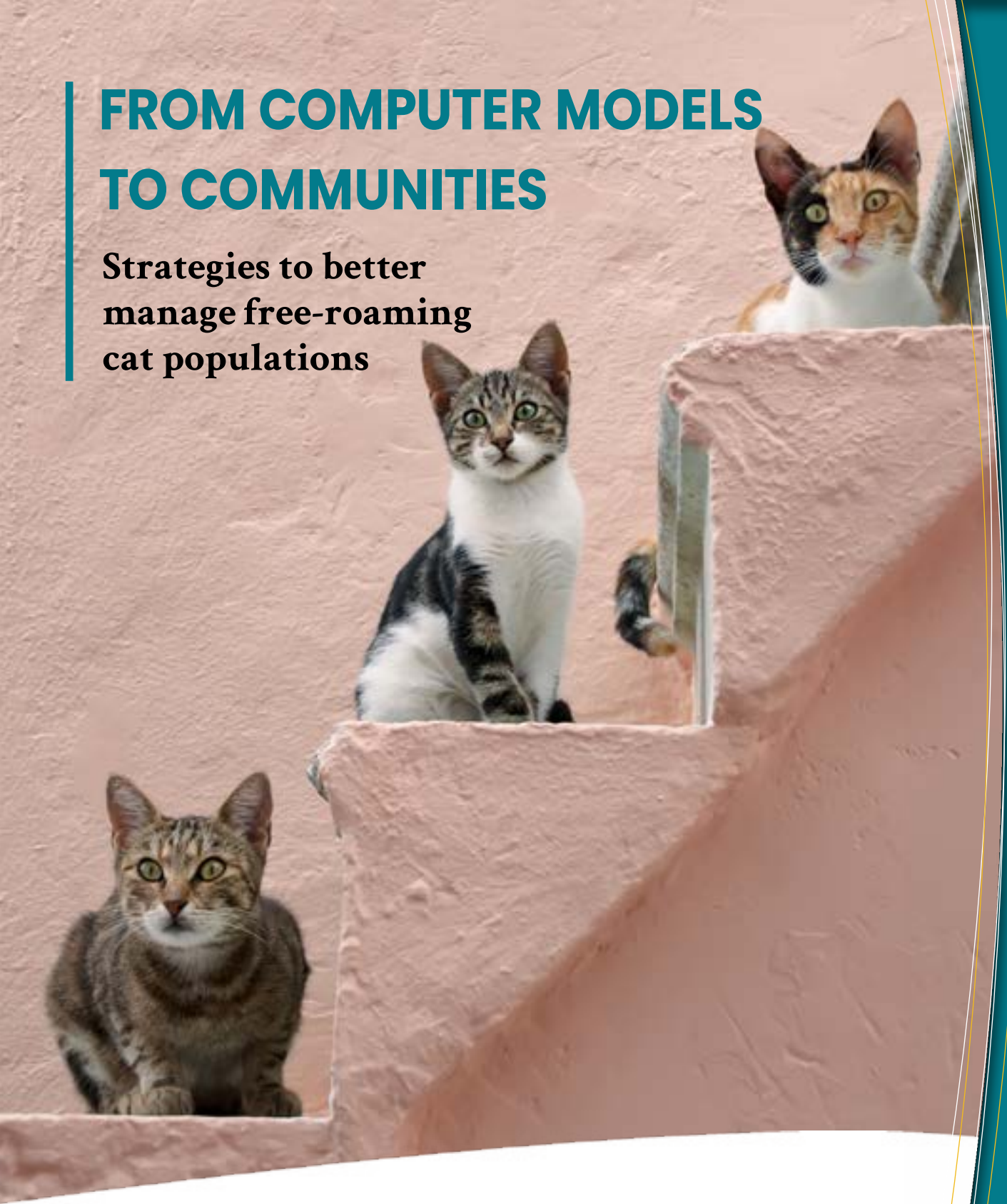
FROM COMPUTER MODELS TO COMMUNITIES

Strategies to better manage free-roaming cat populations



ACC&D
Alliance for Contraception in Cats & Dogs

Modeling team members

- Aaron Anderson, PhD, USDA APHIS NWRC
- Valerie Benka, MS, MPP, ACC&D
- John Boone, PhD, Great Basin Bird Observatory; HSI / HSUS; ACC&D Board of Directors
- Joyce Briggs, MS, ACC&D
- Julie Levy, PhD, DACVIM, DABVP, University of Florida College of Veterinary Medicine; ACC&D Scientific Advisor
- Philip Miller, PhD, Conservation Planning Specialist Group, Species Survival Commission, IUCN; ACC&D Scientific Advisor
- Felicia Nutter, DVM, PhD, Cummings School of Veterinary Medicine at Tufts University
- Margaret Slater, DVM, PhD, ASPCA® Strategy & Research
- Christopher Slootmaker, PhD, Mountain Data Group
- Steve Zawistowski, PhD, ASPCA® (emeritus); Hunter College

Acknowledgements

The publication of this guidance document was supported by a grant from the Kenneth A Scott Charitable Trust, a KeyBank Trust. Early model development was supported by the American Society for the Prevention of Cruelty to Animals and Merial, now Boehringer Ingelheim Animal Health, through grants to ACC&D. Funders had no role in study design, data collection and analysis, decision to publish, or preparation of the publications.

CONTENTS

Introduction

Trap-neuter-return (TNR) projects for free-roaming cats (FRCs) can be done in a variety of ways. Some projects sterilize cats fairly evenly and consistently across a large geographic area for an extended time period. Others focus efforts in more concentrated areas or over shorter time periods. Still others simply respond to needs or requests where and when they arise. Projects vary in size and scope, as well; some limit activities to capture and sterilization, while others add additional elements of care, like vaccination and ongoing feeding and caretaking. Still others weave in adoption and relocation, when appropriate.

Knowing more about the likely impacts of different TNR strategies can help people make more informed choices. It can also help to create better, more cost-effective management policies. At the moment, there is little real-world data to help in choosing the best approach to TNR. Fortunately, there is a "next best" option: use what real-world data exist, add expert input where needed, and simulate the effects of different TNR approaches using a realistic computer model.

The Alliance for Contraception in Cats & Dogs (ACC&D) did just this. We brought together a team with diverse expertise to create a realistic simulation model of FRC populations. The process relied a lot on concepts and work from wildlife biology (we define some of these concepts and related terminology in Appendix A). One of our main goals was to identify the most effective and cost-efficient ways to reduce the size of FRC populations over a 10-year period when using sterilization-based management. We also compared these to lethal approaches.

Complete descriptions of our simulation model are available in three peer-reviewed articles. All can be downloaded for free:

1. Simulating Free-Roaming Cat Population Management Options in Open Demographic Environments (PLOS ONE, 2014) – analysis of population size outcomes of different management approaches; there is no cost data.

2. Guidance for management of free-roaming community cats: a bioeconomic analysis (Journal of Feline Medicine and Surgery, 2021) – analysis of both population size and cost outcomes of different management approaches, with a focus on balancing population impacts and expenses.

3. A Long-Term Lens: Cumulative Impacts of Free-Roaming Cat Management Strategy and Intensity on Preventable Cat Mortalities (Frontiers, 2019) – analysis of how to save the most lives when managing FRC populations, with a focus on minimizing kitten deaths.

The publication you are reading now shares practical guidance from our modeling results. It is intended for people and agencies that want to manage FRC populations by reducing their size humanely, and to do it better—more effectively, at a lower cost, and with fewer deaths of cats and kittens along the way.

Note

This guidance is based on a simulation model that draws on "real world" data and expert input. However, the reality is that no model can exactly predict future outcomes or account for all the unique factors of an individual project. No matter what kind of management you do, monitoring will tell you if FRC numbers in your population are responding as the model would predict. Therefore, monitoring is important, particularly if your goal is to reduce population size. Monitoring is discussed in the "Recommendations and guidelines" section.

An overview of our computer simulation model

We started each simulation with 50 cats in a "focal population." A focal population isn't necessarily a single group of cats. It could be many smaller groups that can interact with one another. Most FRCs don't live on islands, and so our model assumed that there would be some immigration of new cats, emigration of existing cats, and, unfortunately, abandonment of new cats by people. Even though we began with 50 cats in each simulation, we confirmed that our results and conclusions also apply across a wide range of starting population sizes.

In our modeling, we simulated many of the ways that FRC populations are managed: TNR; removal for adoption; removal for euthanasia; removal for a combination of adoption and euthanasia; combined TNR and removal for adoption; periodic culling; non-surgical contraception[1]; and taking no action. All of these management approaches were then simulated across a range of intensities. For TNR models, we defined "high intensity" as sterilizing 75% of intact cats every six months. For removal models, we defined "high intensity" as removing 75% of all cats (most would be intact) every six months. "Low-intensity" meant that only 25% of intact cats were sterilized, or 25% of all cats removed, every six months.

We simulated each combination of management type and intensity over 10 years. We then calculated what would be the final FRC population size; total number of cats sterilized, euthanized, and adopted; total cost; and other details. We combined these into a "cost efficiency index" (CEI) that summarized the reduction in population size achieved on a per-dollar basis.

Here are our key findings. You can learn more in the journal publications. The numbers at the end of each bullet reference the relevant article.

1 There are currently few options for non-surgical fertility control for cats, but ACC&D is working to advance new products and anticipates future options for FRCs. You can learn more at www.acc-d.org. Technologies that can be applied in the field would not only omit the need for surgery; they would also omit the need for transport and recovery time for treated cats.

Key findings

- **High-intensity TNR is significantly more effective at decreasing the cat population, preventing kitten deaths and controlling costs than lower-intensity TNR.** When TNR is done more intensively at the beginning of a project, it pays off in terms of greater population size reduction, better cost efficiency, and less work required later on. In short, despite its initial cost, high-intensity TNR provides more "bang for the buck." Lower-intensity TNR costs more and produces smaller population size reductions in the long run. However, if it is the only option, it can still accomplish more limited population control as well as benefitting the cats who are sterilized. (2)

- **High-intensity removal is effective at decreasing the cat population, but it is only cost-efficient with lethal approaches.** High-intensity lethal removal (trapping and killing FRCs) is the most cost-efficient way to reduce population size. However, this requires killing a large number of cats over a short period. Low-intensity lethal removal and periodic culling are more commonly practiced in communities. Low-intensity lethal removal and periodic culling are much less effective for population size reduction, as well as more expensive. Therefore, although high-intensity removal could in principle work, many people want alternatives for their communities that don't require killing large numbers of cats, and high-intensity TNR is a good alternative. (2)

- **Removal for adoption is a humane alternative, but costs more.** Removing cats for adoption has the same population reduction impact as lethal removal, with the advantage of not killing cats. However, the costs of adopting a cat are typically much higher than the costs of euthanizing it. Removal for adoption also costs more than TNR. (2)

- **Immigration and abandonment of cats can sabotage success.** Immigration and, especially, abandonment of intact cats and kittens can dramatically reduce the impact and efficiency of any population management intervention. (1, 2)

- **Management approach and intensity dramatically affect numbers of preventable deaths.** Kittens have a big impact on population management efforts. They are also a major animal welfare consideration given their high death rate, and a majority of FRC mortalities are kittens. High-intensity TNR can reduce preventable kitten deaths by over 95% (a reduction that is considerably greater than other management approaches), and increase cumulative lifesaving. (3)

In a nutshell

High-intensity TNR can be an excellent strategy to achieve cost-effective, long-term population reduction and limit preventable deaths of cats in the process Achieving the best outcomes, however, requires concentrating – or "front-loading" – management so that a large proportion of cats in your target population are sterilized in the shortest possible period of time (we'll describe in the next section exactly how you do that). Front-loading means your costs and time investments will be high at the beginning but will decline substantially over time and be lower overall when summed over multiple years. Less-intensive TNR management also can reduce populations and preventable deaths over time to a lesser degree (and for a higher cost) and should not be dismissed if it is the only realistic option.

Recommendations & guidelines

We offer the following recommendations and guidelines to help you achieve the best outcomes in reducing both numbers of FRCs and preventable deaths of cats and kittens. All of the recommendations are based on the key findings listed above combined with the experience of those involved in this project.

- **Identify the target population and set goals:** You should begin any management program by 1) identifying the FRC population that is your management target, and 2) defining your management goals.

  Cat populations are typically defined by the area that they occupy (e.g., several city blocks or a campus), but they can also be defined by the specific places where they are observed (e.g., a feeding station). FRCs can live in loose knit groups, which we assumed for our analyses, or they can live singly.

  Management goals should be clear and include relevant metrics, quantitative targets, and timelines. For example, a well-defined goal could be to "reduce the number of cats in the target population by 50% or more within eight years." Goals could also focus on such things as the cost of the management project, reducing nuisance behaviors, or improving cat welfare.

- **Build monitoring into your programs:** Once you define your goals, monitoring the target FRC population will help to identify your baseline numbers, measure progress, and support adaptive management. When resources allow, monitoring is strongly recommended and can be implemented in a variety of ways. Even proactively reaching out to feeders and caretakers can serve as monitoring and improve the effectiveness efforts to decrease population size. We offer one relatively simple approach in the section "A simple method to estimate trapping and sterilization targets," and more detailed advice here. For an even deeper dive into the topic of monitoring and other aspects of FRC management, we recommend the toolkit from our friends at the DC Cat Count.

- **"Frontload" TNR:** The long-term outcomes of your project will be much better if you perform as many TNR surgeries as possible early on, when the most cats are intact. This intensive, or "frontloaded," approach allows you to start benefitting from a mostly sterile FRC population almost immediately. This benefit will compound over time. "Slow and steady" does not win the race when it comes to TNR!

  How exactly can you frontload? There are at least a couple ways to think about it. One way is to follow the approach we used in our model and develop specific sterilization targets for every six-month period. If you choose this approach, it's very helpful to have monitoring data to help estimate the number of cats in your target population so that you can calculate these targets, as described in more detail at the end of this section.

  Alternatively, if it's not convenient to structure your efforts in six-month increments, you can achieve good frontloading by following these three steps:

  1. Get at least 75% of your target population sterilized as quickly as you can, even if means mobilizing additional short-term help and resources.
  2. Once this is done, you can scale back your effort in the original target area, but keep trying to push the sterilization percentage of your population progressively higher, bit by bit.
  3. Do not let the sterilization rate of your population fall below 75%.

  Though these two approaches are not exactly equal in terms of their likely population impacts, both are strongly frontloaded, meaning that most of the sterilization surgeries will occur at the early stages, and both will product better results than lower-intensity alternatives.

  One of the biggest challenges of frontloading is trapping enough cats to quickly reach a high sterilization percentage. Though we can confidently say that this approach is most effective long-term in terms of cost and reducing population size, it is

not logistically simple. One strategy might be to concentrate on mass trapping the "easier"-to-access cats first. After this phase, the program would focus on the smaller number of harder-to-reach cats and new cats entering the population in order to get those new cats sterilized as quickly as possible, and before they can reproduce. The longer this takes, the more it will cost in time and kittens born. When a high level of sterilization is achieved quickly, there are relatively few cats left intact, and so the actual number of cats still needing to be trapped and sterilized is relatively small.

Another common problem with frontloading occurs when your capacity to trap cats or do sterilization surgeries is insufficient to achieve frontloading within your entire target area of interest. In these cases, the solution is "phasing", which we describe in one of the sections below.

- **Immigration and abandonment:** Our recommendations assume modest immigration (especially of intact cats) and kitten abandonment in the target population (i.e., less than 5% of the population's carrying capacity per year). Our simulations suggest that these kinds of dispersal have a major impact on the results of FRC population management programs. As immigration and abandonment increase, programs are much less likely to be effective, and the cost to achieve a target outcome will be much higher. When they are reduced, cost-efficiency and effectiveness increase. This means that, when possible, programs could initially target FRC populations that are less likely to experience a lot of immigration due to natural barriers like rivers or highways. It is also beneficial to pair TNR with programs to identify and address the root sources of FRCs and cat abandonment in the community, including improving access to veterinary care, rehoming resources, and other community-based supports.
- **Maintenance:** To reduce the size of a FRC population, it is important not only to achieve a high percentage of sterilized cats within the target population, but also to then maintain that percentage over time. Maintaining a proportion of at least 75% will be sufficient for most locations without high levels of immigration or abandonment. The actual number of cats you'll need to sterilize to achieve and maintain this overall proportion of sterilized cats will be relatively high at first, but then will decline greatly once most of the population is sterilized.

  "Maintenance" sterilization is critical. If TNR stops, the percentage of cats in the population that are sterilized will decline over time. As this happens, the number of cats in the population will increase. To confirm that you are reaching sterilization targets, it is important to monitor the population. This involves using metrics, plus a mark (e.g., ear tip) to identify sterilized animals. Monitoring will allow you to determine how many cats in the population are sterilized and then set trapping targets to maintain a 75% goal. Since the number of unsterilized cats in the population will change over time, those targets will also change over time. We provide an example for determining trapping targets on page 10.
- **Phasing:** Phasing is a process where you first conduct an intensive TNR effort in one area, and then shift that intensive focus to other (usually nearby) areas. Given the value of frontloading to achieve the best results most efficiently, phasing is the only practical way to implement TNR across big areas, like whole cities or counties. But phasing can also be helpful in smaller areas like neighborhoods or zip codes when your capacity to trap cats or do surgeries is not sufficient to frontload the whole target area all at once.

  The idea is to first focus on a subset of the area where you can succeed in achieving a high sterilization percentage quickly, given your available resources. Then you move on to the next subset, while keeping an eye on the subset(s) that were addressed initially to maintain their sterilization rates. Over time, using phasing to increase the size of the population that is mostly sterilized makes your progress more robust and sustainable. We suggest building explicit phasing plans into your projects and funding proposals wherever possible.

- **Trapping**: Once you start doing TNR, the proportion of intact cats in the population will decline. This is great! However, it also means that it can become harder to trap the remaining intact animals. You will need to plan for how to trap enough cats to reach and maintain the target percentage of sterilized animals. This might involve using drop traps or novel baits. In addition, putting out a lot of traps to catch many cats in a short period of time might help to reduce numbers of "trap-shy" cats.
- **Population impact and lag times:** Once you reach your target for percentage of sterilized cats, you might see population-level effects in about two years. However, it will take about five years for a target population to begin to stabilize at its new, lower numbers, and up to 10 years to fully stabilize at this lower level. Therefore, management programs that last less than five years may not produce a measurable population impact, even when they are doing all the right things. This means that managing populations using TNR should be thought of as a longer-term undertaking.
- **Removal versus sterilization:** Removing a cat from a population (whether it is then adopted or killed) has a greater impact on reducing population size than sterilizing and returning that individual through TNR. This makes sense: removal immediately subtracts both the individual and its reproductive capacity from the population, whereas sterilization subtracts only its reproductive capacity. This speaks to the value of adopting out socialized FRCs that don't have someone attached to them, especially kittens and abandoned pets, even though the cost of removal for adoption is higher than other interventions.
- **Targeting kittens versus adults:** Our results indicate that it is better to target all cats for

sterilization, regardless of age. Sterilizing a young cat has a greater impact on population size than sterilizing an older cat because a young cat could produce more future litters. However, prioritizing only juveniles (which we define as < 6 months of age) for sterilization is not advised for two reasons: 1) They are typically a minority of the reproductively active cats at any given time, meaning that focusing only on them would not address most of the cats that are generating litters. 2) Mortality among juveniles is often higher than among adults. Therefore, the impact of sterilizing young individuals is "diluted" by their typically higher removal rate (by dying) from the population.

- **Females versus males:** Focusing only on females for sterilization would improve the cost-efficiency of population reduction. However, because it is not possible to selectively trap females (and we know that capturing any cat can be challenging!), we recommend that all captured cats be sterilized. Sterilizing males may also improve their welfare and decrease nuisance behaviors, which also has benefits. If more cats are trapped during a trapping session than can be sterilized, the females might be prioritized. Surgery providers can facilitate prioritizing females by subsidizing the cost of a spay more than the cost of a neuter.
- **Integrated management:** Combining TNR with outreach to reduce abandonment, adoption programs for social cats, and management of resources (e.g., food and shelter) is likely to be more effective than any single approach on its own. The costs of activities beyond TNR will vary, and non-monetary values should also be considered (e.g., adoption of cats who can be socialized is more expensive, but offers welfare benefits and will likely gain more public support than removal for euthanasia). Engaging other organization that may specialize in outreach and adoption can keep a TNR organization focused on the mission of high-intensity TNR.

A simple method to estimate trapping and sterilization targets

In this document, we've repeatedly discussed the value of frontloading. However, achieving frontloading requires you to meet certain targets for sterilization percentage and trapping.

Below we describe a relatively simple method that uses simple monitoring data to generate a rough estimate of the number of unsterilized cats in your target population at any given time. It requires that the sterilization status of individual cats is known, either through an identification mark (e.g., ear tip) or other means.

This method makes a number of assumptions, and we therefore suggest that its results be interpreted with caution. Even so, having an estimate is important for setting trapping and sterilization targets for each trapping session.

This method requires that you count or estimate three quantities:*

1. The **total number of sterilized cats in your target population**. Early on, this is simply the total number of cats that you have brought to the clinic for surgery and then returned to the field. Later, you will have to subtract estimated mortality from this total.
2. The **number of sterilized cats** that you count during a monitoring count, observation period, or trapping session.
3. The **number of unsterilized cats** that you count during that same monitoring count, observation period, or trapping session.

*We recommend viewing our **Guide to implementing a population monitoring program** for support in designing a monitoring program that will permit you to estimate these quantities.

Example

During Year 1 of a TNR program, 150 cats were sterilized. Based on typical annual survival and dispersal rates, we estimate that of these 150 cats, 10% died or left the target population, leaving 135 *(#1 in the list above)*. During a monitoring survey preceding our upcoming trapping session, we count 40 ear-tipped (sterilized) cats *(#2 in the list above)* and 45 unmarked (unsterilized) cats *(#3 in the list above)*.

To estimate the number of unmarked and unsterilized cats remaining in our population, we make 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

The formula for estimating the total number of unmarked, unsterilized (TU) cats is:

TU = (OU x TM) / OM
So, TU = (45 x 135) / 40 = 152.

The formula for estimating the total number of cats in the population (TC) is:

TC = TU + TM
So, TC = 135 + 152 = 287.

Of the 287 cats estimated in our population, 135 are sterilized, giving an estimated sterilization percentage of 47%, well below the minimum target rate of 75%. In order to reach a 75% level, a total of 216 cats would need to be sterilized, or 81 additional cats. This would ideally entail targeting 81 cats for sterilization in the upcoming trapping session. Alternatively, fewer cats could be targeted, but then the effort described above would need to be repeated to ensure that the sterilization rate becomes progressively higher as time passes. It is worth emphasizing, as well, that 75% is a minimum target rate, and aiming for a higher rate provides more assurance that a positive result will be achieved in a timely way.

Appendix A: Glossary

Wildlife biology uses many terms that are also applicable to simulation modeling, monitoring, and managing FRC populations. They are described below.

Carrying capacity: Every environment has an upper limit to the number of FRCs that it can support. This upper limit is determined by available resources such as food and shelter. It is called the "carrying capacity," which is often abbreviated as "K." Some cat populations may be at or near K, which means the population cannot grow (e.g., there are not resources to support immigrating cats, kittens born into the population will die, infectious disease outbreaks are more common). Other 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 and maintain cat numbers below their local carrying capacity.

Density-dependence: Density-dependence refers to the fact that the rates of population growth, survival, reproduction, and dispersal (among other variables) are not fixed. 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, kitten survival rates 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 more abundant). Density-dependence tends to operate in a way that keeps the population close to K, which 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 cat removal or TNR.

Dispersal and abandonment: Most often, a FRC population targeted for management has some degree of contact with neighboring populations, allowing cats to move from one population to another. As your target population drops below K, there are fewer resource limitations and more opportunities for new cats to successfully join the population. Dispersal can therefore work to counteract your attempts to reduce population size. Abandonment of formerly owned cats or litters can function similarly to supplement your target population.

Lag times: When you 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 of animals, which has an immediate impact on population size. Those seeking to manage free-roaming cats through TNR need to be aware that substantial lag times in population reduction are to be expected.

Updated January 2022

ABOUT ACC&D

The Alliance for Contraception in Cats & Dogs (ACC&D) was founded to advance non-surgical sterilants and contraceptives for cats and dogs and to promote their global accessibility.

However, this resource is designed for much broader use: mass vaccination campaigns, animal birth control initiatives, Trap-Neuter-Return projects, clinical studies, or any project or research that involves animals outside of a laboratory setting.

2815 NE 66th Ave
Portland, OR 97213
Telephone: +1 503-358-1438
Email: info@acc-d.org

acc-d.org

ACC&D
Alliance for Contraception in Cats & Dogs