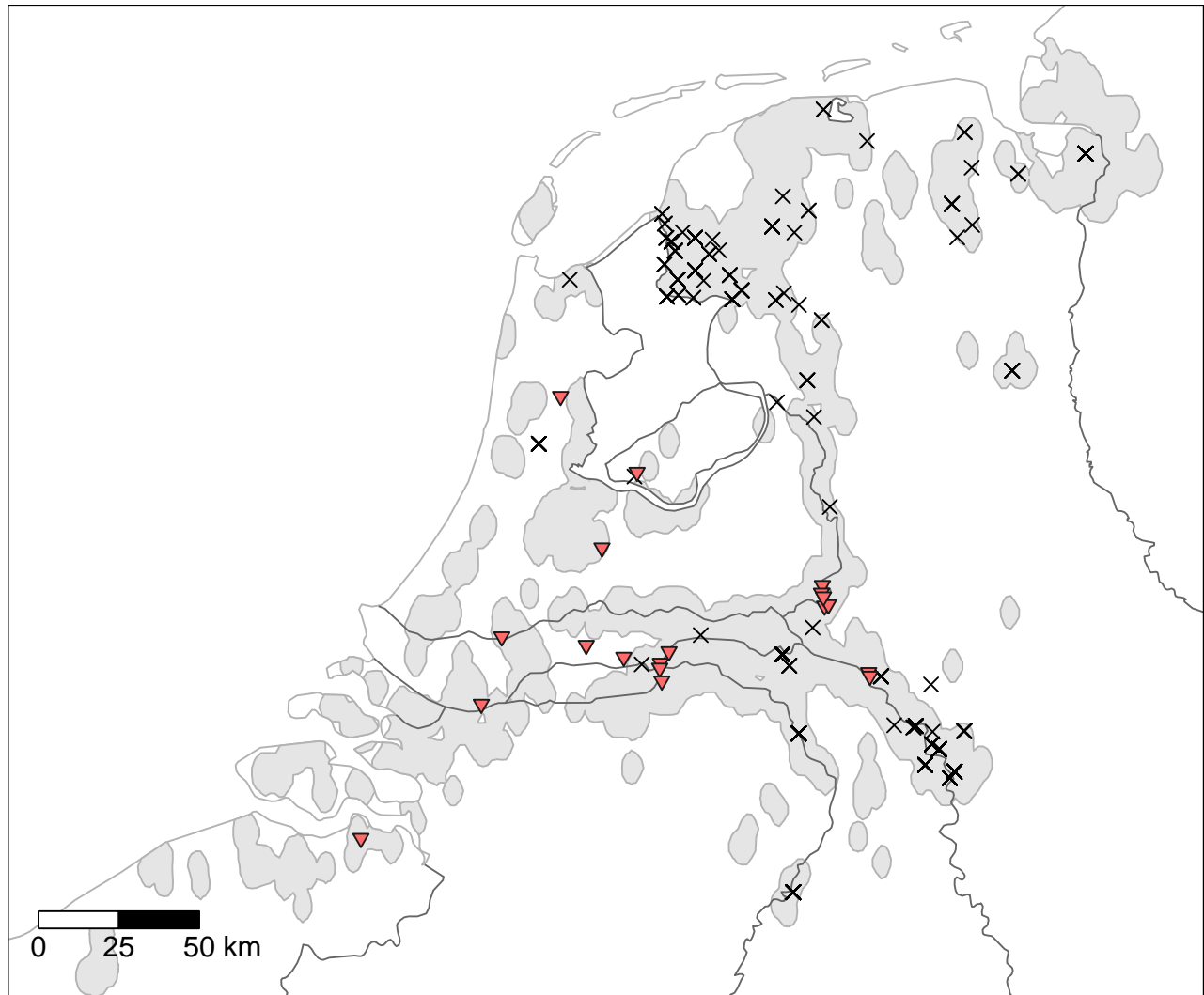


Study area and datasets



Data collection sites in the study area. Three datasets used in the study are represented on a map of the main wintering grounds of the North Sea population of Whitefronts. Lines represent coasts (light) and major rivers (dark).

Crosses mark sites ($n = 64$) where the sizes of flocks of Whitefronts, and the numbers of families with at least one juvenile within them were recorded between autumn 2000 and spring 2017. Triangles mark positions ($n = 19$) from 13 GPS tracked families of geese (3 in 2013, 4 in 2014, 6 in 2016) where individuals left the family (see details in text). Sites where geese with numbered neckbands were observed, and their family sizes counted, between 2000 and 2017, are bounded by a kernel shaded grey ($n_{obs} = 10,635$, $n_{sites} = 8,416$).

Trends in family size

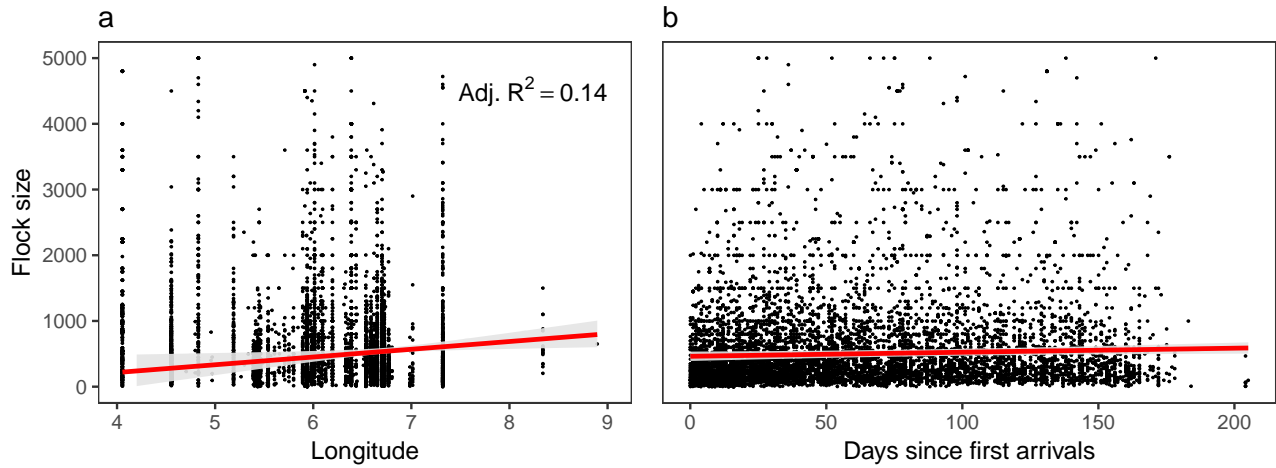
```
## pdf
## 2
```

Model output for generalised models run on two datasets with family size as response.

GAM fit with longitudinal position, days since first autumn arrivals, predation index, and flock size as fixed parametric effects. Habitat type, observer, and breeding year are iid. random effects modelled using a “re” smoothing basis (adjusted $R^2 = 0.0084$). Data used were counts ($n = 51,037$) of successful families in flocks. Lines show partial fit for longitude (a), and partial fit for days since arrivals (b).

GAM fit with longitudinal position, days since first autumn arrivals, and predation index as fixed parametric effects. Individual identity and breeding year are iid. random effects modelled using a “re” smoothing basis (adjusted $R^2 = 0.007$ including, and $= 0.005$ excluding unsuccessful pairs). Data used were counts ($n = 10,635$) of marked geese in pairs or families. Lines show partial fit, including (solid) and excluding (dashed) unsuccessful pairs, for longitude (c), and partial fit for days since arrivals (d).

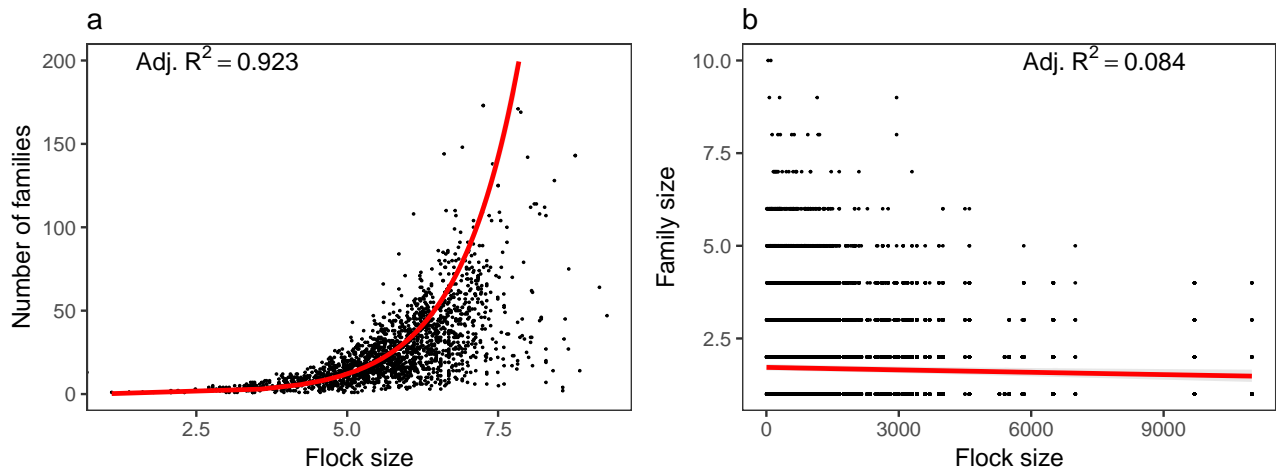
Trends in flock size



Model output of generalised models run on flock count data.

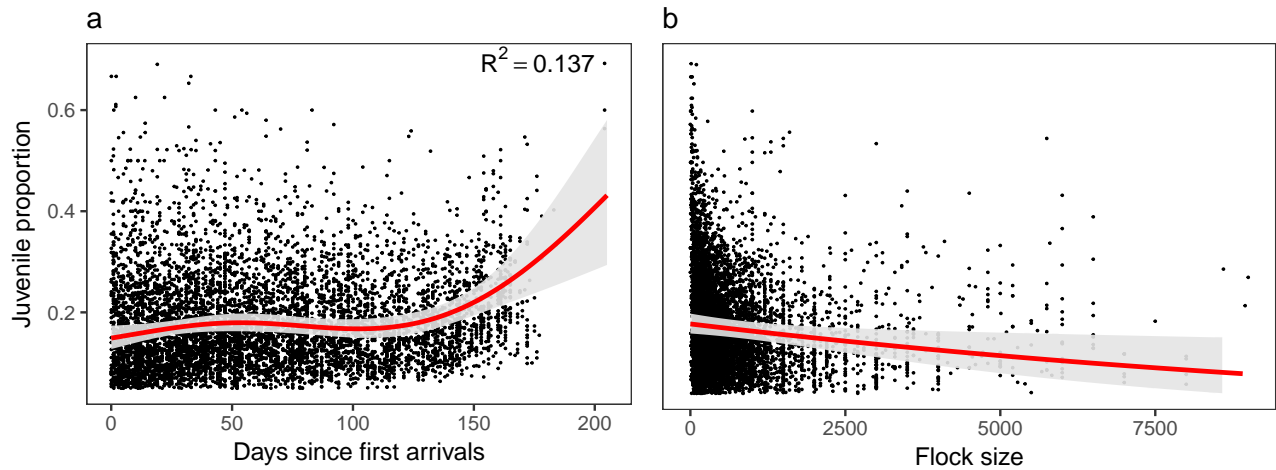
GAM fit with flock size as response and longitude as fixed parametric effect, (b) GAM fit with flock size as response and days since first autumn migration arrivals as fixed parametric effect, and with breeding year,

Families in flocks



Trends in families of Greater White-fronted geese in flocks. The number of families of geese present in a flock increases significantly with the size of the flock (left). The size of a families shows a non-significant decrease with the increasing size of flocks (right). 95% confidence intervals are shaded grey.

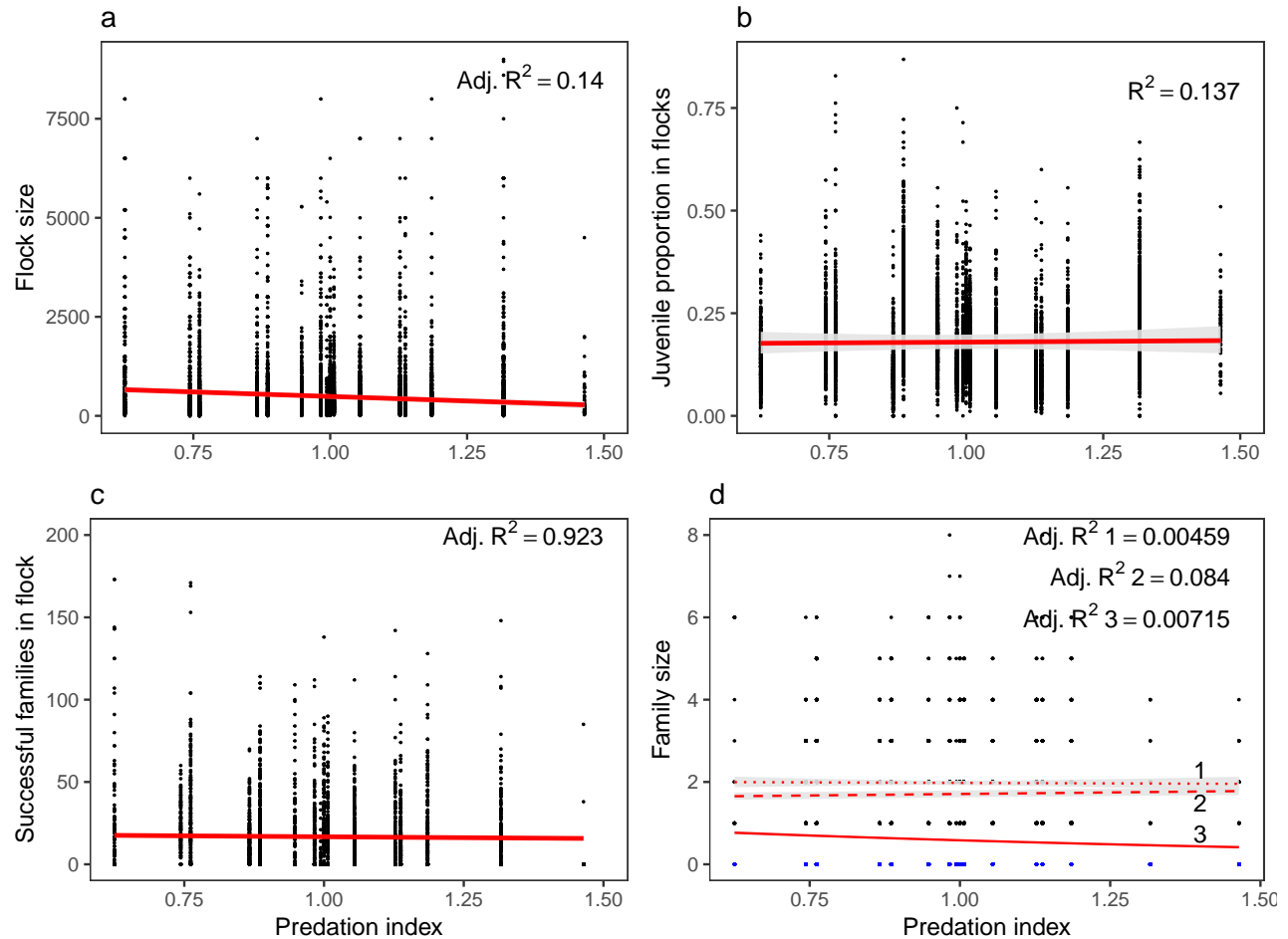
Trends in juvenile proportions



Trends in the proportion of first winter birds in flocks of Greater White-fronted geese. The proportion of first winter juveniles present in flocks shows a non-linear trend over the winter (left), with an initial increase as flocks of birds that bred successfully arrive later in the autumn, a subsequent plateau when the population has fully arrived, and a final increase as adults leave earlier for the breeding grounds, leaving juveniles behind.

A significantly lower proportion of larger flocks is comprised of first winter juveniles (right), despite the number of families increasing with flock size (see previous). 95% confidence intervals are shaded grey.

The effect of summer predation on flocks



Trends in flock size and proportion of first winter juveniles in relation to summer predation. Flock sizes of geese are significantly smaller when summer predation, estimated from an index of lemming abundance in each year and the preceding one, is higher (left). The proportion of juveniles in flocks is, however, not significantly affected by summer predation (right). The number of goose families counted in flocks does not vary significantly over different levels of summer predation (left) as estimated for each year from an index of lemming abundance in that year and the preceding one. The effect of summer predation is better seen when comparing family sizes at different levels of summer predation (right). Families when recorded as pairs that have bred successfully, ie, with at least one juvenile, do not show a significant response to summer predation (dashed line). Summer predation instead appears to reduce the number of successful families overall (solid line), as seen when unsuccessful pairs, ie,

with no juveniles, are also recorded in the data.