# *Young and naive* or *old and experienced*
who leads the way to new migration strategy?
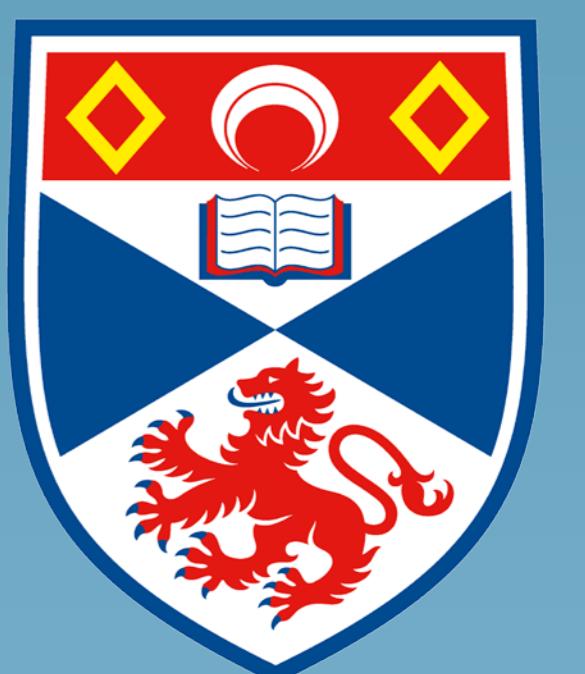
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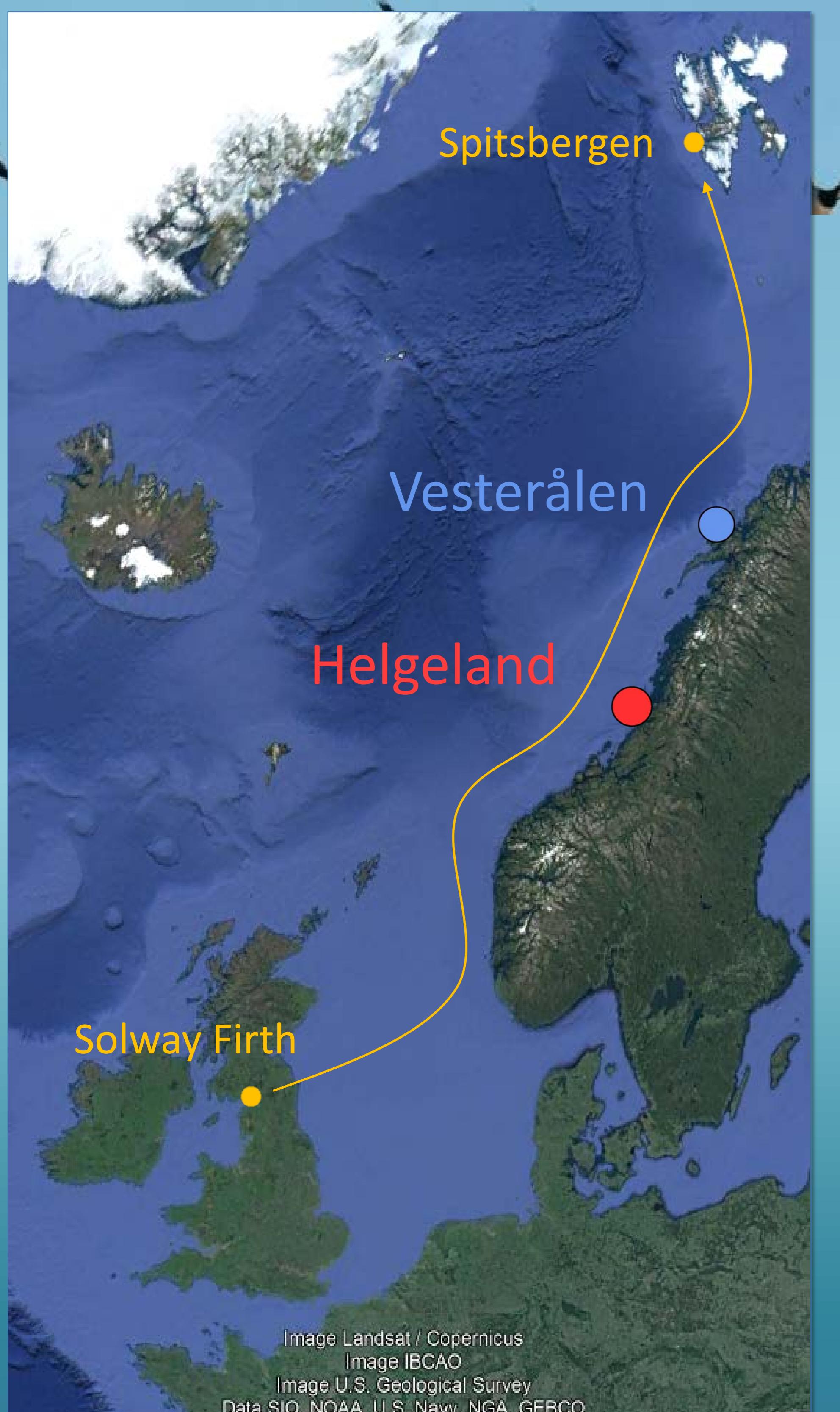
The number of barnacle geese that breed on Spitsbergen has increased, thanks to conservation efforts. During migration to the breeding grounds, all geese traditionally stopped in Helgeland for a foraging break. From 1994 onwards, geese have started to stage in Vesterålen instead. The number of birds visiting Helgeland is now declining.
Total numbers by courtesy of Larry Griffin, Wildfowl & Wetlands Trust, Slimbridge
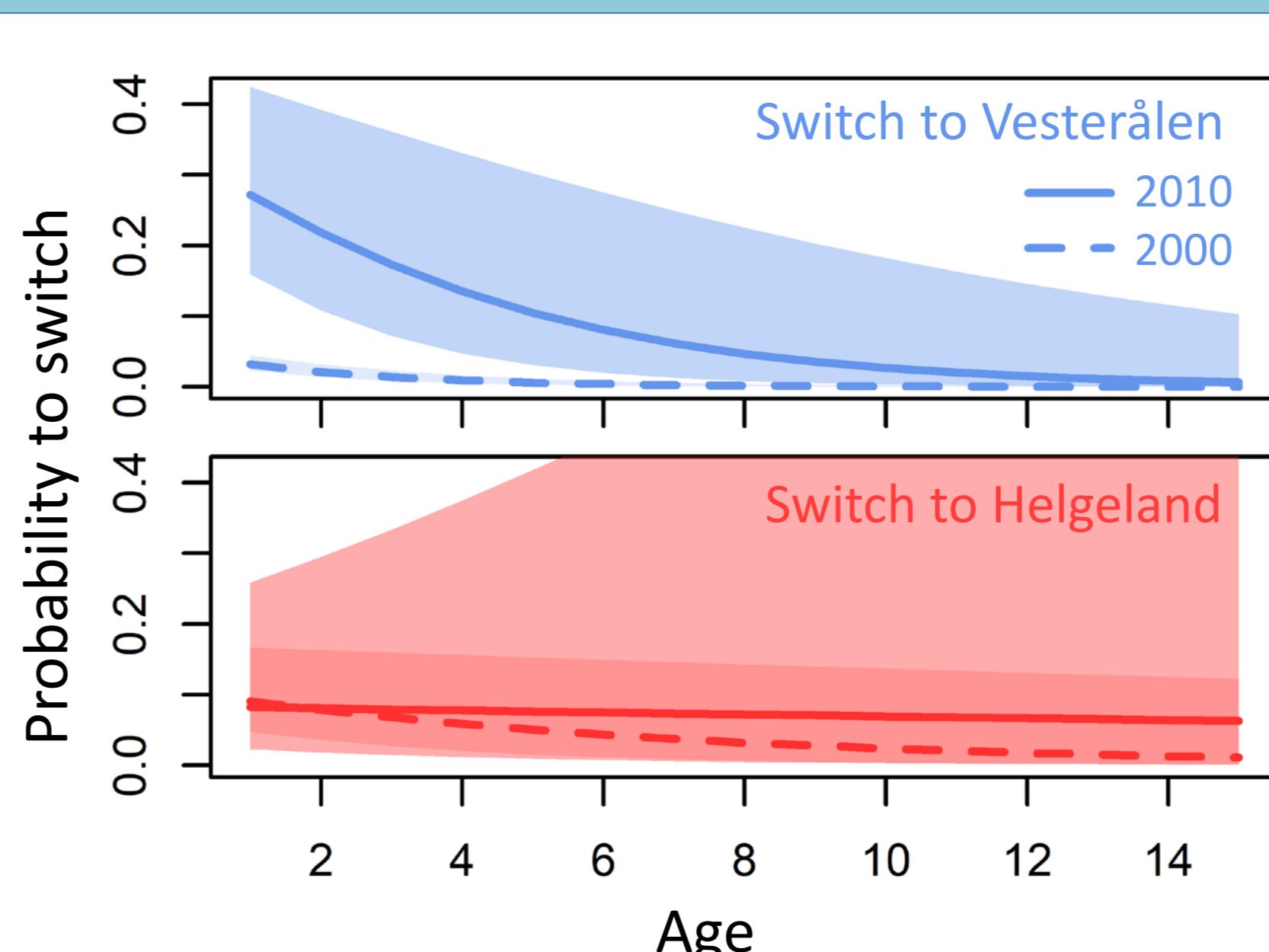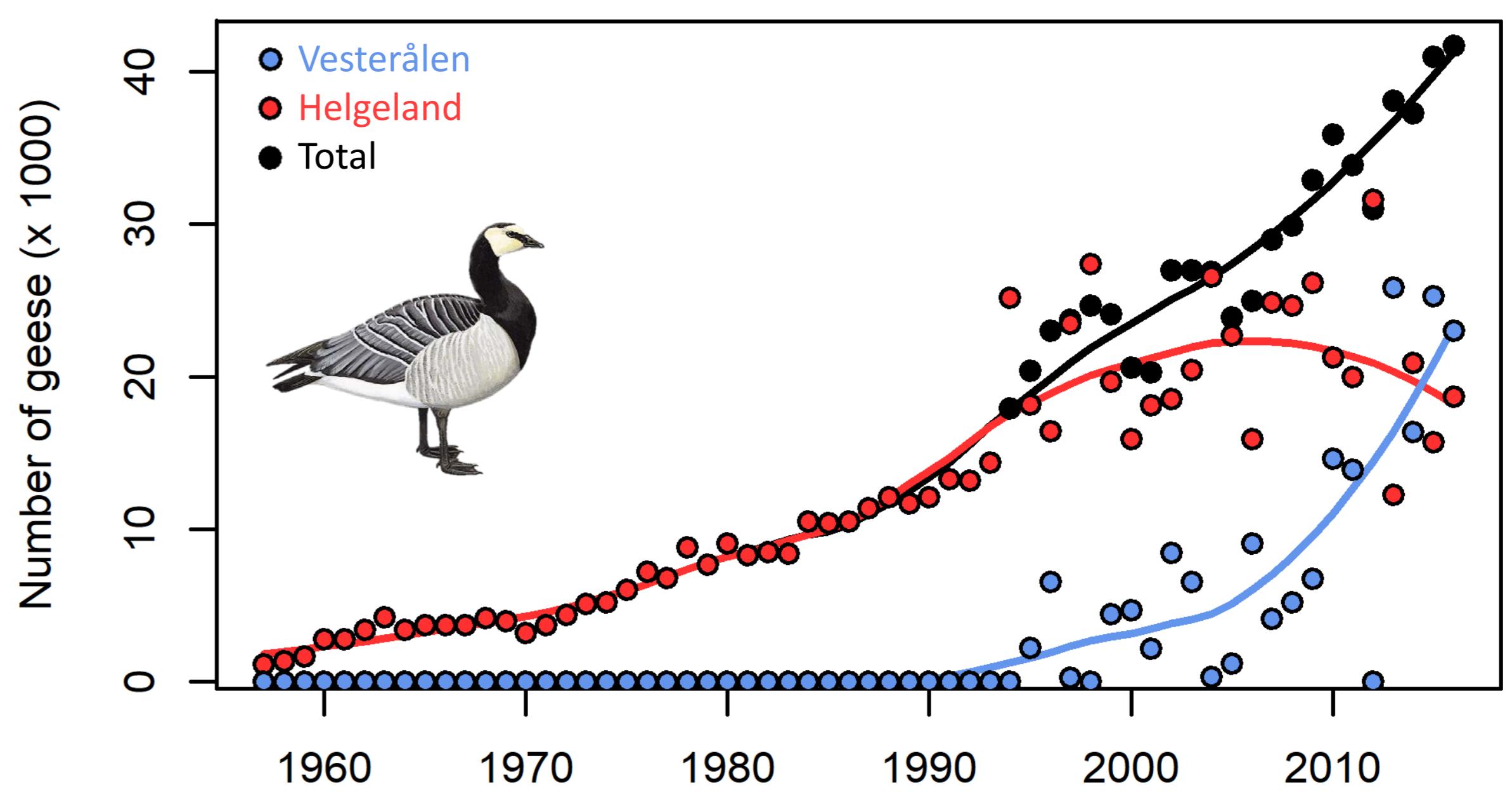
Observations show that the annual probability of young birds to switch from Helgeland to Vesterålen has increased, but not vice versa.
Estimated from repeated sightings of individual geese. Coloured areas show standard errors.
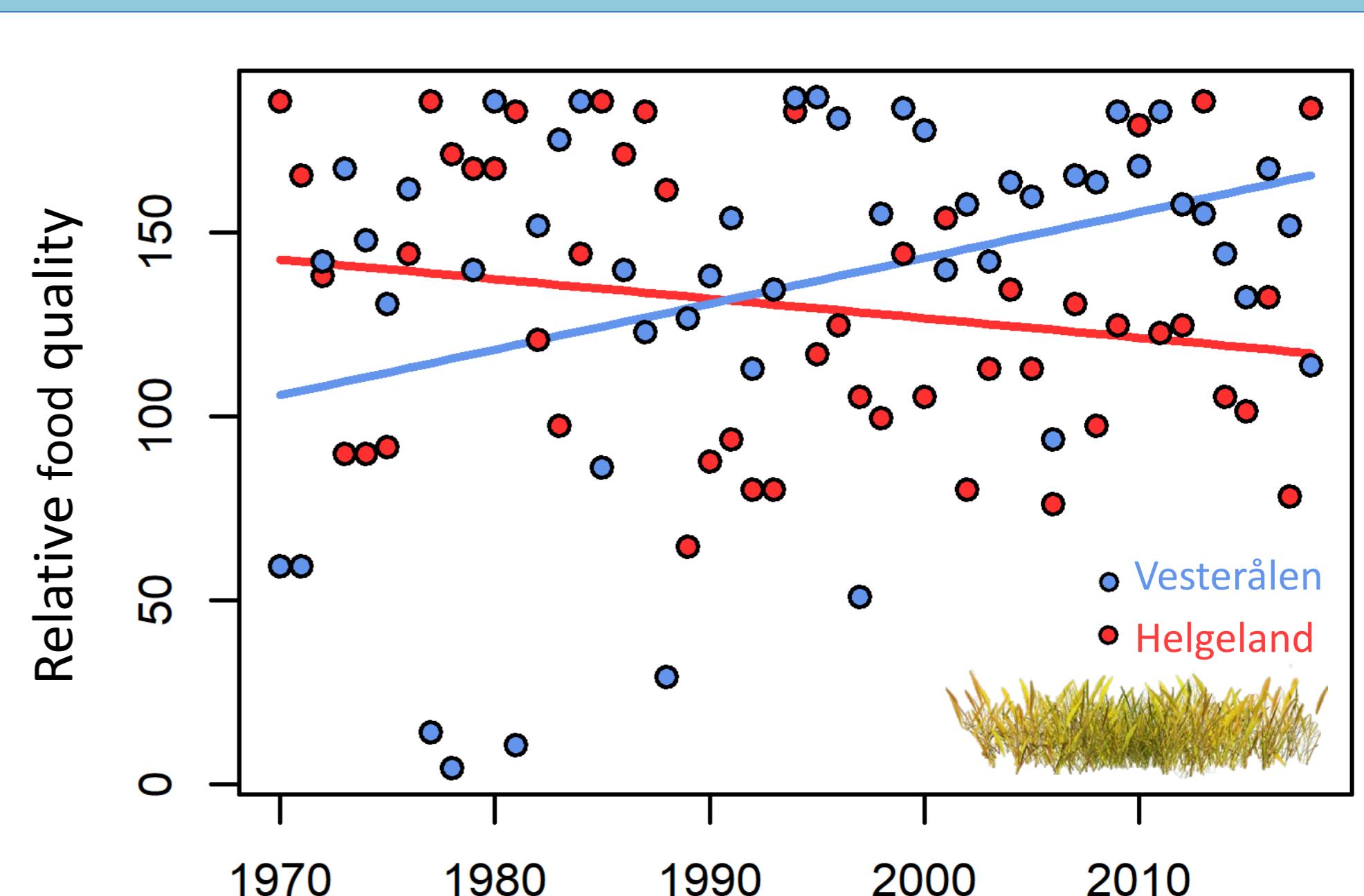
The spring peak of grass quality has shifted due to climate change. Vesterålen has increased in quality in the migration period, whereas Helgeland has decreased.
Estimated from the local onset of spring, which is derived from daily temperature data.

Research question
Population migratory strategy is changing fast. What learning mechanisms are required to mimic this pattern in an individual-based computer simulation?

Red mechanisms are required

	Vesterålen staging starts after 1990 and then keeps increasing fast	Helgeland staging decreases after 2000	Switching probability increases to Vesterålen but not Helgeland	Switching probability higher for juveniles
Copy parents	-	-	-	-
Copy random	-	-	-	-
Copy majority	-	-	-	-
Copy others, based on	Success or age	age	-	-
Probability of exploring other site	≥0.1 & ≤0.5	≥0.1	-	-
Memory	≥10 years	≥10 years	-	-
Group size	≥10	≥10	-	-
Probability to change group	-	-	~0.2	~0.2
Extra juvenile probability	-	-	-	+~0.5

(preliminary results)

BEST MODEL
- Group size = 100
- Most experienced group member leads
- Group leader changes preference with 10% chance if the other site is better
- Animal uses life-time experience to determine which staging site is better
- Young birds have a higher tendency (0.7) than adults to switch group (0.2)
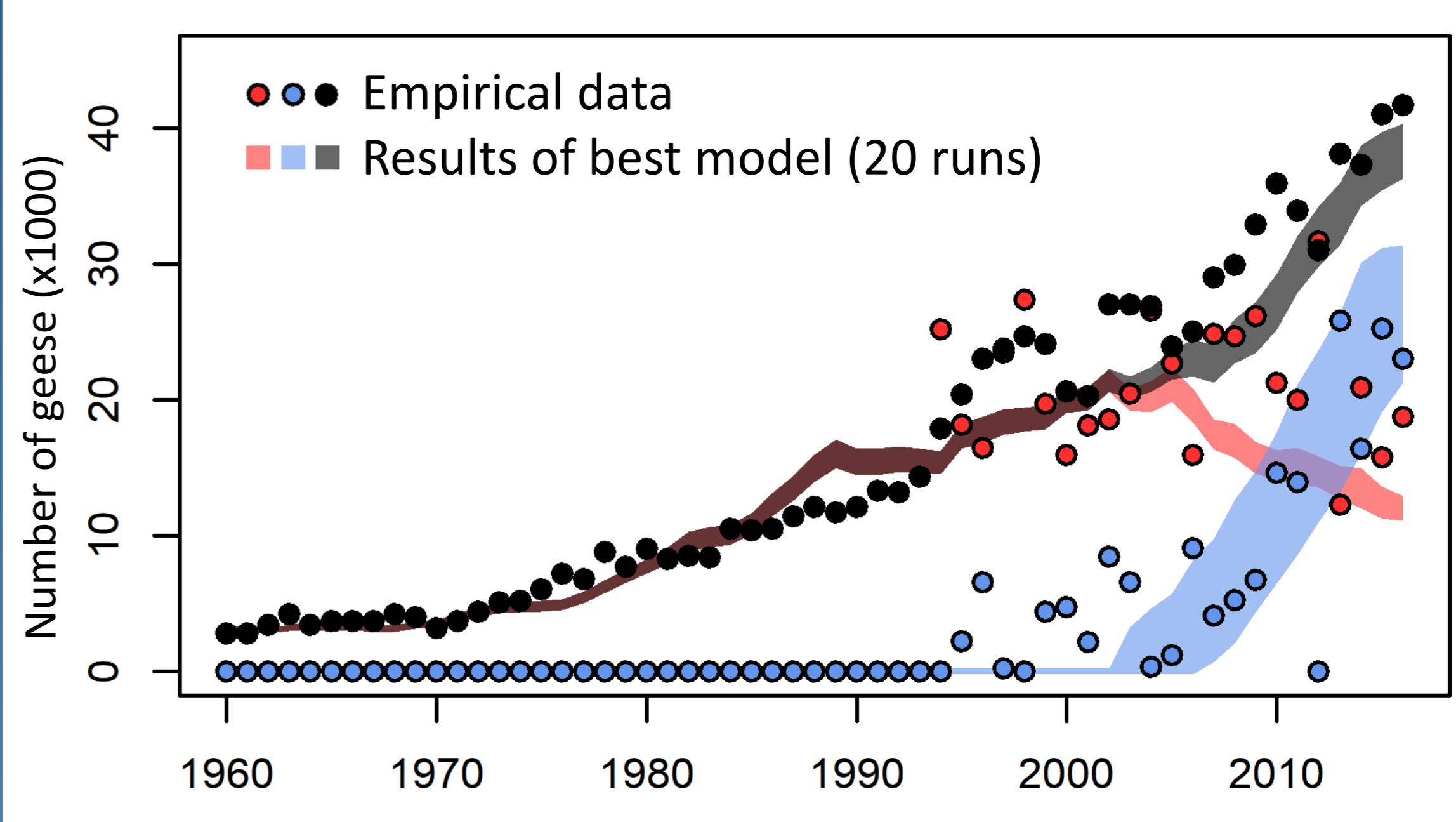
MODEL DESCRIPTION
- Individual-based model in R
- Start with 3000 individuals that stage on Helgeland
- In each year all individuals
    1. choose a partner if unpaired (adults only)
    2. choose a staging site (Helgeland or Vesterålen)
    3. reproduce with probability that depends on quality of staging site in that year (adults only)
    4. die with a fixed probability of mortality
- Quality per staging site is calculated using annual weather data from 1960 onwards
- Mortality is higher until 1970, such that population size is ~3000 in 1970. Model starts in 1900, to have stable age distribution in 1970
- Carrying capacity of staging sites is assumed equal, and is chosen such that it fits with the population growth between 1960 and 1990