Citizen science or pseudoscience?: A review of "A case study in citizen science: The effectiveness of a trap-neuter-return program in a Chicago neighborhood"

Rick Sinnott, Certified Wildlife Biologist (The Wildlife Society)

Citizen science is a method employed by scientists who use the services of volunteers to gather information and, in some cases, help design the study and analyze scientific data under supervision. In "A case study in citizen science: The effectiveness of a trap-neuter-return program in a Chicago neighborhood" authors Daniel Spehar and Peter Wolf claim to use citizen science to demonstrate the efficacy of one of their pet projects: reducing feral and stray cat populations by trapping, neutering, and returning them to their capture sites (Spehar and Wolf 2018).

The authors wrote the article to prove the effectiveness of a trap-neuter-return (TNR) program. That's why they call it a "case study." However, their misuse of the concept of citizen science calls into question their motive, because the data they used appears to be invalid or impossible to interpret, which leads one to question whether TNR really was effective in this instance.

Citizen science

Citizen science is not new. Volunteers have been used in countless small and large scientific endeavors, primarily to collect data. The Audubon Bird Count, which uses over a hundred thousand volunteers across North America, has been gathering useful data on bird distribution and population trends for more than a century (Schouten 2016). However, the technique has gained new life in recent years through the use of social media and other powerful forms of digital connectivity.

Citizen science has been ignored or scorned by many scientists because the people collecting the data may be untrained and unvetted, leading scientists to question the validity of the data. Scientists who want to use citizen science have labored to overcome the bias of other professionals by developing standards for study design, data collection, observer training, scientific oversight and other necessities of objective scientific research.

Citizen science is not an exception to the scientific method, as Spehar and Wolf seem to think. Its results must be judged by the same criteria as all scientific research (Wyler and Grey 2016).

Manuals and guidelines for conducting citizen science differentiate between projects initiated by one or more scientists and those conceived by volunteer participants who contact and collaborate with one or more scientists (Cooper et al. 2007, Wyler and Grey 2016, Cornell Lab of Ornithology 2018). Both methods are valid; however, both involve professional scientists from the earliest stages of the project.

Citizen science isn't for everyone. Researchers who have employed volunteers have voiced concerns over the fact that some projects may not be suitable for volunteers, for instance those that require arduous or repetitive work (Thelen and Theit 2008). Thelen and Theit (2008) also noted that "volunteers who lack proper training in research and

monitoring protocols are at risk of introducing bias into the data" and "members may lie about data."

Concern that a volunteer might make mistakes in identification, cut corners on surveys, "dry lab" results, or flat out lie about their observations is heightened when only one volunteer does all the work. This is much less of a problem when hundreds or thousands of volunteers are contributing, and outliers can be identified or minimized. Similarly, if the sole, unsupervised volunteer is a strong advocate for a program, the odds that he or she might fudge the data are increased.

Scientific training and oversight are critical components of many citizen science projects (Cohn 2008). Projects that require higher levels of skill are feasible; however, volunteers often require additional training or longer periods of participation in order to increase experience. Many volunteer programs have documented or suffered from "learner" effects whereby data collectors become more accurate over time (Catlin-Groves 2012).

In a review of the past two decades of published research, Catlin-Groves (2012) found the literature suggests that the reliability of inherently patchy data is the most troubling aspect of citizen science. It is important, she argued, to ensure that "sampling design does not introduce bias, and that counts are shaped by the data and not the ability of the observer to detect or record data."

The problem with patchy data is compounded when only one observer with a relatively small set of data is involved. Large data sets collected by numerous observers decrease "noise," resulting in greater statistical power and robustness. Observations and analyses cannot be trusted if the data may be incorrect or the observer biased. Catlin-Groves (2012) notes that this is the reason why many citizen science projects use standardized protocols replicated across many stratified survey plots. There should be enough participants to sufficiently monitor and assess impacts over a broad enough region to allow for cumulative effects (Cooper et al. 2007).

To the contrary, Spehar and Wolf seem to assume that citizen science entails finding a set of data – or, in a previous article, a set of assumptions and personal communications masquerading as data (Spehar and Wolf 2017) – collected by a nonscientist and publishing it as if it conformed to scientific standards. I addressed the myriad shortcomings of Spehar and Wolf (2017) in a previous review (Sinnott 2020).

Poor science

For this article Spehar and Wolf found a 10-year compilation of feral and stray cat observations compiled by Vanessa Smetkowski in Chicago. It wasn't hard to find. Smetkowski has published a blog since at least 2012, and her blog presented most of the data used by Spehar and Wolf.

We don't need to ferret out Smetkowski's resumé to suspect her findings. For many reasons, this so-called case study fails to meet the minimum thresholds of a scientific study, much less prove the efficacy of TNR.

Inadequate study design.—Even a good analysis can't overcome the congenital disorders of a poorly designed study. Before wasting their time (and our time) in analyzing and publishing Smetkowski's findings the authors should have known the data

set violated the guidelines for citizen science and the tenets of the scientific method. Only one person collected the data. Smetkowski, like the two authors, is an advocate for TNR. She has no scientific training or experience. She did not ask the advice of or collaborate with a scientist during study design or data collection. The study was confined to a small area embedded in the middle of the city, which subjected population estimates to intensive border effects. There was no study design, no standard survey protocol, no replication, no control population, no statistical analysis, no hypothesis to disprove.

One problem with her study antedates concerns for scientific training and experience. From the beginning Smetkowski admitted it was difficult to communicate with many people in her study area – people who were maintaining undiscovered feeding stations – because they spoke Spanish, a language in which she was not conversant (Smetkowski 2012*a*).

In contrast to the lofty goals and important questions of many citizen science initiatives, Smetkowski's Cats in My Yard study began when she attempted to capture one sick cat. Then she focused her attention on capturing only the cats in her yard. Her interest evolved slowly over the first three years "into a systematic initiative to trap, sterilize, and return or adopt all the free-roaming cats in an entire neighborhood," according to Spehar and Wolf (2018).

After Smetkowski captured neighborhood cats, she attempted to find homes for them. Cats not adopted or taken to a shelter were ear-tipped, sterilized, microchipped and returned to the capture location. Smetkowski didn't have a microchip scanner. She believed she could identify several hundred free-ranging cats by sight. She didn't try to keep track of unknown cats that came to her yard or locate other feeding stations in her neighborhood until 2007. That's when she began keeping records on free-roaming cats and cat "colonies" in her neighborhood.

Smetkowski, like most TNR advocates, uses the term "colonies" to describe the groups of cats that gather at a feeding station. Some of the feeding stations were less than a block apart, cats roam about (although they may prefer one feeding station over others), and so-called cat "colonies" are not exclusive in terms of territories or breeding activity. Therefore, I will refer to them as feeding stations.

Not a 10-year study.—Although Spehar and Wolf, following Smetkowski's lead, repeatedly claim that this was a 10-year study involving 20 "colonies," not every feeding station was monitored for 10 years. In the first year, 2007, only one site was monitored. A second site was added in 2008. By the end of 2009, the third year of the 10-year study, three-quarters of the 20 feeding stations had yet to be discovered. By the end of 2011, halfway through the 10-year study, eight feeding stations (40%) were not being monitored. In order to claim that the study monitored cats at 20 feeding stations, the duration of the study shrinks to four years. By then Smetkowski and others had removed dozens of cats from the study area.

Miscounting cats.—Smetkowski conducted counts at feeding stations "on an annual basis, at minimum, through a combination of visual observation (year-round) and informal interviews with colony caretakers (in December of each year)." In practice, Smetkowski observed cats while jogging through the neighborhood and checking on caretakers for updates "when she failed to encounter them for more than a few months

on her trips through the neighborhood." When her contacts told her about new cats, Smetkowski claims she did not include them in her data set unless and until she observed them herself. This is an amateurish way to conduct population surveys and surely overlooked fluctuations in cat numbers and fates.

Sightability is a major issue in counting free-ranging animals, particularly in environments where most individuals are well hidden most of the time. For example, another citizen science project used 30 volunteers to count free-ranging cats in a small suburban neighborhood in Portland, Oregon. Like Smetkowski, the volunteers walked roads and a few trails. Not surprisingly, when they mapped all sightings, cats were observed primarily on or near roads. This pattern of distribution is nothing like that found when cat locations are mapped using GPS collars (Liebezeit and Sallinger 2015, Gehrt et al. 2013). To their credit, the Portland researchers recognized that their count was a population index, not a complete census. Smetkowski's cat counts, conducted primarily from roads in an urban setting, were much less intensive and organized.

Unlike the Portland volunteers, Smetkowski didn't count cats at night, when free-ranging cats tend to be most active (Gehrt et al. 2013). Despite the serious flaws in her methodology, Spehar and Wolf want us to believe her figures represent accurate counts, not indices, of the free-ranging cat population.

Here's an example from Smetkowski's blog of why that's a bad assumption. One of her 20 "colonies" – Stealth – was comprised of one cat that she thought might have been an "indoor-outdoor" cat. She trapped the cat in an empty lot in 2013. She claims she never saw the cat again except for one time nearly two years later (Smetkowski 2017). "Eventually," she admits, "I 'retired' the Stealth Colony in my TNR Case Study." That's interesting, because Spehar and Wolf's Table 3 shows the Stealth "colony" had one cat at entry, but no cats were counted from 2013 to 2016. So the "retired" Stealth "colony," comprised of one cat that was seen twice in four years, was believed to have contributed to the "success" of the case study.

In the same blog post, Smetkowski (2017) told the tale of finding a new cat "colony" only one block from her home in 2017. This "colony" consisted of four ear-tipped cats, all from different "colonies" in her study area. These were cats that had "disappeared" from her other feeding stations and, presumably, weren't counted in the final tally in 2016. How many other cats – ear-tipped, untreated, or newly arrived – eluded Smetkowski's observations? We'll never know.

Smetkowski found one of her 20 "colonies" in 2011. The Bonita feeding station was maintained by a neighbor one block from Smetkowski's house (Smetkowski 2012*a*). This was the second feeding station located only a block from her house that she didn't find until the study was half over. According to Smetkowski, this new "colony" consisted of three ear-tipped cats. Thus, they had already been trapped, neutered and released by somebody but Smetkowski didn't say whether she recognized them. She never again found cats at this site after 2011. This was also chalked up as a measure of the "success" of her TNR program. But what if the three cats merely moved to another feeding station, perhaps outside of her study area, as they had already shown a tendency to do?

Similarly, her Rockstar "colony," which wasn't discovered until 2012, had ear-tipped cats when she found it (Smetkowski 2012*b*).

It is unclear how Smetkowski accounted for cats that had not been treated and ear-tipped because the figures included in her blog and in Spehar and Wolf (2018) primarily refer to 195 "TNR'd" cats. Smetkowski did include some untreated cats in the counts shown in Table 1. According to her and the authors, "unrecorded cats already on site likely accounted for the majority of what appear to be spikes in population occurring in a number of colonies up to three or four years after entry (Table 1)." Thus, while the final count in 2016 appears to include only ear-tipped cats, the analysis that claimed an 82% reduction from "peak levels" was based on counts earlier in the study that included unmarked cats. Not counting all untreated cats in her population estimates and claim of success – because she hadn't seen them or because they weren't "her" cats – renders this whole exercise in "citizen science" absurd.

Population reduced largely by removal.—The article trumpets the finding that over a 10-year period, the number of free-ranging cats in Smetkowski's study area declined from a peak of 152 to a final tally of 44, a decline of 82% from "peak" size, or 54% from each feeding station's "enrollment" in the study.

The "peak" population at each feeding station is a mysterious figure. Although "peak" population size is mentioned 15 times in the article, how it was obtained is never defined. It appears to represent an informal high count at each feeding station, often "between year two and year three after program entry." In other words, it was not part of the normal year-end census protocol and probably includes cats from other feeding stations or not otherwise included in the study.

The number of cats counted at a feeding station when it was "enrolled" in the program was often higher than the number of cats reported for the first year the site was censused (Table 3). Smetkowski was finding homes for kittens and adoptable adult cats as well as euthanizing a few sick cats. Presumably the reduction in numbers from "entry" to the first census reflects this attrition. For example, although 75 cats were counted at the 20 feeding stations at "entry" only 54 cats were actually tallied at the capture sites on their first year in the study.

Cats were not only adopted out at "entry," however. Anecdotal evidence provided in the article and in Smetkowski's blog indicates that cats were being adopted or euthanized throughout the study period.

Smetkowski often didn't know what had happened to missing cats, some of which were presumably captured by animal control or taken to veterinary clinics. According to her records, of the 195 individual cats documented during her 10 years of observations, 59 (30.3%) were adopted. Even more cats (67, 34.4%) "disappeared." In addition, Smetkowski believed 6 (3.1%) were euthanized, 13 (6.7%) died from other causes, 3 (1.5%) were returned to owners, 2 (1%) were "relocated outside of the program area," and 1 (0.5%) was seized by animal control. Thus, over the course of the study at least 71 of the 195 cats were removed from the population by adoption, euthanasia, or relocation. Over half (67) of the remaining 124 cats "disappeared."

Let's assume that all of the missing cats were adopted, euthanized, relocated, dispersed or picked up by animal control. That's highly unlikely because some of them must have been killed by vehicles or died by other means, but it'll help put an upper limit on the number of cats removed from the population by means other than predation, illness or

accidental mortality. If 67 disappearing cats are added to the 71 cats Smetkowski knows were removed, then 138 of the 195 cats (71%) were removed over the course of the study. Conversely, if we assume that all 67 disappearing cats died of illness or old age or were killed by vehicles, predators or other means (also highly unlikely), then only 71 cats (36%) were removed. Therefore, Smetkowski and others reduced the cat population 36-71% without resorting to TNR.

Clearly, removing one-third to two-thirds of the cats from a free-ranging population by adoption or other means is an effective way to reduce the population, at least temporarily. TNR represents the opposite strategy – that of releasing the cats after capturing them. Spehar and Wolf measured population decline from "entry" or "enrollment." The first annual count after "entry" was lower for half of the "colonies," which probably accounts for cats that were initially removed from the population.

To more closely assess the efficacy of TNR one should compare the number of free-ranging cats in the population the first year of the program, after the initial adoptions, with the number at the end of the study period. According to Table 3 there were 54 cats counted in the first year each feeding station was censused. Forty-four cats remained in 2016. That's a 19% decline, not the 82% (from peak populations at each feeding station) or 54% (from "entry") decline touted by Spehar and Wolf. But none of those figures make sense unless you believe that Smetkowski's annual tallies of ear-tipped cats were accurate, unbiased and comprehensive.

The number of cats at eight of the 20 sites actually increased over the course of the study, while numbers at four sites remained the same. Only two of the sites – which were reduced from 8 and 7 cats to zero – kept the neighborhood's cat population from achieving a net increase over the 10-year period. Did these cats die of old age or did they simply disperse to a nearby feeding station?

Pseudoscience

Calling Smetkowski a citizen scientist doesn't make her one. She had made no attempt to involve experts in designing her project and she didn't report contacting or collaborating with scientists at any point during data collection. The data she collected is impossible to analyze in any objective manner. But Spehar and Wolf forged ahead anyway.

Study area size.—Typical of her naiveté and lack of research experience, Smetkowski believed her study area encompassed 1 mi^2 (Smetkowski 2016). Spehar and Wolf concluded it was 1 km^2, or less than 40% as large as she thought. However, the authors' own scientific acumen was sorely lacking. As measured on Google Earth the study area appears to be closer to 0.86 km^2 – about one-third of the size claimed in Smetkowski (2016). As if that wasn't bad enough, the map shown on her website (Smetkowski 2016) depicts a study area smaller than that shown in Spehar and Wolf's article. You cannot publish a legitimate scientific article if you don't know the boundaries and size of your study area.

Such a small study area, embedded in a much larger matrix of neighborhoods with their own populations of free-ranging cats, is bound to have edge effects. Cats whose home ranges extend outside of the study area, and cats from outside the study area whose

home ranges extend into it will confound data analysis unless something is done about it.

Scientists employ methods to account for home ranges that overlap the boundary of the study area. Gil (2015) explains some of the difficulties inherent in studying urban systems, but wildlife biologists have recognized and adjusted population estimates for the "edge effect" or "boundary effect" for a long time (Stickel 1946). Smetkowski, of course, is clueless about this problem. Similarly, Spehar and Wolf appear to be unaware of the most rudimentary techniques for conducting population estimates.

Emigration and immigration.—The mean home range of feral cats in Chicago is about 0.3 km^2 for females and 0.74-0.96 km^2 for males, depending on the population model used (Gehrt et al. 2013). Thus, most of Smetkowski's male cats almost certainly ranged outside the bounds of the study area and many female cats probably did as well. There is no telling how many cats visiting from outside the study area were counted in annual or "peak" counts.

Smetkowski believed only 13 (6.7%) of her cats died from vehicle collisions and causes other than euthanasia, while admitting that 67 (34.4%) of her cats "disappeared" over the course of the study. Using radio collars on free-ranging cats in Chicago, Gehrt et al. (2013) estimated a mortality rate – an *annual* mortality rate – of about 30%, including deaths from disease, vehicle collisions, and coyote predation. There is no way to reconcile these figures, but one must assume that the more objective study, using radio collars and real science, is closer to the mark.

Smetkowski kept track of 195 cats and didn't observe an annual mortality rate of 30%. She used photos "when available," but eschewed the use of microchips, visible tags or radio collars. Could she really differentiate between 195 ear-tipped cats, and an unknown number of unmarked cats, some of them seen only once or twice, without an objective means of identification? We only have her word for it. It seems possible that more cats were "disappearing" than she realized, only to be replaced by cats released in the neighborhood or similar looking cats from adjacent neighborhoods.

Citywide statistics.—Spehar and Wolf would like us to believe that citywide statistics corroborate Smetkowski's claim for a significant decline in the number of free-roaming cats over the course of her study. They cite figures compiled by a local humane society and Chicago Animal Care & Control. But those figures are similar to those often cited by TNR proponents: reductions in the number of cats brought into shelters and euthanized. Obviously, fewer intakes could be due to the presence and publicity of programs like Smetkowski's, and a decline in the number of cats euthanized is almost certainly strongly correlated with a decline in the number of intakes. Intakes and euthanasia rates can in no way substitute for accurate pre- and post-treatment population estimates.

More to the point, the entire paradigm for Chicago's free-ranging cats shifted radically beginning in 2007, the year that Smetkowski initiated her study, when the city legalized outdoor feeding stations and TNR programs such as Smetkowski's Cats in My Yard. According to Spehar and Wolf, TNR efforts in adjacent neighborhoods were "widespread" during the study. If more people, like Smetkowski, began trapping and releasing free-roaming cats after 2007, then one would expect fewer cats would be rounded up by private humane societies and the city's animal control officers because ear-tipped cats were off limits.

One statistic reported by both the humane society and animal control agency was consistent with Smetkowski's observations: from 2011 to 2015 over 20% of the 3,500 free-roaming cats treated by the humane society and from 2007 to 2016 30% of the 21,000 cats treated by animal control were adopted out instead of released. Again, removing cats from the population by adoption or other means is not TNR.

Kitty litters.—Spehar and Wolf claim that "the last known litter of kittens produced by a cat living outdoors in the program area" was born in 2009, only two years into the project. This claim is entirely bogus. Smetkowski had found only 5 of the 20 feeding stations by 2009 and couldn't be expected to have found all the kittens in the study area. The "last known litter" is also a red herring. Spehar and Wolf admitted that another litter was born outside to a cat abandoned in 2014. Was this not also a free-roaming cat? One wonders how many other kittens were born in the study area to recently abandoned or "indoor-outdoor" cats that didn't meet their flexible criterion for a free-roaming cat and therefore weren't mentioned. One of the major problems with TNR, perhaps the main reason it has never been shown to work on a community-wide scale, is that it appears to encourage cat owners to abandon still fertile cats because they believe the cats will be taken care of by someone else (Castillo and Clarke 2003, Urseny 2012).

Duration of study.—Another critical consideration is missing in the analysis of TNR's efficacy in this and other studies that claim reduced populations. The study didn't last long enough. Even 10 years is not long enough.

Computer simulations have demonstrated how a hypothetical population of free-ranging cats would fare under various management options (Miller et al. 2014). In an isolated environment, a hypothetical population of 200 cats would drop precipitously to approximately 10 cats after 5 years of trapping and removal. It would take 10 years for sterilization alone to achieve the same level of success. After about 10 years an isolated cat population would be reduced to zero by removal, but it would take about 15 years for sterilization to achieve that goal. That's in an isolated population.

All of this becomes moot, however, when a cat population is not isolated. Under scenarios where there is connectivity between the study population and neighboring cats, a hypothetical population of 200 cats can never be eliminated. After declining precipitously for about 5-7 years, the cat population levels off at about 25 cats if all trapped cats are removed. If all trapped cats are sterilized, the population declines precipitously for about 7 years, then levels off at about 100 cats. Spehar and Wolf used 10 years of Smetkowski's data and claimed that her cat population had declined 54% using both removal and sterilization. Based on the simulations conducted by Miller et al. (2014), the population may very well level off at this point. If so, TNR (even including some removals) will never achieve Smetkowski's stated goal of eliminating free-ranging cats from her neighborhood.

According to her blog, Smetkowski continues to find "colonies" and free-ranging cats, but hasn't shared her annual neighborhood cat counts since 2016.

Spehar and Wolf cited Miller et al. (2014) but didn't grasp (or didn't acknowledge) the significance that the short duration of their data set should have had on their claim that the TNR "case study" was successful. This is what happens when confirmation bias clouds critical thinking.

Pseudoscientists

Smetkowski has all the trappings of a "cat person." She obviously loves cats. She kicked off this study after attempting to capture a sick cat in her yard. She is a strong advocate of TNR, which has been likened to hoarding cats outdoors. Most of the 195 free-roaming cats she captured and monitored had her name on their microchip, even though she had no microchip scanner and wasn't using the microchips to identify cats. She did this because she considered herself "responsible for them." She started a blog to share her "success" with others. With the fate of millions of free-ranging cats at stake there is undoubtedly a great deal of self-imposed pressure on Smetkowski to present her "case study" as successful.

Nevertheless, like their previous article touting the success of another TNR "case study" (Spehar and Wolf 2017), the blame for publishing poorly designed studies in a scientific journal lies with Spehar and Wolf, not the volunteers who conducted the research without scientific oversight.

Although Spehar and Wolf claimed that the "purpose of the present study was to examine the effectiveness of a TNR program," there was no objective assessment. They simply used data that Smetkowski had published in her own blog and labeled her project a success. A good scientist is a skeptical scientist. Spehar and Wolf accepted her "success" story as gospel because their biases led them to want to confirm that it was so.

Spehar and Wolf are dead set on publishing scientific evidence that TNR is an effective way to reduce free-ranging cat populations. They freely admit that "TNR has been conducted most often at a grassroots level, which has led to inconsistent data collection and assessment practices. Consequently, a paucity of data exists." And yet they blithely used inconsistent and biased data collected by an unsupervised volunteer in an attempt to correct that deficiency and claim that TNR is effective.

Like their previous article in Animals, Spehar and Wolf revealed what appears to be an undue influence by their sponsors. Best Friends Animal Society, the Michelson Found Animals Foundation, Inc., the Edith J. Good Residuary Trust, Maddie's Fund®, Found Animals, and the Humane Society of the United States all advocate TNR and no-kill sanctuaries for cats. These nonprofit organizations accept and steer other TNR proponents towards large grants from The PetCo Foundation and PetSmart Charities (Best Friends Animal Society 2018), two of the leading funders of animal welfare and TNR programs in North America (Anonymous 2017, PetCo Foundation 2018). PetSmart, PetCo and WalMart, another major cat food distributor that funds TNR programs (Alley Cat Allies 2018), obviously desire to maintain high numbers of cats, even feral and stray cats, as long as they are being fed kibbles.

In the article Spehar called himself an "independent researcher," however he obtained a Master of Science degree in Animal Policy and Advocacy from Humane Society University in 2015. He has been a TNR volunteer since 2003, a writer for Mercy for Animals since 2015, a senior district leader for the HSUS since 2013, and a cofounder of the Together Initiative for Ohio's Community Cats in 2016. All of these organizations support and advocate for TNR, and this article appears to be an extension of that

advocacy. How can one claim to be an "independent researcher" when he or she was educated by and works for one of the funding sponsors?

Wolf holds a bachelor's degree in mechanical engineering and a master's degree in industrial design. In his spare time he is the "Cat Initiatives Analyst" for Best Friends Animal Society, and he has worked for Maddie's Fund®. Since 2010 he has published a pro-TNR blog called Vox Felina where he routinely gripes about the "flawed science promoted by many TNR opponents" (Wolf 2018).

Accepting funding from a special interest organization is not necessarily a sign that the research will be biased. However, these authors seem to have crossed a line, admitting in the article that the funding sponsors "provided general guidance for the design of the study and were periodically apprised of project status during data collection, analysis, and interpretation; and the writing of the manuscript." Funding organizations don't normally exercise that level of control. Unless, of course, they hope to influence the outcome.

Properly conducted citizen science is not pseudoscience. But Spehar and Wolf have a stated agenda: to rectify the existing "paucity of analyzable data" collected by TNR enthusiasts. They've found a data set collected by a single volunteer, although they admit at least eight times in the article that the data has "limitations" which can only be rectified by "more consistent and reliable data compilation." Thus, they seem perfectly willing to ignore the scientific axiom (Cohn 2008) that the only thing worse than no data is bad data.

Wait … what?

In summary:

- According to Spehar and Wolf, Smetkowski "recorded significant reductions in a free-roaming cat population as the result of a neighborhood TNR program."
- They reported that Smetkowski trapped and marked 195 cats from 20 feeding stations during a 10-year study.
- However, 40% of the feeding stations and many of the cats weren't found until the study was half over.
- Smetkowski was still finding feeding stations and cats after her study ended.
- Additional free-roaming cats reported by others were not included in the population counts unless Smetkowski saw them too.
- Therefore, Smetkowski counted some, but not all free-roaming cats.
- Smetkowski didn't consider "indoor-outdoor" cats to be free-roaming, although they have many of the same impacts as feral or stray cats.
- Smetkowski admitted that spikes in her population counts were due to "unrecorded cats already on site."
- She and the authors dismissed the undocumented movement of cats in and out of the tiny study area as insignificant and immaterial.
- Mortality of marked and unmarked cats was largely unaccounted for because Smetkowski documented only 6 cats euthanized due to illness or injury, with another 19 cats having died from "other causes" over the 10-year period, while over one-third of her marked cats "disappeared."

- Therefore, reductions in her population counts were primarily reductions in the number of marked cats; Smetkowski had no idea how many unmarked cats were in the population or whether their numbers were declining or increasing during the study.
- Incredibly, while some untreated cats were included in annual population counts, the final count that was used to calculate population reduction over the course of the study didn't appear to include untreated cats, which made it seem as though reductions were more substantial than they were.

Thus, this second of two studies by Spehar and Wolf published in the scientific journal Animals only serves to make a mockery of the scientific method. It is unclear whether the authors submitted the two articles with cynical intent ("See, I told you a scientific journal will publish anything that looks like science!") or if they did it knowing or suspecting that the data were flawed because they wanted, as Wolf has admitted, "to give TNR supporters some desperately needed resources for debating the issue" (Kelly 2012). Perhaps Spehar and Wolf truly believe that their study designs, data collection methods, and analyses are adequate to prove what they claim. Unfortunately for them, their article proves nothing of the sort.

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