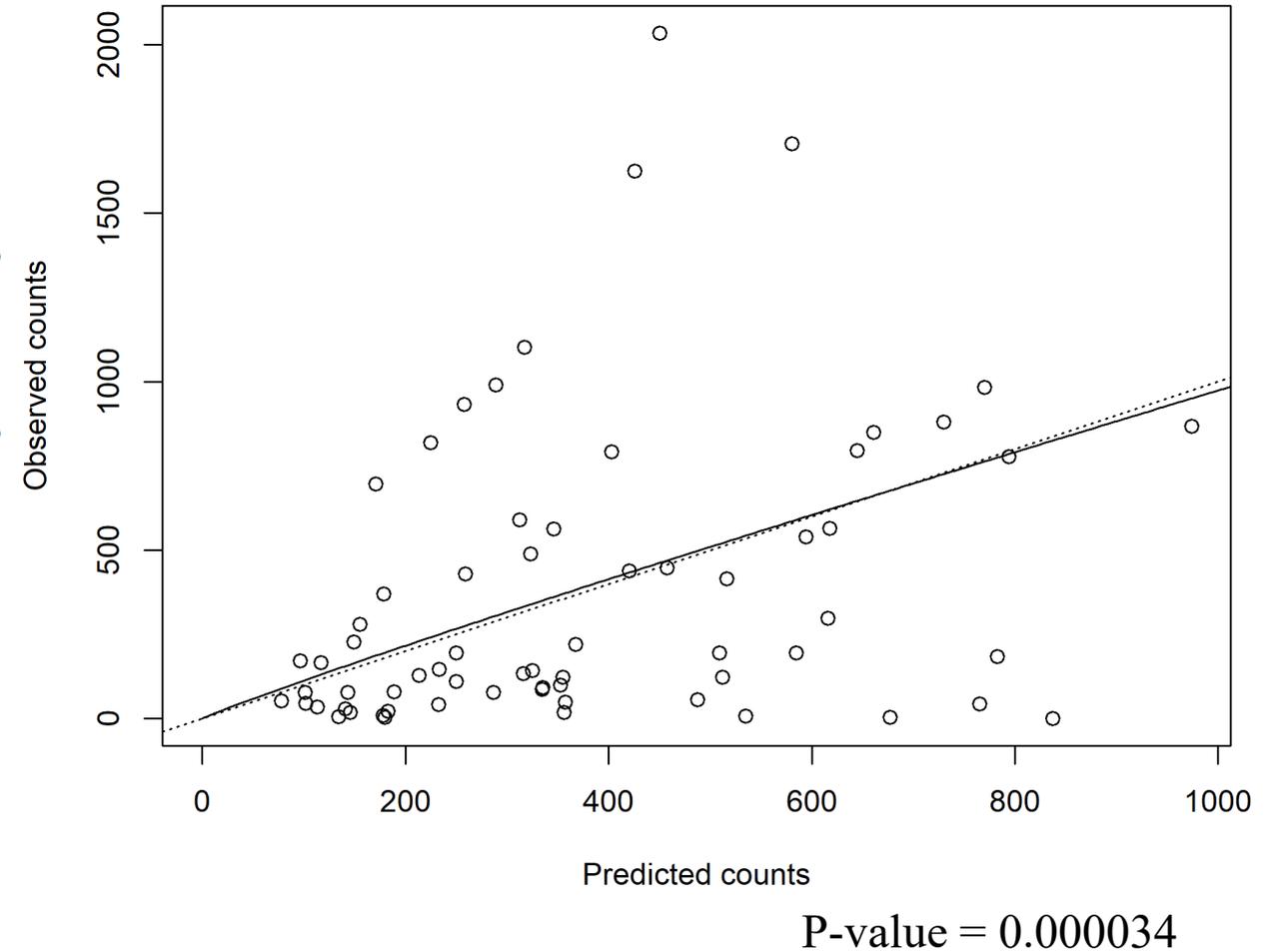
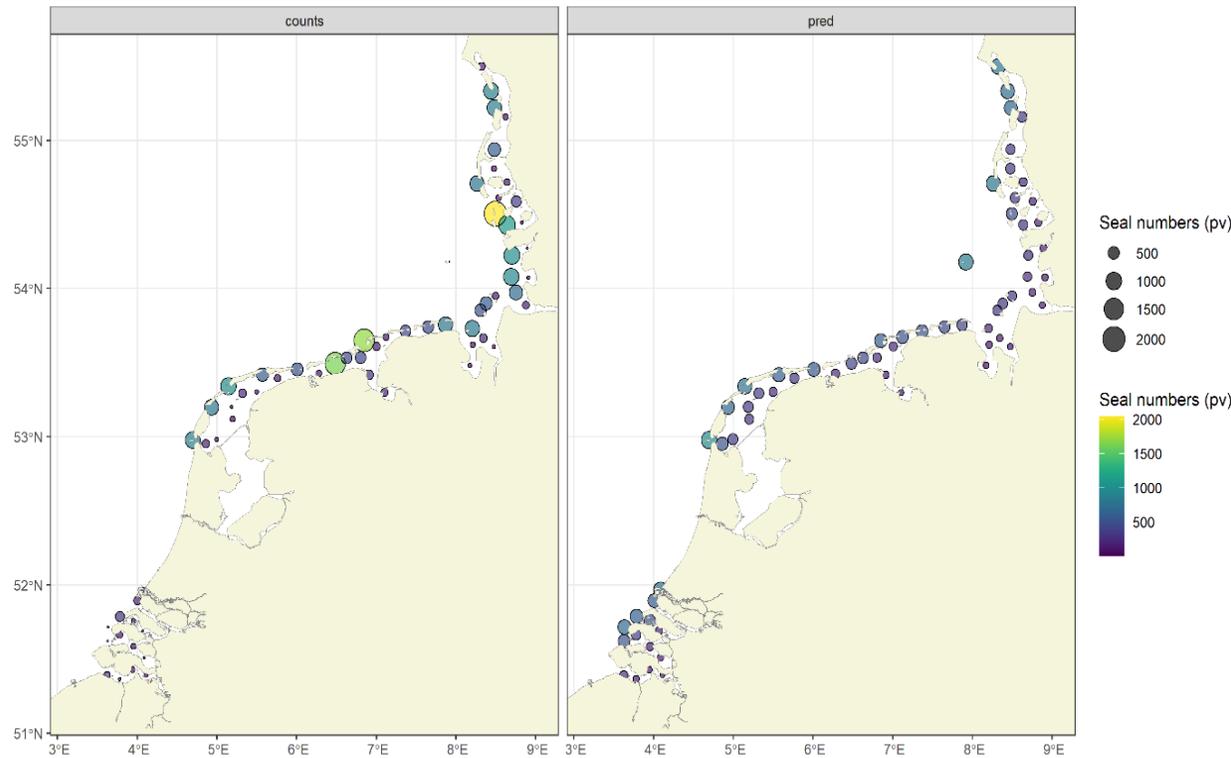
Predicted counts



# Relationship offshore and onshore distribution

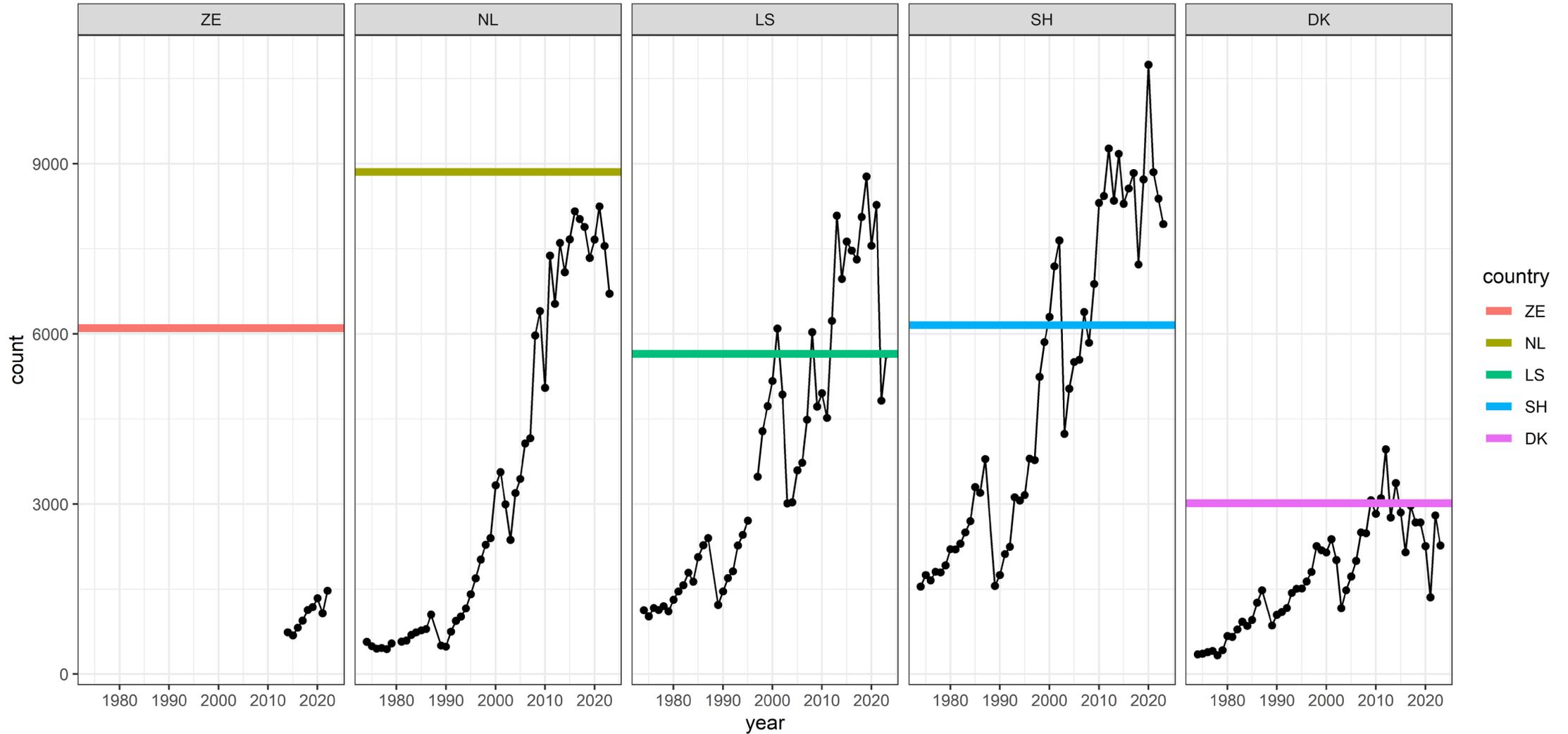
Observed

Predicted



# Cumulative by region

Estimated carrying capacity by region - Harbour seal



# Residuals: Predicted and observed haul-out size

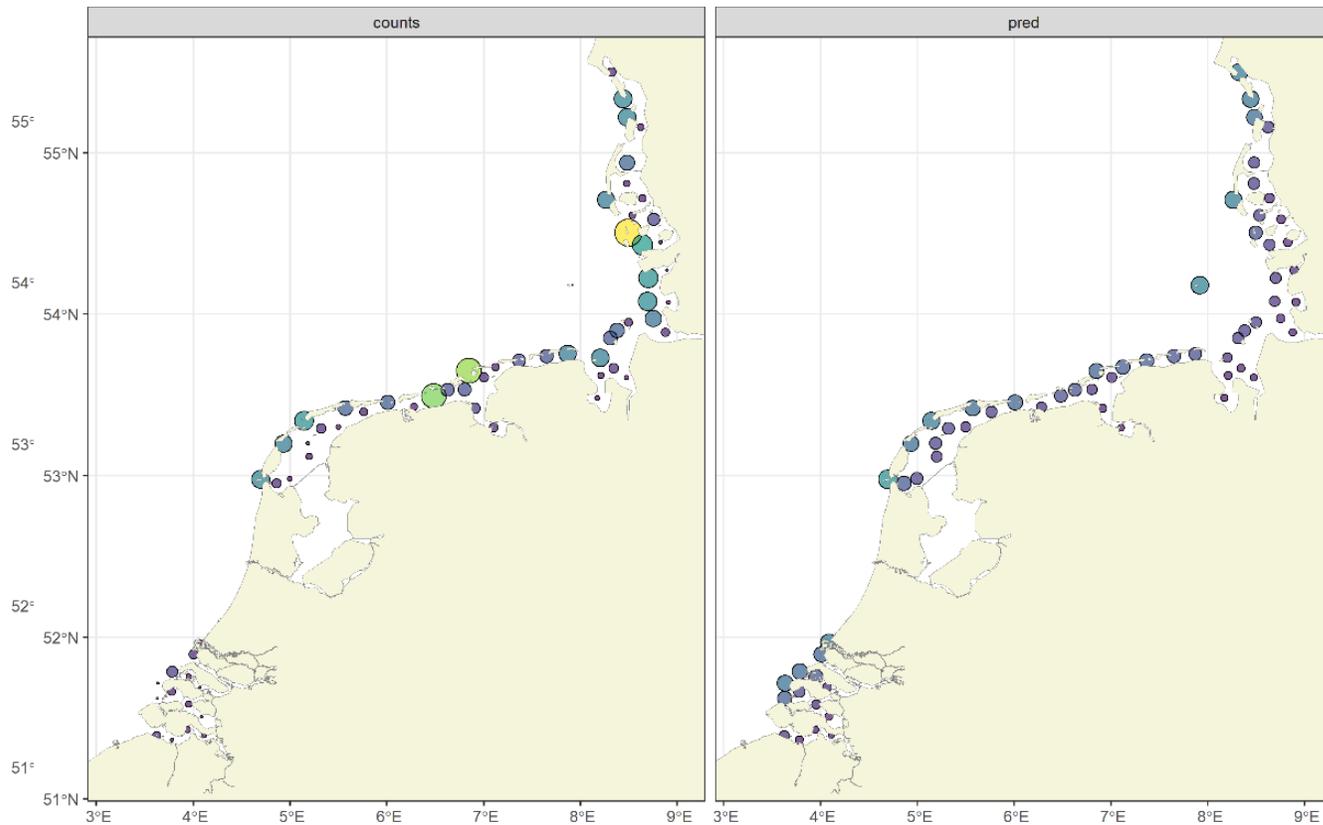
Observed counts

-

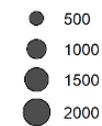
Predicted counts

=

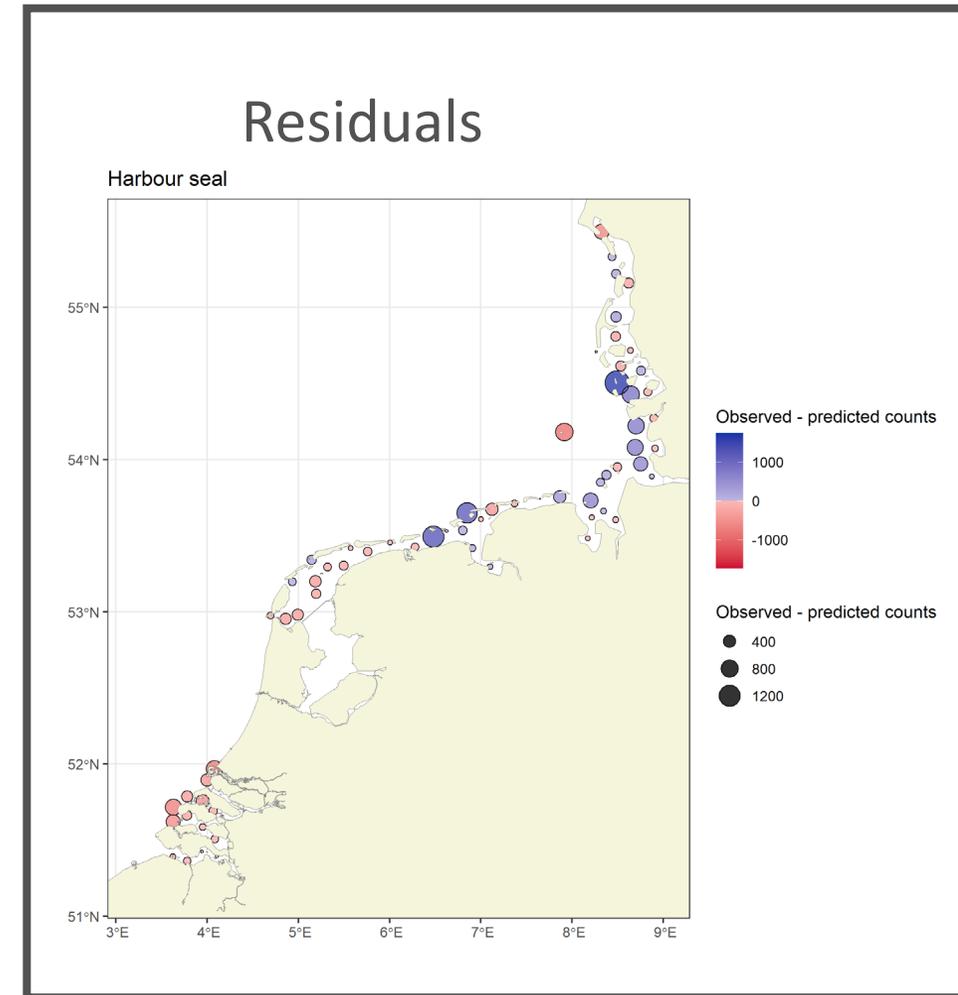
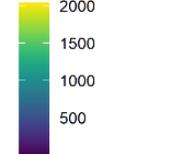
Residuals



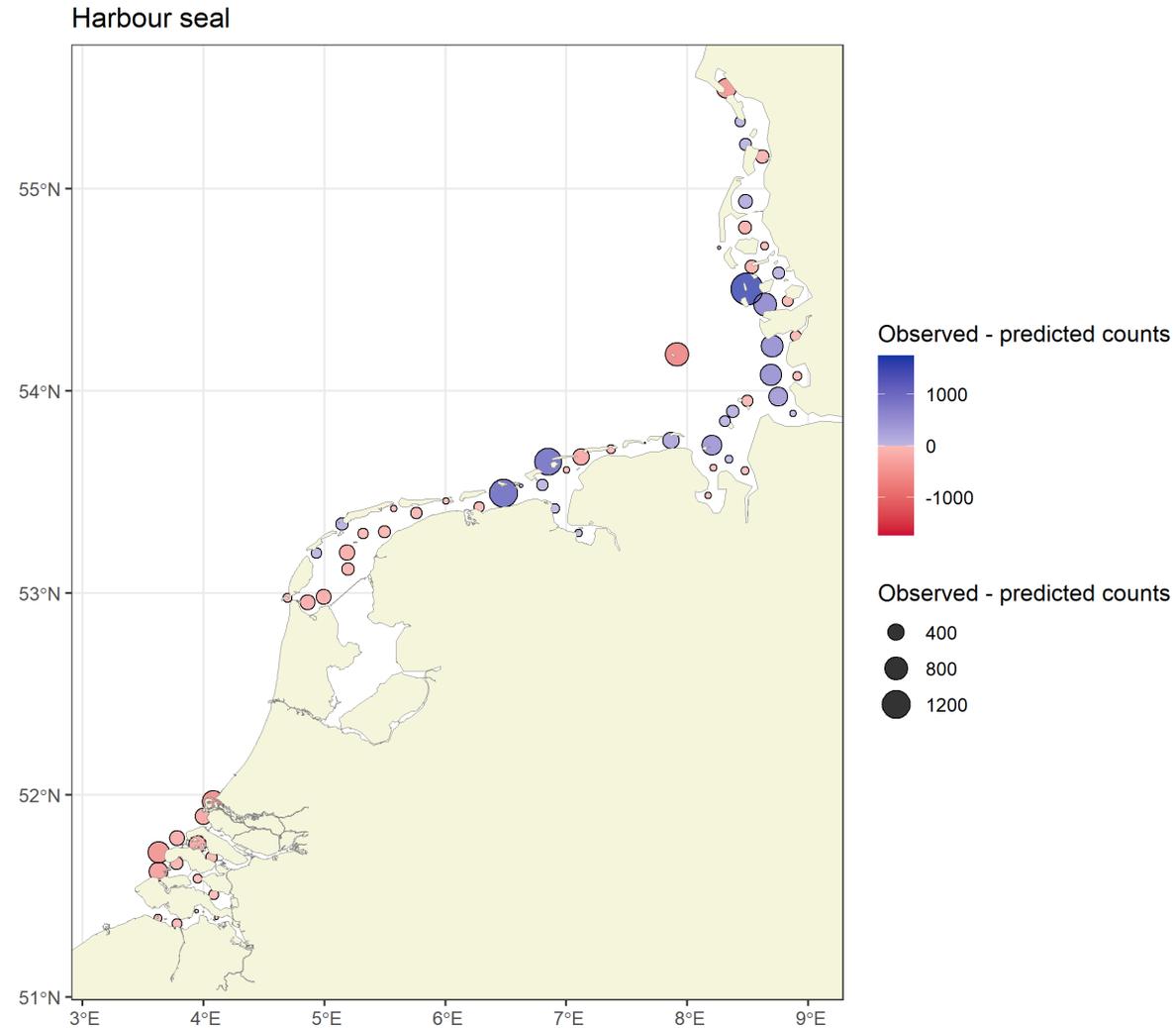
Seal numbers (pv)



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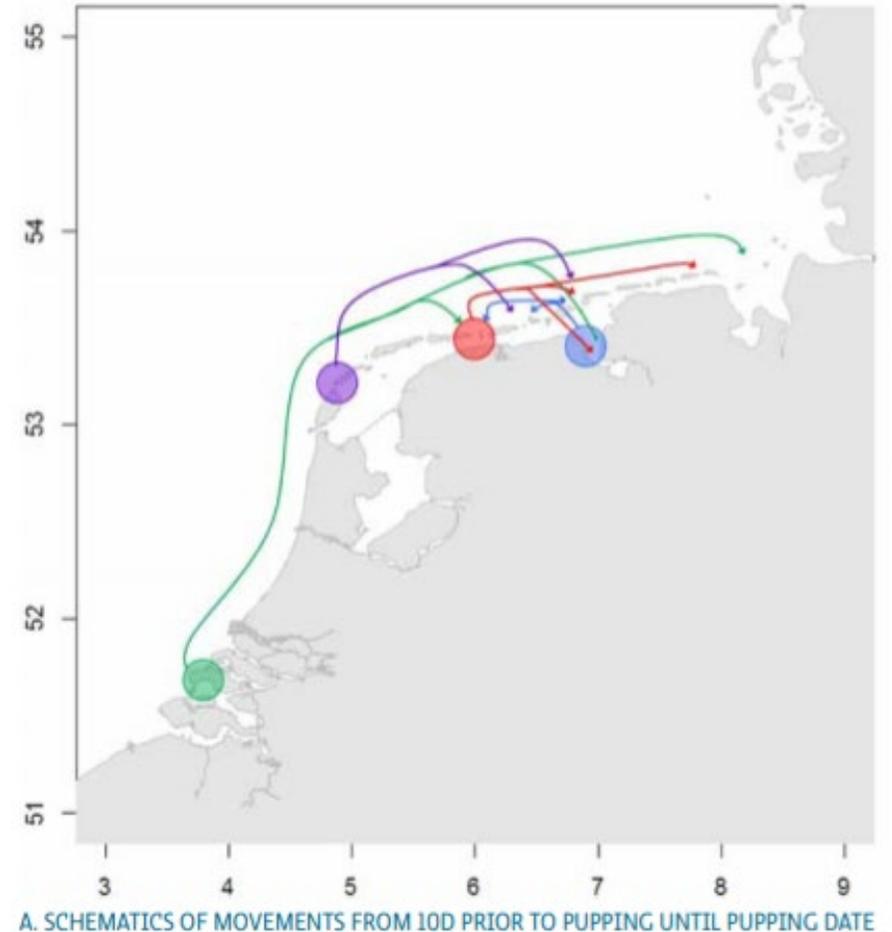
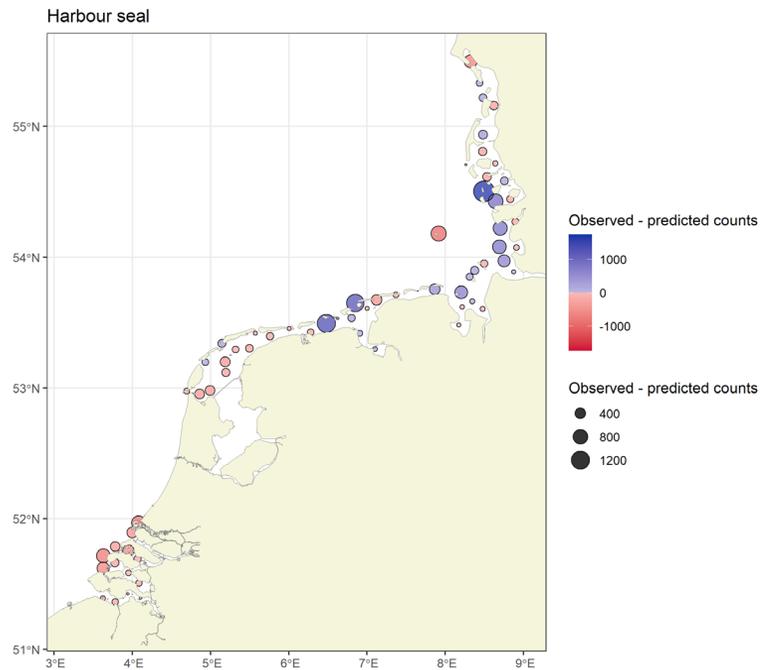


# Residuals: Predicted and observed haul-out size



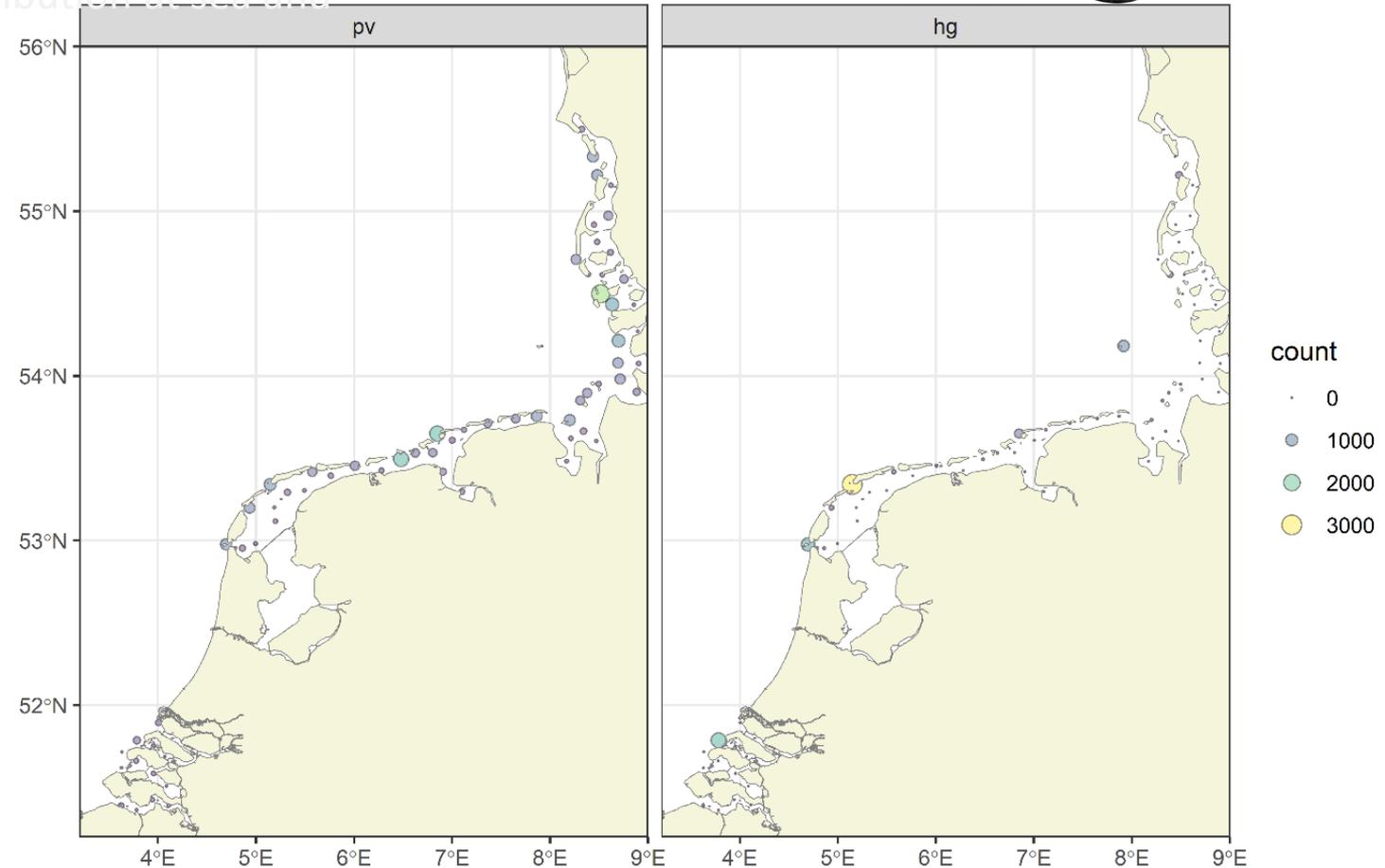
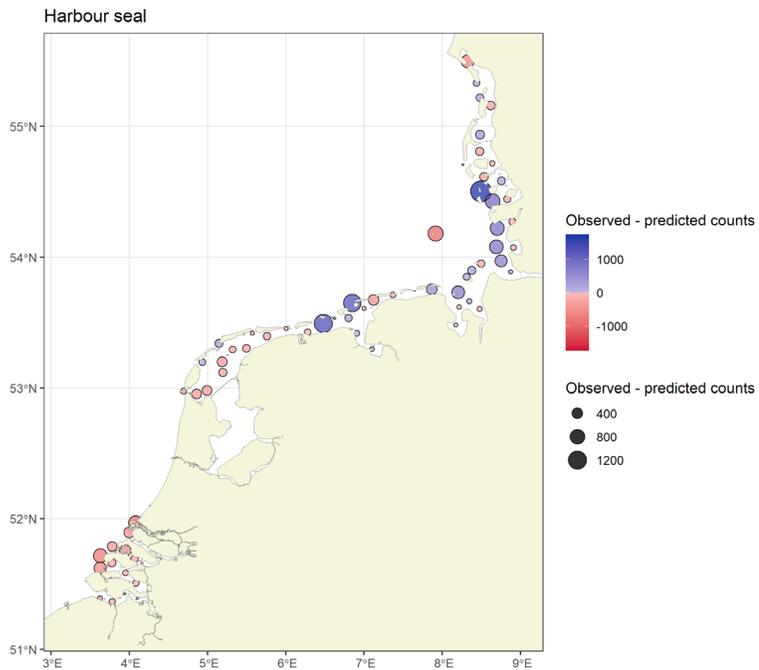
# Residuals: Predicted and observed haul-out size

1. Moulting counts in August not representative for 'feeding season'?
2. Competition with grey seals?
3. Other environmental factors influencing distribution at sea and on land (e.g., disturbance)?



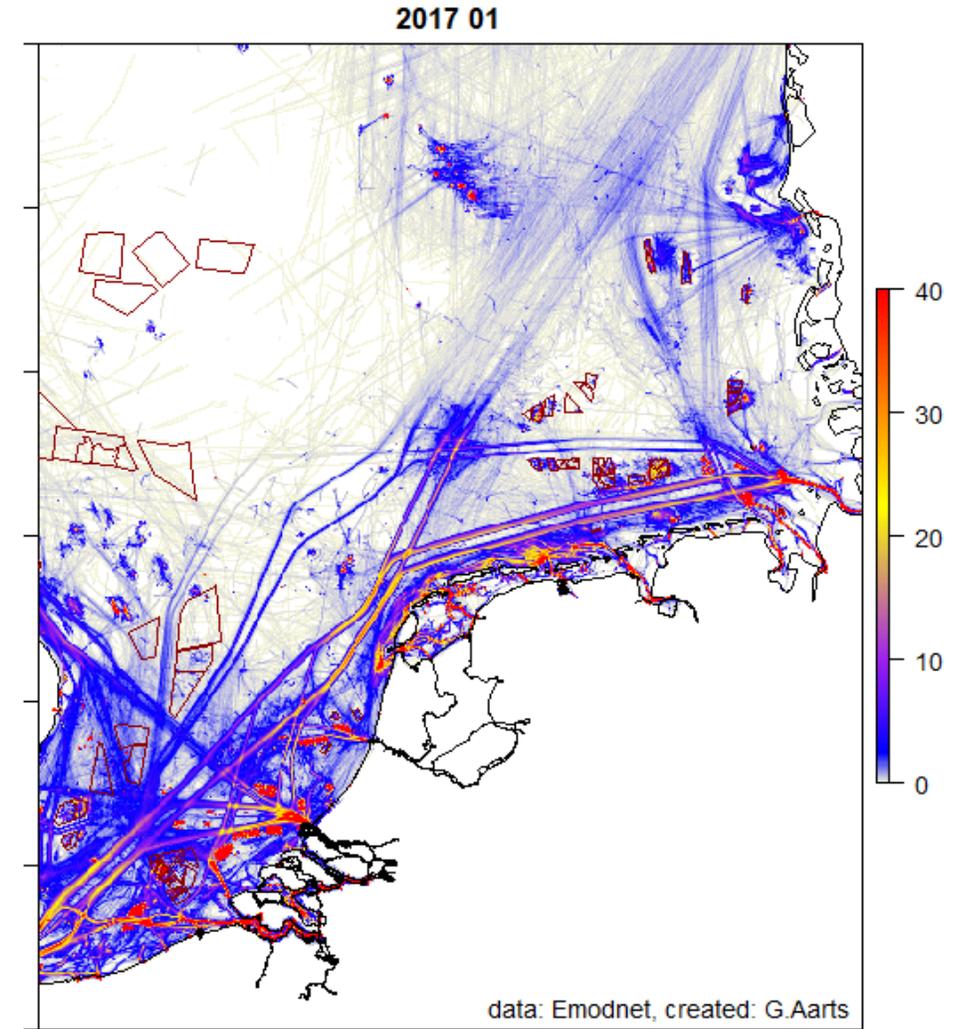
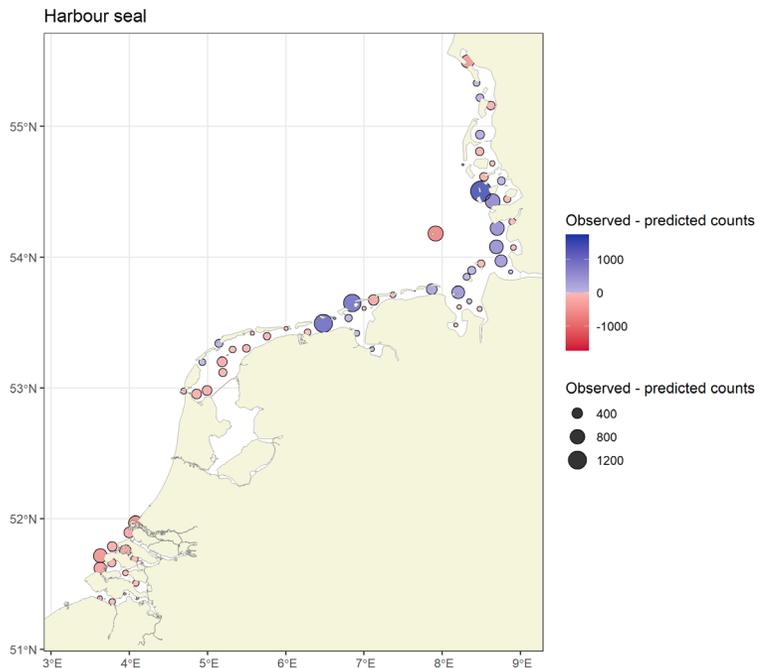
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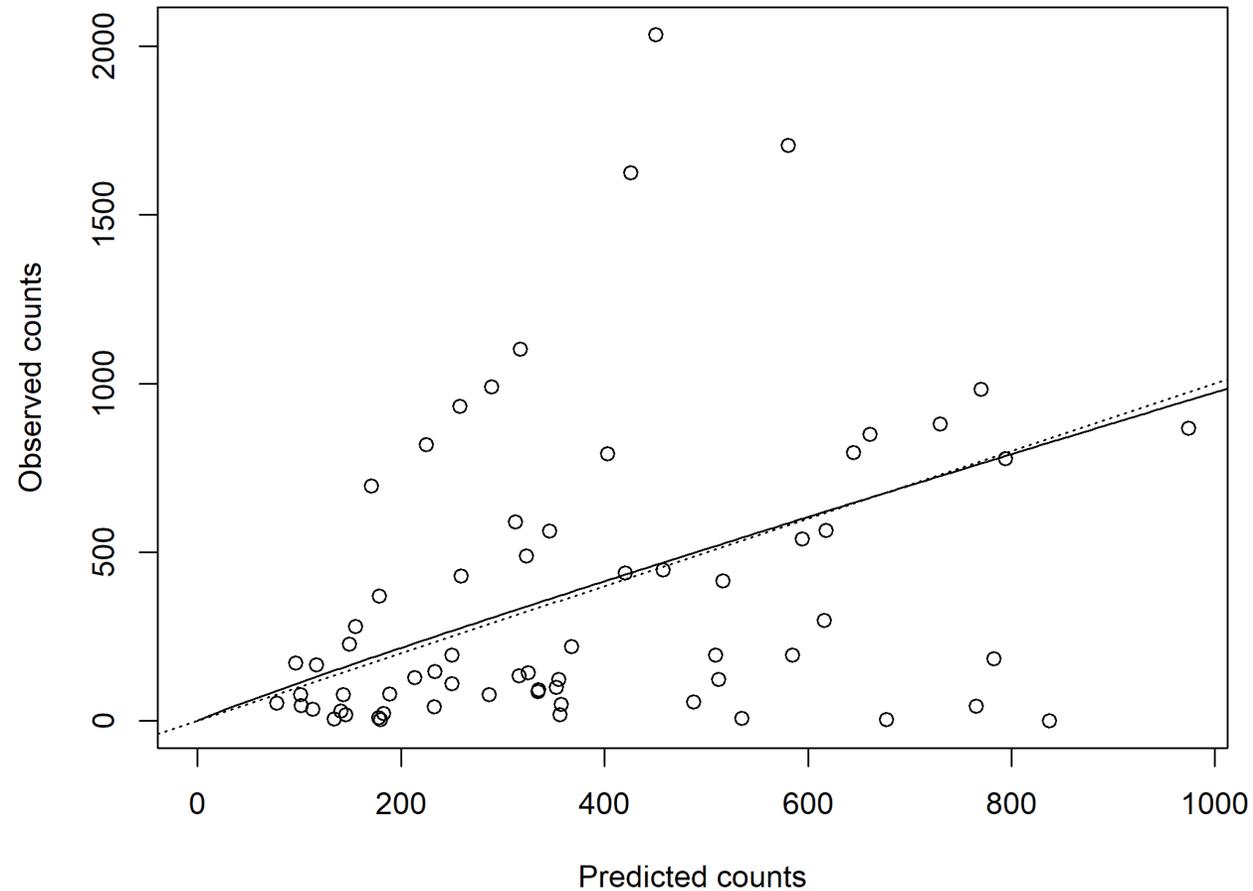
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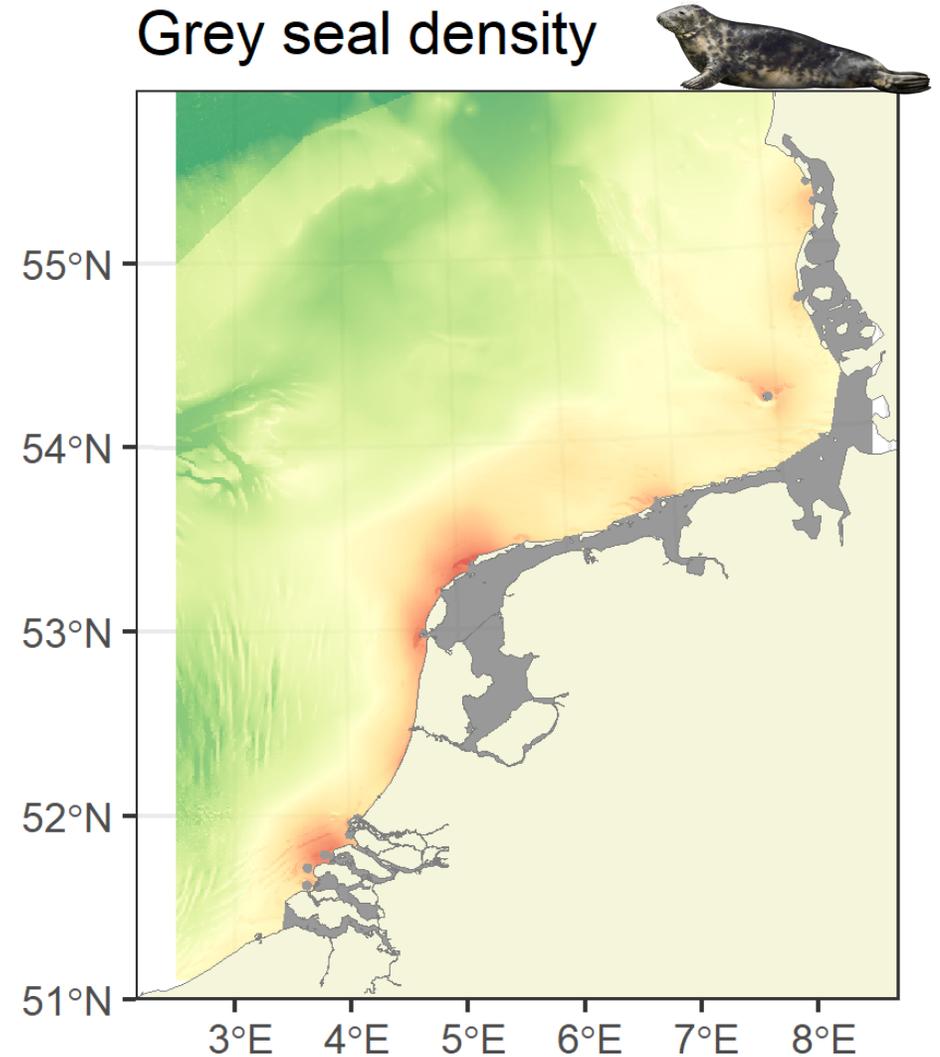
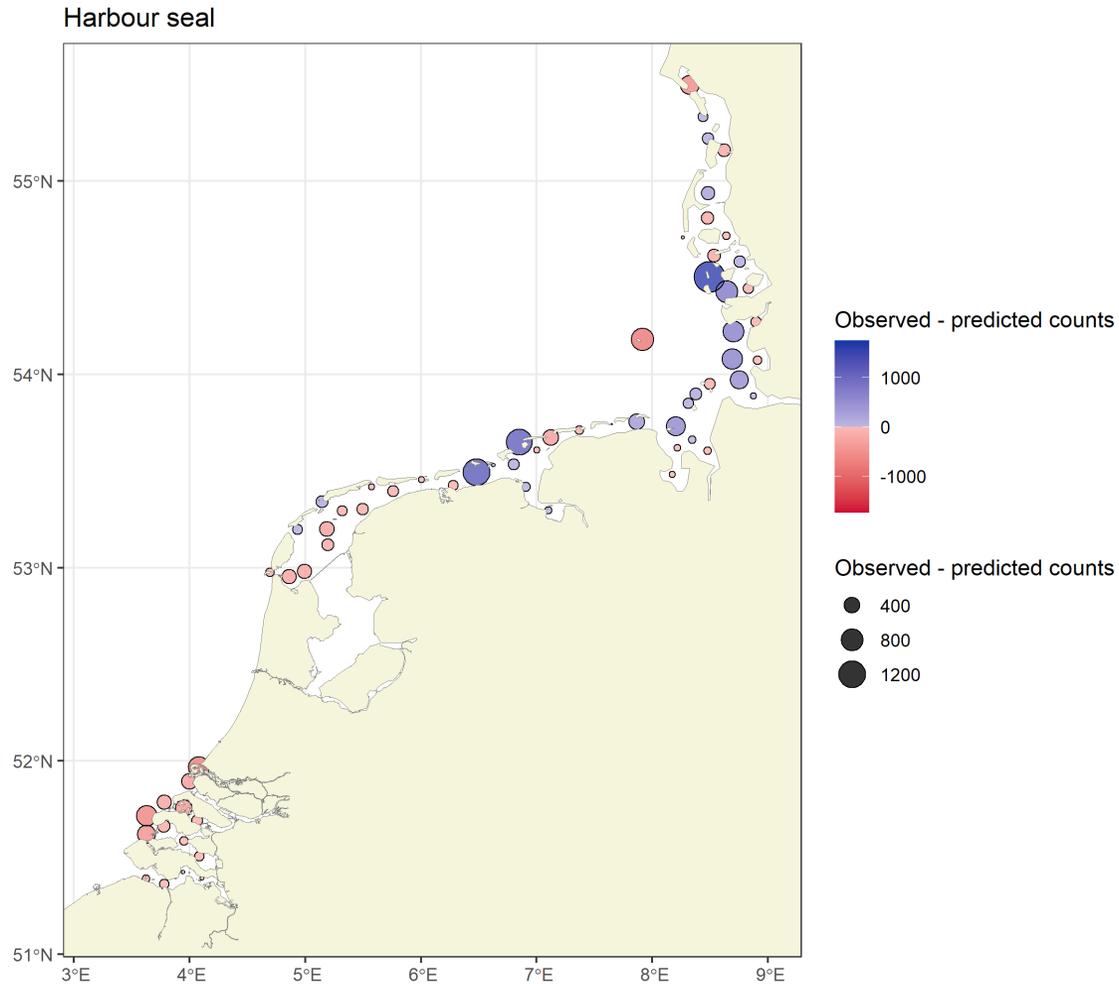
# Is onshore distribution of harbour seals regulated by offshore habitat quality?

Yes, but large unexplained deviations



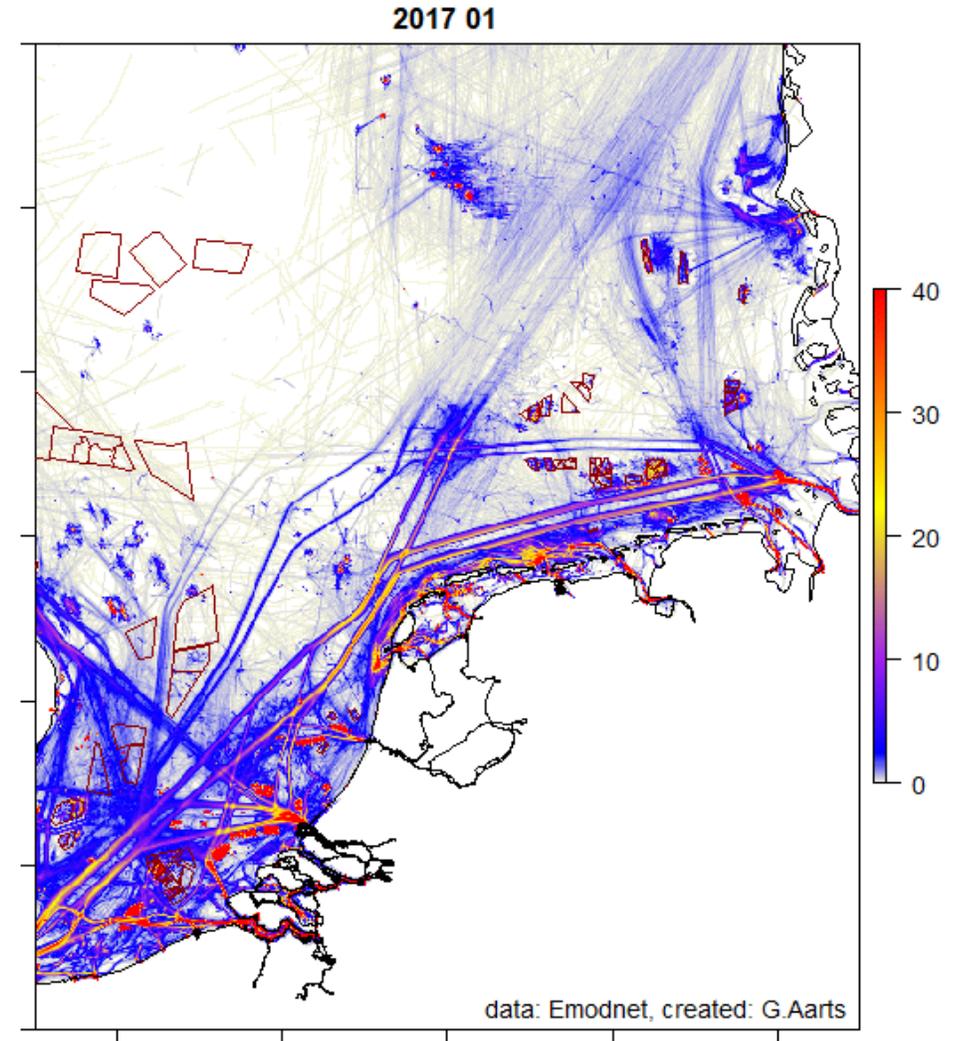
# Future research plan

## 1. Include possible grey seal 'competition'



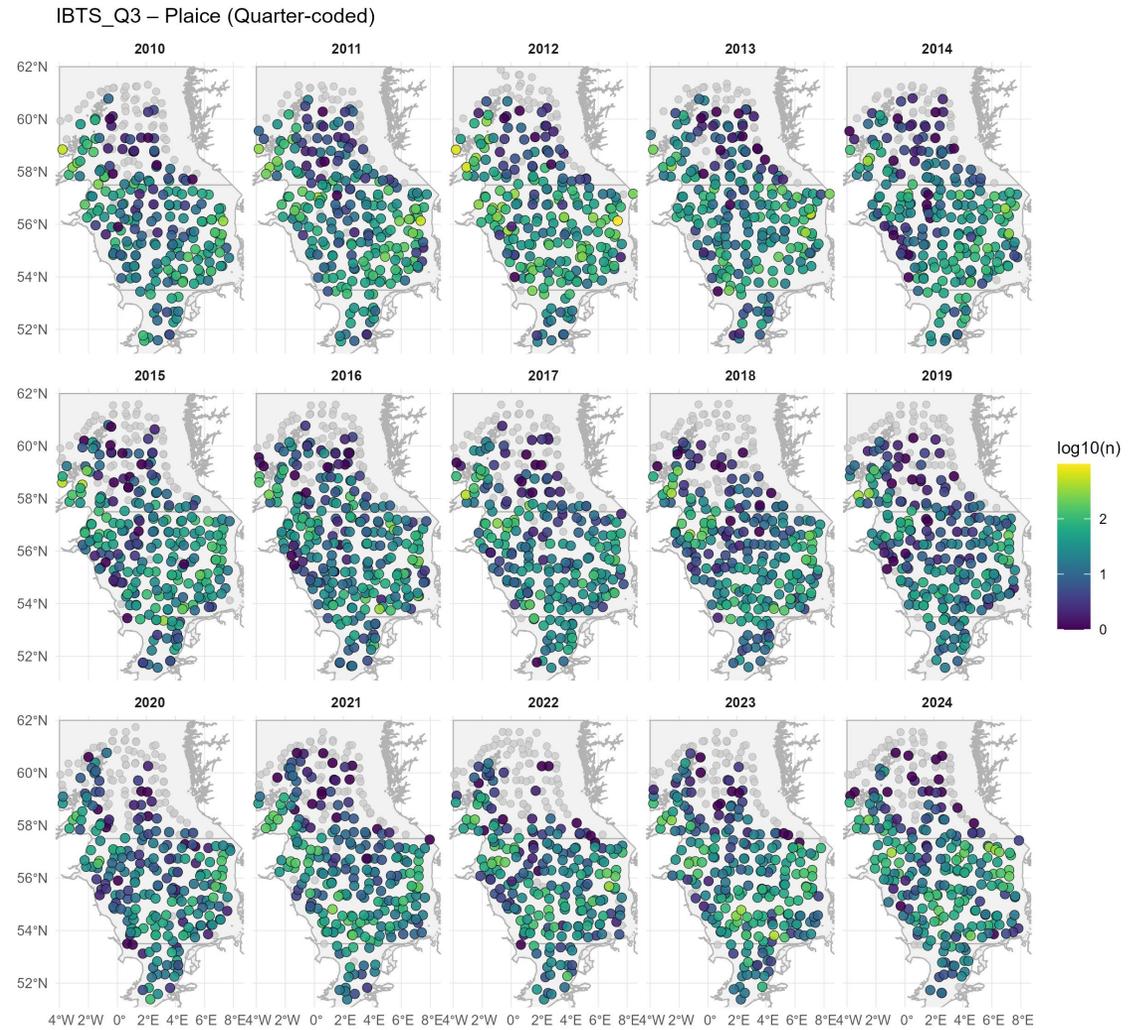
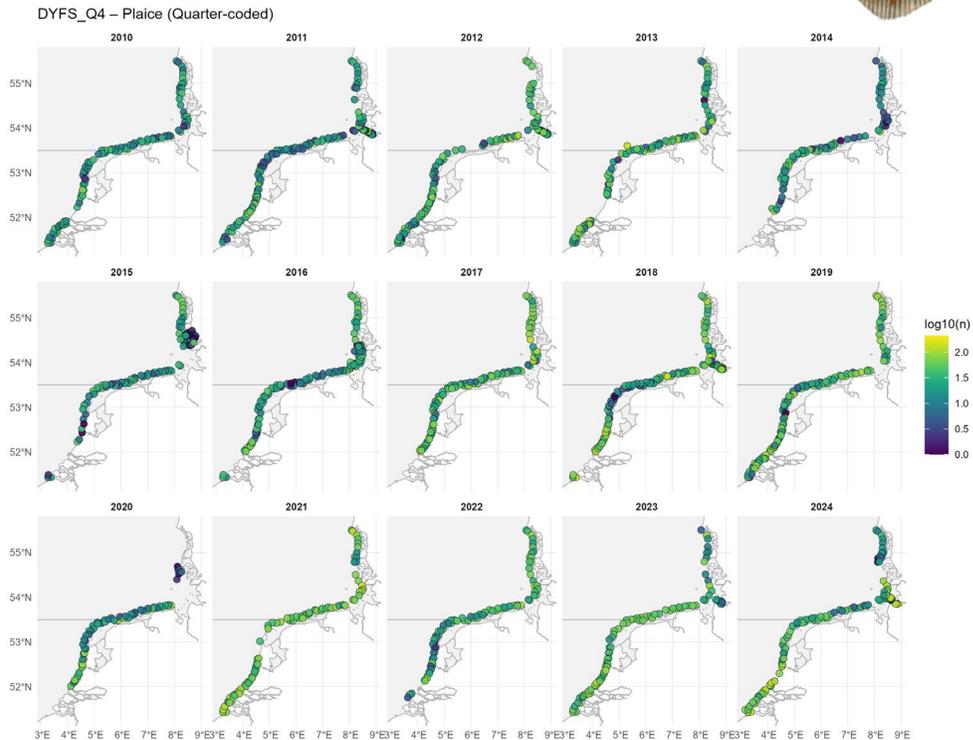
# Future research

1. Include 'competition' by grey seals
2. Include anthropogenic effects



# Future research

1. Include 'competition' by grey seals
2. Include anthropogenic effects
3. Include prey-availability



# Conservation applications

The graphic features a large green leaf with a detailed vein pattern as a central background. Above the leaf is the European Commission logo, which includes the European Union flag (a blue circle of twelve gold stars) and the text "European Commission" in a white box. To the left of the leaf, there is a photograph of a natural landscape with tall grasses and a small body of water under a blue sky. The entire graphic is framed by abstract, wavy shapes in shades of blue, beige, and red.

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**Nature Restoration Law**  
For people, climate, and planet

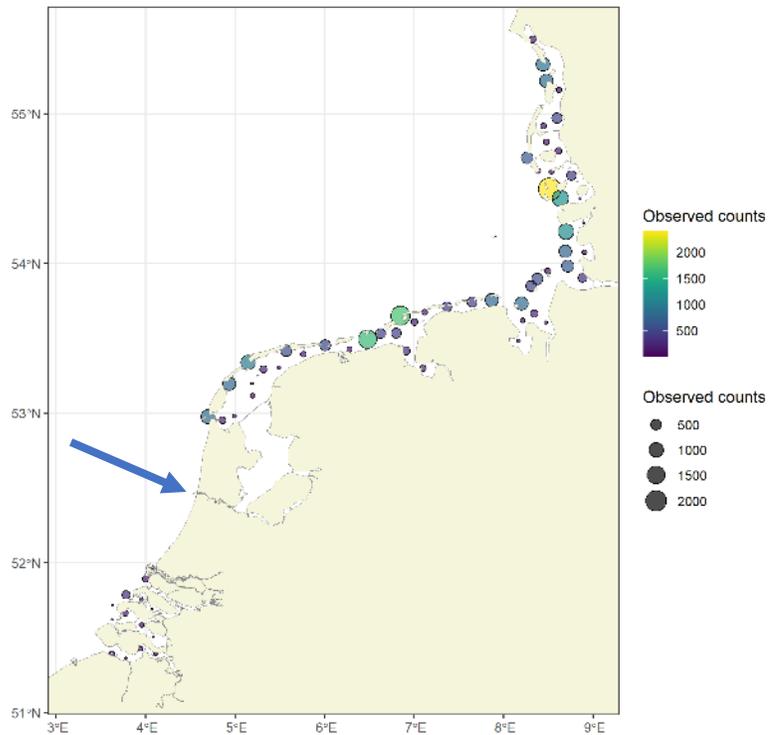
22 June 2022  
#EUGreenDeal



# Management applications

# Management applications

## Habitat restoration

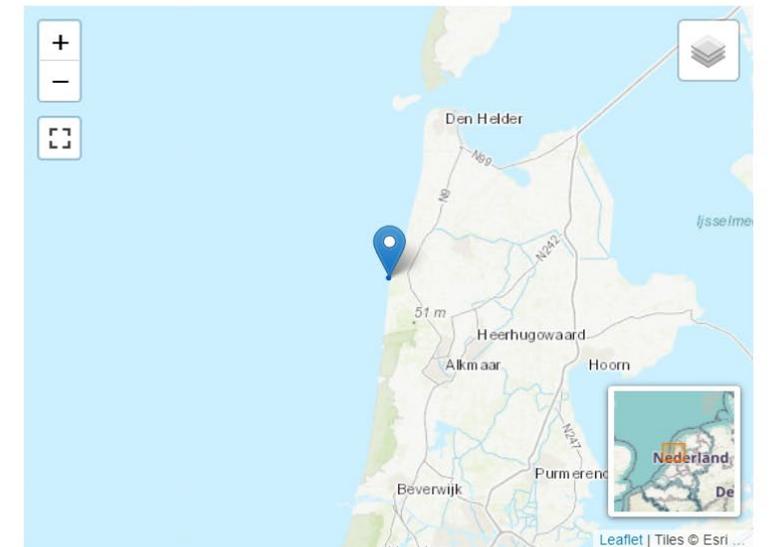


### 68 ter plaatse

📅 2014-10-17 16:40  
👤 Bram Laan  
📍 Hondsbossche Zeewering - Noordzee (NH)  
✅ goedgekeurd (met bewijs)

GPS 52.7484, 4.6411  
RDS 104619 529270  
nauwkeurigheid 100m  
bron copied observation

Route



### Details

### Foto's

Datum 2014-10-17 16:40

# Habitat restoration



# Acknowledgements



We thank our national and international collaborators who kindly provided the aerial survey count data: Anders Galatius (DK), Armin Jeß (SH), Christian Abel (LS), Jens Brackmann (LS), Floor Arts (ZE) and Mark Hoekstein (ZE). The following crew assisted in seal tagging (alphabetic order): Bakker Arnold, Baptist Martin, Boersma Eelke, Booij Peggy, Bos Oscar, BravoRebolledo Elisa, Chris Veenstra, Cremer Jenny, Dankers, Norbert, de Jong Martin, de Vries Simon, de Wal Freek-Jan, Dijkstra Arjen, Dijkstra Eelke Seibren, Jol Johan, Kirkwood Roger, Klaas Kreuijer, Koelemij Erica, Laros Nico, Leeuwen van Piet Wim, Meerstra Bert, Meesters Erik, Meijboom Andre, Perdon Jack, Pool Chris, van der Wal Nanneke, Reijnders Peter, Sonneveld Cor, Tamara van Polanen Petel, van Dijk Jan, van Gool Ad, van Hoppe Maarten, van Leeuwen Piet-Wim, van Zweeden Carola, Verdaat Hans. The Dutch Ministry of Agriculture, Fisheries, Food Security and Nature (LVVN), Groningen Sea Port, Eneco, and Gemini windpark funded the seal GPS transmitters. LVVN funded the aerial surveys in the Wadden Sea and we thank the pilots, in particular Aad Droge. We thank Rens Cronau, Jakob Asjes and Tim Schellekens for their constructive comments. **Finally, we would like to thank RWS (MONS program) and the European Union for funding this research.**

Thanks for listening

