Population Dynamics and Potential of a Long-Acting Contraceptive

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Overview

- Definitions and terminology
- Discuss the requirements and limitation of population dynamics modeling
- Present unchecked population model
- Present 3 year contraception model results

Populations

- Populations are a group of animals who live and reproduce together
- Populations are also “cats in a shelter”, “feral cats in the neighborhood”, “all cats living in a county”, etc.
- Different populations likely are different

Data for Populations: Vital Rates

- Closed populations have only:
  - Birth (fecundity, fertility)
  - Death (mortality, survival)
- Open populations also have:
  - Immigration (movement into the population)
    - Abandonment, adoption
  - Emigration (movement out of the population)
    - Lost, adopted, euthanized

How measure vital rates

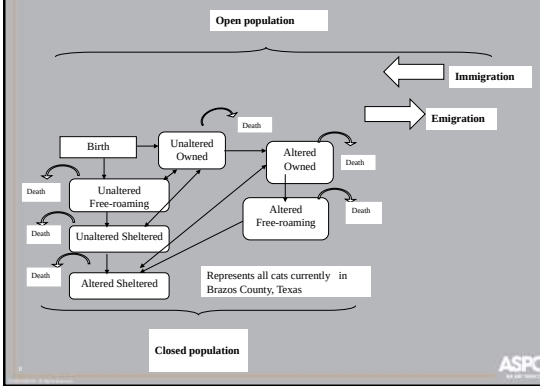
- Fecundity/birth rates
  - Use only females
  - Males ignored in models if plenty to go around
  - Average # female kittens/litter
  - May be different in different life stages or ages
- Mortality/death rates
  - Percentage of cats surviving each year

Population Growth

- If births and immigration greater than deaths and emigration
  - Population grows with time
- If birth and death equal (and closed population), stable population
  - Zero growth
- If births/immigration are lower than deaths/emigration
  - Population will decrease: TNR goal

Population Dynamics Models

- Provide a simplified version of a complex biological system
- Allow projection into the future of population size, composition
- Allow testing of management methods for feral cats
  - Including efficacy of spay/neuter



Population Dynamics Model Results

- Are influenced by many factors (to follow)
- Can tell us what are the most important factors
- And there are many different types of models
  - We won't deal with that

Cat-related Factors Influence Models

- Different birth and death rates by age or life stage
  - We don't know about survival difference by spayed or not
- Seasonal effect on breeding
- Male behavior: there are enough males to breed all available females
  - Males aren't "rate limiting"

External Factors that Influence Models

- How long a time period are we studying?
  - Catastrophic events like weather and disease
- Carrying capacity of the environment
  - How many cats will food and shelter sustain?
  - In urban areas, very high populations are known
- Type of population are we looking at
  - One colony, one park, one community, one state
  - For population dynamics must be a single intermingling group that breeds together

Population Assumptions Influence Models

- Closed or open population (immigration or emigration)
  - If the population is feral cats in a county
  - Immigration is:
    - Owned cats lost or abandoned
    - Feral cats that move in from neighboring counties
  - Emigration is:
    - Adoption of strays
    - Removal of ferals

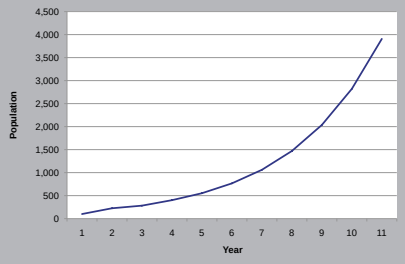
Models to Follow

- Apply the spaying, survival and births annually for a 10 year period
  - We assumed nothing catastrophic in that time
- Closed population
- No seasonal effect
- Unchecked population grows exponentially (based on data it does…)
  - But clearly other factors that prevent this

Data for Models from Literature

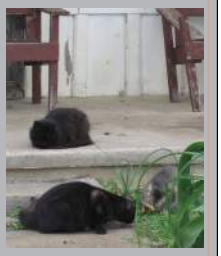
- Survival of < 1 year olds (juveniles)
  - 27% to 73% to their first birthday
- Survival of adults (≥ 1 year)
  - 55 to 78% each year (average of 3 year life span)
- Birth rates
  - 0.4 to 1.6 female kittens/juvenile female/year
  - 2 to 3.8 female kittens/adult female/year
- Can do many combinations
  - Presenting mid-range fertility and survival

Hypothetical cat population (n=100 to start), no sterilization (mid level rates)



What about 3 Year Contraception?

- Instead of surgical (permanent) sterilization
- Cats become fertile after 3 years and would need re-treatment (trapping)
- Can this sort of product be useful for feral cat population control?



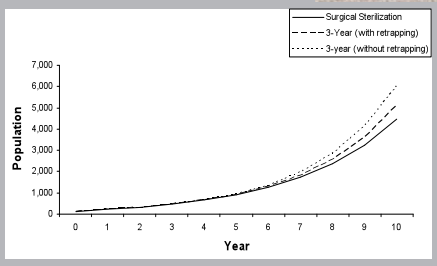
3 year Contraception Model

- Always works for full 3 years
- Closed population
- Used a variety of survival and fertility data
- Compared to permanent sterilization (eg surgical)
- Will 30% of the population treated stabilize the population?

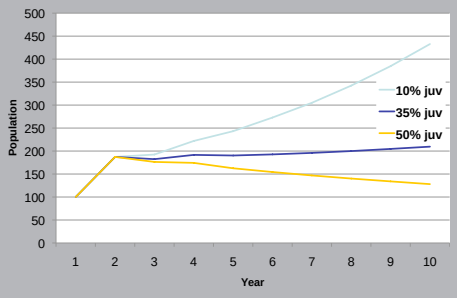
3 Year Contraceptive

- 30% isn't high enough for mid fertility and high survival
- Control of population very dependent of survival times
  - If average life span > 3 years, efficacy will go down
- Re-trapping of previously contracepted cats important with higher survival rates
- Much better than doing nothing

Results with 30% of Females "Treated"



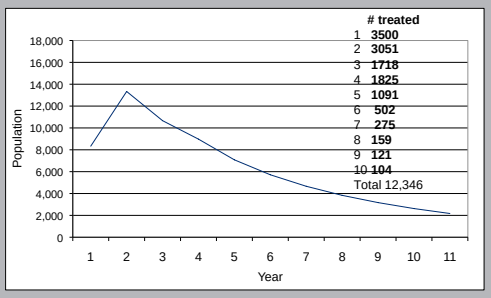
35% 3 year Adult Contraception with Re-trapping (mid levels)



If we change the % of juveniles, how many contraceptions each year?

Year	# Total Tx (35:35)	# Total Tx (50:35)	# Total Tx (10:35)
1	25	25	25
2	30	17	38
3	26	21	29
4	28	25	28
5	27	25	26
6	25	27	21
7	24	30	19
8	24	33	17
9	25	37	16
10	25	42	15
Total	259	280	235

100,000 people, ~16,000 cats, 60% contraception with re-trapping



To Halt Population Growth

- Annual female juvenile and adult 3 year contraception of 60% of intact cats
  - If also re-trapped previously contracepted cats at 60%
  - If don't re-trap contracepted cats at 60%, population slowly grows
  - This is for mid-range fertility and a 3-year survival

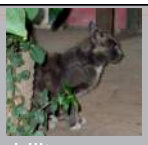
With Permanent Sterilization

- Need 51% of adult and juvenile female cats be surgically sterilized annually
- Or, ~71% of the total female and 81% of the adult female population sterilized at all times
- Without juvenile sterilization, 91% of adult intact cats would need to be sterilized annually
- After stabilized, would be sterilizing ~14% of the total female population per year

What We Learned

- There is a lot of variability in reported survival and birth rates of cats
- No data on:
  - Carrying capacity
  - Long-term "natural" cat populations
  - Survival following sterilization
- Little data on:
  - Immigration or emigration

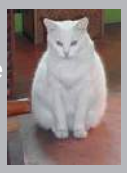
Lessons to Remember



- Different populations of cats of interest likely also have high variability
  - Some knowledge of this is needed for models
- Closed populations rarely realistic
  - Can be useful for comparison purposes
- Usually survival, rather than birth rates, are most important factors for the results
  - Juvenile survival usual key…have to survive to breed

Key Lessons

- Juvenile (< 1 year old) cat reproduction much more important than adults
  - So focusing on < 1 year olds gives a great bang for the sterilizing buck
- Populations that can be spayed at reasonably high rates must be targeted
  - Doing a few cats from many separate populations won't help
  - Doing all the cats in small populations results in zero population growth



Acknowledgments

- Dr. Christine Budke
- ACC&D, Joyce Briggs

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- Budke, Slater. Understanding Population Dynamics Models: Implications for Veterinarians. In: Consultations in Feline Internal Medicine, 6. Ed. JR August. W.B. Saunders: Philadelphia, Nov 2009.