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Effect of Capacity for Care on cat admission trends at the Guelph Humane Society, 2011–2015

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ABSTRACT

In recent years, there has been a growing concern regarding populations of cats who are homeless. Shelters are constantly overwhelmed by the influx of cats without caregivers and are seeking solutions to enhance positive outcomes for them. In 2014, the Guelph Humane Society implemented a population management program to expedite the movement of cats through the shelter by decreasing the average nonhuman animal's length of stay using scheduled intakes to control for overcrowding and by implementing strategies to increase adoption rates. This study investigated the time trends in admission rates of cats to the Guelph Humane Society to assess the effectiveness of a population management program called Capacity for Care using a generalized linear autoregressive moving average model. From January 2011 to December 2015, a total of 3295 live cats were admitted to the Guelph Humane Society. When the analysis was adjusted to account for admissions of kittens, there was a significant reduction in admissions for adult cats ($p < .01$) following the introduction of the population management program. The results also showed a strong seasonal peak in total admissions during the summer months.

KEYWORDS

Cat overpopulation; Capacity for Care; shelter intake; time series; count data

In recent years, there has been an increased focus on reducing the number of companion animals (pets) entering the shelter system. Since 2001, twice as many cats have been admitted to Canadian shelters as dogs (Canadian Federation of Humane Societies [CFHS], 2012). Studies in the United States have shown a decrease in dog admissions to nonhuman animal shelters, while the number of cat admissions continue to rise (Lord et al., 2006; Morris & Gies, 2014; Morris, Wolf, & Gies, 2011). The CFHS reported similar results to those in the United States after gathering intake data from shelters throughout Canada (CFHS, 2012), though a recently published report by the CFHS (2015) claimed that cat intake numbers decreased consistently from 2011 to 2014. While it is extremely important to monitor the progress of animal shelters throughout the country, it is essential for shelters to also monitor the progress in their own community. In addition to each community having a unique animal population structure, communities differ in their human population structure and the various socioeconomic factors affecting nonhuman animal ownership and relinquishment.

Insufficient capacity, particularly for cats, remains an issue for a number of shelters across the United States and Canada, with the number of healthy cats being euthanized continuing to be of concern (CFHS, 2014). In an attempt to increase the welfare of shelter cats and promote healthy alternatives to unadoptable cats, several shelters in the United States and Canada have implemented

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a shelter population management program referred to as Capacity for Care (C4C). In 2014, the Guelph Humane Society (GHS) was one of two Canadian animal shelters that the CFHS designated as a pilot site for the implementation of C4C (CFHS, 2015). The C4C program utilizes several strategies designed to achieve the overall goal of maintaining shelter capacity, while simultaneously attempting to improve instrumental aspects of a nonhuman animal shelter including adoption rates, length of stay, and incidence of illness (CFHS, 2012; Karsten, n.d.).

The current study focused on reducing intake, which is just one aspect of the C4C population management program. Strategies to reduce the intake of cats include using appointment-based relinquishments, while providing alternative strategies to intake and reducing unwanted litters in the community through programs such as "Shelter-Neuter-Return" (CFHS, 2016). Another program that can be used as an alternative strategy to shelter admission is the "Barn Cat Program," through which unsocialized stray cats are rehomed as barn cats rather than being admitted to a shelter (CFHS, 2012).

Cats entering the shelter system are often categorized based on where they were acquired, but these subpopulations can be further categorized by age. Several studies have examined shelter cat admissions based on age and revealed a distinct "kitten season," which occurs at the beginning of spring—around March to April (Nutter, Levine, & Stoskopf, 2004; Scott, Levy, & Crawford, 2002; Wallace & Levy, 2006). A study by Marston and Bennett (2009) in Australia showed evidence of a seasonal peak in admissions during the warmest time of year (December–April); however, once kittens were accounted for, little variation was found in cat admissions. Wallace and Levy (2006) studied pregnancy trends in feral cats throughout several US cities and found that despite geographical variation, the incidence of pregnancies in feral cats peaked around March to April. These findings display the importance of acknowledging the various subpopulations of cats that comprise the shelter population. Each community may differ in the types and proportions of subpopulations of cats who enter the shelter system, signifying that interventions should be community-specific.

Data collected on a fixed timescale are often autocorrelated, as data points collected closer in time are more similar than data points collected farther apart in time. These data therefore require a time-series modeling approach, as the data defy the rule of independence required when using a regular generalized linear model. Time-series models are often used in economics, and more recently, they have been used in the fields of personal emergency health services (Chen & Yip, 2015) and public health (Lal, Ikeda, French, Baker, & Hales, 2013). Although some studies have used time-series analysis to investigate animal conservation efforts (Keith et al., 2015) and more recently to investigate temporal patterns in Feline Immunodeficiency Virus (FIV) and Feline Leukemia Virus (FeLV) seroprevalence (Chhetri, 2015), the current study is the first to use time-series analysis to investigate animal shelter admissions data.

Performing a time-series analysis using animal shelter intake data will provide information about and insights into any long-term trends in admissions, seasonal effects of admissions, and the characteristics of the cats who comprise the shelter population. Determining which sources represent the majority of shelter admissions can help ensure that the most effective management strategies are being used to overcome cat overpopulation. For example, if large proportions of kitten admissions are coming from cats with caregivers (owners), then strategies could be aimed toward earlier neutering of owned cats. Shelter intake data collected by the GHS provide a unique opportunity to study temporal trends in cat overpopulation and simultaneously investigate the effectiveness of the C4C management program, which has yet to be evaluated using data from multiple years.

The primary objective of this study was to determine the long-term trends in admissions and the effect of the intake reduction strategies used during the implementation of the C4C program on cat admissions. Concomitantly, this study analyzed seasonal variations of cat admissions and investigated the subpopulations of cats entering the shelter, including subpopulations based on age, sex, neuter status, and source of admission.

Materials and methods

Data for this study were collected from the GHS during January 2011 to December 2015. All cat admissions during this time period were extracted from the GHS data management system, PetPoint (http://www.petpoint.com). GHS staff collected the data upon intake of animals and subsequently input the data into PetPoint. The C4C program was implemented at the GHS in August 2014. The key elements implemented as part of the C4C program at the GHS are highlighted in Table 1. Components of the C4C program that are believed to have an impact on cat admissions include scheduled intakes, or appointment-based relinquishments, and strategies that help reduce the number of unwanted cats in the community, such as the Barn Cat Program and the Shelter-Neuter-Return Program (Karsten, n.d.).

Furthermore, portals were created between pairs of cages to provide a singly housed cat with two cage spaces while allowing for separation of food and water from each cat's litter box and minimizing disruptions while cleaning (CFHS, 2016; Karsten, 2010). Portalization of cages also allows for fewer cats on the adoption floor at one time, which has been hypothesized to increase adoption rates (American Society for the Prevention of Cruelty to Animals, n.d.). Further details regarding the population management strategies formulated for the C4C program have been described by Karsten (n.d.).

Data obtained from the GHS shelter records used in the current study included animal identification number, date of admission, age, sex, neuter status, and intake type. Incomplete cases were maintained in the data set, as covariates were not used in the statistical analyses. Cases with a missing variable were included in the data set for the purpose of descriptive statistics and were categorized as "unknown." For the purpose of this study, adult cats were considered to be those aged older than six months old and kittens were considered those aged six months old or younger on their date of admission. Cats with "yes" in the spayed/neutered column were assumed to have been altered prior to their entry into the GHS. Exploratory analysis of the time series of admissions data was completed with seasonal time-series decomposition using loess (STL), which is a smoothing

Table 1. Overview of key elements implemented during Capacity for Care case study at the Guelph Humane Society in August 2014.

Elements Implemented	Description
"Portalization" of Cages	Portals were created between adjacent cages, creating a double-compartment cage. Allowed cats to choose where to spend their time, created a separation of food and water from the litter box, and minimized disruptions while cleaning.
Scheduled Intake	Appointment-based relinquishment was used to help ensure that the shelter did not go over capacity and to permit cats to have adequate space while they await an outcome. It also provides an opportunity to discuss alternatives to relinquishments or acquire information about a cat's medical history.
Fast-Tracking Adoptable Cats	Fast-tracking the most adoptable cats (e.g., juveniles) decreased the stray-hold period and provided earlier health examinations and vaccinations.
Shorter Adoption Forms/Fewer Restrictions	Fewer adoption restrictions including shortening the application process encouraged a prompt adoption process.
Barn Cat Program	Rehomed cats who were not adoptable through the shelter system and placed them with families looking for a "barn cat." These cats were spayed/neutered before being placed to ensure they do not contribute to the growing cat population.
Shelter-Neuter-Return	Healthy feral cats who were unadoptable through the shelter system were spayed/neutered and vaccinated and then returned to their home location. If it was not possible to place them in their home location, then they were rehomed through the Barn Cat Program.
Categorical Pricing	Implementation of categorical pricing promoted the adoption of cats who were considered to be "less desirable."
Adoption Specials/Events	Holding adoption events or specials prevented the inventory of cats from exceeding the shelter's capacity, especially if there were cats waiting to be relinquished.
Cage Enrichments (e.g., curtains, elevated beds)	Increased cat welfare while in the shelter through improved cage enrichment by incorporating cat toys, elevated beds, cat curtains, etc.
Aim to Run at or Below Shelter Capacity	Ensured that management, staff, and volunteers were committed to ensuring that the shelter remained at or below capacity at all times. This involved changes in shelter policies.

Note. Data were compiled from the Canadian Federation of Humane Societies (2016).

procedure that decomposes a time series into trend, seasonal, and remainder components (Cleveland, Cleveland, McRae, & Terpenning, 1990).

A generalized linear autoregressive moving average (GLARMA) model (Dunsmuir & Scott, 2015) was used to analyze the data, as this type of modeling can account for the autocorrelation in the time series of monthly intake counts. Because the data consist of counts, a Poisson GLARMA model was fit, and if overdispersion (i.e., greater variability than expected) was found to be present using the deviance test, then a negative binomial GLARMA model was fitted to account for it. Backward elimination was used to select variables for the final model. The model fit was assessed using the Akaike information criterion, likelihood ratio test, and Probability Integral Transform (PIT) histogram and (partial) autocorrelation function plots. The time trend was modeled using a function of calendar time in months ranging over the entire study period (i.e., 1–60). To account for potential seasonal effects due to environmental conditions, 11 dummy variables were generated to represent the effects of February to December, using January as the reference month in the model. The intervention effect due to the C4C program was included in the model using an indicator variable.

Initial analyses indicated a seasonal trend due to kittens; therefore, the time series of adult cat admissions was also analyzed (i.e., excluding admission counts of kittens) to determine the effect of kittens on seasonal variation. All statistical analyses were performed using R and RStudio statistical software (R Core Team, 2016; RStudio Team, 2016). A significance level of 5% was maintained for all tests and confidence interval estimates.

Results

There were a total of 3895 records of cat admissions to the GHS during the study period. Based on the unique identification numbers provided by the GHS, some cats were admitted more than once; however, only their first admission was used for the current analysis. In total, there were 99 duplicates in the data set, 39 of whom were returned adoptions, while the remainder were thought to be strays and were picked up by an Animal Control officer. There were 505 cats (13%) categorized as dead on arrival. These cats were removed from the data set. As a result, a total of 3291 cats in the data set were aggregated to 60 monthly counts for analysis.

A significant decreasing secular trend (i.e., decreasing long-term linear trend) in the number of cat admissions to the GHS was found throughout the entire study period. The number of monthly cat admissions to the GHS ranged from 15 to 118 throughout the study period, with a mean of 55 and a median of 52 cats. The mean number of cats admitted to the GHS in the year prior to the C4C intervention (August 2013–July 2014) was 52 cats per month. The mean intake of cats in the year after the C4C intervention (August 2014–July 2015) was 37 cats per month.

Descriptive statistics regarding the breakdown of age, sex, and neuter status can be found in Table 2. As can be seen in Table 3, a large proportion of admissions were taken in as strays (79.9%), while only 16.4% of cats admitted were surrendered by their owners/guardians. The remaining admissions were either transferred in from another shelter (0.3%), seized by officials (1.4%), or serviced in due to an emergency involving their owners (2.0%). Approximately 37% of cats admitted were kittens, and the majority of the cats admitted were sexually intact (63.7%). Twenty-nine percent of owner-surrendered cats had been neutered prior to their dates of admission, whereas only 13% of stray cats had been neutered prior to their dates of admission.

Time-series analysis resulted in a negative binomial GLARMA model being the best-fitting model for the data. Figure 1(a) displays the observed versus predicted data from the final model. While a secular downward trend and a seasonal component were detected in the monthly admission rates, the C4C program intervention was not found to have an effect when analyzing the data set of all live cat admissions to the GHS. The final negative binomial GLARMA model included a significant seasonal component (see Table 4). There was a significant increase in the intake of cats at all months, except for February. The month of July experienced the highest peak

Table 2. Guelph Humane Society admissions based on age, sex, and neuter status.

Characteristic	*n*	%
Age		
Kitten aged six months or younger	1221	37
Adult older than six months	1723	52.3
Unknown	351	10.7
Total	3295	100
Sex		
Male	1488	45
Female	1580	48
Unknown	227	7
Total	3295	100
Neuter Status		
Neutered/Spayed	506	15.4
Intact	2099	63.7
Unsure	690	20.9
Total	3295	100

Table 3. Source of admission of cats to the Guelph Humane Society (2011–2015) by age.

Admission Source	*n*	%
Owner/Guardian Surrender		
Kitten aged six months or younger	178	5.4
Adult aged older than six months	315	9.6
Age Unknown	48	1.4
Total	**541**	**16.4**
Stray		
Kitten aged six months or younger	1021	31.0
Adult aged older than six months	1330	40.3
Age Unknown	284	8.6
Total	**2635**	**79.9**
Serviced In (Emergency)		
Kitten aged six months or younger	3	0.1
Adult aged older than six months	48	1.5
Age Unknown	13	0.4
Total	**64**	**2.0**
Seized/Custody		
Kitten aged six months or younger	13	0.4
Adult aged older than six months	27	0.8
Age Unknown	6	0.2
Total	**46**	**1.4**
Transfer In (from another shelter)		
Kitten aged six months or younger	6	0.2
Adult aged older than six months	3	0.1
Age Unknown	0	0
Total	**9**	**0.3**
Total	**3295**	**100**

on average, with 218% more cats taken in compared with January. The seasonal component of the time-series admissions data can be observed in the second quadrant of Figure 2, which provides a visualization of the time-series decomposition of all live cat admissions using STL.

The data set of cat admissions to the GHS for the same study period was analyzed excluding kittens. A total of 1723 adult cats were admitted during 2011 to 2015. Figure 1(b) displays the observed versus predicted data from the final model excluding kittens. This analysis revealed a significant decreasing secular trend in admissions, and less seasonal variation was found in monthly cat counts of adults compared with the analysis that included kittens (see Table 5). Furthermore, this data set revealed a significant decrease in adult cat admissions to the GHS after the implementation of the C4C program ($\beta = -.277$, $p < .01$; Table 5). In absolute abundance, it equates to an 8% decrease in adult cats per year being admitted to the GHS during the study period and a 24% reduction in the intake of adult cats after the implementation

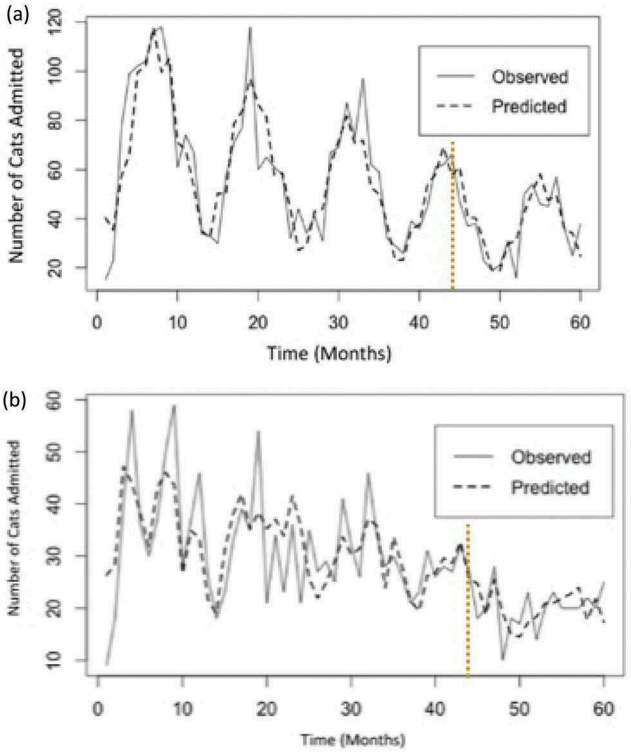

Figure 1. (a) Observed admissions versus predicted admissions from the generalized linear autoregressive moving average model using a data set including all live cat admissions to the Guelph Humane Society from January 2011 to December 2015. Intervention implementation during Month 44 is indicated. (b) Data set excluding kittens aged six months or younger admitted to the Guelph Humane Society from January 2011 to December 2015. Intervention implementation during Month 44 is indicated.

Table 4. Regression coefficients of the final negative binomial generalized linear autoregressive moving average model on monthly cat admissions at the Guelph Humane Society.

Linear Model Coefficients	Estimate	SE	*z* ratio	*p*	Risk Ratio
Alpha	35.22	11.69	3.012	<.01	
AR (1)	0.03109	0.03636	0.855	.392	
January (Intercept)	361.84050	48.32696	7.487	<.01	
Trend	−0.17809	0.02401	−7.418	<.01	**0.84**
February	−0.02783	0.15237	−0.183	.85	**0.97**
March	0.42759	0.15403	2.776	<.01	**1.53**
April	0.49225	0.15327	3.212	<.01	**1.64**
May	0.88647	0.14915	5.944	<.01	**2.43**
June	0.99666	0.14827	6.722	<.01	**2.71**
July	1.15714	0.14676	7.885	<.01	**3.18**
August	1.00988	0.14858	6.797	<.01	**2.74**
September	1.04701	0.14886	7.033	<.01	**2.85**
October	0.70409	0.15309	4.599	<.01	**2.02**
November	0.69268	0.15280	4.533	<.01	**2.00**
December	0.42533	0.15168	2.804	<.01	**1.53**

Note. Data set includes all live cat admissions from January 2011 to December 2015.
AR = autoregression component.

of the C4C program (August 2014–December 2015). The trend and seasonal components of this data set are shown in Figure 3. Figure 4 displays the intake of adult cats and kittens, where a strong seasonal peak can be seen each year.

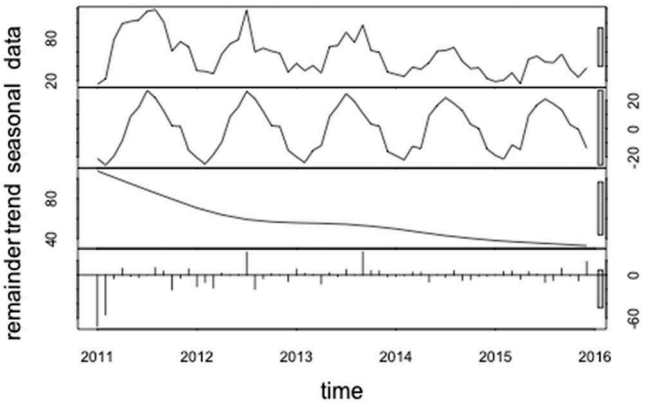

Figure 2. Seasonal decomposition of time series by loess (STL) using a data set including all live cat admissions from January 2011 to December 2015 (intervention implemented August 2014). Top panel (observed data): monthly time series of all live cat admissions to the Guelph Humane Society. Second panel (seasonal component): seasonal pattern of cat admissions per 12 months. The values at 0 indicate no seasonal variation, values greater than 0 indicate an increasing seasonal pattern, and values less than 0 indicate a decreasing seasonal pattern. Third panel (trend component): STL fitted trend of cats admitted to the shelter. Fourth panel (residuals): remainder after trend and season were fit to the time series.

Table 5. Regression coefficients of final negative binomial generalized linear autoregressive moving average model on monthly cat admissions at the Guelph Humane Society.

Linear Model Coefficients	Estimate	SE	*z* ratio	*p*	Risk Ratio
AR (1)	−0.04379	0.01961	−2.233	.02	
AR (2)	−0.06300	0.01977	−3.186	<.01	
January (Intercept)	177.83243	27.61502	6.440	<.01	
Trend	−0.08680	0.01372	−6.326	<.01	**0.92**
Intervention	−0.27653	0.05295	−5.223	<.01	**0.76**
February	−0.06124	0.15299	−0.400	.69	**0.94**
March	0.30766	0.15096	2.038	.04	**1.36**
April	0.38829	0.12969	2.994	<.01	**1.47**
May	0.45539	0.12943	3.519	<.01	**1.58**
June	0.35319	0.13347	2.646	<.01	**1.42**
July	0.49068	0.12992	3.777	<.01	**1.63**
August	0.54317	0.13054	4.161	<.01	**1.72**
September	0.53781	0.12975	4.145	<.01	**1.71**
October	0.22172	0.13780	1.609	.11	**1.25**
November	0.50792	0.14410	3.525	<.01	**1.66**
December	0.33665	0.14188	2.373	.02	**1.40**

Note. Data set excludes kittens aged six months old or younger admitted to the Guelph Humane Society from January 2011 to December 2015.
AR = autoregression component.

Discussion

To our knowledge, this study is the first to use time-series methods to evaluate animal shelter admissions data, in addition to being the first study to evaluate the effects of the population management strategies aimed at reducing intake as part of the implementation of the C4C program using data from multiple years. The results suggest there was a decreasing secular trend in cat admissions to the GHS from January 2011 to December 2015, as well as a strong seasonal swing in kitten admissions that peaked in July. When the data set was reanalyzed excluding kittens, there was a significant decrease in adult cat intake associated with the C4C intervention.

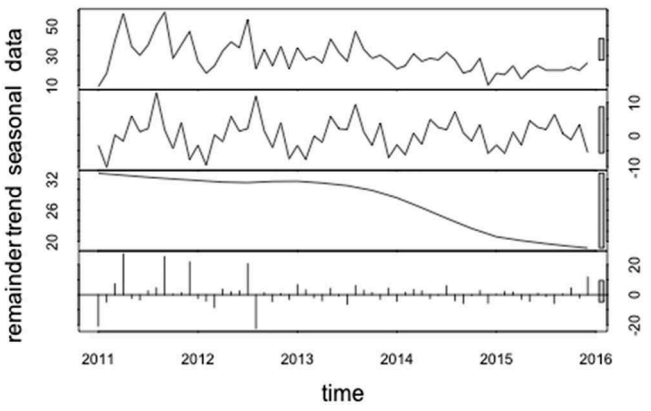

Figure 3. Seasonal decomposition of time series by loess (STL) using a data set excluding kittens aged 6 months or younger admitted to the Guelph Humane Society from January 2011 to December 2015 (intervention implemented August 2014). Top panel (observed data): monthly time series of adult cat admissions to the Guelph Humane Society. Second panel (seasonal component): seasonal pattern of cat admissions per 12 months. The values at 0 indicate no seasonal variation, values greater than 0 indicate an increasing seasonal pattern, and values less than 0 indicate a decreasing seasonal pattern. Third panel (trend component): STL fitted trend of cats admitted to the shelter. Fourth panel (residuals): remainder after trend and season were fit to the time series.

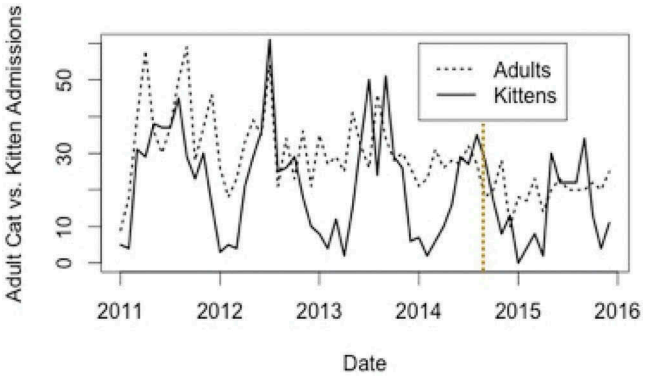

Figure 4. Admissions of adult cats (aged older than six months) and kittens (aged six months or younger) to the Guelph Humane Society, 2011–2015. Intervention implemented in August 2014 is indicated.

The current study contained a total of 60 months of data, 43 months prior to the C4C intervention and 17 months post-intervention. In addition, the model presented here adjusted for season and trend, both of which are important to consider when collecting time-dependent data. The trend component showed a significant secular decrease in all cat admissions at the GHS throughout the entire study period. Cat admissions decreased approximately 16% with each additional year, when all live cat admissions were analyzed (see Table 4). The secular decreasing trend in cat admissions in this study is in agreement with the results from the "Animal Shelter Statistics" report released by the CFHS (2015), which showed decreases in cat admissions in Canada since 2011. Although the exact causes of this decrease are undetermined, the CFHS (2015) has suggested that spay/neuter efforts, educational initiatives, and increased networking between shelters may have contributed to the gradual decrease in shelter cat admissions countrywide. However, it should be noted that the CFHS does not report certain changes that occur at shelters, such as changes to intake policies,

which may affect admission numbers over time. This report, however, contains data from only 52% of Canadian Humane Societies and Societies for the Prevention of Cruelty to Animals (CFHS, 2015); therefore, there is potential for response bias toward shelters that have been successful in their efforts to decrease intake and improve outcomes as these shelters are more likely to respond to the survey.

While diligent efforts by the GHS may certainly play a role in the secular decreasing trend in cat admissions seen during the study period, there could also be external causes. In 2014, it was observed that numerous cats whose owners allow them to roam outdoors in Guelph were disappearing, and it has been suggested that coyotes were responsible for the loss of these cats (Levenson, 2014). Concurrent with the decrease in cat admissions to the GHS were record-breaking cold winters in Southwestern Ontario, Canada (where Guelph is located). One could therefore hypothesize that free-roaming cats and kittens were likely to have reduced survival rates during recent winters, potentially contributing to the decrease in shelter admissions. In addition, during the study period, the city of Guelph changed its garbage disposal system (Warren, 2015), switching from bags to lockable plastic bins that obstruct animals from eating garbage. The effect of the change in garbage disposal could result in less food available for free-roaming cats and perhaps a lower survival rate, resulting in fewer admissions to the GHS.

In 2016, the CFHS released a report regarding the C4C case study at the GHS. This report showed a 10% decrease in cat admissions from one year prior to the C4C program compared with one year after (CFHS, 2016). Data from a longer period of time provide the opportunity to show more precise results and be more forgiving of small fluctuations in data (CFHS, 2016). We found that the C4C intervention variable was not significant in the time-series model for all live cat admissions. This finding signifies that the C4C program did not have a significant effect on the total cat admissions to the GHS when all age groups were considered. Although intake is expected to decrease with the intake diversion techniques used in the C4C program, an increase in intake could also be projected if there is a consistent demand for shelter space (CFHS, 2016)—for example, if the shelter were to be overwhelmed with litters of unwanted kittens. Nevertheless, when the data set was reanalyzed after removing kittens, the C4C program showed a significant reduction in admissions of adult cats (see Table 5). After the C4C program was implemented, the GHS saw a 24% decrease in adult cat admissions during the study period (see Table 5). These results suggest that the C4C program resulted in a decreased intake of adult cats.

With respect to the seasonal component of the time series (Figure 2, second quadrant), only one seasonal peak was observed. As Marston and Bennett (2009) suggested, this finding may indicate that there is not a significant quantity of queens having a second litter each year, or a second seasonal peak would be expected approximately three months after the first. However, it is possible that a second litter has been absorbed by the community, revealing no effect on the admissions at the GHS. Similar to the results of Marston and Bennett (2009), seasonal peaks were much more apparent in the data of kitten admissions compared with adult admissions (Figure 4). This finding suggests that the significant seasonal swing found when all ages were included in the data set can be attributed to what is commonly known as a "kitten season."

The most recent report released by the CFHS (2015) displays the sources of admissions for the average Canadian shelter. The GHS took in an average of 79.2% stray cats from 2011 to 2015, whereas the intake of strays into the average Canadian shelter during the same time period varied from 49% to 63% (CFHS, 2012, 2013, 2014, 2015). The second main source of cat admissions at the GHS was from owner surrenders, which comprised 16% of the total intake. This proportion is much lower than that of the average Canadian animal shelter, which ranged from 22% to 34% owner-surrendered cats during a similar time period (CFHS, 2012, 2013, 2014, 2015). It is possible that the GHS receives a higher proportion of strays than the average Canadian animal shelter, as it is the principal animal shelter in the city and is contracted by the city of Guelph to provide animal control services, including impounding stray domestic animals. It is also possible that a higher proportion of individuals relinquish owned pets as "strays," whether to avoid the associated costs of relinquishing an owned animal or due to the social stigma associated with relinquishing an owned pet. Further

research would need to be conducted to determine why the GHS receives a higher proportion of strays compared with the average Canadian animal shelter.

One of the common limitations that arises when collecting shelter intake data is that it is not always possible to determine whether a cat categorized as a "stray" is truly a stray, has been semiowned, or is an owned outdoor cat (Marston & Bennett, 2009). Furthermore, without any data collected on the level of socialization (and thus the likelihood of the cat not being feral), it is difficult to speculate retrospectively whether cats categorized as strays have been owned or semiowned during their lifetimes. Based on the findings of the current study, we emphasize the importance of increasing spay/neuter efforts within the community, as only 15.4% of cats admitted to the GHS were known to have been previously spayed or neutered on their dates of admission.

Approximately 37% of cats admitted to the GHS during the study period were kittens aged six months old or younger, and the majority (83.2%) of these kittens were taken in as strays. If these kittens were in fact strays, increasing efforts to reduce the number of free-roaming cats having litters could make a significant impact on the number of cats entering animal shelters. Programs such as the Barn Cat Program and the Shelter-Neuter-Return Program (also called Trap-Neuter-Return (TNR)), which are both aspects of the C4C program, could be utilized to further reduce the free-roaming cat population. Although the topic of TNR can be quite controversial (Jessup, 2004) and some have found it to be ineffective in reducing the homeless cat population (Castillo & Clarke, 2003), others have found a combination of approaches, including adoption of homeless kittens, to be successful in reducing the homeless cat population (Levy, Gale, & Gale, 2003). We believe a combination of approaches is required for successful reduction of homeless cats in the city of Guelph.

Due to the high proportion of cats categorized as "strays," it would be beneficial for the GHS to track whether queens are admitted together with their kittens when collecting data. Previous research by Marston and Bennett (2009) revealed significant differences in the types of cats admitted by animal management officers versus members of the public. For example, animal management officers were more likely to admit entire colonies, whereas members of the public were more likely to admit kittens without queens (Marston & Bennett, 2009). If members of the public are admitting litters from an owned cat as "strays," then perhaps an incentive could be made to encourage these individuals to have their queens spayed. At minimum, collecting this type of data will allow the GHS to have a better idea of the proportion of queens still at large in the community.

Conclusion

This study was the first to evaluate the effects of specific intake management strategies implemented at the GHS as part of the C4C program using long-term data while adjusting for trend and seasonality. We detected a long-term decreasing secular trend, which was not previously considered in evaluating the C4C program, by comparing intake data for one year before and after the start of the C4C program at the GHS (CFHS, 2016). Our results demonstrate the importance of breaking down data based on categories such as age, admission source, and neuter status to provide more depth to the analysis of shelter admissions data. Excluding kittens from the analysis, the C4C program was associated with a significant decrease in intake of adult cats. The current study measured only one impact of the C4C program (i.e., cat admissions), and future studies should also focus on how the C4C program affects other outcomes of shelter cats including the presence of disease while in the shelter and the overall welfare of cats while in the shelter.

In addition, research examining the impact of the C4C program on owned and unowned free-roaming cat populations outside of the shelter should be considered. Unfortunately, the results from this study cannot easily be generalized to other shelters, as each community may differ in factors that influence shelter admissions as well as the animal population itself. Our study

provides a good foundation for other shelters to evaluate the effects of the C4C program in their context.

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