GUIDANCE DOCUMENT

Briefly Summarizing Key Findings and Their Practical Application for Managing Free-Roaming Cat Populations

Companion piece to the publication "Simulating Free-Roaming Cat Population Management Options in Open Demographic Environments", by Miller PS, JD Boone, JR Briggs, DF Lawler, JK Levy, FB Nutter, M Slater, and S Zawistowski. PLOS ONE 9(11): e113553. doi:10.1371/journal.pone.0113553. 2014.

Prepared by the ACC&D Free-Roaming Cat Model Development Team:

John Boone, PhD - Great Basin Bird Observatory
Joyce Briggs, MS - Alliance for Contraception in Cats & Dogs
Dennis Lawler, DVM, FNAP - Illinois State Museum, Pacific Marine Mammal Center Laguna Beach
Julie Levy, DVM, PhD, DACVIM-University of Florida, College of Veterinary Medicine
Philip Miller, PhD - IUCN/SSC Conservation Breeding Specialist Group
Felicia Nutter, DVM, PhD, DACZM - Tufts University
Margaret Slater, DVM, PhD - ASPCA
Steve Zawistowski, PhD, CAAB - ASPCA

INTRODUCTION

In 2013, an expert group organized by the Alliance for Contraception in Cats & Dogs (ACC&D) completed work on a detailed computer simulation model for free-roaming cat populations, which was published in 2014. This model exceeded past efforts in its scope and level of detail, and provided substantial insight into the most effective ways to manage free-roaming cats. In this document, we translate these lessons into guidelines for trap-neuter-return (TNR) management programs. Those interested in reviewing and evaluating the full rationale for our conclusions should consult the full publication, available on-line and cited above.

CONCEPTS

Although free-roaming cats are unique in many respects, they are still subject to many of the same factors that regulate wildlife populations. Some of these factors, such as survival rates and reproductive rates, will be familiar to readers. Others that may be less familiar are introduced in this section. In contrast to most previous efforts, our model incorporated these complex regulating factors in a realistic way.

Carrying capacity: Every environment has an upper limit to the number of free-roaming cats that it can support, which is determined by the amount of resources (food, shelter, etc.) that are available. This limit is called the carrying capacity, which is often abbreviated as "K". Cat populations in some places may be at or near K, which means the population cannot grow. In other places, cat populations may be below K, which means the population will grow unless constrained by some factor other than resource availability. A common management goal may be to reduce cat numbers below their local carrying capacity, sometimes substantially below that level.

Density-dependence: Cat populations can be characterized by their rates of survival, reproduction, and dispersal (i.e. movement out of the cat's original home range), among others. However, these rates are not necessarily fixed for a given population. Instead, they may have one value when the population is at a high density and a different value when it is at a low density. As one example, survival rates of kittens will almost always be lower when the population is at K (and resources are limited), than when the population is below K (and resources are therefore more abundant). Density-dependence tends to operate in a way that keeps the population close to K, and therefore it can make it more difficult to humanely reduce the size of a target population. It is important to note that this phenomenon, sometimes described colloquially as the "vacuum effect", can occur anytime a population is reduced below K, regardless of whether that reduction occurred because of a cat removal program or a TNR program.

Dispersal and Abandonment: Most often, the population we are targeting for management has some degree of contact with neighboring populations, allowing cats to move from one population to another. As our target population drops below K, resource limitations will be relaxed, and immigrating cats will be more likely to become successfully established. Dispersal can, therefore, work to counteract our attempts to reduce population size. Abandonment of formerly owned cats or litters can function in a similar way to supplement our target population.

Lag Times: When we sterilize members of a cat population and then return them to their place of origin, the size of that population does not immediately change. That change only occurs over time, as sterilized animals fail to reproduce and eventually die. This is in contrast to "removal" methods of population management, which have an immediate impact on population size. Those seeking to manage free-roaming cats humanely need to be aware that substantial lag times in population response are to be expected when relying solely on sterilization.

RECOMMENDATIONS AND GUIDELINES

Identifying the Target Population and Setting Goals: You should begin any management program by carefully delineating the target population, and defining your management goals. Populations are typically defined by the area that they occupy (several city blocks, a town, a campus, etc.), but can also be defined in terms of specific places where they can be observed (a feeding station). Goals could include reducing the current population size by some percentage, preventing further increases in population size, or maintaining a stable population while preventing "excess" reproduction. Then, a monitoring program should be implemented to measure progress towards your goals. For more information on how to monitor cat populations, see *Counting Cats: A Generalized Population Monitoring Program to Inform the Management of Free-Roaming Cats*,[1]).

Managing Carrying Capacity: Before discussing recommendations for reproductive management, it should be noted that in some cases, reducing carrying capacity by eliminating of

[1] *Counting Cats: A Generalized Population Monitoring Program to Inform the Management of Free-Roaming Cats*, John D. Boone. Ph.D. Senior Biologist, Great Basin Bird Observatory; Board of Directors, SPCA of Northern Nevada and Margaret Slater, D.V.M., Ph.D. Senior Director of Veterinary Epidemiology, ASPCA Shelter Research and Development, available here.

gradually reducing unmanaged sources of food and shelter can be an effective way to reduce population size.

Target Rates for Sterilization: In order to reduce population size, it is necessary to achieve and maintain a high sterilization rate within the target population. The threshold sterilization rate necessary to "tip the balance" towards population size reduction will vary somewhat from site to site, but a consistent 75% sterilization rate will be sufficient for most locations. If this sterilization rate is maintained over time, the population will begin to decline after a lag period (see above), and eventually will stabilize at a lower density (typically around ½ of K). Higher sterilization rates will produce larger declines over time. Maintenance efforts are critical. If management efforts are discontinued at any point, the sterilization rate will decline, and population will move back towards K.

In order to confirm compliance with these sterilization targets, some form of ongoing population monitoring is needed, along with some form of marking to identify sterilized animals. ACC&D provides guidance on both topics, which is available at www.acc-d.org. Monitoring allows us to determine the current sterilization rate, and to set periodic trapping targets necessary to achieve and maintain that sterilization rate. Since the number of unsterilized cats remaining in the population will change over time, these targets will also change over time. A worked example for determining trapping targets is shown in the Appendix.

Non-Surgical Sterilization and Contraception: Non-surgical fertility control for cats is not widely available at present, but ACC&D is actively fostering the development of new products and anticipates their increasing use in coming years. Some of these methods may produce permanent sterilization, and others may produce temporary contraception. Permanent non-surgical sterilization will have the same population-level impacts as traditional surgical sterilization on a per-procedure basis, with the added benefits of lower cost and faster treatment times that may allow more cats to be sterilized. Temporary contraception will have the same efficiencies, but because some cats will eventually return to fertility, it will necessarily have less impact on population size than permanent sterilization on a per-procedure basis. We therefore investigated the differences between permanent sterilization (either surgical or non-surgical) and a temporary contraceptive (such as GonaCon™) featuring three-year effectiveness. We found that the contraceptive method could effectively reduce population size, but that reaching and maintaining a given sterility rate would require the treatment of about 1/3 more cats than would be necessary with permanent sterilization. Despite this, we anticipate that it may often be more cost effective to treat a larger number of cats with a non-surgical contraceptive than to treat fewer cats with permanent surgical sterilization, and we are currently conducting an economic modeling analysis to create more detailed guidance.

Trapping: Those managing cat colonies should be aware that as the proportion of unsterilized cats left in a population declines, it may become increasingly difficult to capture remaining reproductively active animals. Although the overall amount of trapping effort to maintain the target sterilization rate will not necessarily increase over time, the effort required to capture a single, unsterilized cat likely will increase. Realistic planning should be conducted to ensure that sufficient trapping effort can be mobilized to reach and maintain the target sterilization rate.

Lag times: Once the target sterilization rate is reached, population-level effects may become noticeable in about two years, but it will take about five years for a target population to begin to stabilize at a new, lower population size, and up to 10 years to fully stabilize at this new, lower level. Therefore, management programs that last for less than five years may not produce a measurable population impact. If management is terminated or suspended, the time required to return to a pre-management population level will probably be much shorter than the time required to produce the population decline.

Dispersal and Abandonment: The recommendations presented above are based on an assumption that modest levels of immigration and abandonment are occurring in the target population (i.e. < 5% of K per year). If dispersal and abandonment can be reduced significantly as part of our management efforts, the effectiveness of a population control program can increase dramatically. Functionally, this means that less

effort is needed to maintain the target sterilization rate, or conversely, that a higher sterilization rate can be reached for the same amount of effort. If, however, dispersal or abandonment is present at higher levels than what we assume, or if it increases substantially as our target population begins to decline, it can easily undo any positive impacts of our management efforts. There are several lessons implicit in this finding:

1) Management efforts will be most effective for target populations that are relatively isolated from neighboring populations, which limits the potential extent of immigration. This reality should factor into the identification of the target management population.
2) As dispersal and abandonment rates increase, population control programs are less likely to be effective. Accurately measuring dispersal rates is a specialized and labor-intensive activity, but colony caretakers may be able to get some sense of relative dispersal rates by observing the frequency with which new individuals are observed within their target population.
3) Educational and outreach efforts to reduce abandonment can significantly aid in population control, and may be a critical management approach in many situations.

Removal versus Sterilization: Under the assumptions of our model, removal of an individual cat from a population (by adoption or euthanasia) has a greater impact on population size reduction than sterilizing and then returning that individual. This finding is intuitive and expected in that removal immediately subtracts the individual's reproductive capacity AND that individual itself from the population, whereas sterilization subtracts only its reproductive capacity. This finding emphasizes the importance of seeking adoption outlets for free-roaming cats that can be socialized, typically kittens and juveniles.

Kittens versus Adults: Sterilizing a single young cat which has an entire reproductive life lying ahead of it has a greater long-term impact on population size than sterilizing a single older cat. However, targeting only juveniles (< 6 months of age) for sterilization is a poor strategy for two reasons. First, juveniles typically comprise a distinct minority of the reproductively active cats within the target population at any one time. Therefore, an exclusive focus on juveniles would fail to address most of the cats that are generating litters. Second, mortality of juveniles can be higher in many circumstances than mortality of adult animals in their prime reproductive years. Therefore, the impact of sterilizing juvenile animals is "diluted" by their typically higher removal rate from the population. Our results clearly indicate that it is better to target all reproductively capable cats for sterilization regardless of age.

Females versus Males: In principle, it would be far more effective to target females for sterilization than males. However, because it is not possible to selectively capture females, we recommend that all captured females and males be sterilized. An exception could occur if more cats are trapped during a given trapping session than can be sterilized. In that case, females should be sterilized preferentially. Depending on the method of sterilization and the need to address issues other than pure population control, surgical sterilization of males may have the benefit of decreasing nuisance behaviors and improving their welfare.

Integrated Management: Combining reproductive intervention with outreach efforts to reduce abandonment, adoption programs for cats that can be socialized, and management of resources (food and shelter) is likely to be more effective than any single approach in isolation.

UNKNOWNS AND NEEDS FOR BETTER DATA

Our modeling effort and the recommendations derived from it are based on the best information we could obtain about the dynamics of free-roaming cat populations. We acknowledge, however, that this information is incomplete. As our understanding of cat populations improves, our recommendations can improve as well. In this

section, we describe the most important information gaps that currently exist, and suggest topics for further study.

Behavioral Role of Altered Animals: It is often stated that altered cats "fill up" space in a population and prevent other, unsterilized animals, from moving in. However, there is in fact very little data that demonstrate the degree to which this phenomenon actually occurs. In particular, we do not know whether neutered males have any capacity to discourage remaining unaltered males from having free access to receptive females. We currently assume that no such interference exists within our model. Further study of how sterilized animals function within a population is necessary to clarify this matter.

Dispersal: Some information is available for cat dispersal rates, but it is limited. Better information about typical dispersal rates, the range of dispersal rates under different conditions, and the survival rates of dispersing cats is needed. In particular, we assume that dispersal is strongly density-dependent, but do not have enough information to explicitly model this process. In our modeling effort, we only explored two alternatives; a modest fixed level of dispersal, or no dispersal. Further exploration of the impacts of higher levels of dispersal would be informative.

Frequency of Abandonment: Similarly, better data regarding typical abandonment rates under different conditions is needed. Locations with high-abandonment rates may be functionally impossible to manage effectively until abandonment rates are reduced. We also need a better understanding of the socio-economic and attitudinal factors that contribute to higher abandonment rates and prevention of abandonment.

Metapopulations: As previously mentioned, most of the cat populations that are targeted for management are actually part of a larger, inter-connected network of populations that is called a metapopulation. We have not yet explicitly modeled these larger systems, and therefore cannot determine the optimal management approaches. More explicitly, we need to investigate whether it is better to intensely manage cats within a small part of the metapopulation, or to manage a larger part of the metapopulation at lower intensity.

Cost-Benefit Analysis: A comparison of different management strategies should explicitly incorporate cost, especially when attempting to determine the relative merits of current surgical approaches and the non-surgical approaches that are beginning to become available. At present, we have not considered cost in our analysis. However, we are currently in the process of conducting a cost-benefit analysis for surgical vs. non-surgical methods.

APPENDIX: A SIMPLE METHOD TO ESTIMATE TRAPPING AND STERLIZATION TARGETS

The method described in this appendix can be used to generate a rough estimate of the number of unsterilized cats that are present in your target population. This, in turn, allows you to set trapping and sterilization targets for each trapping session. The method depends on having previously sterilized and marked some cats, so it cannot be employed at the very beginning of a management program, only once it is underway. We acknowledge that this method makes a number of assumptions that may be imperfectly met, and therefore suggest that its results be interpreted with caution.

This method assumes that every sterilized cat is marked in a way that is readily visible. It requires that you count or estimate three quantities:

1) The number of sterilized cats in your target population. In early stages of your program, this is simply the cumulative number of sterilized cats. Later, you will have to subtract estimated mortality from this total.
2) The actual number of sterilized cats that you count during an observation session or trapping session.
3) The actual number of unsterilized cats that you count during that same observation or trapping session.

We recommend that you consult *A Generalized Population Monitoring Program to Inform the Management of Free-Roaming Cats* for assistance in designing a valid monitoring program that will permit you to estimate these quantities.

Example: During the first year of a TNVR program, 150 cats were sterilized. Based on typical annual survival and dispersal rates, we estimate that of these 150 cats, 10% have died or left our target population, leaving about 135 (item #1 in the list above). During a monitoring survey preceding our upcoming trapping session, we counted 40 marked (sterilized) cats (item #2 in the list above) and 45 unmarked (unsterilized) cats (item #3 in the list above). In order to estimate the number of unmarked and unaltered cats remaining in our population, we perform the following calculation:

Estimated total number of marked and altered cats (TM) = 135
Observed number of marked cats (OM) = 40
Observed number of unmarked cats (OU) = 45

Estimated total number of unmarked, unsterilized cats (TU) = (OU x TM) / OM

So, TU = (45 x 135) / 40 = 152, and the estimated total number of cats in the population (TC) is given by TC = TU + TM, or 135 + 152 = 287.

Of the 287 cats estimated in our population 135 are sterilized, giving an estimated sterilization rate of 47%, well below the minimum target sterilization rate of 65%. In order to reach a 65% level, a total of 187 cats would need to be sterilized, or 52 more cats than are currently sterilized.

With this information, we could target the capture and sterilization of 52 cats, if that is a feasible goal during the upcoming trapping session. If not, fewer cats could be targeted, but with the realization that the effort described above will be repeated to ensure that sterilization rate becomes progressively higher as time passes. We remind the reader the 65% is a minimum target rate, and that aiming for a higher rate provides more assurance that a positive result will be achieved in a timely way.