ACC&D
Alliance for Contraception in CATS & DOGS

Counting Cats: Recommendations for Population Monitoring Programs to Inform the Management of Free-Roaming Cats

Prepared by ACC&D Scientific Advisors:

John D. Boone. Ph.D.

Senior Biologist, Great Basin Bird Observatory; Biostatistical Consultant, Humane Society International

Margaret Slater, D.V.M., Ph.D.

Senior Director of Veterinary Epidemiology, ASPCA Shelter Research and Development

I. INTRODUCTION

Management of free- roaming cats was once a matter of interest primarily to animal control departments, public health officials, wildlife biologists, and a small but dedicated corps of cat colony caretakers. Over the last two decades, however, advocates for feral cats have become increasingly well organized, their ranks have grown substantially, and they have developed "TNR" (trap-neuter-return) programs as a humane alternative to lethal methods of population control. More recently, some conservationists and public health officials have questioned the efficacy of TNR and called for a return to traditional approaches to managing cat populations, including lethal control. Consequently, management approaches for free- roaming cats are now being debated in the public arena, and often receive substantial media attention. Because systematically-collected data on free-roaming cat populations is relatively limited, these exchanges take place in a substantial 'information vacuum', rendering it difficult to build a strategic consensus among different factions or to demonstrate convincingly the comparative effectiveness of different management options. This problem could be mitigated by systematic and coordinated data collection, preferably those that could be widely implemented at low cost by with the assistance of cat colony caretakers and other volunteers. This document introduces the design principles and basic implementation steps for such programs. It is our belief that if the data collection process described herein were widely and consistently implemented, it would help to improve the efficiency and effectiveness of non-lethal management alternatives, and would additionally provide a basis for constructive engagement about cat management issues.

II. SCOPE AND APPLICATION OF THIS DOCUMENT

This document contains two sets of recommendations:

1) The first set or recommendations is designed for people implementing TNR programs for a single cat colony or a small number of colonies. It is assumed that these individuals have limited time for monitoring activities and little if any technical background in population biology or field studies. These recommendations, given below in Section V, are very simple by intention, but if followed carefully they will allow the colony manager to better document the effects of their management efforts, and to better optimize these efforts so that they have the greatest possible impact.

2) The second set of recommendations, beginning in Section VI, describes approaches that are appropriate for monitoring cats in entire neighborhoods, cities, counties, or regions. For these large-scale monitoring applications, only a subset of the entire area of interest is actually surveyed, and it is critical that this subset be representative of the whole area. Achieving representative sampling requires that survey site selection be at least partly randomized, and that the survey efforts be adequately replicated. Planning this type of program may require the involvement of individuals with some technical experience, but we describe the appropriate steps and considerations in some detail for those interested.

III. GOALS OF POPULATION MONITORING

The fundamental goal of population monitoring is to determine how a population changes over time. It may also be used to compare populations in different areas, or to estimate the size of a population. A well-designed monitoring program can also help to determine whether changes in the population are attributable to human management efforts, unintentional human influences, environmental factors, or other causes. Animal population monitoring programs are most frequently used by biologists to assess the health and viability of wildlife populations, but a much more widely-known monitoring effort is the United States Census, which has been in continuous operation since 1790.

In order to accomplish some or all these goals, a monitoring program must meet several basic requirements. It must carefully define a population of interest, and it must take measurements of this population without introducing unintended biases. For most purposes, it must operate at regular intervals, ideally over a relatively long time span, and of critical importance, it must use consistent field methods at all times.

Meeting these goals for small areas (one or a few colonies) is very feasible in most cases. When larger areas are being monitored (a whole city, for instance), meeting these requirements can become more difficult and expensive. In these situations, monitoring costs can be controlled by making use of volunteers or cat caretakers to help collect data, by focusing on population attributes that can be measured, counted, or estimated quickly (even if they cannot be determined precisely), and by rigorously prioritizing the goals of the program.

IV. WHY SHOULD WE MONITOR?

In terms of costs and benefits, there are two compelling reasons why monitoring should accompany any substantive management effort, whether large or small. First, management strategies and tactics cannot be legitimately evaluated or optimized without collecting monitoring data. Over time, the relatively small amount of funding and effort required to operate such a program will repay itself many times over in the form of better outcomes. Second, those who provide funding for humane management programs increasingly require the generation of metrics. A well-designed monitoring program provides metrics that are scientifically defensible, objective, and suitable for statistical analysis (if desired).

Despite all of its tangible benefits, monitoring is often omitted or inadequately addressed in many management efforts. For this reason, it may be instructive to briefly describe a highly-effective monitoring effort that parallels, in many ways, what we propose in this document for large areas. The

North American Breeding Bird Survey (BBS) (https://www.pwrc.usgs.gov/bbs/) was established in 1966 to meet an urgent conservation need to document population trends of multiple bird species. From its modest beginnings, the BBS grew to the point where today, over 4,000 survey routes are monitored regularly, almost entirely by volunteers. The BBS survey has produced a continuous 46-year data set of unparalleled utility in conservation biology, and BBS data often provide our "first warning" when a bird species begins to decline. The power of this monitoring program lies not in its perfection, but in its consistency over a long period of time, its broad geographical coverage, and its exceptional cost-effectiveness.

It is sobering to contemplate the amount of effort that has been expended over years and decades in thousands of local humane management efforts without an adequate effort to document whether these efforts have achieved their desired goals. Had systematic monitoring occurred in even a small fraction of these instances, our understanding of cat populations and our ability to productively focus future efforts would now be much farther advanced. Small programs can be implemented almost immediately by colony caretakers and managers. Building larger programs, or a coordinated network of smaller programs, is a long-term process that can most effectively be initiated by implementing pilot programs. These pilot programs can demonstrate the feasibility and value of systematic monitoring, while simultaneously serving as a laboratory in which to fine-tune and optimize field methods and administrative oversight.

V. RECOMMENDATIONS FOR A SIMPLE MONITORING PROGRAM AT ONE OR MORE COLONY SITES

The steps for a basic monitoring program associated with one or more colonies are listed below. It is assumed that the TNR program will mark every sterilized cat with either an ear tip or an ear notch.

1) Define your population of interest. This will probably be a feeding station, or perhaps a series of feeding stations located in close proximity to one another.
2) Define your goal. In all likelihood, your goal will be to cause a gradual decline in colony numbers as a result of TNR efforts. Ideally, you can be even more specific, i.e. "My goal is to cut the size of this population in half over five years".
3) Determine your counting protocol. Monitoring involves counting cats at periodic intervals, and seeing how these counts change over time. This can be done in the daytime, or at nighttime using flashlights or spotlights for help in visualizing cats. The details of how you conduct the counts are not nearly as important as consistency. Every aspect of the counting protocol should be determined initially, and then repeated exactly every time you do a cat count. This includes the time of day when the count occurs, the duration of the count, the area within which the count is made, the acceptable weather conditions for making the count (best to avoid rainy or windy weather), the type of lights used (if done at night), and anything else you might think of. Resist the temptation to ever deviate from this protocol, even if you think doing so will result in seeing more cats; the power of a monitoring program does NOT depend on counting every cat, but it does depend on CONSISTENCY.
4) What to record. During every count, make note of the date, and keep a tally of the cats seen. For each cat, attempt to determine if it has a notched or tipped ear (indicating that it is sterilized);

binoculars can be of real assistance here. If you recognize the members of the cat colony, it is also helpful an informative to note whether each cat is a known colony member, or a new arrival. You may also wish to record whether cats appear to be healthy, injured, pregnant, etc., and to estimate the age of the cat (or at least to indicate whether it is an adult or kitten). The best way to organize this information is to create a data sheet where each cat seen is described on a single line. This line has several columns, each of which describes a feature of interest. For example one column might be titled "Sterilized", and a yes or no value recorded for each cat. Another column might be "Previously known cat", again with yes and no values entered for each cat

5) How often to count. Conduct the initial count as early as possible in your management effort. Repeat the counts at least twice a year, though conducting counts quarterly or monthly is better. Regardless of the interval, identify particular times of year for the counts, and stick as closely as possible to those times, year after year. For instance, you might choose to do your counts every 1 March, 1June, 1 September, and 1 December, or as close to those dates as possible.
6) How to use the data. The two most critical things to do with the data you collect are to follow cat numbers over time, and to follow cat sterilization rates (i.e. the number of sterilized cats seen during the count divided by the total number of cats seen during the count) over time. Ideally, you can plot these two quantities over time on a graph, using excel or a similar program, or even by hand. In order to cause your colony size to decline, it is necessary in most cases to reach a sterilization rate of about 70% or more, and more importantly to MAINTAIN that sterilization rate on an ongoing basis. If you do this, you will probably see your colony size start to decline over the course of a few years. If you do not maintain that sterilization rate, your colony size will probably not decline. Achieving this sterilization rate will be harder if you have a lot of new cats appearing at your colony due to abandonment or immigration. If you are having trouble reaching the target sterilization rate, you will have to try to find a way to trap and sterilize more cats in order to cause colony size to decline. In addition to following the number of counted cats and sterilization rate, you may also wish to follow the number of kittens over time, the condition of cats over time (which will hopefully improve with good colony management).
7) How to get help. If you follow these steps and have questions about how to interpret your data, ACC&D might be able to help. Please send us a message with your question and we will do our best to provide you with feedback.

VI. PRINCIPLES OF MONITORING PROGRAM DESIGN FOR LARGE AREAS

The steps described in the preceding section remain applicable when we seek to monitor larger areas, such as neighborhoods, cities, counties, or regions. The main difference between monitoring a small number of colonies and monitoring larger areas is that we usually cannot survey an entire large area of interest. Instead, we have to take samples from the large area, and then extrapolate data from these samples to the whole area we wish to characterize and understand. This reality requires that we introduce a number of statistical concepts and approaches into monitoring design. Therefore, the material below introduces technical concepts that may not be of interest to the general reader. However, it is provided for those with a curiosity about the topic, or those with some knowledge of statistical sampling concepts. The sections below provide a framework for assessing population trends and measuring management impacts

across larger areas in a scientifically valid way. Additional information on all of these topics can be explored in Sutherland (2006) and Thompson et al. (1998). Designing a monitoring program for a larger area is best done with advice and assistance from people or organizations that have relevant technical knowledge, but once designed the monitoring programs themselves can be implemented by individuals without a technical background.

Target population, or "sampling frame": In all monitoring efforts, it is critical to carefully delineate the population or populations that we are attempting to characterize. A target population could be a particular colony of cats that is centered on a city block, the cats residing in a particular county, or the entire cat population of North America. Characterizing the target population is important because it defines the area within which field surveys are conducted (the sampling frame), and defines the area within which we can potentially draw statistical inferences from the data we collect.

Sampling: Sampling refers to the process of measuring subsets of the target population that are collectively representative of the target population as a whole. Results from representative samples can, if adequately replicated, be extended to the rest of the unsurveyed population with relative high confidence. These subsets often take the form of defined survey plots, points, or routes (hereafter, referred to as "sampling units"). At the most basic level, sampling plans require that sampling units be selected randomly in an attempt to eliminate potential biases, and that they be sufficient in number to mostly eliminate most of the influence of random sampling error. As we will see below, however, simple randomization is not always an adequate or efficient way to obtain representative sample units from the target population and determining the degree of replication required is rarely a straightforward exercise.

Replication: Replication of sampling effort is both spatial (the number of different sampling units within the sampling frame) and temporal (the number of times that sampling units are re-visited over time). In principle, the amount of replication that is required for a particular monitoring effort can be determined with mathematical calculations. In reality, however, these calculations rely on a number of simplifying assumptions that may not apply in complex, real-world settings. Therefore, degree of replication is more often determined within a cost-benefit framework, tempered by the judgment of an experienced study designer.

Stratification: Stratification is a modification of randomized sample unit selection that becomes increasingly important as our target populations and sampling frames become larger and more diverse. It can best be explained by means of an example. Imagine that our goal is to characterize the free-roaming cat population of San Bernardino County, CA. This county has one large metropolitan area (greater San Bernardino) and a handful of smaller towns (Victorville, Barstow, Needles), but by far the greatest surface area of the county is covered by natural to semi-natural mountain forests and Mojave Desert scrublands. If we were to randomly select 25 sample units for counting cats within this county, most of them would occur, purely by chance, in the undeveloped portions of the county that are relatively inhospitable to free- roaming cats. Few, if any, random sample units would occur in the populated areas where we would expect most county's free- roaming cats to live. Estimates that were derived from this set of sample units would therefore be unlikely to accurately portray the county's free- roaming cat population. The most basic solution to this problem is to divide, or stratify, the sampling frame into two parts; urbanized areas and relatively uninhabited areas. Within each of these two areas, we can then select

random sampling units, giving priority of effort to the kinds of areas where cats are more likely to occur. Depending on the diversity of the target population and environment that characterizes the sampling frame, stratification can either be very basic, or relatively complex, and for smaller and relatively uniform target populations, it can be eliminated altogether. It is important to note that even for large, diverse target populations a stratification plan does not need to account for all significant sources of variability; only those that could conceivably result in significant biases or inefficiencies if a purely randomized sampling approach were pursued. In general, it is advisable to consult with an experienced monitoring program designer when a proposed sampling frame is geographically diverse, or when the density of cat populations within the sampling frame is highly varied.

Plots: One approach to survey design is to divide the sampling frame into multiple, contiguous plots using hardcopy maps, Google Earth maps, or a Geographic Information System (GIS). Other approaches are possible and valid, however, we will describe a plot-based approach, in which the basic counting protocol consists of walking along roads within a selected plot and tallying any cats that are observed. Initially, the plots that cover the sampling frame can be assigned to different strata (see above) depending on their properties. A subset of these plots are selected as sample units, based on the survey stratification design and replication requirements. Plot size does not need to be entirely consistent, but as a general rule, it is helpful for plot size to be reasonably uniform or regular, and furthermore plot size should be reasonable in relation to the survey effort required to cover a plot.

Relative versus absolute estimates: When designing a monitoring plan for cats, we should always explicitly consider whether or not it is important to estimate population size. We emphasize that it is not necessary to estimate population size in order to document changes in population size and sterilization rate; these can be monitored sufficiently and cost effectively using the raw cat counts obtained using a basic standardized counting protocol (as described in Section V). Population size estimates may, however, be useful if a program manager wishes to make resource and budget projections based on the estimated number of cats in the management area. If this is the case, it is generally necessary to use multiple survey techniques, as described below.

Field survey protocol**:** Until recently, very little work had been done to determine the most efficient and effective way to count cats in the field. Identification of an effective counting protocol is critical because the propensity of cats for nocturnal activity and concealment could make them more difficult to detect than some other species. By way of comparison, in the authors' experience, about 40% of all free-roaming dogs living in a given area can be detected by simply walking through that area during the morning hours, a detection rate that is fully adequate for effective monitoring. It is not yet well documented whether comparable surveys for free-roaming cats would achieve a detectability that approached this level, an important consideration given that very low detection rates create potential problems for data analysis. Some researchers have effectively overcome these issues by using motion-activated "camera trapping" to count cats in specific locations (Bengsen et al. 2011, Finkler et al. 2011, Jones and Downs 2011), but it seems unlikely that this method would be suitable for general use.

Recently, the authors have conducted cat surveys in New York City (Slater), Maui (Boone), and Portland (Boone) and their work, along with information about the activity pattern of cats (Haspel and Calhoon 1993), will soon lead to recommendations for a standardized cat counting protocol. For now, we

provisionally propose a cat counting protocol that is described in Section VII. Other protocols are possible and valid, and as mentioned above, the most critical element of any protocol is that is be consistently adhered to in all particulars and on all occasions.

Basic surveys, intensive surveys, and population size estimates: When our goal is to monitor population change and sterilization rates, a basic counting protocol (described in the preceding section and elaborated upon in Section VII) is entirely adequate. When population size estimates are also required, it is generally necessary to combine basic surveys, which are performed in all sample units, with more intensive survey methods, which are performed in a subset of sample units. Many different survey methods can qualify as "intensive" but all are more time-consuming than basic surveys, which is why it is generally not practical to use them in most of the sampling units. They may include detailed observational surveys, photo-capture surveys, and so-called "mark-recapture" techniques (Bengsen et al. 2011, Finkler et al. 2011, Jones and Downs 2011). Regardless of method, the purpose of intensive surveys is to get a better estimate of the true number of cats. It is assumed that the basic surveys "miss" a significant portion of the cats that are actually present, but by comparing basic survey counts and intensive survey estimates in a set of sampling units where both types of surveys are conducted, we can estimate the proportion of cats that are missed during basic surveys. This "detectability ratio" can then be used to correct basic counts in all the sampling units where they were conducted, producing an estimate of the cat population in each sampling unit. These estimates for sampling units are then extrapolated to unsampled plots within the sampling frame to generate an overall population size estimate. This extrapolation may involve additional corrections and adjustments, and will likely be guided by the stratification design of the survey, neither of which is described in detail in this document. The interested reader is encouraged to further consult the references listed below, or to contact the authors for more details.

Exploratory data analysis: Monitoring programs are designed primarily to determine population trends, but they may also facilitate exploratory data analysis, more specifically the attempt to find relationships between cat distribution patterns and the underlying factors that might help to explain those patterns. Within the United States and many other parts of the world, it is straightforward to obtain a wide array of information about the specific areas in which cats are surveyed in the form of GIS data sets, This information could include human population density, socioeconomic status, ethnic profile, demographic profile, average household size, average time of residency, educational levels, traffic data, proximity to certain kinds of locations (dump sites, water sources, parks), and much more. By combining this externally derived data with the data generated by a monitoring effort, exploratory data analyses can be conducted to identify correlations between human or environmental factors and the number of cats that are present.

VII. EXAMPLE: DESIGNING AND IMPLEMENTING AN OUTDOOR CAT MONITORING PROGRAM

In order to more tangibly illustrate the concepts described above, this section outlines the process of designing and implementing a large-scale monitoring program, using an area well-known to the authors. This exercise is entirely theoretical, and judgments about the design of this program were made without

the level of analytical diligence that would characterize the design of an actual program. Additionally, the hypothetical details discussed herein may not be directly applicable to other potential target populations of interest to the reader. Nonetheless, this section captures the basic steps of developing a monitoring program.

Target population: Free- roaming cats in Churchill County, NV. Churchill County contains one moderately-sized town (Fallon), substantial agricultural / rural areas, a large wetland preserve complex, and extensive public lands dominated by sagebrush shrublands and pinyon-juniper woodlands.

Goals:

1. Estimate the relative population size of free- roaming cats in Churchill County.
2. Quantify how TNR programs in Fallon affect relative population size over time.
3. Determine the density of cats in the wetland preserve, in comparison to the other parts of the county.
4. Develop a better understanding of whether or not agricultural / rural areas surrounding Fallon influence population dynamics within the town.

Time frame: Because TNR programs in Fallon are projected to continue indefinitely, the monitoring program should operate for at least five years, in order to potentially document changes in relative population size.

Stratification: There is reason to suspect that the density of free- roaming cats will vary among the town of Fallon, agricultural areas, the wetland reserve complex, and undeveloped shrubland and forest landscapes. Furthermore, the physical extent of these four land cover types varies substantially within Churchill County, rendering a fully randomized survey site selection process inefficient. Therefore, the sampling frame will be stratified by four land cover types. Within the sampling frame, contiguous plots are delineated, and assigned to strata based on their predominant land cover type. We considered stratifying further within the town of Fallon to distinguish between relatively affluent neighborhoods dominated by owned, single-family housing versus relatively depressed neighborhoods dominated by rental housing. However, given that these two potential strata are roughly equal in geographical size, we concluded that randomized survey site selection within Fallon would adequately capture both, and that no formal stratification for this factor was required.

Replication: Given that there are limited resources available, we constrained the monitoring plan to adhere to a fixed annual budget, and chose to distribute effort in the following ways:

1. In the Fallon stratum, ten plots will be randomly selected for basic surveys. Two of these ten plots will also receive intensive surveys. One of the intensive survey plots will be randomly selected. The second will be placed in a location where TNR efforts are focused. Intensive survey plots are used in this design only because we are interested in knowing more about cat movements, reproduction, and survival in our different

geographical areas; they are not required for generating detectability estimates because we are not attempting to generate a valid population size estimate.

2. In agricultural / rural stratum, six basic survey plots will be randomly selected. Two of these six plots will be randomly chosen to receive intensive surveys as well.
3. In the wetland preserve stratum, six basic survey plots will be randomly selected, and two of these plots will be randomly selected to also receive intensive surveys.
4. In the natural shrubland and woodland areas, which are relatively arid and resource-poor, we expect to find very few, if any cats, and will therefore assume an effective population size of zero. No survey effort will be devoted to this stratum.

Plot Selection: Each stratum is divided on a map into plots of ~ 20 acres (4 ha). The predetermined number of basic survey plots is randomly selected from those available in each stratum. If any of the selected plots present pragmatic concerns related to safety or accessibility, they can be discarded and replaced with a new randomly-selected plot.

Field survey protocols: The following protocols for survey methods are used:

Basic surveys: Selected plots are surveyed twice every year; once in May – June, and once in October – November. If the plot has a well-developed road system (as will be the case within the town stratum), the basic survey consists of a pair of surveyors walking all roads within the plot over a 2-3 hour period beginning just after dusk, counting every cat observed with the aid of spotlights and binoculars, marking their positions on maps, and recording other attributes indicated on a standardized basic survey data sheet. Attributes could include:

a. estimated age of cat
b. sex, if determinable
c. spay – neuter status (ear-tipping or notching)
d. presence of a collar
e. general condition
f. evidence of pregnancy or lactation
g. behavior engaged in when observed
h. size of the group in which the cat is observed
i. evidence of any nearby resource supplementation (i.e. feeding station)

In areas where the road system does not provide adequate access to the entire plot, cross county travel may be required, which should follow a grid search pattern provided to the surveyor. Surveys will not be conducted during periods of inclement weather.

Intensive surveys: Intensive surveys occur in selected plots once per year, during the May – June rapid survey time frame. The primary goal of the intensive survey effort is to determine the number of different individual cats that are observed within the survey plot. Each intensive survey consists of a two-day period in which two observers attempt to observe as many cats as possible (using both day and night observation sessions), and record their attributes and behaviors as indicated on a standardized intensive survey data

sheet. Additionally, the intensive surveyors should photograph as many cats as possible, creating a catalogue of individuals present within the plot. If this approach proves difficult, an alternative mark-recapture method will be used. This consists of conducting a basic post-dusk survey on the first day, during which any cats with distinctive and easy-to-describe features will be carefully noted and recorded. These cats are regarded as "marked". On the second day, the survey will be repeated, and for every cat observed, it will be recorded whether or not it is one of the "marked" cats from day 1, or a different cat. A plot-wide population estimate can then be calculated with the following formula, where T = total number of estimated cats in plot; TM = total number of "marked" cats from day 1; OM = number of marked cats seen on day 2; and OU = number of unmarked cats seen on day 2: $T = (TM \times (OU + OM)) / OM$.

Administration and volunteer recruitment: We determined that it is necessary to recruit and train at least four, and up to eight reliable volunteers to conduct surveys. Ideally, some of all of these volunteers would already be involved in local cat management efforts. The monitoring budget provides for a small stipend to reward these volunteers for their effort, and covers the costs of any driving required. Surveyors will be provided with relatively simple guidance materials that can be printed on a "ready-reference" card. This will be accompanied by data sheets for recording data in a standardized format, and a map of the assigned survey routes or areas. Volunteers will be assigned to conduct rapid counts only, at least initially. SPCA employees will conduct intensive surveys, which require a greater level of commitment and attention, until if and when volunteers can be sufficiently trained to perform this function. Administration is provided by a designated employee of the SPCA of Northern Nevada, who coordinates with local TNR groups and the volunteers they provide to ensure that the survey schedule is maintained and that data sheets are submitted in a timely manner.

Data analysis: The SPCA administrator collates data, and collaborates with qualified consultants to analyze data to address project goals. Over time, the relative population size counts obtained at the surveyed plots can be examined to determine if the change in a statistically significant way. Depending on where TNR efforts are concentrated, some survey plots might serve as "control" sites, while others serve as "treatment" sites.

This section has described a purely theoretical exercise, but it accurately illustrates the process of creating and implementing an actual monitoring plan for a large and diverse area. Although the ongoing operation and administration of such programs can be successfully accomplished by informed administrators from the humane field and volunteer field surveyors, the initial design and the subsequent analysis phases of a monitoring program can benefit substantially from expert assistance. Sources for this assistance could be obtained by contacting a local University (typically Geography or Biology Departments), or City / County Departments of Public Health or Planning. Additionally, the authors of this paper may be able to provide suggestions for obtaining assistance in your area.

VIII. CONCLUSION

Efforts to assess the effectiveness of humane management programs for outdoor cats, while well-intentioned, have been hampered by the lack of sufficient monitoring data. This problem has become more and more apparent as debates and conflicts about different management options have escalated. By adapting the population monitoring principles and framework developed over decades by wildlife biologists, cat advocates can better focus and optimize their efforts, and can more effectively engage with other constituencies. . Effective monitoring for a small number of colony sites can easily be accomplished by colony caretakers following the recommendations given in Section V. The development of monitoring programs for larger areas does require some professional assistance, particularly in the early design stages and for data analysis, but given time, precedent, and the ongoing involvement of national animal welfare organizations, systematic monitoring can evolve into a relatively low-cost, high-value adjunct to ongoing management efforts

IX. LITERATURE CITED

Bengsen A, J Butler, and P Masters. 2011. Estimating and indexing feral cat population abundances. Wildlife Research 38:732-739.

Finkler H, E Hatna, J Terkel. 2011. The influence of neighbourhood socio-demographic factors on densities of free-roaming cat populations in an urban ecosystem in Israel. Wildlife Research 38:235-243.

Haspel C and RE Calhoon. 1993. Activity patterns of free-ranging cats in Brooklyn, New York. Journal of Mammalogy 74(1):1-8.

Jones AL and CT Downs. 2011. Managing feral cats on a university's campuses: how many are there and is sterilization having an effect? Journal of Applied Animal Welfare Science 14(4):304-320.

Sutherland WJ (ed.). 2006. Ecological Census Techniques: A Handbook (2nd ed.). Cambridge University Press, Cambridge, UK. 432 pp.

Thompson WL, GC White, and G Gowan. 1998. Monitoring Vertebrate Populations. Academic Press, San Diego CA. 365 pp.