

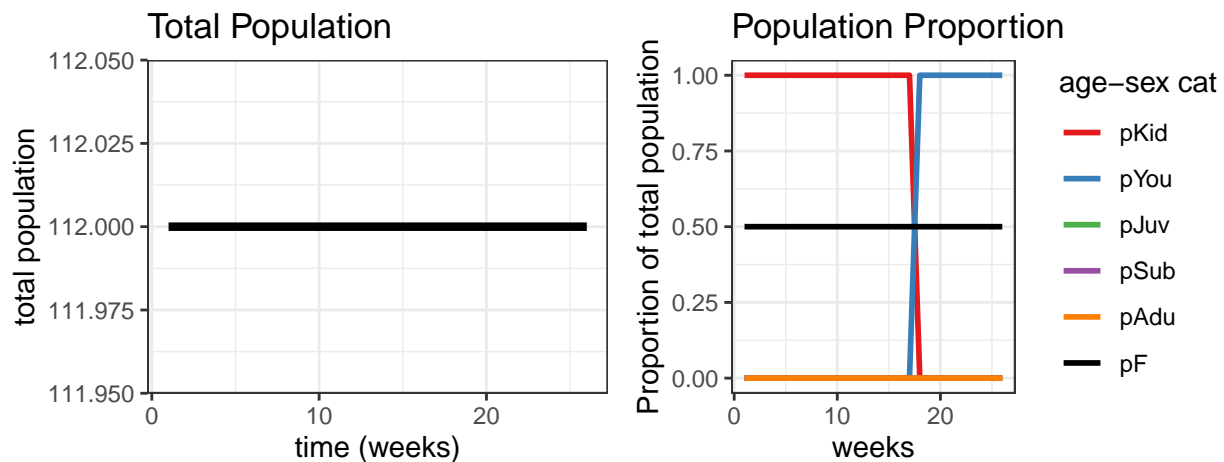
Dynamics Model Testing

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2023-03-14

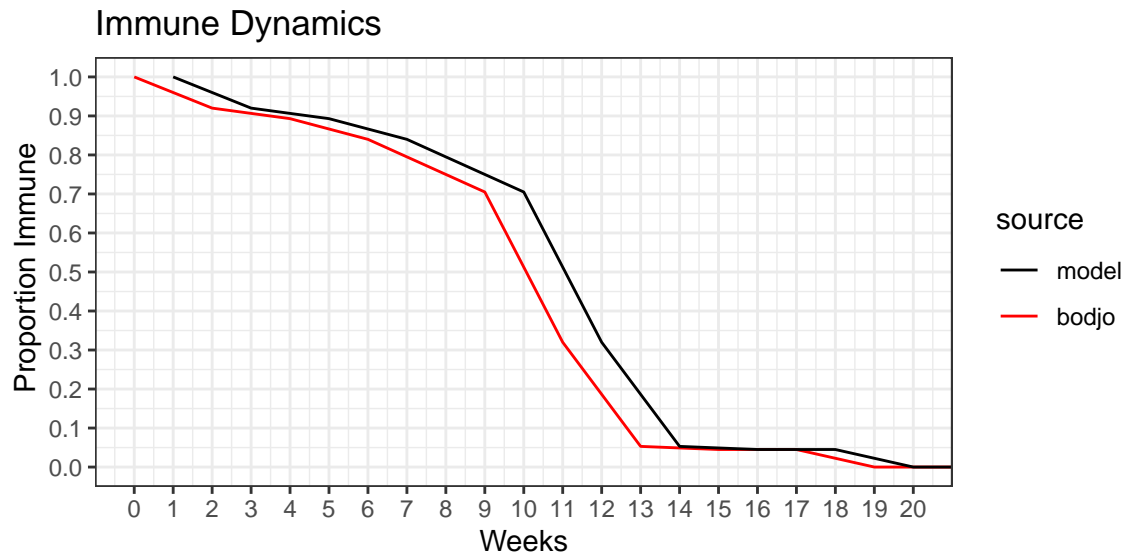
Maternal Immunity

- Check implementation of maternal immunity decay by comparing model output to empirical data (from Bodjo *et al*)
- Run model with conditions to replicate Bodjo *et al*
- Bodjo *et al* tested the duration of maternal immunity in 112 lambs up to 150 days after birth, born to ewes vaccinated with the homologous PPR vaccine “Nigeria 75/1” at day 90 and day 120 of pregnancy.
- Parameters:
 - set 112 lambs to immune offspring compartment
 - set rest of population to 0
 - set mortality, offtake, and all demographic rates (except maternal immune decay) to 0
 - set M:F ratio to 1:1
 - plot proportion immune for first 6 months of simulation
 - plot should mirror the immune decay from Bodjo raw data.



Maternal Immunity Interpretation

- The population remains constants at 112 animals for the duration of the simulation
- All animals begin in the pKid compartment, and move into the pYou compartment at week 18



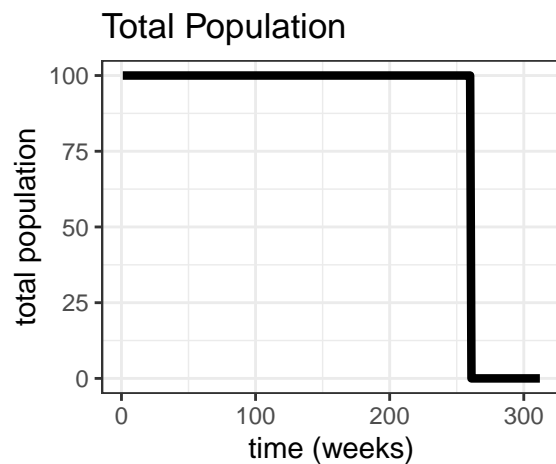
Maternal Immunity Interpretation

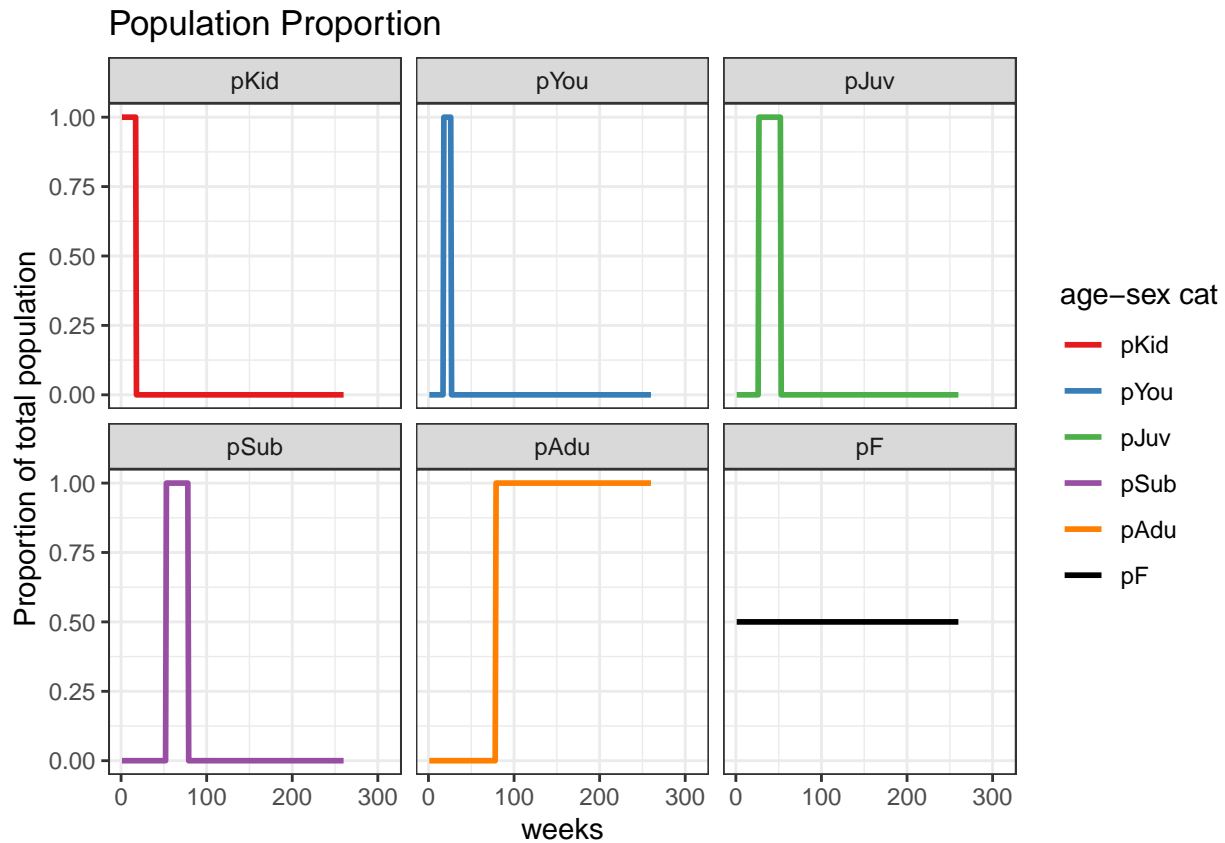
- The model exactly replicates immune decay from Bodjo data
- The apparent 1 week lapse is because the model starts at week 1 with 100% offspring in the immune compartment

Demographic Processes: Basic Model

- 1) Do animals move through age compartments as expected?
 - Parameters:
 - Set the population to 100 animals
 - Assign all animals to S1 age group (first age-group, susceptible offspring)
 - Set all demographic parameters (births, deaths, intake, offtake, maternal immunity) to 0
 - Set the max life-span of males and females to 5years
 - Set M:F ratio as 1:1
 - Animals should move through age compartments uniformly, at 5 years population will die out.

NB: NaN values due to dividing by 0 when population dies out (fix this in `demos_summary.R`)





Basic Model Interpretation

- The population remains constant up to 5 years (week 260)
- Animals move through discrete age groups uniformly as expected

Mortality

2) Check that model with mortality functions as expected i.e. should be able to analytically solve population decline?

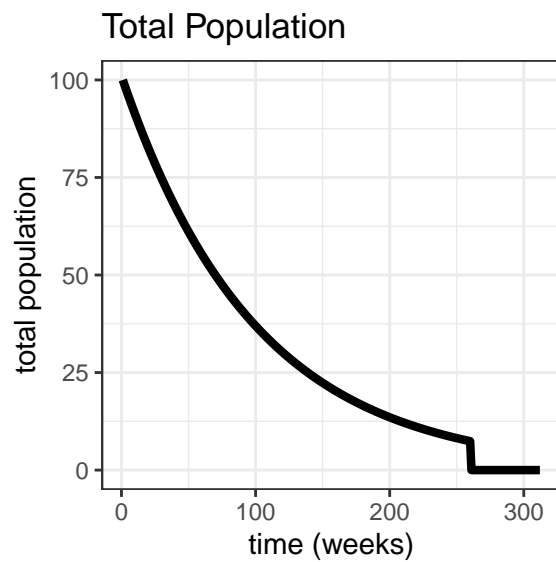
- Parameters:
 - Set the population to 100 animals
 - Assign all animals to S1 age group (first age-group, susceptible offspring)
 - Set **mortality rate** to 0.01 per week
 - Set all other demographic parameters (births, intake, offtake, maternal immunity) to 0
 - Set the max life-span of males and females to 5years
 - Set M:F ratio as 1:1
 - Animals should move through age groups, with constant mortality rate, until 5 years

Test validation: what is the gradient of the curve?

- *Limited time to run tests so this is basic validation...*
- Briefly:
 - The mortality rate is 0.01/week in all age groups
 - Therefore survival is 0.99/week
 - Given survival we can calculate the expected population size after e.g. 1year, 5 years, and compare this to model output.
 - Expected 1 year survival = $0.99^{52} = 0.59$
 - Expected 5 year survival = $0.99^{(52*5)} = 0.07$

- Compare these figures to model output (`output_df`) below...
- *Calculate gradient of the curve..?*
- Model population output:

weeks	Population
53	59.3
260	7.4

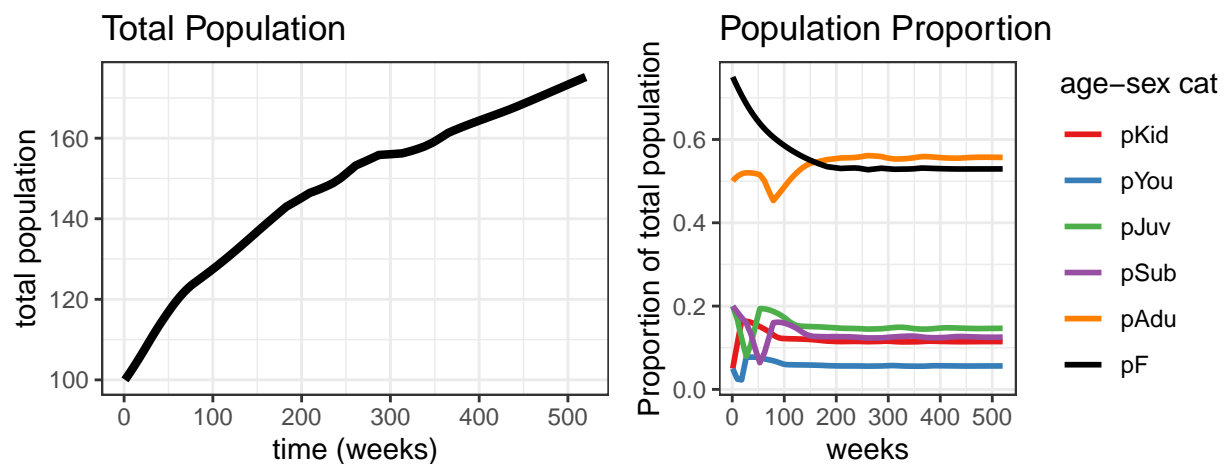


Mortality Interpretation

- Model output for population size at years 1 ($N = 59.3$) and year 5 ($N = 7.4$) equal to expected population size based on mortality of 0.01 (survival of 0.99)

BAOBAB data

- Test model using demographic rates from (simple) BAOBAB dataset
- Parameters calculated from data supplied by Andrea from Louga & Kolda (Senegal) Sheep & Goats
- Here use Kolga Goats data
 - Data provided as monthly rates
 - For testing calculate median monthly rates
 - Convert to weekly rate by dividing median monthly rate by 4.345 (av. wk/mnth)
 - See '~/OneDrive - Royal Veterinary College/PPR Collaborations/Data Bank/Baobab_data (Apr2021)/look-at-data.R' for details
- Parameters:
 - mortality: 0.00537 (constant for all youth, adult, m, f)
 - births: 0.023 (adult F only)
 - intake: 0.0121
 - offtake: 0.0121
 - NET offtake: 0
 - Population: 100
 - M:F ratio (0.25:0.75)
 - Population proportions:
 - * Kid (0.05),
 - * You (0.05),
 - * Juv (0.2),
 - * Sub_M (0.05), Sub_F (0.15),
 - * Adu_M (0.05), Adu_F (0.45)
- NB: data for population size, M:F ratio and population proportions are estimates, not provided in Baobab dataset



Further Tests - to be completed

Births

Population Size

Population Structure