Controlling tick borne diseases through domestic animal management: a theoretical approach

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THE MACAULAY LAND USE RESEARCH INSTITUTE

research today for land use tomorrow

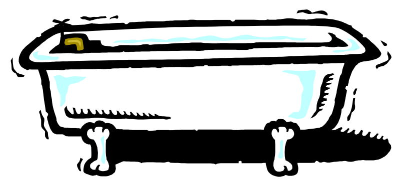
Talk Outline

- Background of tick biology
- Management strategy
- Model Results
- Future plans

Louping Ill Virus (LIV)

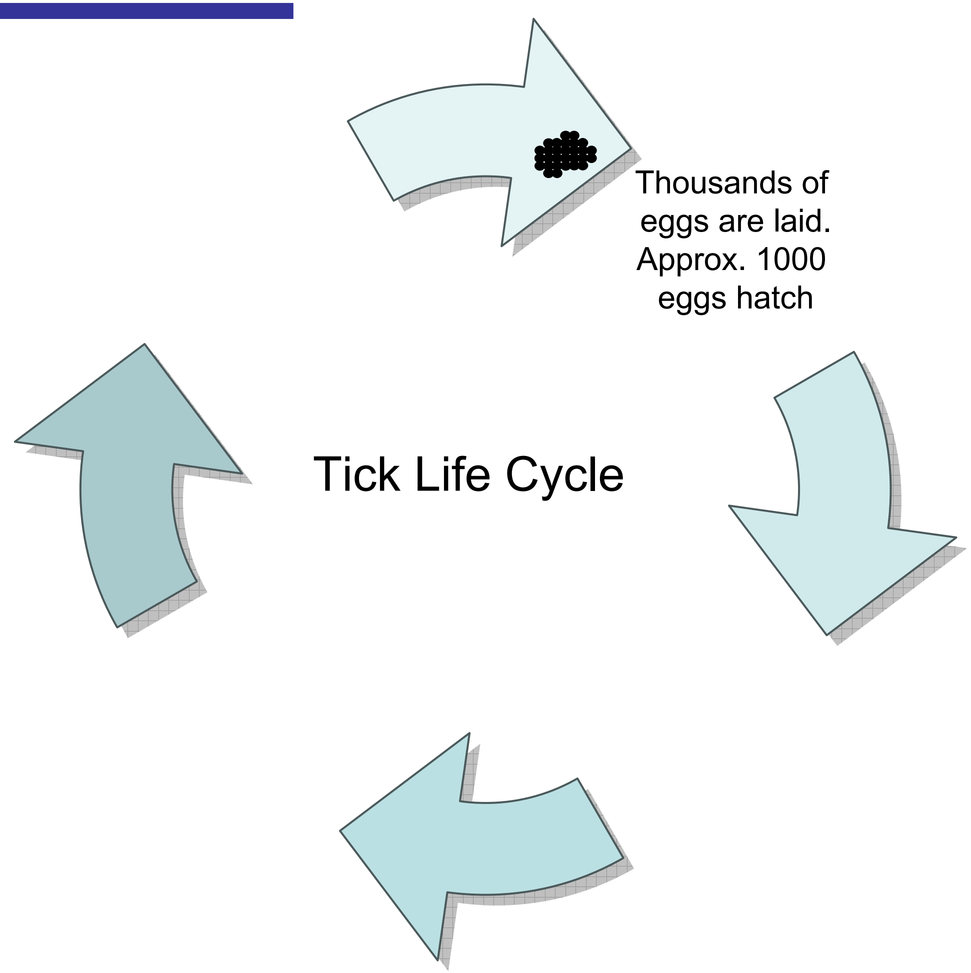
- Tick borne disease
- Affects sheep and grouse

- Sheep vaccinated and ‘dipped’

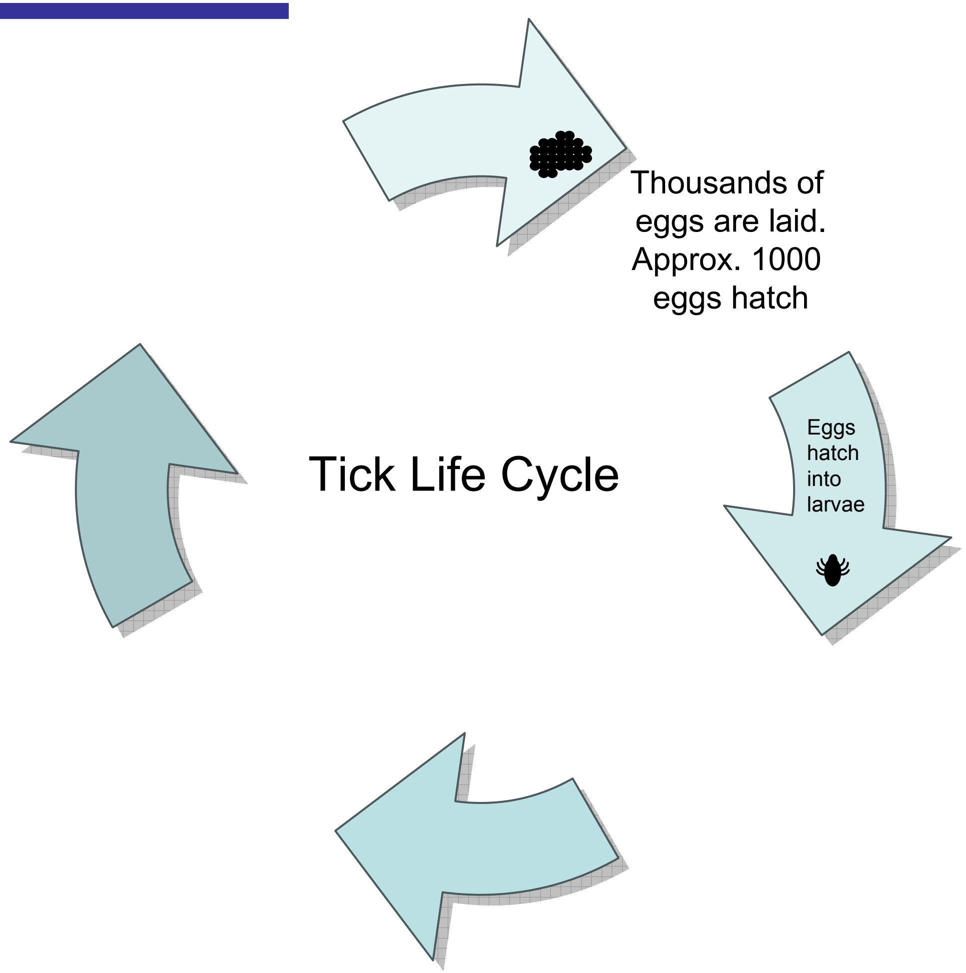


- 80% mortality in infected grouse

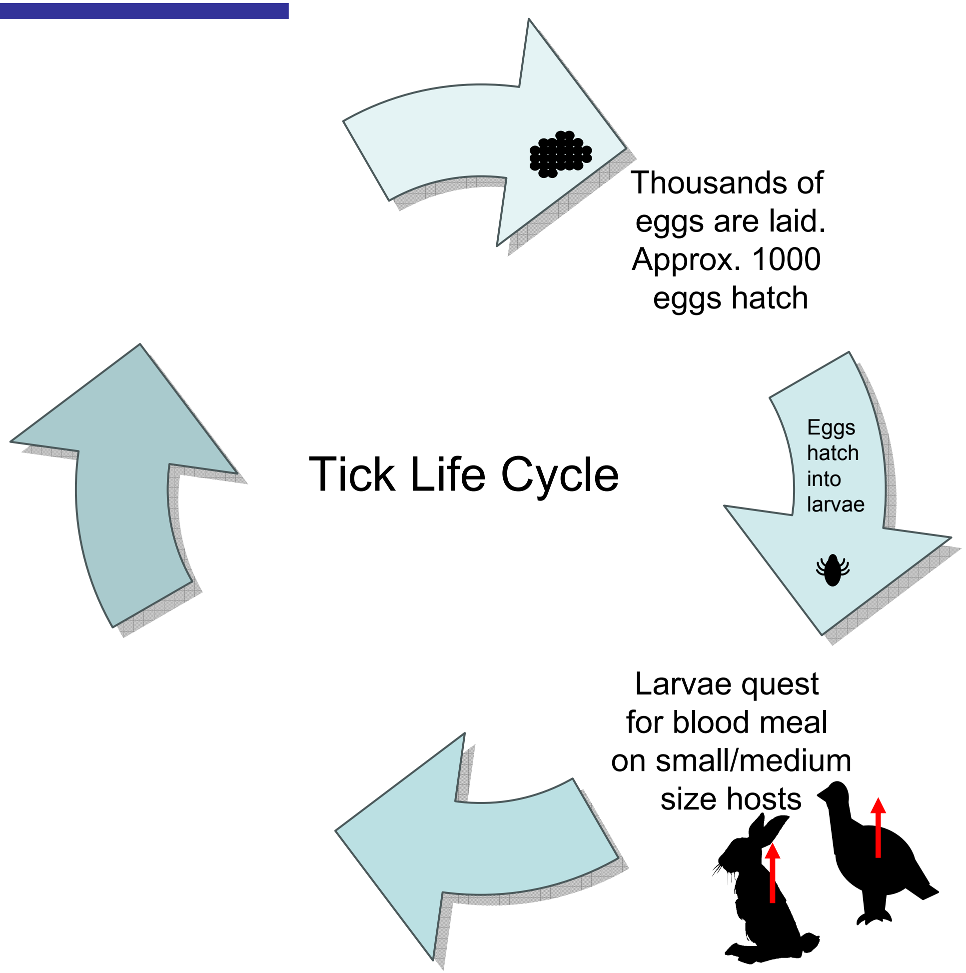
Tick Life Cycle



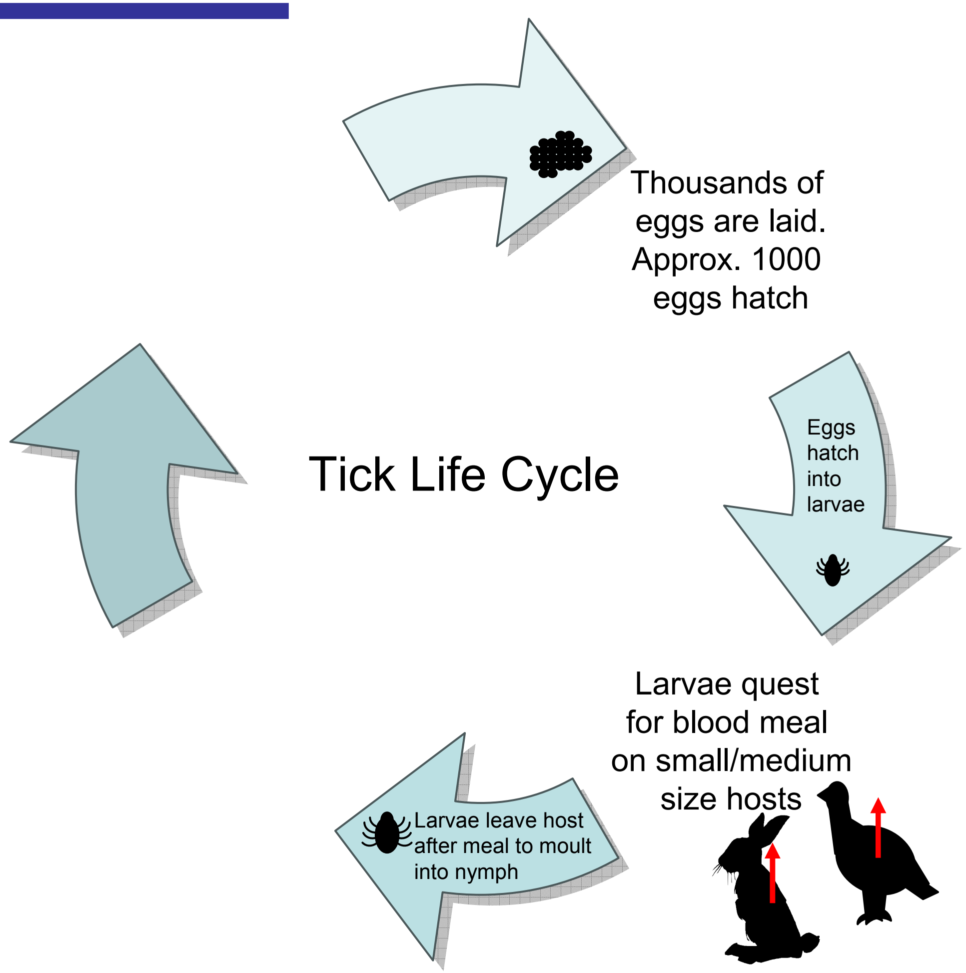
Tick Life Cycle



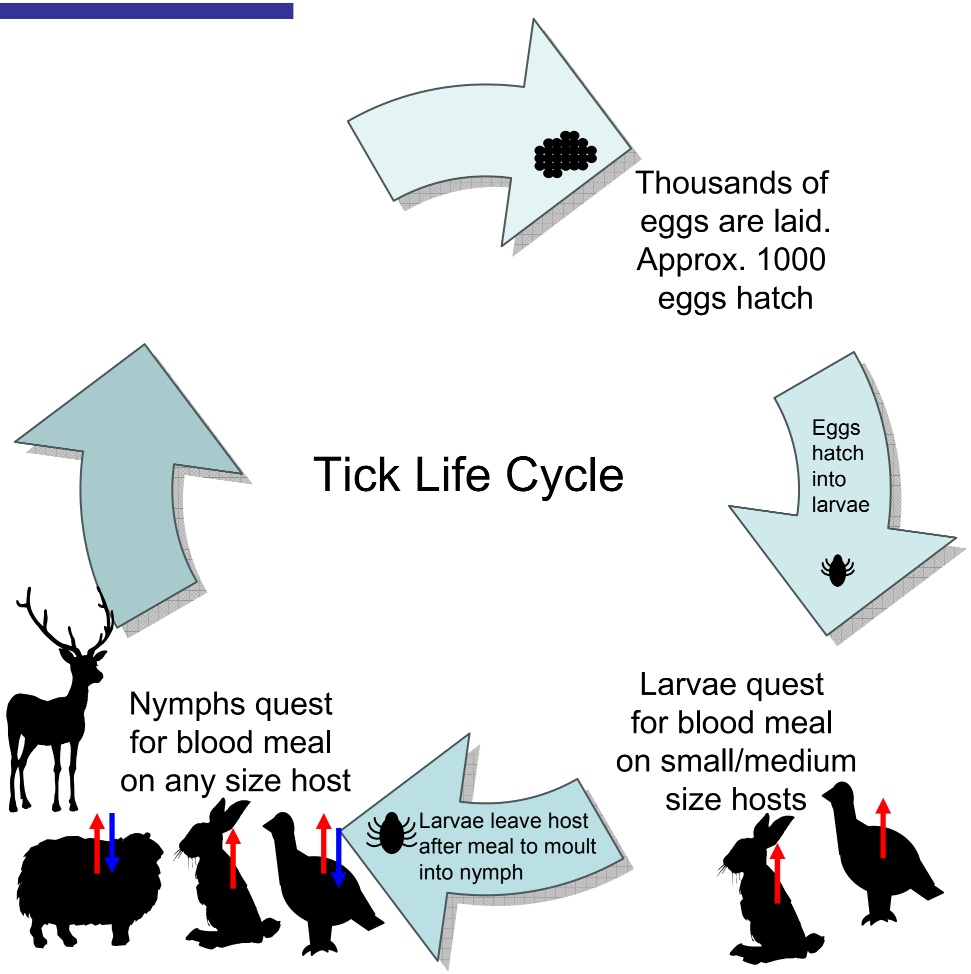
Tick Life Cycle



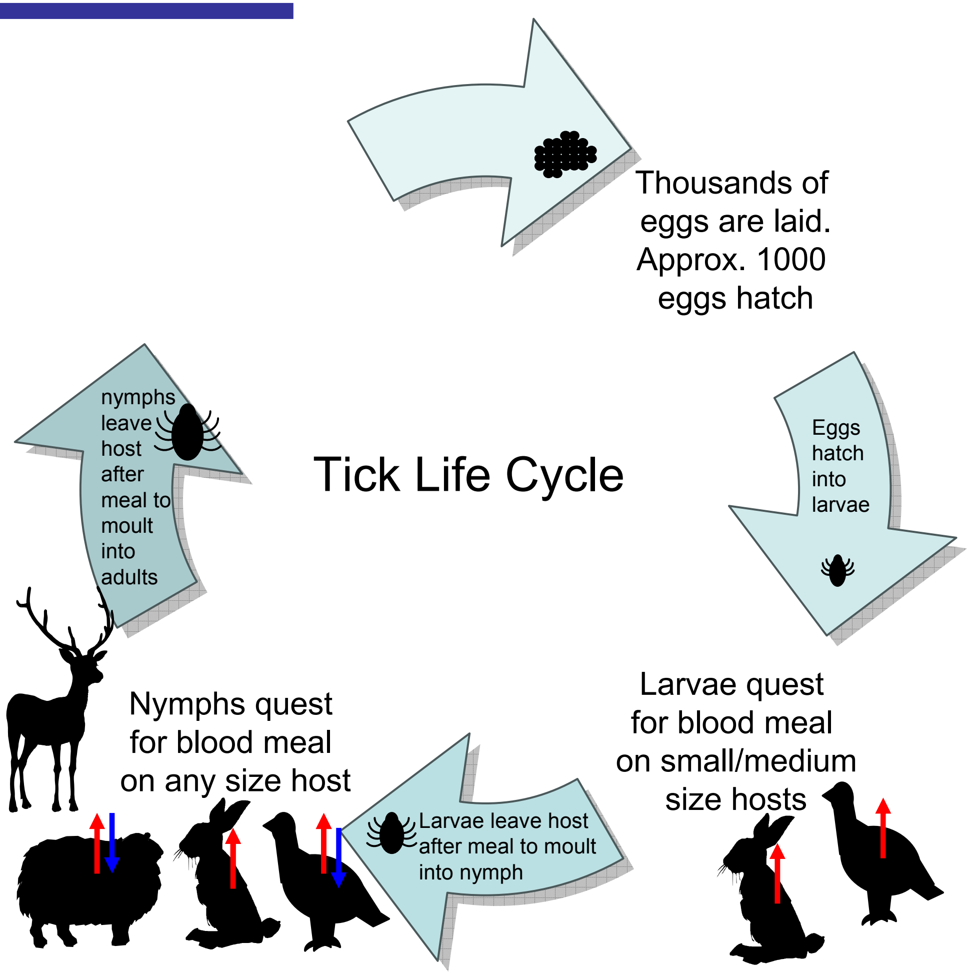
Tick Life Cycle



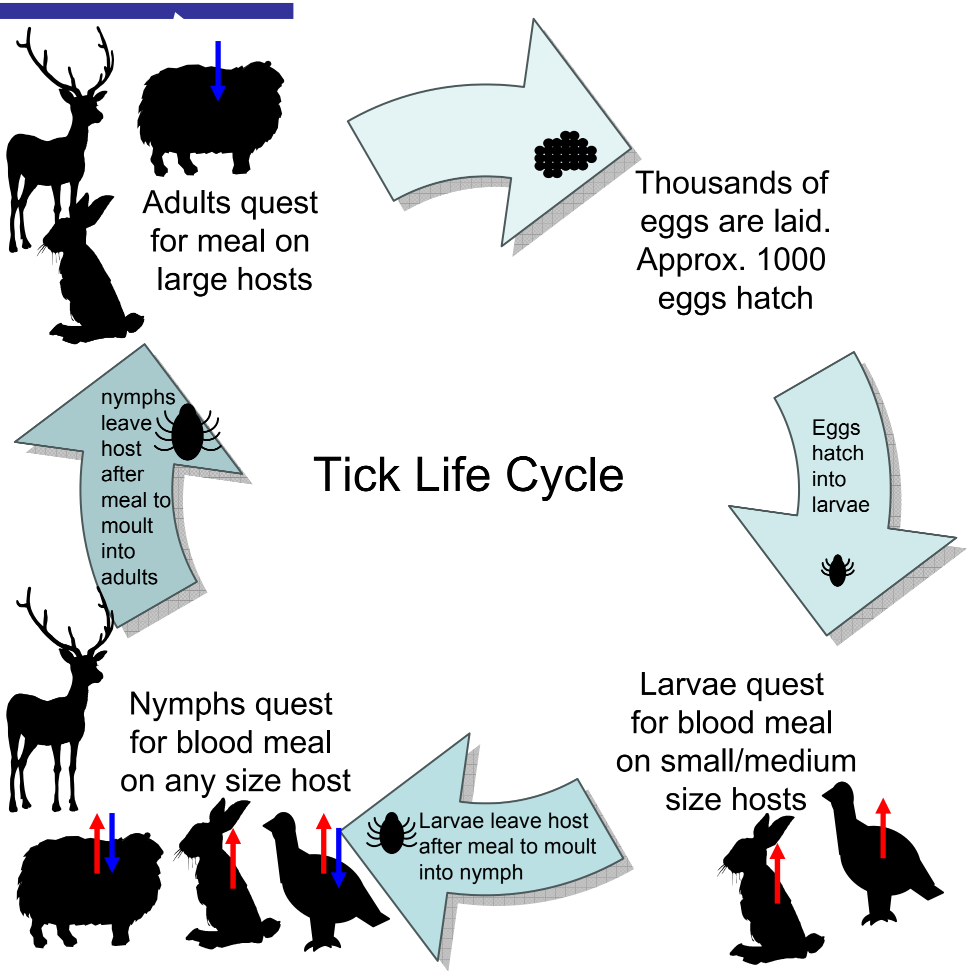
Tick Life Cycle



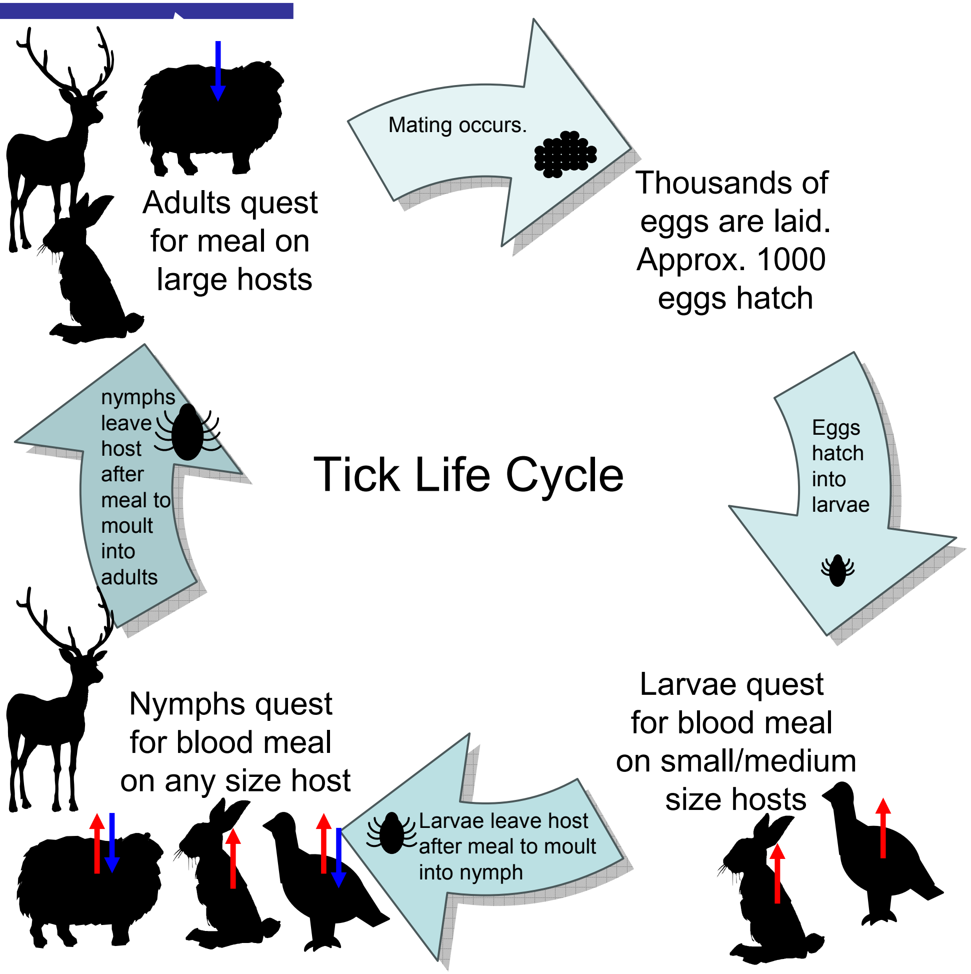
Tick Life Cycle



Tick Life Cycle



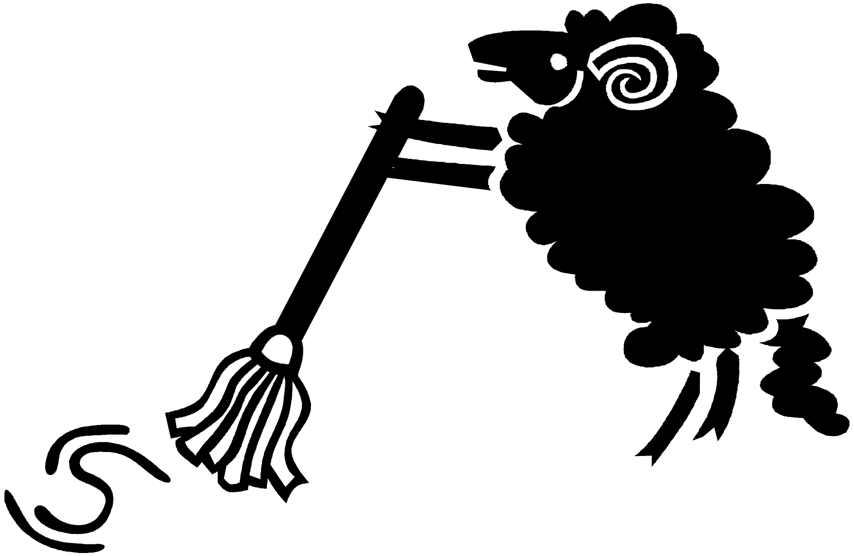
Tick Life Cycle



Control strategies

- No ticks = no disease
- Treat/remove wild animal hosts
  - Ethical/legality issues
- Treat domestic hosts
  - Sheep tick mops

Sheep ‘tick mops’

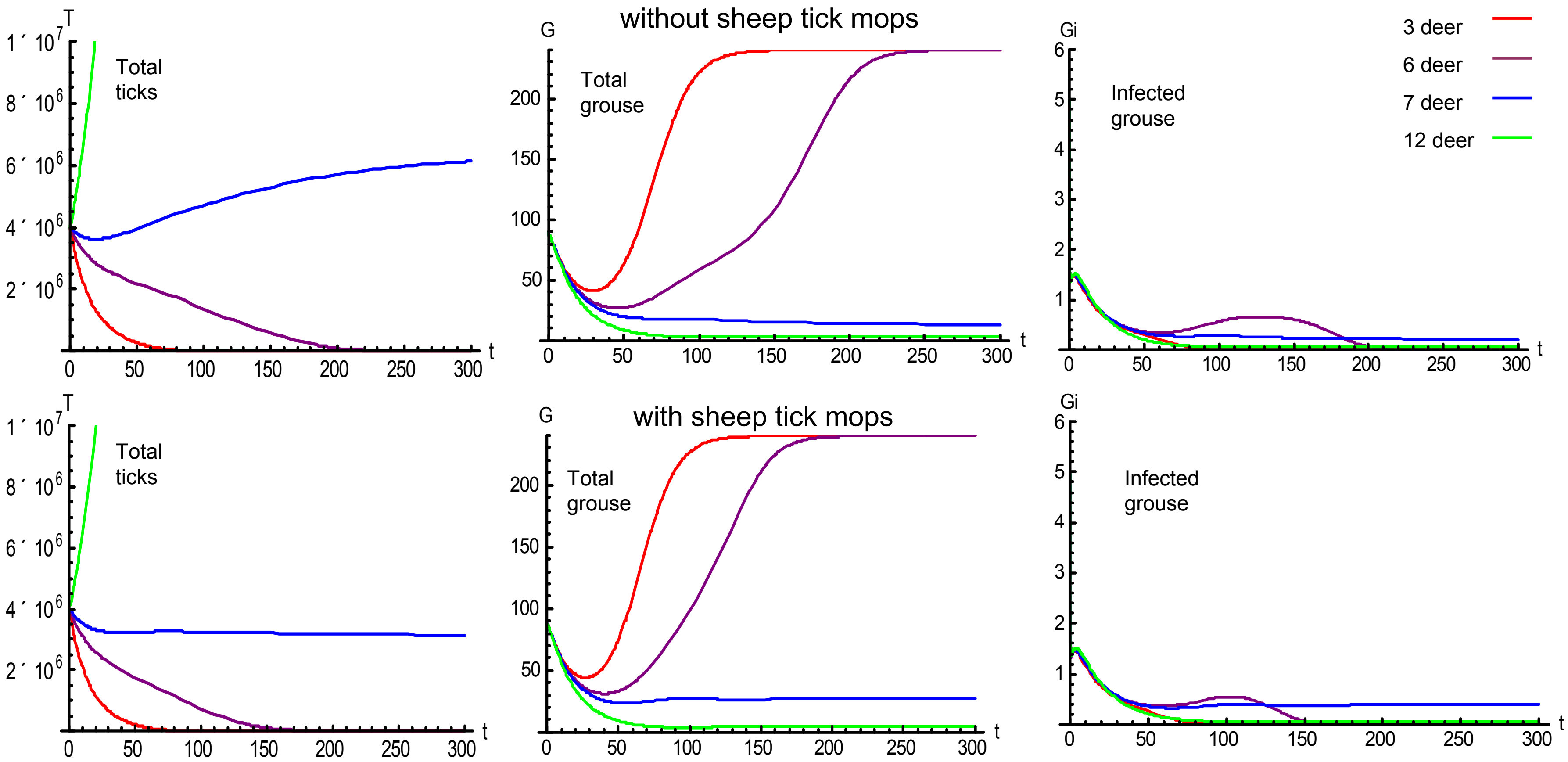


- Actively use sheep treated with acaracide to ‘mop up’ ticks.

Sheep Model Results

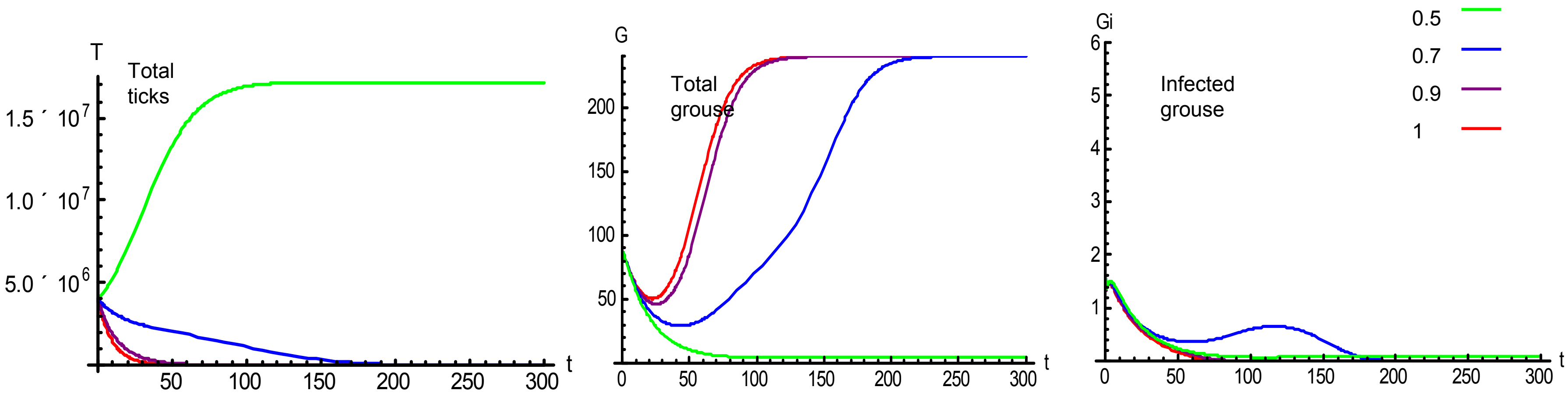
- Model run in Mathematica
- What effect do sheep tick mops have with different deer densities?
- What effect does varying the efficacy have?

Model predictions with deer



- As deer numbers increase tick numbers increase and grouse numbers decline
- Increased deer numbers reduces effect of sheep tick mops

Different efficacy levels



- High efficacy speeds recovery
- Low efficacy prevents recovery, worse than no sheep?

Conclusions

- Using sheep tick mops can be effective

If:

- very few deer

- high level of efficacy

Empirical evidence

- Game and Wildlife Conservation Trust Key Findings:
  - The use of sheep as ‘tick-mops’ may reduce tick biting rates on grouse chicks where deer densities are lower than five per 100 hectares.
  - Red deer densities of 10 per 100 hectares appear to be too high for ‘tick-mops’ to be effective.

(Are sheep tick-mops effective in Scotland?

http://www.gct.org.uk/text03.asp?PageId=339)

Future work

- Seasonality
- Deer tick mops
- Fieldwork/collaboration for validation data

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landowners/shepherds for data
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DEPARTMENT OF COMPUTING SCIENCE AND MATHEMATICS

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The model

$$\frac{dG_s}{dt} = (a_g - s_g G)G - b_g G_s - (\beta_1 + P\beta_3)T_i G_s$$

$$\frac{dG_i}{dt} = (\beta_1 + P\beta_3)T_i G_s - \Gamma G_i \quad \text{where } \Gamma = \alpha + b_g + \gamma$$

$$\frac{dG_z}{dt} = \gamma G_i - b_g G_z$$

Grouse equations

$$\frac{dT_s}{dt} = (a_t - s_t T)T(\beta_5 D + (1-d)\beta_6 S) - \beta_2 T_s G_i - b_t T_s - \beta_3 T_s G - \beta_5 T_s D - \beta_6 T_s S - d\beta_7 T_s S$$

$$\frac{dT_i}{dt} = \beta_2 T_s G_i - b_t T_i - \beta_3 T_i G - \beta_5 T_i D - \beta_6 T_i S - d\beta_7 T_i S$$

Tick equations