Effect of TNR Rate on Population Dynamics of Cats

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Key Questions

What is the effect of Trap-Neuter-Return (TNR) rates on the population of feral cat?

What TNR rate makes the number of altered cats outnumber other subpopulations while not causing extinction of the cat population?

How can this be applied to Lubbock?

1 Population Beverton-Holt Style Model

$$\frac{dN}{dt} = -\mu N^2,$$
$$N^+ = N + \alpha S N,$$

$$N_{t+1} = \frac{(1+\alpha S)N_t}{1+\mu N_t}.$$

μ: death rate
α: reproduction rate

S: Proportion of Reproductive Cats

2 Population Beverton-Holt Style Model

$$\frac{dA}{dt} = -\mu A(A+U)$$
$$\frac{dU}{dt} = -\mu U(A+U)$$
$$A^+ = A + \min(s, U)$$
$$U^+ = U + \alpha U - \min(s, U)$$

$$A_{t+1} = \frac{A_t}{1+\mu(A_t+U_t)} + \min(s, U_t)$$
$$U_{t+1} = \frac{(1+\alpha)U_t}{1+\mu(A_t+U_t)} - \min(s, U_t).$$

μ: death rate
α: reproduction rate

s: TNR rate

2 Population Strictly Discrete Model

$$A_{t+1} = A_t - \mu A_t(A_t + U_t) + \min(s, U_t)$$
$$U_{t+1} = U_t + \alpha U_t - \mu U_t(A_t + U_t) - \min(s, U_t)$$

μ: death rate
α: reproduction rate

s: TNR rate

3 Population Numerical Model

$$A_{t+1} = A_t - \mu_A A_t(A_t + U_t) + \min(s, U_t) + a * a_A$$

$$U_{t+1} = U_t - \mu_U U_t(A_t + U_t) - \min(s, U_t) + \frac{1}{m} K_t + a * a_U$$

$$K_{t+1} = K_t - \mu_K K_t + \alpha U_t \frac{U_t}{A_t + U_t} - \frac{1}{m} K_t + a * a_K$$

μ: death rate
α: reproduction rate
m: months to mature

s: TNR rate
a: total abandons per month
a_A,a_U,a_K: percentage of abandons

Inspiration

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

A discrete-time bioeconomic model of free-roaming cat management: A case study in Knox County, Tennessee

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- Use of literature and other papers for parameter values
- Corroboration of our chosen parameters

Parameter Values

	Description	Value	Source
α	Reproduction rate	0.667	Feral Cat Project/Tuckahoe
μ_U	Unaltered cat death rate	0.019	Cats in Action
μ_A	Altered cat death rate	0.008	Cats in Action
μ_K	Kitten death rate	0.206	Feral Cat Project/calculation
s	Spay/neuter rate	0.25 - 2	Data (KAC)
m	Months to maturity (kittens)	6	Feral Cat Project
a	Abandonment	5	Estimate: local sources
a_X	Proportion of abandonment from X	Varies	Proportion from Data (LAS)

Table 1: A summary of the main parameters used.

Kitten Death Rate Derivation

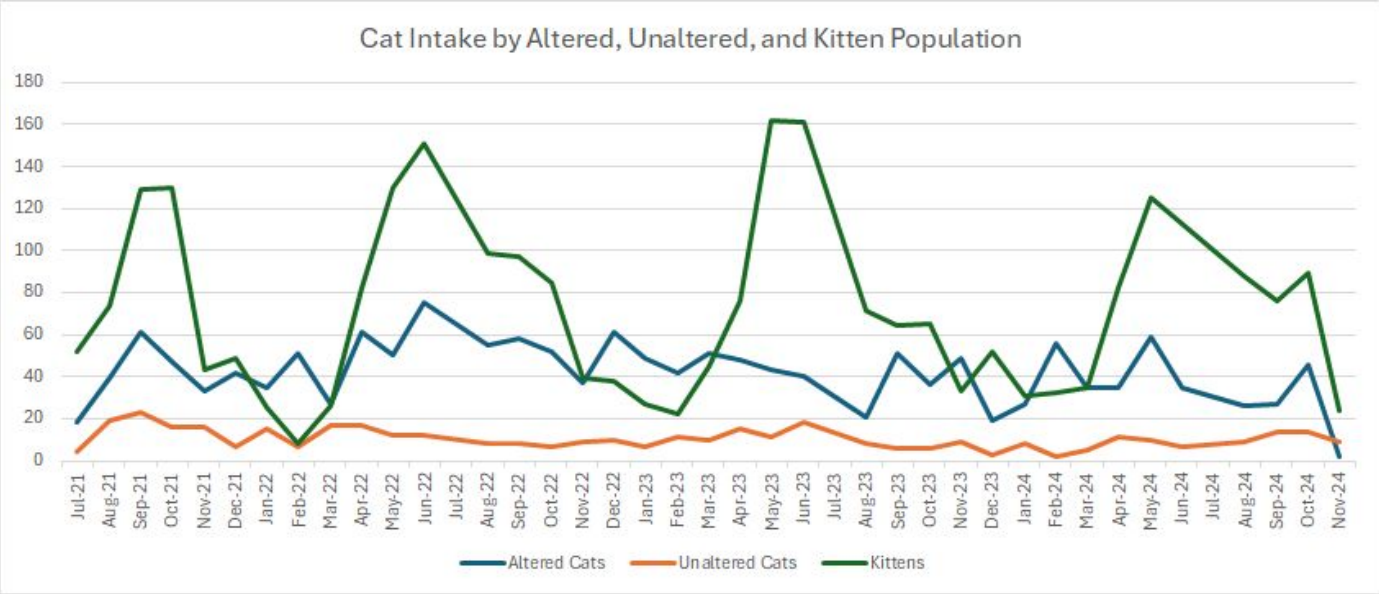
$$K_6 = (0.25)K_0 = K_0 r^6$$

$$0.25 = r^6$$

$$0.7937 \approx r$$

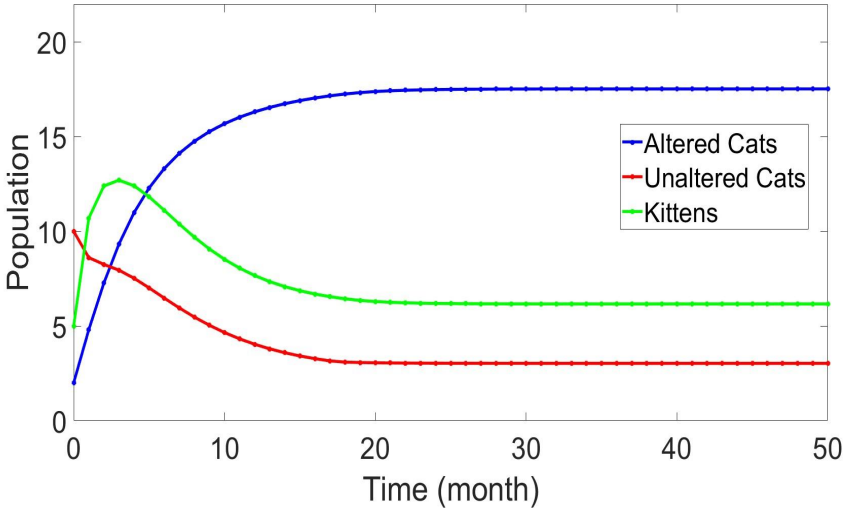
$$(1 - r) \approx 0.206 = \mu_K$$

Data Utilization

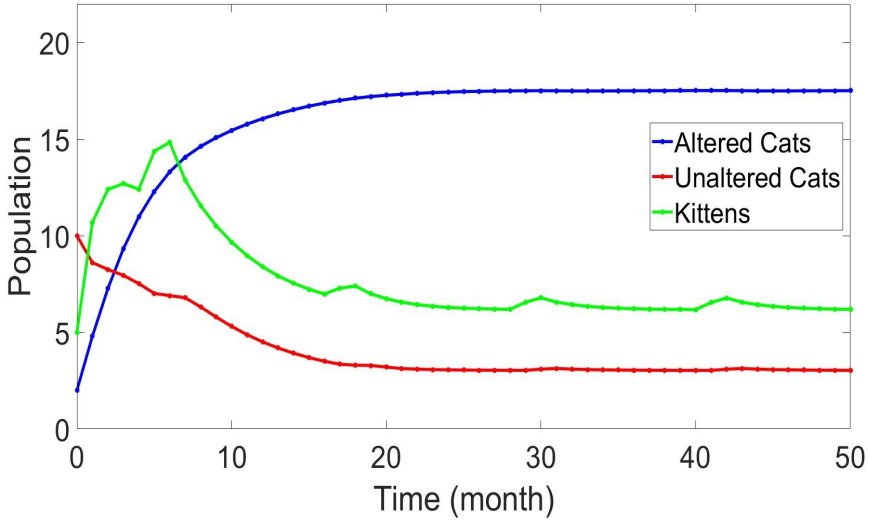


Simulations

No Baby Boom

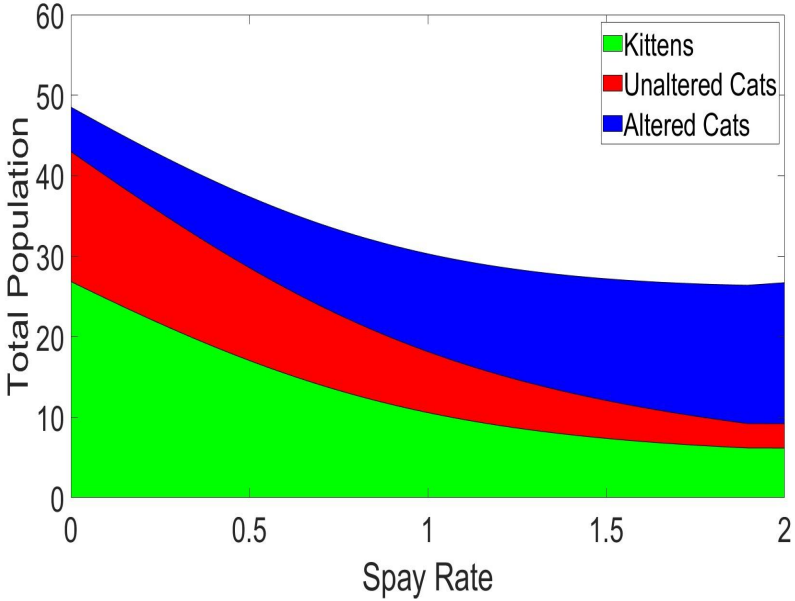


Baby Boom

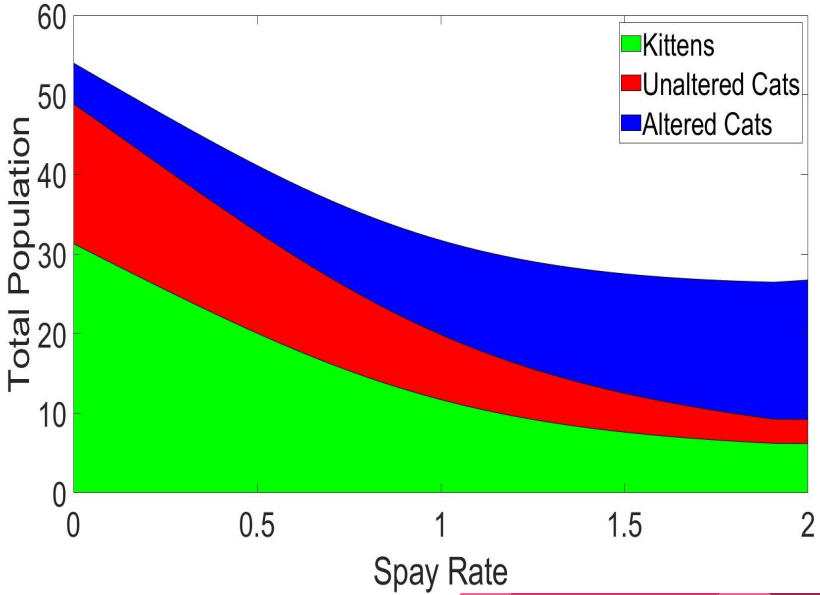


Simulations: Stacked Population

No Baby Boom

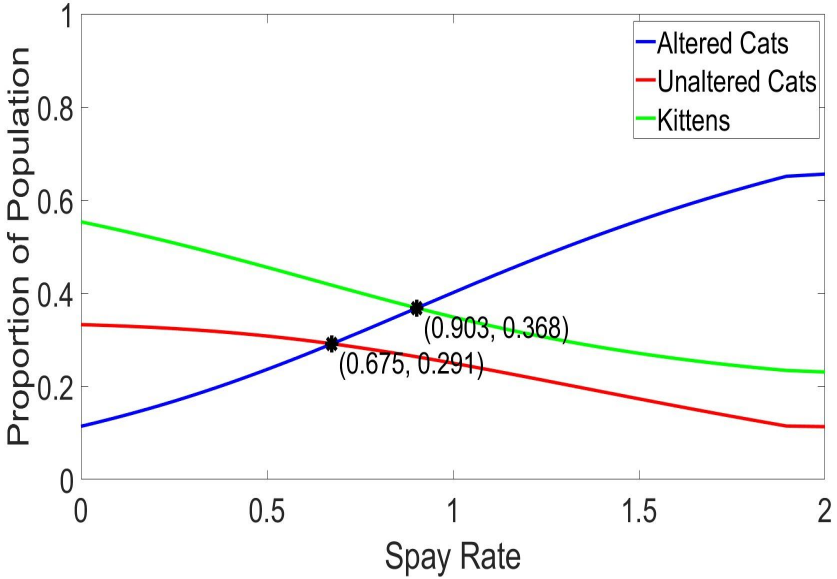


Baby Boom

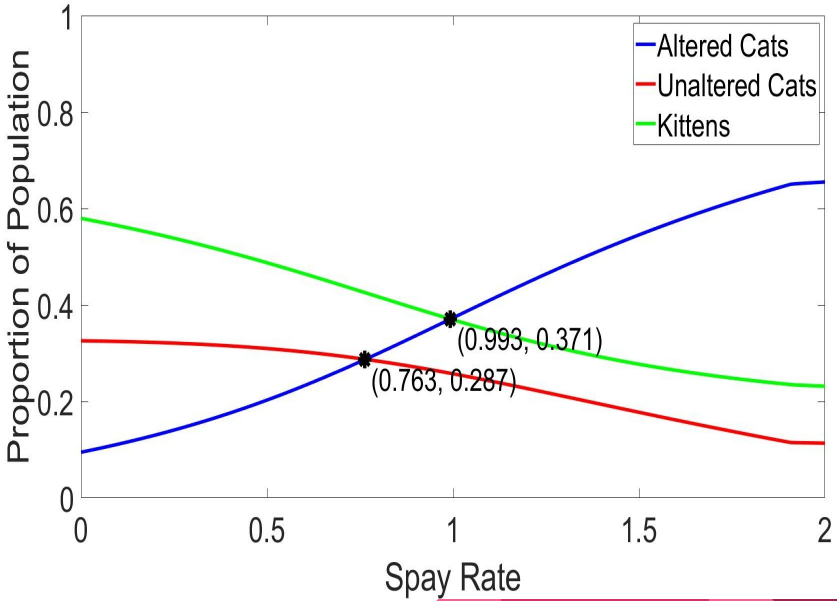


Simulations: Proportion of Total Population

No Baby Boom



Baby Boom



Questions?