

The Perceived and Actual Impact of Outdoor Domestic Cats on
Local Ecology in Massachusetts, and the Effects of Education
on Cat Owner Behavior

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Abstract

The negative impact outdoor cats have on local ecology and wildlife populations is well documented across the world, but many cat owners and non-cat owners either are not aware of the impact or do not understand the potential severity of the situation. This project aimed to gauge the knowledge and attitudes held by residents of the state of Massachusetts pertaining to the ecological impact of outdoor cats through a survey provided to Massachusetts residents. The findings show the majority of outdoor cat owners and indoor/outdoor cat owners do not believe their cat has an impact on local ecology, even if they observe their cat returning prey items home. There was a statistical significance between rural-urban demographics; with significantly more rural respondents believing their cat did not have an impact on local ecology than the expected response distribution. The majority of indoor cat owners and non-cat owners did believe cats in their neighborhood have an impact on ecology, although there was no statistical significance across rural, urban, and suburban demographics. The majority of outdoor and indoor/outdoor cat owners imposed no limit on their cat's access to the outdoors, with rural respondents making up the largest portion of those responses. The belief that outdoor cats do not have an impact on local ecology paired with a large number of outdoor cat owners that do not impose a time restriction on their cat's outdoor access leads to cat owner practices that unknowingly exacerbate an already existing problem. Educational materials should particularly be geared towards populations of cat owners that are less likely to understand the negative impacts outdoor cats make in an effort to change cat owner behavior in ways that promote more responsible ownership. The second aim of this project was to assess the knowledge and attitudes held by Massachusetts elementary students pertaining to the impact of outdoor cats and to effectively educate them. A lesson was given at Elm Park Community School and preliminary results showed that students were not fully aware of the issue of predation. An assessment given after the lesson showed only a slight improvement in overall knowledge and an increased desire to combat the problem. The sections that saw the most improvement included information that many of the children found emotional connection to or saw a clear method by which they could incorporate it into their daily lives. Therefore, ecological lessons should be crafted to have as much of a connection to the target group as possible. Additionally, the age of the target group must be taken into consideration, as the

maturity level of the project's student group presented issues such as distraction and an increased difficulty of comprehension.

Executive Summary

The domestic cat has been a part of human civilization for thousands of years. They have had their roles as companions and hunters. With the continued development of human civilization increased human density has contributed to rapidly expanding cat populations and with it, over predation. With this increasing rate of predation, the way of life of more and more species is at risk. Although human expansion is the primary cause of habitat loss and extinction, domestic feline predation is still a very important and treatable factor. The issue however, is the widespread lack of education that keeps citizens unaware and therefore unable to assist in alleviating the issue. This project aimed to assess the extent of this problem and to explore methods by which the proper information could be related to common households in Massachusetts. We accomplished this by 1) surveying adults and 2) engaging elementary school children on the issue.

We constructed a survey that quantified cat caregiving practices and perceptions of cats on local ecology in Massachusetts. In addition, questions used to quantify outdoor cat owner caregiving practices as well as non-cat owner and indoor cat owner behavior towards local outdoor cats were given. The surveys were distributed through email and as a hand out in an elementary school. It was also directly administered at a survey station at Northborough Free Library.

In development and analyses of surveys, we considered cat ownership and degree of urbanization (urban, suburban, rural). After analyses, it was revealed that cat owners recognized that cats can have a negative impact on the local ecosystem at a lower rate compared to non-cat owners. This statement held true regardless of whether or not the owner's pet brought back prey to the household. In addition, the highest response for time the pet was allowed outdoors was no limit, with the limit being all day as the second highest response. A connection between the time allowed outside and the belief that their pet had no effect on local ecology can possibly be explained by outdoor cat owners not knowing that letting their cat outdoors has an impact. It was

found that there was no significant difference in perception or behavior between respondents across an urbanization gradient.

Although feline predation and overpopulation is a very real issue, many people, including both cat owners and non-cat owners, are not aware of it. There are many reasons for this, but it can be addressed through targeted education. If there was a way to effectively introduce information relating to the issue to local households, then the ideal outcome would be increased awareness and ecological activism in those areas. The project explored this possibility by creating and administering an educational program at Elm Park Community School in Worcester, MA. Through discussions with the school's after-school program director, a sample group of two after-school second grade student groups was chosen. Student availability and prior experience with the groups contributed to this choice.

Two different assessments were given to the students before and after the lesson and the questions included were divided into three categories: "informational", "attitudinal", and "combined". Each category assessed a separate aspect of the issue and responses were ranked accordingly. A post-lesson assessment compared with a pre-lesson assessment displayed a higher overall level of knowledge and changes in expressed attitudes concerning personal ability to take on small actions that would make a positive difference.

Finally, we recommend to future groups who would wish to continue the project to consider the following statements. A future survey should assess the relationships that respondent age, gender, and education level have with knowledge and attitudes towards to issue. Additionally, a deeper focus should be on respondent beliefs as opposed to pet behavior in order to get a better picture of cat owner attitudes. The major contributing factor to issues that arose was the age of the students. These issues included difficulty of concept comprehension and overall maturity. The high level of post-lesson comprehension and attitude assessment of the sole fourth grade student participating in the lesson suggests the possibility of an overall increase of lesson effectiveness if presented to older children. Many of the students held associations between feline predation and its depiction on television shows and channels. It is recommended to investigate whether there is a correlation between knowledge of ecological concepts and facts and their depiction in mainstream media.

Authorship

This project was collaborated upon by Olivia Shraibati and Christian Zelaya. Christian Zelaya focused on the sections regarding the educational lesson and its analysis. Olivia Shraibati primarily focused on the survey and brochure and their analysis. Other sections were a collaboration of both parties.

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Table of Contents

Abstract	2
Authorship	5
Acknowledgements.....	5
Predation	9
<i>Regional Impact and Perception</i>	10
<i>Response</i>	10
Education	11
<i>Academic environment</i>	12
<i>Educational Lesson</i>	13
Formative Assessment	14
<i>Real World Environment</i>	14
Survey	15
Methodology	17
Survey Creation	18
Survey Administration	19
<i>Obtaining Permission</i>	19
<i>Distribution and On-site Administration</i>	20
Survey Analysis	20
Education	20
<i>Obtaining Permission</i>	20

<i>Lesson Plan</i>	21
<i>Informational Brochure</i>	22
Results.....	23
Survey	23
Lesson	27
<i>Participants</i>	27
<i>Pre-Assessment</i>	27
<i>Post-Assessment</i>	28
Discussion.....	30
Survey	30
Lesson	32
Recommendations.....	35
Appendix A: Cat Survey	40
Appendix B: Additional Survey Tables	45
Appendix C: Course Development Form.....	46
Appendix D: Pre and Post Lesson Assessments	49
Appendix E: Pre and Post-Assessment Metrics	51
Appendix F: Informational Brochure.....	56

Introduction

The species *Felis catus* or as it is more commonly known, the domestic cat, has coexisted with human population for centuries, serving as companions and hunters. As such, they have enjoyed a place in ecosystems all around the world due to human aided importation, intentional or otherwise. As an exotic species in many areas however, their insertion into ecosystems had and continues to have many repercussions. An example can be seen in the population decline of select bird species (Beckerman et al. 2007). Although the main factor in population decline is habitat loss due to human expansion and other actions, cat predation is still a significant issue that can be partially alleviated through intervention (ABC Birds [Date Unknown]).

Feline predation is generally attributed to those feral domestic cats who do not have an owner from whom they can receive a reliable source of food. This is not necessarily the case however. Domestic cats are opportunistic hunters and will hunt even if they are not hungry. Certain house cat behaviors also directly serve to oppose widespread knowledge and acceptance of this fact. A study recording cat behavior through the use of collar-mounted cameras revealed that in many cases, these house cats consistently either ate or left their prey on the spot (Abernathy et al. 2013). As a result, most of the questioned owners did not believe that their pet exhibited any hunting behavior. This example represents a trend of misinformation perpetuated by a lack of direct physical evidence that can be seen featured in several studies.

Although there have been many studies analyzing the issue and involve exposing owners to methods to intervene and affect their cat's behavior, there is a surprising lack of reports that assess the effectiveness of educational programs in promoting positive cat owner and non-cat owner practices. Although there have been a few studies assessing the teaching of ecology, these are usually conducted with students of at least secondary school age. There have been little to no studies done on teaching young primary school students about ecology and subsequent effects on their attitudes towards ecological issues.

This project had two purposes. The first was to assess knowledge level and attitudes held by residents of Massachusetts in regard to the issue of cat predation and to determine if there is any correlation between several factors such as residence type (rural, suburban, or urban) and cat ownership. The second purpose was to administer an educational program aimed at students

attending a Worcester public school. This program was intended to raise awareness of the issue and to facilitate a change in the beliefs held by the students in reference to the material presented.

Background

Predation

The domestic cat has experienced widespread introduction to various environments around the world. In virtually all instances, the domestic cat has been known to have a severely negative effect on the impacted ecosystem such as endangering certain species through over predation and in some cases leading to extinction (Blancher 2013). At least 33 bird species have become extinct on oceanic islands as a direct result of feline predation (Blancher 2013). Interestingly, there are many secondary effects that contribute to the reduction in population, such as increased vulnerability to other species and changes in behavior as a result of increased energy expenditure on survival and decreased energy spent on feeding and rearing young (Beckerman et al. 2007). These behavioral modifications include changes to foraging patterns and habitat use. Additionally, it has been shown to affect survival rates and clutch size (Beckerman et al. 2007). Eventually this forced prey behavioral modification coupled with direct predation is enough to possibly render the affected species extinct.

Large populations of feral cats in particular pose potential problems to human populations, as zoonotic diseases such as the rabies virus and *Toxoplasma gondii* have the potential to infect humans that come in direct contact with their saliva or feces (SFM Veterinary Committee et al. 2012). However, the risk of catching rabies from a cat is lower than the risk of catching rabies from animals such as skunks, bats, and foxes, which account for more than 90% of reported cases according to recent statistics from the CDC (Feral 2014). Feral cat communities also suffer in overall welfare, as the mortality rate of kittens born outdoors can be up to 75% within a half a year of life (SFM Veterinary Committee et al. 2012). Other factors such as disease, hardships as a result of climate, and starvation also contribute to a poor quality of life and often times a life expectancy of less than five years (SFM Veterinary Committee et al. 2012). These facts combined with the disruption and harm outdoor cats can have on wildlife ecology and ecosystems create an exigency to address these problems.

Regional Impact and Perception

The number of prey items an outdoor cat obtains is often estimated by the owner by counting the number of prey items brought back to the owner's property. Although this is a common practice, there is research suggesting that this vastly underestimates the number of prey items an outdoor cat captures. Abernathy et al. 2013 analyzed feline predation habits using collar mounted cameras has shown that cats tend to only return a small percentage (23%) of prey back to the owner's home, potentially leading many to believe that their pet does not pose a problem to the surrounding ecosystem. However, there are studies such as one conducted in Brazil which analyzed cat feces which found that domestic cats hunt steadily year round regardless of the amount of food their owners provide them (Ferreria et al. 2014).

Measuring the effects of cat predation on urban ecosystems and rural ecosystems is an important but complex distinction, as the structure of an ecosystem exist along a gradient (McDonnell M. J. 1990). Urban rural gradients describe the spectrum of ecosystems with varying degrees of human structural development; such as roads, buildings, sewage systems, and power lines (McDonnell M. J. 1990). Outdoor cats have been shown to kill more prey in rural areas as opposed to urban ones (13), but there are many unique problems for wildlife in urban areas that may contribute to a more impactful loss of life as a result of cat predation (Adams 2010). These include human behaviors that result in habitat loss and high levels of disturbance, which can reduce the amount of resources available to wildlife in urban settings (Adams 2010). Although outdoor cats cannot be wholly to blame for declines in urban wildlife population, they contribute to a decrease in wildlife populations and make an existing problem worse (Adams 2010).

Response

In the past there have been several attempts to curb this problem including extermination (Hobbs et al. 2001) and sterilization (Litster 2014) of feral cats, with varying degrees of success. Extermination in particular poses many issues logistically and ethically. The problem can be approached for an animal ethics perspective, which puts the concept of non-human personhood and the moral status of non-human animals first, or an environmental ethics perspective, which takes a more utilitarian approach to the natural environment (Mautner et al. 2005). In the case of animal ethics, it would not be considered ethical to exterminate feral cats as a means of

population control, compared to an environmental ethics perspective that would find it acceptable due to feral cats being a thriving invasive species and their prey items often being negatively affected on a population level. Using extermination as a method of population control often leads to excessive poisoning of non-target species, which is a major logistical problem as decreases in non-target species populations can change the biodiversity in ways that negatively affect the ecosystem. For example, the rodent control poison “Compound 1080” had also seen widespread use by farmers in order to control the coyote populations (Garmon 1982). It was eventually found that many non-target animals were also being killed by the poison, such as various bird and black bears, leading to its ban in coyote control use (Garmon 1982). It can also cause ethical issues as extermination may eradicate outdoor pets that are not the target population, effectively killing animals that belong to families. Transferring poisons involved in eradication up the food chain can also inadvertently harm the local ecosystem and negatively impact the health and stability of the ecosystem, posing both logistical and ethical dilemmas. Variables such as roaming populations render the method unfeasible over sufficiently large areas. So far, the only successful instances of planned extermination are those conducted on islands with a small and self-contained ecosystem (Hobbs et al. 2001).

Education

There are many methods used to facilitate changes in behavior and increased knowledge of a particular subject, such as the circulation of informational brochures and verbal explanations of solutions. A study analyzing the impact of given advice and intervention concerning fall hazards in the home of elderly participants address this prospect (Bennett et al. 2002). Advice was given both verbally on specific issues in a given home and through a brochure which gave general advice. For example, 408 participants were given specific advice on removing rugs and mats from potentially hazardous locations and 54.9% acted accordingly (Bennett et al. 2002). For the 548 subjects who received only general advice from the brochure, only 46.7% took the suggested action (Bennett et al. 2002). The study showed that in every instance specific advice was more effective in leading to compliance with suggested actions (Bennett et al. 2002). However, the brochures still proved to make a noticeable, if smaller, difference as well (Bennett

et al. 2002). This suggests that brochures are still viable as a standalone educational vehicle, but should be supplemented with specific advice whenever possible for better results.

A second viable method for facilitating changes in behavior is the construction and administration of an educational program which stresses participant interest and engagement. A study was conducted on the effectiveness of an educational program about airline cabin safety on Taiwanese fifth and sixth grade students (Liao 2014). The students were initially given a pre-assessment survey that was used to gauge mean knowledge levels that would be used for comparison with a post-assessment survey. The program consisted of three different modules: lecture, a demonstration and an educational film on airline cabin safety. Certain modules were given to certain student groups and not to others in order to determine the individual effectiveness of each one. The study showed that students responded most favorably to the teacher-given lecture coupled with an interactive demonstration (Liao 2014). Students responded with not being very interested in or engaged by the educational film. In the post-assessment survey, 94.2% of respondents stated that they would share information they gained with their family and 97.5% responded that they would correct any incorrect behavior during their next flight (Liao 2014). This study suggests that well-constructed educational programs can make positive behavioral alterations in the target audience.

Academic environment

Methods concerning educational program construction, such as presented in Liao 2014 were prominent in our own study involving the school children at Elm Park Community School. We approached this by first assessing the expected results in two different categories (MEERA [Date Unknown]): outcomes and impact. Outcomes are the immediate, short-term results while impacts are what would be expected to occur over an extended amount of time. Therefore, it is important to first determine the desired impact and then construct methods to achieve desired outcomes to facilitate the desired result. For example, research has been conducted on the effects of environmental education in public schools (NCLI [Date Unknown]). The outcome was that students were given a better understanding of various environmental issues and the impact was that many students would go on to be more engaged in topics relating to those same issues (NCLI [Date Unknown]). This is due to the fact that students received education on a subject that

had more relevance to their daily lives. Therefore, if the material is presented in the manner that resonates most with the target audience, then the possibility of achieving both desired outcomes and impacts is at its highest. The practice of organizing successful youth environmental action is an example of an ideal impact. Past projects such as the implementation of a combined community run butterfly house and education center (Decker et al. 2009) by a local school teacher have shown that youth environmental enthusiasm can be cultivated and used to influence both the community and the environment itself. Student volunteers served as tour guides for any people interested in the butterfly house as well as educators for those who wished to learn more. Additionally, they worked as caretakers for the butterflies who lived and were raised inside the house.

Educational Lesson

A very effective method of introducing educational material into a classroom setting is through the presentation of a well-developed lesson. These lessons can be very informative and have the potential to positively influence participant behavior (Liao 2014). In order to develop a quality lesson, a well-developed lesson plan must first be created (Derri et al. 2014). As stated in Derri et al. 2014, teachers who plan effective lessons “ a) have a clear idea of the objectives to be achieved and the ways they will be achieved, b) identify their students’ level and needs and design appropriate learning experiences, c) design lesson sequences, and clear and appropriate instructions, d) set realistic and challenging goals in order to promote learning for all students, e) use appropriate questions to enable students’ understanding, and f) select appropriate strategies for class organization and management.” The best lessons are those that are tailored to individual classes and manage to take into consideration the overall strengths and weaknesses of the student target group as a whole. In addition, the lesson must be flexible enough to accommodate the needs of particular students who learn at different rates (Williford et al. 2013, Curby et al. 2009)

When the material in a lesson focuses on or uses material relevant to the target students daily lives, it becomes more easily received and retained for a longer period of time (Williford et al. 2013). However, there is the possibility that the presented material will not hold the same importance or relevance to each student in the targeted class.(Liao 2014) There are methods to make a lesson that is not immediately relevant interesting and engaging, as seen in “An

evaluation of an airline cabin safety education program for elementary school children”(Liao 2014). In this program, the material was presented to the children in the form of a film, a lecture or a demonstration. The results collected in a post-lesson assessment showed that students exposed to a combination of the lecture and engaging and inclusive demonstration showed the greatest improvement in knowledge of the lesson material (Liao 2014). Demonstrations and educational class activities that encourage student engagement and participant have been proven to have a positive effect on learning and material retention (Derri et al. 2014). In addition, most of the students expressed a willingness to change their airline cabin behavior accordingly and to relate the lesson material to their family and friends (Liao 2014).

Formative Assessment

The usage of pre and post lesson formative assessments are an excellent way to gauge student reception and general effectiveness of educational programs (DuFour 2014). One of the most simple yet practical versions is the written assessment. In a written assessment, selected questions are presented to the participant who then records their answers in the requested order. Pre assessments are useful for determining the initial knowledge level of the targeted individual or group (Liao 2014). A metric created with the knowledge of the target audience’s level is created and applied to the analysis of pre-assessment results (DuFour and Stiggins 2014). The post assessment analyzes target reception and lesson effectiveness and so must be constructed with those purposes in mind. Questions that test knowledge retention can be included and serve as a superficial indication of effectiveness. These are to be supported by more personal open-ended questions that require thought and a complete idea to be expressed in the student’s own words (formative assessment website source). The metric for these questions is potentially wider but can give a more personal and complete indication of lesson effectiveness (formative source).

Real World Environment

In recent years there have been several groups that developed projects or products in order to educate and assist pet owners in curtailing their cat’s predatory habits. These products

such as the Catbib™, which is a small plastic triangular bib hung on the collar in front of the cat’s chest, result in a lowered chance for a successful hunt either by alerting the prey beforehand or hindering the cat’s ability to pounce or otherwise attack in an effective manner (Bradley et al. 2007).

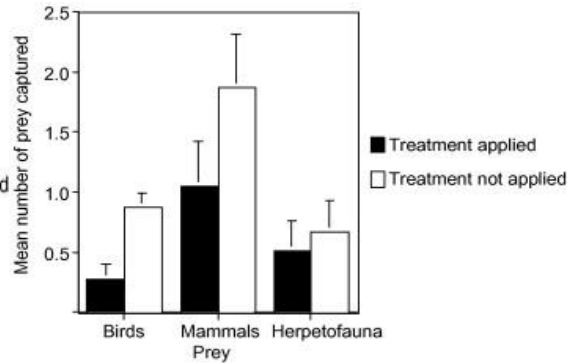
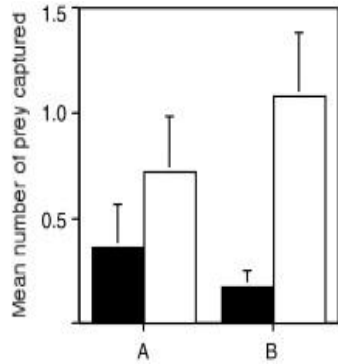


Figure 1: Effect of order treatment on results **Figure 2: Total Prey capture rates**

Many owners have observed firsthand a reduction in prey returned to the area of residence as well as hunting behavior over time while using the Catbib™ (Bradley et al. 2007). This reduction in hunting behavior was also observed even after the Catbibs™ were removed (Bradley et al. 2007). They are attached to the collars of the cats in such a way that other everyday activities are not negatively affected. Other methods involve the implementation of recommended owner actions which follow the precautionary principle (Calver et al. 2011). These include, but are not limited to mandatory sterilization, enforced curfews, and confinement of the pet cat’s to the owner’s property. Sterilization has yielded the most effective results which, unlike mandatory confinement, is not overwhelmingly unpopular within the population centers.

Survey

Surveys are used in professional environments as a means to collect information that is important and relevant to the interests of those who create and distribute them. As a result, there have been many studies and books written with the intent of discovering the ideal survey presentation. This “ideal” varied in response to restrictions or differences that are present when

surveying different groups of subjects. In order to determine the optimal survey format for a specific case, there are five questions that must be answered (Groves et al. 2004):

1. What is the target population?
2. What is the sampling frame?
3. What is the sample design?
4. What is the mode of data collection?
5. Is it an ongoing survey or a one-time survey?

The target population is the most important parameter due to the fact that it directly influences the rest of the four initial guide questions and the way that the survey is written. The question of target population potentially covers age, gender, educational level or other variables that are relevant to any given survey.

There are two main categories of surveys: the interview and the questionnaire (Trochim 2006). The interview method requires that a trained interviewer asks questions face to face or over the phone. Due to the requirement of having to utilize a paid trained professional in the survey process, the interview method is far less viable method than the questionnaire method for a team with limited resources. The questionnaire method is less expensive while offering more versatility.

The three main types of questionnaires are the drop-off survey, the online survey and the group survey (Trochim 2006). Due to the lack of direct administration in all of these variations however, complications such as sudden taker drop-off and survey fraud can arise. Survey design standards such as an unbiased presentation, determination of the optimal amount of questions to be asked and quality overall structure flow help to offset those issues (Boyer et al. 2012). Additional standards include limiting the complexity of the questions, not forcing a response at any point and keeping it relevant to the targeted demographic (Boyer et. al 2012) Ideally the taker will have finished the survey without having felt discomfort as a result of answering the questions presented. Therefore, the desired outcome is to have a taker that has both provided data useful to the project and that is satisfied with their survey experience.

Methodology

The purpose of this project was to understand cat owners' and non-cat owners' perception of the impact outdoor cats have on local ecology, and attempt to decrease the negative effect these cats produce by educating human caretakers that may unknowingly support or enable feline behavior that is destructive to local ecology. The primary goals of this project was focused around data collection through surveys limiting feline predation through education in the form of informational brochures, as well as an educational module that was administered to children attending Elm Park Community School. The survey quantified cat owners' caregiving practices as well as their cats' hunting behaviors. This survey also targeted non-cat owners and their attitude and behavior towards outdoor cats. The perception of outdoor cats' impact on local ecology was also measured for both demographics. Our survey targeted people from 3 main developed environments- rural, urban, and suburban in order to view potential trends in data based on human population density and the degree of environmental urbanization. The educational portion of our project centered around both youth and adults; with our educational module tailored to an audience of 7-9 years old and our educational brochure geared towards adults.

The initial goal was to create a viable survey online through Qualtrics.com targeting cat owners and non-cat owners that see cats in Massachusetts. This survey then received approval (#15-017) from WPI's (Worcester Polytechnic Institute) Institutional review board to ensure it complied with ethical guidelines and regulatory requirements established for research that involves human subjects (Institutional Review Board [Date Unknown]). Once IRB permission was acquired, emails were sent out to public libraries in Massachusetts asking permission to conduct the survey on their premises. The After-School Program Director at Elm Park Community School was contacted to obtain approval to conduct the educational module at the school and send the adult survey home with students for their parents to fill out the adult survey. In addition, an online version of the survey was sent via email to WPI faculty, staff and students.

After survey results started to come back, the educational module was given at Elm Park Community School; with pre- and post- written formative assessments of the children's

knowledge of the topics included in the educational module. Following the completion of the distributed surveys and the post educational module assessment, the informational brochure was distributed to the 2nd and 3rd graders to take home with them. A few weeks following the survey and instructional unit a second survey was given to gauge the effects (if any) the lesson and brochure had on cat ownership behavior as well as the behavior of non-cat owners that interact with outdoor cats.

Survey Creation

In order to begin making the survey, the construction methods outlined in *Survey Methodology* (Groves et al. 2004) were referenced to form a conceptual basis. The first recommended questions in *Survey Methodology* to be answered were: ‘What is the target population?’, ‘What is the sampling frame?’, ‘What is the sample design?’ ‘What is the mode of data collection?’, and ‘Is it an ongoing survey or one-time survey?’. The target population was decided to be both cat owners and non-cat owners primarily in Central Massachusetts. The sampling frame consisted of visitors to Northborough Free Library, parents of second grade Elm Park Community School students, and WPI faculty and staff. The sample design was the stipulation that the respondent had to currently be residing in Massachusetts. The mode of data collection was decided to be a physical paper-based survey sent to Elm Park Community School second grader parents and a computer based survey for library visitors, WPI faculty and staff. Lastly, it was decided to be a one-time survey. Using the answers to the five guideline questions, our individual survey questions were then created.

The survey was written with two main factors in mind; gathering useful information from as many survey takers as possible and creating a short and direct survey. In order to make the survey accessible to a larger number of people, survey questions targeted non-cat owners that interacted with or saw outdoor cats as well as cat owners. In addition to collecting responses on the perceived impacts outdoor cats make on local ecology, additional questions were also included to quantify outdoor cat owner caregiving practices as well as non-cat owner and indoor cat owner behavior towards local outdoor cats. These survey takers were divided into two major demographics, cat owners and non-cat owners. If the survey taker was a cat owner, the questions they received were also dependent on if a cat owner owned an indoor or outdoor cat. The

condition for each question displayed to a particular survey taker is shown in detail in Appendix A. Owners of cats that were allowed outdoors in particular were asked how long their cats were allowed to stay outside. The survey was made as brief as possible to encourage as many people as possible to take it, resulting in a larger sample pool and a higher likelihood that the survey participants would complete the entire survey.

The survey was made using the tools provided on Qualtrics.com (Qualtrics, Provo, UT). Several different data collection techniques were implemented in the distribution of the survey. Drop-off surveys, online surveys, and personal surveys were all used to reach as many survey takers as possible. The drop-off survey consisted of the printed version which was given to the school children to take home to their parents. This type of survey was used due to it being the most logistically feasible option. The online survey was given directly from Qualtrics.com and was sent out via email to WPI undergraduates, faculty, and staff. The surveys that were administered at libraries were delivered via the same medium as the online surveys but the survey takers were face to face with the people administering them, allowing them to interact freely and ask questions about the content of the survey, resulting in personal surveys instead of purely online surveys.

Survey Administration

Obtaining Permission

Permission to administer the survey in libraries was given from each library individually after speaking to a library representative, which would result in the approval for the survey content and location after the library board of directors for review and approve the plan. Elm Park Community School had similar steps for survey distribution approval, with the school's extracurricular program director and the principal overseeing the process. The follow up survey quantifying any change in behavior after the brochure distribution and educational module followed the same procedure for approval. In addition to permission from individual locations to present the survey, the Worcester Polytechnic Institute Institutional Review Board reviewed and approved all surveys used in this project.

Distribution and On-site Administration

The survey was distributed to WPI students, and faculty and staff online through an email containing a description of the project and a link to the survey. The drop-off surveys were given to local schoolchildren for their parents to complete after a brief explanation of what the survey was about and how to fill it out. The students were given a time frame in which they should return the completed survey, should their parents consent to taking it. The personal surveys were given to the people who volunteered to take the online survey at one of the manned project survey booths in front of Northborough Free Library. The results all surveys were either automatically or manually uploaded to the Qualtrics server.

Survey Analysis

Descriptive statistics were used to describe the basic features of the data obtained from the survey. This was done to highlight notable distributions of results as well as the possible significance of them. We also tested for differences in geographical demographics on the opinion of cat impact on local ecology and/or populations of local wildlife using a chi-square test. This was done separately for the group containing outdoor cat owners and indoor/outdoor cat owners and the group containing non-cat owners and indoor cat owners to determine the statistical significance it had on the opinion of cat impact on local ecology and/or populations of local wildlife. The expected values for each group were calculated under the assumption there was no difference between rural urban, and suburban demographics. Due to a small sample size for this particular question ($n = 31$), we used a relaxed level of significance ($\alpha = 0.10$).

Education

Obtaining Permission

In order to gain permission to present educational information to the children, the proposed material must have adhered to the guidelines described in Elm Park Community School's course development form. It must then have been reviewed by the school's extracurricular program director, Courtney Cox, and sent to the principal for final approval. In

addition, we were restricted to surveying children in the after-school tutoring programs due to the fact that too many school days had already been cancelled because of snowfall. Due to this restriction, the pool of students that would be exposed to our program was lessened. However, the total number of 2nd and 3rd graders in the program was equal to the number of children in an average class at the school.

Lesson Plan

While the surveys were being distributed, an educational module targeting 2nd graders was constructed. It was presented to school children in after school tutoring programs soon after survey data from the student households was received. Although it was not absolutely necessary to include a waiting period between survey distribution and presentation of the lesson, this was done to enable necessary modifications to the lesson if there were common misconceptions that needed to be clarified.

The method of delivery for the lesson was decided to be an interactive projector-aided lecture. Information was presented on printed sheets of paper that were placed on the projector for the children to view. The lecture was designed with student interactivity in mind in order to maximize engagement (Liao 2014). To that end, many of the pages included only a topic heading or pictures. The target audience was split into two groups, according to which day they attended the after-school program. Students were asked to raise their hands to respond to any questions asked and many of their answers were recorded on the pages as they watched. These “question” pages were then followed up by a picture that represented the relevant information and a verbal explanation. Care was taken to ensure that each student had a chance to respond in order to maximize the lesson interaction (Williford et al. 2013).

For each group, the lesson was followed the next day by a supplementary game of educational bingo, played like traditional bingo. The purpose of the game was to add another, more exciting interactive portion to the lesson. On each card passed to students were sixteen different answers corresponding to questions to be asked by the person running the game. The game itself was not designed to be overly difficult or to punish students based on wrong answers. Rather, between each question, students were called upon to respond with their own answer, ensuring that the right response would be reinforced by the children themselves. Once a student

achieved “bingo”, a reward was given based on participation and behavior leading up to that point (Emmer et al. 2010).

After the educational module was administered, the informational brochure was distributed as a supplement to the lesson. Several weeks after the lesson, these students and their parents were intended to be asked to fill out a questionnaire on whether or not there have been any changes to how they interact with their cat. This would have done to measure any changes that have occurred since the lesson and if any of the changes are a direct result of educational material. Due to time constraints however, this course of action had to be dropped.

Formative Assessment

Due to the mixed open-ended and closed-ending nature of the questions, a modified version of the categorical coding system of analysis was used (UC Davis 2015). The questions presented to the students tested either related attitudes, knowledge, or both. The responses were coded into a 1-4 categorical scale and ranked according to criteria created for each individual question. There were three question categories: “informational”, “attitudinal” and “combined”. The “informational” category tests knowledge of facts related to the lesson. The “attitudinal” category assesses student perception of and disposition related to the issue presented in the specific questions. The “combined” category tests the student’s ability to apply factual knowledge into addressing the issue presented, in addition to analyzing their stated reasons and methods in doing so. Ranking system shown in Appendix E.

Informational Brochure

The main objective of this brochure was to communicate simple, useful facts about wildlife conservation in response to outdoor and feral cats. The content was designed to be relevant and relatable to the reader, with specific sections addressing the general public as well as cat owners in particular. The content was also intended for readers of all ages, allowing the information to be communicated to children as well as adults. This brochure introduced background on how wildlife is impacted by outdoor and feral cats as well as how outdoor cats can suffer negative repercussions from spending time outside. This was done to appeal to as broad an audience as possible, targeting both people who are concerned about local ecology and

people concerned about the wellbeing of their cats. The Q&A sections had succinctly phrased information challenging common misconceptions on the role of cats' impact on wildlife. Many of these topics were geared towards the comment section of the online survey where many misconceptions were stated.

Results

Survey

We administered a survey to Massachusetts residents either online through Qualtrics.com or in person in the form of a take home survey from February 19 - April 1 2015. There were 238 people who took the survey and 229 who completed it (Appendix A). Survey takers were fairly evenly distributed in urban areas (26.0%) and suburban areas (25.0%), but a large majority identified themselves as living in a suburban area (49.0%). One hundred five of the 224 survey takers were cat owners (46.9%) while 119 (53.1%) were not. Of these 105 cat owners, only 3 owned outdoor only cats while 36 owned cats that were both indoor and outdoor. The majority of surveyed cat owners had indoor only cats, as shown below in Table 1. Cat owners that listed their cats as being indoor only or both indoor and outdoor were then given the option to list the reasons for keeping their cat indoors. All (n=24) of the responses were geared towards the safety of the cat and the concern of predators that could harm cats. Eleven of the 24 responses explicitly included the word 'safety' and 7 of the 24 responses included the word 'predator'.

Table 1: Distribution of pet indoor cats, outdoor cats, and both indoor and outdoor cats belonging to cat owning survey takers.

#	Answer	Sample Size	%
1	Indoor only	66	62.86%
2	Outdoor only	3	2.86%
3	Both indoor and outdoor	36	34.29%
	Total	105	100.00%

The majority (36.1%) of outdoor cat owners imposed no limit on the amount of time their cat was allowed outside (Figure 3). The second highest response was to allow pet cats outdoor access all day only. The respondents from the rural demographic showed a large preference imposing either no limit on their cat’s access to the outdoors (41.1% of all rural respondents) or allowing them access all day (23.5% of all rural respondents). Both suburban (31.3% of all suburban respondents replied ‘no limit’) and urban (33.3% of all urban respondents replied ‘no limit’) demographics showed a preference for those options as well, but the rural demographic showed a higher concentration of responses in those two options compared with suburban and urban response distributions.

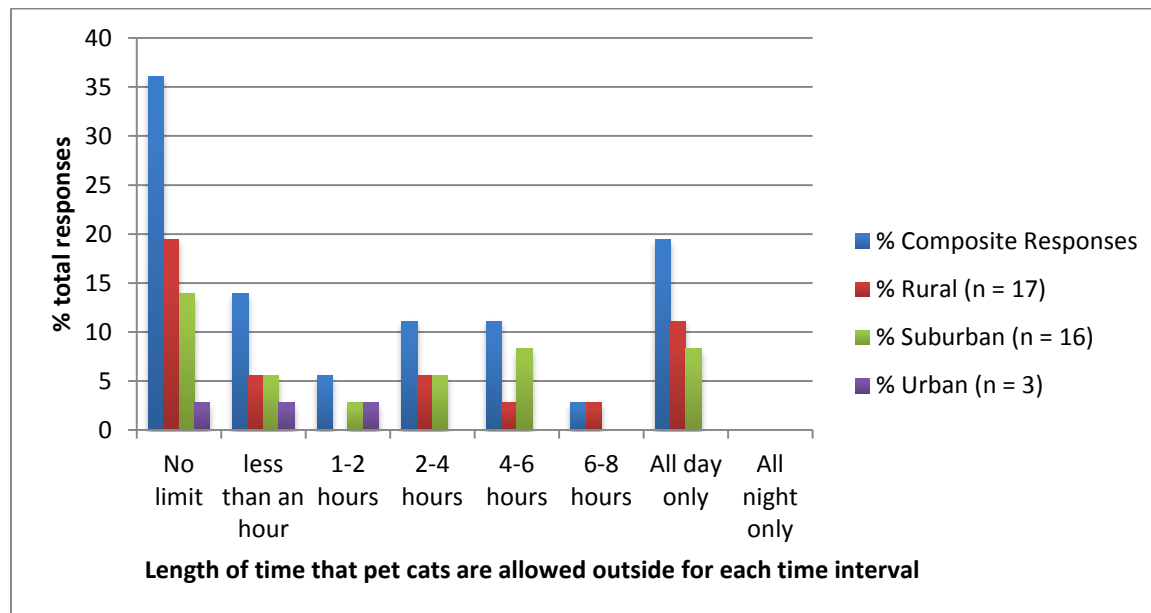


Figure 3: The % total responses for how long pet cats are allowed outside for every time interval, also including responses based on rural, suburban, and urban demographics.

These same cat owners were then asked if their cats ever brought prey back to their house, and if so, how many prey items on average is brought back every month. The majority (76%) of these cats brought back prey items, and none exceeded 10 prey items per month (Table 2). The distribution of observed prey items brought back to the owner’s household was 24 (96%) of cats for small mammals, 16 (64%) for birds and 1 (4%) for insects.

Table 2: Average number of prey items outdoor and indoor/outdoor cats return to owner's household per month.

	<i>Answer</i>	<i>Sample Size</i>	<i>%</i>
1	1 prey item	7	21.21%
2	2 prey items	6	18.18%
3	3 prey items	1	3.03%
4	4 prey items	5	15.15%
5	5 prey items	2	6.06%
6	6-10 prey items	4	12.12%
7	10-15 prey items	0	0.00%
8	15-20 prey items	0	0.00%
9	20-25 prey items	0	0.00%
10	greater than 25 prey items	0	0.00%
11	No[ne]	8	24.24%
	<i>Total</i>	33	100.00%

The majority of outdoor and indoor/outdoor cat owning respondents (62.2%) believed their cats had no impact on local ecology (Figure 4). In particular, the majority of cat owners that reported prey items returned also believe their cat have no impact on local ecology and/or populations of local wildlife. In addition, the majority of cat owners who reported no prey items returned also believed their cat have no impact on local ecology and/or populations of local wildlife. There was a significant difference in opinion between rural, urban, and suburban demographics for outdoor and indoor/outdoor cat owners about the local impact cats have on ecology ($\chi^2 = 5.55$, $P < 0.10$). In particular, more rural respondents thought that there was no impact than expected. Unlike outdoor and indoor/outdoor cat owners, there was no significant difference in opinion of the local ecological impact of cats for non-cat owners across rural-urban demographics ($\chi^2 = 1.53$, $P > 0.25$).

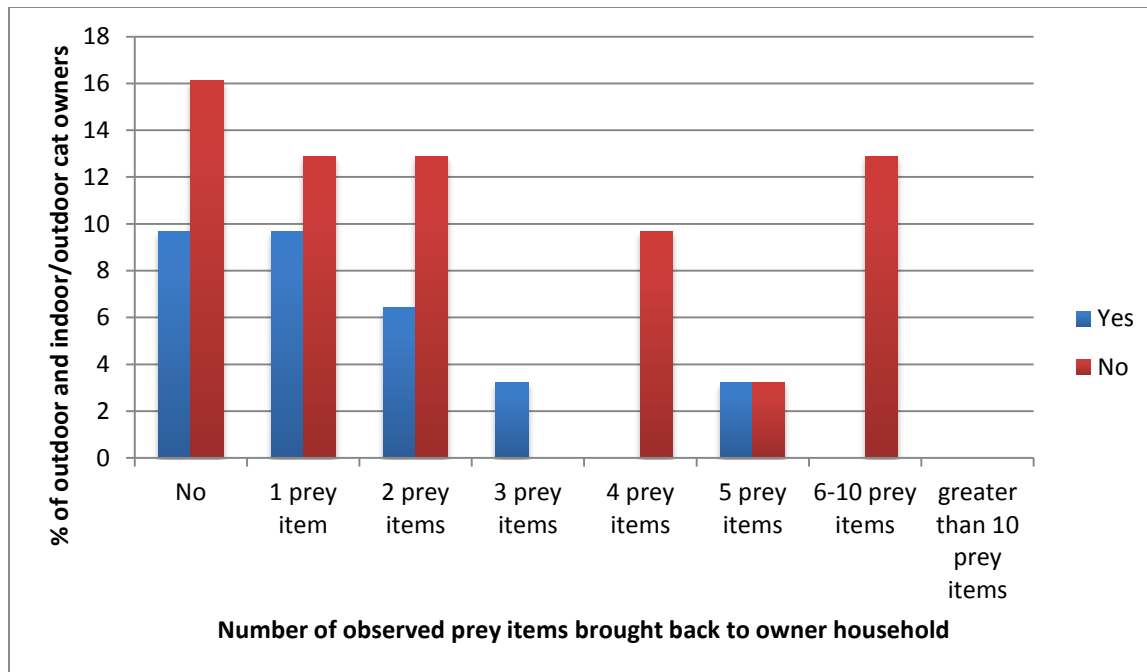


Figure 4: Bar graph of the percentages of outdoor and indoor/outdoor cat owners that feel that their cat has an impact on local ecology ('Yes') and those that feel their cat does not have an impact on local ecology ('No') according to the number of observed prey items brought back to owner households.

Survey takers that did not identify as cat owners or were cat owners with indoor cats were asked if they saw cats in their yard or on their property, and what they did if they saw them. This group consisted of 183 survey takers, with 111 (60.7%) respondents responding that they did see cats in their yard or on their property and 72 (39.3%) respondents responding that they didn't. 74% of respondents that saw cats in their yard or on their property did nothing, 8% would feed them, and 18% chase them off their property. This question also allowed for a written portion where most of the received responses consisted of statements about feeding outdoor cats or chasing them away, with only one response mentioning bringing stray cats to the veterinarian and no kill shelters. The majority of non-cat owners believed cats in their neighborhood had an impact on local ecology (62%) unlike the majority of outdoor and indoor/outdoor cat owners that believed their cats did not have an impact on local ecology (65.7%).

Lesson

Participants

The participants consisted of 20 Elm Park Community School's Participants separated into 2 groups of 11 and 9 students respectively according to their scheduled after-school program attendance. Nineteen (95%) of the students were in 2nd grade while 1(5%) student was in fourth grade. The fourth grade student had previously been exposed to ecological science lessons (i.e., the food chain) while all of the second graders had not yet been exposed to relevant information in the classroom. All of the students live in an urban environment and only 3 (15%) have pet cats at home.

Pre-Assessment

Two (25%) of the questions fell solely into the informational category. An average categorical ranking of 1.32 suggested very little to no prior knowledge. Two (25%) of the responses fell into the attitudinal category. An average categorical ranking of 1.87 suggested that the children held attitudes that contributed to the issue. Four (50%) of the questions fell into the "combined" category. An average categorical ranking of 2.01 suggested basic knowledge but the inability to apply it to the issue. The total mean ranking of 1.8 and Standard Deviation (SD) of 0.68 suggested a uniform lack of prior of knowledge and presence of attitudes which contribute to the problem.

Table 3: Student score rankings on the pre-lesson assessment meant to test prior knowledge and beliefs related to the issue of feline predation.

Pre-Assessment: Questions	1(#)	2(#)	3(#)	4(#)	Mean
					Ranking*
					(SD)
1.What do you think ecology is? (i)	20	0	0	0	1.00 (0.00)

2. Do you think cats are a big problem for birds? Why or Why not? (c)	6	6	8	0	2.10 (0.85)
3. Do you think cats are a big problem for mammals? Why or Why not? (c)	3	10	7	0	2.20 (0.69)
4. Where do you think cats should spend their time? (a)	7	6	5	2	2.10 (1.02)
5. Do cats ever get into trouble while living outside? Why or Why not? (i)	9	9	2	0	1.65 (0.67)
6. Should you ever take your cat to the veterinarian (animal doctor)? If so, why? (c)	8	5	7	0	1.95 (0.88)
7. Do you think cats should ever be on a leash? (a)	10	7	3	0	1.65 (0.74)
8. If you have a cat, but can't keep it, what do you think you should do? (c)	6	12	2	0	1.80 (0.61)
Total Mean					1.80 (0.68)
(i) information category					
(a) attitude category					
(c) combined category					
*Metric for rankings given in Appendix E					

Post-Assessment

Three (42%) of the questions fell into the “informational” category. An average categorical ranking of 2.6 suggested that the majority of students retained a basic understanding of the material with a significant amount retaining moderate understanding. Two (28.5%) of the questions fell into the “attitudinal” category. An average categorical ranking of 2.2 suggested that while students reacted positively to the lesson, the majority did not or could not elaborate on what they enjoyed learning. Two (28.5%) of the questions fell into “combined” category. An average categorical ranking of 2.6 suggested that the majority of the students displayed a positive attitudinal response and a significant portion of those were able to apply some of the knowledge they had gained to support their view. The total mean ranking of 2.4 and SD of 1.03 showed an

increase in overall class ranking while suggesting a disparity in learning ability and lesson effectiveness.

Table 4: Student score rankings on the post-lesson assessment meant to test lesson effectiveness in raising overall student rankings.

Post-Assessment: Questions	1 (#)	2(#)	3(#)	4(#)	Mean Ranking* (SD)
1.What was your favorite part of the lesson? (a)	5	9	5	1	2.1 (0.85)
2..What role do cats play in local ecology? (i)	1	11	9	1	2.7 (0.80)
3. Name 3 things you can do to improve the safety of pet cats or wildlife: (i)	3	6	4	7	2.75 (1.11)
4. What is something you learned that surprised you? (c)	6	2	8	4	2.5 (1.14)
5. What was the most interesting thing you learned? (a)	6	6	5	3	2.25 (1.06)
6. What is the most helpful thing you learned? (c)	5	3	4	8	2.75 (1.25)
7. Name three or more things you learned in this lesson that you have not previously mentioned: (i)	4	8	4	4	2.4 (1.04)
Total Mean					2.49 (1.03)
(i) information category					
(a) attitude category					
(c) combined category					
*Metric for rankings given in Appendix E					
Sample size: 20					

Comparison of Pre and Post-Lesson Results

There was an increase in overall ranking between pre-lesson results (1.80) and post-lesson results (2.49), for a difference of 0.69. For the “informational” category, the difference in mean rankings was 1.28. For the “attitudinal” category, the difference in mean rankings was 0.33. For the “combined” category, the difference in mean rankings was 0.59. The difference in SD was 0.35.

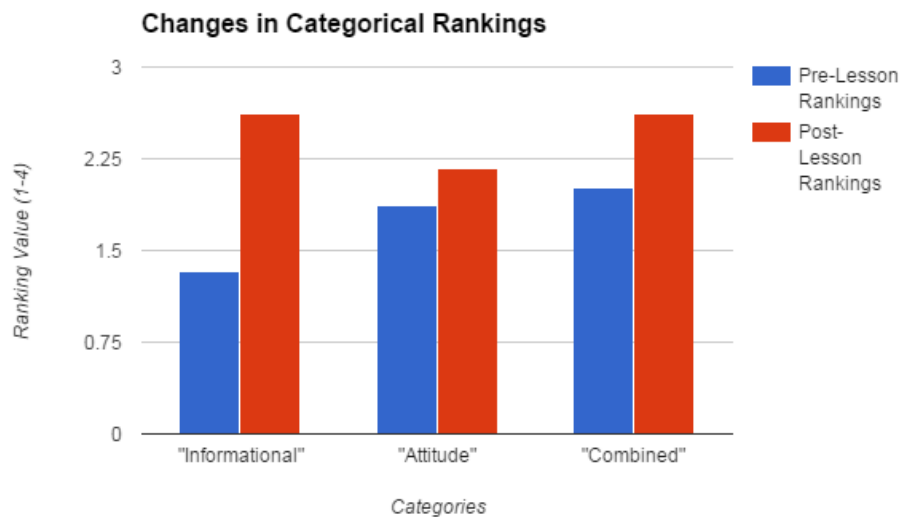


Fig. 3 Changes in categorical rankings compared between pre-assessment results and post-assessment results.

Discussion

Survey

The majority of respondents that were cat owners had indoor cats, with the intent of keeping cats safe from outdoor hazards such as predators. None of the respondents mentioned the desire to protect local wildlife or preserve local ecology, suggesting that attempts at curbing the number of outdoor pet cats would likely be most effective when appealing to cat owners' desire to keep their pets safe. Among respondents that own outdoor or indoor/outdoor cats, the

majority imposes no limit on the amount of time their cat is allowed outside, or allows them to be outside all day. The free responses accompanying this question once again focus on the well-being and safety of the cat, with one mention of catching mice. This indicates that these respondents do not consider the ecological impact their cats make to be a primary reason for keeping their cat indoors. These results are slightly unexpected when compared to other surveys conducted measuring cat owner attitudes. For example, a previous survey conducted in Perth, Australia on urban and rural residents to gauge opinions on putative impacts of owned cats on wildlife as well as how they felt about proposed regulations suggests promising support for pet cat regulations on both the cat owner's end and possibly at a community level (Lilith 2006). At least 70% of respondents agreed with statements such as 'there is a need to regulate owned domestic cats', 'the presence of cats in nature reserves is harmful to wildlife'; 'local councils should be empowered to restrict the maximum number of cats per household' (Lilith 2006). They also found if registering cats and keeping them on their property from sunrise to sunset became compulsory, 70% more owners would agree to do this (Lilith 2006). These regulatory approaches seem promising for curbing environmental impact, especially in areas where pet cats are allowed free access to outdoors for long periods of time.

The majority of these same cat owners indicated that their cat brought back multiple prey items per month on average but do not believe their cat impacts populations of wildlife or local ecology, suggesting that owners don't necessarily perceive a causal relationship between prey their cat catches and an impact on local wildlife populations. Conversely, the majority of indoor cat owners and non-cat owners believed that cats do make an impact. The difference in distribution is possibly due to outdoor cat owners not knowing that letting their cat outdoors has an impact, while cat owners that have indoor cats or non-cat owners may be more aware of the relationship between outdoor cats and local ecology. A survey measuring the attitudes towards responsible pet ownership also found that non-owners most often thought that there was a problem at a local level (Selby 1989). If this opinion is accurately reflective of the local situation, owning a cat may decrease the likelihood of acknowledging a problem and consequently taking actions to mitigate this. This is particularly problematic given the strong relationship between attitude and consequent behavior among cat owners (Finkler 2012). This further underscores the importance of effective educational measures, with the intent of changing attitudes to ultimately increase responsible cat owner behavior.

The statistical significance shown between urban-rural demographics for outdoor and indoor/outdoor cat owners on the opinion of cat's impact on local ecology can be useful in determining educational material particularly geared towards cat owners in that area, stressing unique hazards presented to pet cats based on their location. The lack of statistical significance shown between urban-rural demographics and opinion of cats' impact on local ecology can possibly be attributed to not taking enough variables into account. Social demographics such as gender, age, and education level may have a significant impact on the distribution of responses. Our survey did not take these variables into account, possibly leading to an incomplete conclusion on significant differences within demographics for non-cat owners and indoor cat owners.

Limitations of this experiment include the wording on questions 6 and 16. These questions were treated as directly comparable despite the variation of 'cats in your neighborhood' and 'your cats' between survey questions. This could have possibly led to differences in the interpretation of the question that can impact collected responses. A follow-up question on how respondents thought cats impacted local wildlife populations and/or local ecology should have been included to gauge more insight into what impact respondent perceived. This would have provided greater insight into the justifications of the opinion that cats impact local ecology. If repeated in the future, this experiment should include greater depth into respondent demographic, with age, gender, and education level being among the questions to be included. Focusing questions more on what respondents think about the role cats play in local ecology and less depth into pet cat behavior indoors would also generate more detailed information into cat owner attitudes. Responses to question 15 most likely underrepresent the number of cats that bring back insects given their size and likelihood of being partially eaten. Ideally future surveys would reach larger audiences to yield a larger number of responses, allowing for more accurate data analysis, especially regarding statistical analysis.

Lesson

All but one of the participants of the lesson program were Elm Park Community School second graders, and the age of the students likely played a large factor in the effectiveness of the lesson. After the lesson was given, discussions with the student's teachers revealed that the science curriculum of the school did not include any ecological lessons until later grades. Due to

this fact, it was expected that most of the students would not be aware of several points and facts presented throughout the lesson. This expectation was confirmed with a pre-assessment mean ranking of 1.80. This ranking suggests that most of the students did not have accurate or substantial knowledge of many of the ecological impacts of domestic and feral felines and held attitudes that ignored or even contributed to the issue. This result is not very surprising. The scope of elementary school student knowledge of many ecological concepts is confined to what they have personally experienced or have had explicitly stated in their textbook (Paraskevopoulos 1998). However, their textbooks will not focus on related ecological topics, such as the food chain, for at least another year or possibly two.

Only a couple of students had experienced cat predation visually, while the rest of the class either had only seen it through television media or not at all. Chawla (2006) conducted a study that assessed the source of environmental concern in individuals. It was found that the single largest contributor in developing environmental concern was time spent outdoors as a child. However, as the average American currently spends 95% of their time indoors, exposure to the natural environment is greatly limited (Wilson 1996). This statistic is especially true with children who live in urban areas, which the Elm Park students do.

The post-assessment was given to both groups one day after the presentation, preceded by an educational bingo game. An informal questioning of lesson material was given about 30 minutes before the game took place and showed student level of retention. The type of information that the students had the hardest time remembering were any numerical facts, such as with the number of domestic and wild cats in the United States. Most students retained the sense of scale (such as if the numbers were in the thousands or in the millions) but many could not get much more specific than that.

Most of the students enjoyed the bingo game, with an average of 9 students per group listing it as their favorite part of the lesson, with others listing it as a secondary favorite. The bingo game was used to promote student interaction, provide repetition of facts and as a refresher to the lesson given the day before. The game progressed well, with all of the students excitedly raising their hands and attempting to show that they knew the answer to the questions. Many stayed involved even after their “prize” (a piece of candy) was given to them when they achieved “bingo”. In addition, many were not bothered by answering a question wrong and were eager to indicate the correct response on their bingo card. The post-assessment given showed an increase

in overall categorical ranking from 1.80 to 2.49. This shows that most students adopted at least a basic understanding of all the lesson material and showed a preliminary change in attitude to the feline predation and safety issue. The questions that ranked highest were those that asked a direct fact based response or questioned a behavior that posed an emotional connection with the students. In particular, the questions “Name 3 things you can do to improve the safety of pet cats or wildlife” and “What was the most helpful thing you learned?” shared the highest ranking of 2.75. Both of these questions invite a personal response and were the most highly received possibly as a result of that connection. When looking at established findings, this result is not particularly surprising. Students have been shown to learn better when the material holds personal meaning and when they are presented with a clear method with which to transfer meaningful knowledge into their daily lives (Vosniadou 2001). The results from the post-assessment showed an overall deviation of 1.03, which suggests a significant disparity between students. Although this result was not surprising, one of the secondary objectives of the lesson was to minimize this disparity by tailoring the lesson as well as possible to the targeted groups. This secondary objective was not successful.

During the lesson, reference was made to the idea of feline reproduction with the intent to explain why taking an animal to the veterinarian for neutering or spaying was an ideal course of action. In reaction to this, many of the students became distracted and fixated on the statement, with many of their responses for the fourth question being a variation on “cats can have kittens?”. This suggests that the 2nd grade children were not yet of the necessary maturity level to teach or even mention certain scientific concepts to.

A single fourth grade student was present for and participated in the entire lesson. This student’s results were marked to signify the difference in response quality. This particular student scored a mean 2.1 ranking on his pre-assessment. While exhibiting a higher than average score in the signified “informational” category, the student scored closer to the average in the “attitude” category and showed the same trend on questions in the “combined” category. However, this particular student returned the only perfect overall 4 ranking on the post assessment. This was greatest improvement shown by any student and also exhibited one of the highest levels of engagement throughout the entire lesson.

Recommendations

The pre-assessment questions that received responses with the highest overall ranking were “Do you think cats are a big problem for birds? Why or why not?” and “Do you think cats are a big problem for mammals? Why or why not?”. Considering that after the lesson was completed, the fact that several of the students made references to specific television show animal characters that played into the dynamic of the feline as bird and mouse hunter implies that targeted media exposure affects knowledge of certain ecological interactions. As this idea was not the focus of the project, it is suggested that a future group look into the effect commercial media has on children’s knowledge of ecological interactions and concepts. A possible way to do this is polling children on their most watched television shows before or after conducting a survey on behavior and knowledge based on selected ecological issues. Afterwards, attempt to discover if there is any correlation between the types of shows watched and performance. This would require research into the shows themselves, identifying any ecological themes if possible. This could not be done completely anonymously, as direct comparisons between individual viewing practices and performance would have to be made.

After analyzing the responses, there was one student whose improvement stood out. This in particular was the sole fourth grader who participated in the lesson. The results shown by the student and overall handling of the presented material suggest that the lesson would be better received by a class of a higher grade. However, due to the sample size of 1, it is recommended that the lesson be given to an entire fourth or even fifth class in order to properly confirm that preliminary evidence. Many second graders had difficulty understanding the meaning of ecology, while the fourth grade student showed understanding much quicker. This potentially suggests that the usage of more complex terms would be much more viable in a higher grade environment. In addition, a more involved and complex game than “bingo” could be administrated, possibly one directly incorporating the food chain or other concepts that they would have learned by that point in their student career.

If the same lesson is given to the same grade level, it is suggested to the future team to spend more time taking into consideration the maturity level of the students. A single statement on reproduction distracted the entire class for several minutes and significantly affected results

for a relevant question. More careful wording or a reimagining of the delivery of such concepts would likely yield better results.

Community involvement and future research into this issue would help both spread awareness and change. Getting citizens involved in the decision making process on how to best deal with this issue would generate better awareness of these problems as well as the possibility of educating people with harmful misconceptions on the impact cats can make on local ecology. Future research into this topic can provide more detailed knowledge about cat owner behaviors and attitudes, which in turn can be used to better tailor educational material or governmental regulations aimed at lessening the impact cats make.

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Appendix A: Cat Survey

Q1 Participation in this survey is voluntary. You may end your participation at any time. It is not required to answer every question in the survey. This survey is also anonymous as no identifying information will be collected. Do you live in Massachusetts?

- Yes (1)
- No (2)

Answer If Do you live in Massachusetts? Yes Is Selected

Q2 Do you live in a rural, suburban, or urban area of Massachusetts?

- Rural (low population density, large land parcels) (1)
- Suburban (intermediate population density, intermediary land parcels) (2)
- Urban (large population density, small land parcels) (3)

Answer If Do you live in a rural, suburban, or urban area of Massachusetts? Rural (low population density, large land parcels) Is Selected

Q3 Are you a cat owner?

- Yes (1)
- No (2)

Answer If Are you a cat owner? Yes Is Selected

Q7 How old is your cat?

- 1 year (1)
- 2 years (2)
- 3 years (3)
- 4 years (4)
- 5 years (5)
- 6 years (6)
- 7 years (7)
- 8 years (8)
- 9 years (9)
- 10 years (10)
- 11 years (11)
- 12 years (12)
- 13 years (13)
- 14 years (14)
- 15 years (15)
- 16 years (16)
- 17 years (17)
- 17 years (18)
- 18 years (19)
- 19 years (20)
- 20 years (21)
- 21 years (22)
- 22 years (23)
- 23+ years (24)

Answer If How old is your cat? 1 year Is Displayed

Q8 Is your cat:

- Indoor only (1)
- Outdoor only (2)
- Both indoor and outdoor (3)

Answer If Are you a cat owner? No Is Selected

Q4 Do you see cats in your yard or on your property?

- Yes (1)
- No (2)

Answer If Do you see cats in your yard or on your property? Yes Is Selected

Q5 Do you do anything when you see them? If so, what?

- Nothing (1)
- Feed them (2)
- Chase them off my property (3)
- Other/additional information (4) _____

Answer If Is your cat: Both indoor and outdoor Is Selected

Q9 How long is your cat allowed to stay outside?

- No limit (1)
- less than an hour (2)
- 1-2 hours (3)
- 2-4 hours (4)
- 4-6 hours (5)
- 6-8 hours (6)
- All day only (7)
- All night only (8)
- Additional information about duration of time: (9) _____

Answer If Is your cat: Outdoor only Is Selected

Q10 Is your cat prohibited from leaving the house at night?

- Yes (1)
- No (2)
- Sometimes (3)

Answer If Is your cat: Outdoor only Is Selected

Q11 Have you attempted to keep your cat indoors in the past?

- Yes (1)
- No (2)

Answer If Have you attempted to keep your cat indoors in the past? Yes Is Selected

Q12 Please list the reasons for keeping your cat indoors.

Answer If Please list the reasons for keeping your cat indoors. Text Response Is Displayed

Q13 What occurred when you attempted to keep your cat indoors?

- No difference in behavior or appearance (1)
- Aggressive towards people (2)
- aggressive towards other pets (3)
- Inappropriate urination or litter box issues (4)
- Destructive behavior (clawing furniture, chewing on household items etc) (5)
- Gained weight (6)
- Attempts to escape house, hard to keep indoors (7)
- depressed, stressed, despondent, bored (8)
- constant crying, meowing, howling (9)
- wakes you up at night or does not allow you to sleep (10)
- Other/additional information: (11) _____

Answer If Is your cat: Outdoor only Is Selected

Q14 Does your cat ever bring back prey items to your house? If so, how many prey items on average does your cat return in a month?

- 1 prey item (1)
- 2 prey items (2)
- 3 prey items (3)
- 4 prey items (4)
- 5 prey items (5)
- 6-10 prey items (6)
- 10-15 prey items (7)
- 15-20 prey items (8)
- 20-25 prey items (9)
- greater than 25 prey items (10)
- No (11)

Answer If Does your cat ever bring back prey items to your house? If so, how many prey items on average doe... 1 prey item Is Selected

Q15 What types of prey items does your cat bring back?

- small mammals (1)
- insects (2)
- birds (3)
- Other/additional information: (4) _____

Answer If Do you do anything when you see them? If so, what? Nothing Is Selected

Q6 Do you feel cats in your neighborhood have an impact on local ecology and/or populations of local wildlife?

- Yes (1)
- No (2)
- Other/addition information: (3) _____

Answer If Is your cat locked in the house at night? Yes Is Displayed

Q16 Do you feel your cat has an impact on local ecology and/or populations of local wildlife?

- Yes (1)
- No (2)
- Other/Additional information: (3) _____

Answer If Do you live in Massachusetts? No Is Selected

Q17 Thank you for taking this survey. Do you have any additional thoughts or comments?

Appendix B: Additional Survey Tables

Table 5: Cross tabulation of outdoor and indoor/outdoor cat owners in rural, urban, and suburban demographics and the perceived impact of cat's impact on local ecology and/or populations of local wildlife. Actual and expected results are shown.

		Rural	Urban	Suburban	Total
Do you feel your cat has an impact on local ecology and/or populations of local wildlife?	Yes	2	8	2	12
	No	13	9	1	23
	Total	15	17	3	35
	Expected Yes	5.14	5.82	1.03	
	Expected No	9.86	11.17	1.97	

Table 6: Cross tabulation of indoor cat owners and non-cat owners in rural, urban, and suburban demographics and the perceived impact of cat's impact on local ecology and/or populations of local wildlife. Actual and expected results are shown.

		Rural	Urban	Suburban	Total
Do you feel cats in your neighborhood have an impact on local ecology and/or populations of local wildlife?	Yes	20	24	18	62
	No	8	18	12	38
	Total	28	42	30	100
	Expected Yes	17.36	26.04	18.6	
	Expected No	10.64	15.96	11.4	

Appendix C: Course Development Form

Elm Park Community School

Course Development Form

Organization or
Individual(s) involved in the course:

Name: Address: Phone: Email:	Name: Address: Phone: Email:	Name: Address: Phone: Email:
---------------------------------------	---------------------------------------	---------------------------------------

Science	Math	Writing	Literacy Tech Lab	Engineering	Music	Theater/ Drama
Social Studies	Reading	Math Tech Lab	Health/PE	Visual Art	Foreign Language	Other

(check more than one to indicate if cross curricular)

Course Name: _____ Duration: _____ weeks _____ Qtr

Statement of philosophy (how it supports the instructional focus) for adding course: (impact on all students, research, best practice evidence, alignment to the standards, how it will enhance the current curriculum etc):

Outcomes: What do you want students to know and be able to do after they take the course?

Principal Joany Santa
23 North Ashland Street Worcester, MA 01609 508-799-3568

“When schools passionately and sincerely adopt the mission of ensuring high levels of learning for all students, they are driven to pursue fundamentally different questions and work in significantly different ways.”- A Shift in School Culture” by Robert Eaker and Janel Keating in the Journal of Staff Development, Summer 2008 (Vol. 29, #3, p. 14-17).

Standards: Alignment to the Massachusetts standards:

Goals: What is the target(s) for student learning this course will accomplish?

Concepts & Objectives: What are the concepts students are expected to understand, "big ideas".

Techniques & strategies: What approaches and instructional strategies will be utilized to teach the course.

Assessments: What assessments will be used to assess the students' knowledge before during and after the course (ex: pre & post assessments, observation checklists, student and/or teacher journal entries, formal summative, informal formative assessments, rubrics)?

Major activities & assignments: Define the major activities and assignments to accomplish the outcomes and goals.

Identify the school resources required:

The following is the group's written submission used to satisfy the questions and the conditions of the form.

Individuals

Christian Zelaya
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Curriculum Category

Science (environmental)

Title: Environmental Impact of Domestic Cats

Our lesson plan has two main functions: provides research results for our Interactive Qualitative Project, but primarily to create an impact on how the students see environmental interactions and consequences in their daily lives.

Our proposed course aims to educate students of the ways in which domestic cats can impact the environment when outside. The ideal end goal would be for these students to be able to identify how different cat owner practices (e.g. letting your pet cat out for different durations of time or taking measures to reduce cat predation on wildlife) can change the magnitude and severity of impact these cats make on local ecology.

There are 4 main concepts students are expected to understand. The first involves an understanding of what an ecosystem is (living and nonliving aspects of an environment that interact). The second is to understand that there can be positive and negative interactions with an ecosystem, that can result in lasting changes to the system. The third concept is that there is a causal link between cat predation on wildlife and the size and health of certain animal populations, especially vulnerable ones. The last main idea is that there are simple and explicit ways that cat owners can limit the impact their cat has on local ecology.

Our lesson plan will focus on being highly interactive with the students. We will ask for their personal observations and opinions during the lecture, and will positively enforce participation with a reward such as small candy or stickers. In addition, we will write down important terms and/or drawings on the chalkboard that would assist in aiding comprehension.

Our course will also include a pre and post written formative assessment that focuses on open ended questions towards the children about the topics that will be or have been discussed in

the course. Pre-course questions will include ideas such as “What do you think ecology is?” and “Do you think cats are a big problem for birds? Why or why not?”. Post course questions will include ideas such as “What role do cats play in local ecology?”, “What was the most interesting thing you learned?”, and “Name 3 things you can do to improve the safety of pet cats or wildlife?”.

Appendix D: Pre and Post Lesson Assessments

Pre assessment

1. What do you think ecology is?
2. Do you think cats are a big problem for birds? Why or Why not?
3. Do you think cats are a big problem for mammals? Why or Why not?
4. Where do you think cats should spend their time?
5. Do cats ever get into trouble while living outside? Why or Why not?
6. Should you ever take your cat to the veterinarian (animal doctor)?
If so, why?
7. Do you think cats should ever be on a leash?
8. If you have a cat, but can't keep it, what do you think you should do?

Post assessment

1. What was your favorite part of the lesson?

2. What role do cats play in local ecology?
3. Name 3 things you can do to improve the safety of pet cats or wildlife:
4. What is something you learned that surprised you?
5. What was the most interesting thing you learned?
6. What is the most helpful thing you learned?
7. Name three or more things you learned in this lesson that you have not previously mentioned:

Appendix E: Pre and Post-Assessment Metrics

Pre-Assessment Metric

1. What do you think ecology is?

It is not expected for the children at this age to be able to adequately answer this question. Any mention of the environment or living organisms would be the first level of knowledge. Any response that mentions some sort interaction between living organisms or the environment would be at the highest level.

No prior knowledge: 1

Basic Knowledge: 2

Adequate Knowledge: 3

Superior Knowledge: 4

2. Do you think cats are a big problem for birds? Why or Why not?

3. Do you think cats are a big problem for mammals? Why or Why not?

.For the second and third question, the answer “yes” is expected from most students. Any of predation is also expected and constitutes the next response level. Further references to diseases and other factors make up the highest level.

An answer of no: 1

An answer of yes with no elaboration: 2

An answer of yes with some elaboration: 3

An answer of yes with much elaboration: 4

4. Where do you think cats should spend their time?

The response most in line with the material of our lesson is any variation of “indoors” and potentially shows that the student has a basic idea that outdoor cats face difficulties if made to live outside.

An answer consisting of any variation of “outdoors”: 1

Any variation of “indoors” with no elaboration: 2

Any variation of “indoors” with some elaboration: 3

Any variation of “indoors” with elaboration relating to ecological effects: 4

5. Do cats ever get into trouble while living outside? Why or Why not?

A correlation is expected to be seen between this question and the previous one. If a student realizes that cats get into trouble outside they will most likely want them to stay indoors. The more “kinds of trouble” listed, the higher level the answer will be.

Answer of no: 1

One listed response: 2

Two listed responses: 3

Three or more listed responses: 4

6. Should you ever take your cat to the veterinarian (animal doctor)? If so, why?

The ideal answer is “yes” with reasons such as vaccinations, basic treatment and spay/neuter serving to raise response level.

Answer of no: 1

One listed ideal response: 2

Two listed ideal responses: 3

Three or more listed ideal responses: 4

7. Do you think cats should ever be on a leash?

Simple yes or no question that also assesses general attitude towards cats wearing leashes.

Answer of no: 1

Answer of yes: 2

Answer of yes with an expressed positive attitude: 3

Answer of yes with an expressed positive attitude and accurate reasoning: 4

8. If you have a cat, but can't keep it, what do you think you should do?

This question tests prior knowledge of alternative resources. Answers such as giving them to family or friends who want them are good. Taking animals to regular shelters shows knowledge of public resources, but the better answer would be specifically no-kill shelters. The lowest level of answer is any variation of letting them loose.

Letting them free or other variations: 1

Citing only personal actions: 2

Citing at least one exterior resource: 3

Citing multiple exterior resources: 4

Post-Assessment Metric

Each result is based on a 1 to 4 scale with the exception of the second question which is on a 1-6 scale, later adapted back to the 1 to 4 scale. The meaning of each individual rubric is related in the section numbers corresponding to the question numbers.

1. What was your favorite part of the lesson?

Due to the inclusion of an engaging and fun educational bingo game with treats as a reward, it is expected that most of the students will input the bingo game as the answer to the first question. However, it is preferred if an answer referencing the source material is received or even reasons why the game was their favorite.

Unrelated Answers: 1

Reference to bingo game or keyword from the lesson: 2

Reference to lesson material and slightly expanded upon: 3

Reference to more than one topic in the lesson and greatly expanded upon: 4

2. What role do cats play in local ecology?

Throughout the presentation the term ecology was stressed multiple times. Its definition and relevance to the presented material was given multiple times. When the term was chosen during the bingo, some time was taken to reinforce comprehension of the term by asking students to respond with its meaning and relevance. In the assessment we are expecting to see the keyword "interact(ion)" and some mention of the relationship between cats and their prey, whether it be by predation or the acquisition and spread of disease.

Unrelated Answers: 1

Reference to what ecology is without explaining how it relates or including a keyword without any expansion: 2

Reference to predation or disease without the keyword “interaction” :3

Including the keyword “interaction” and referencing the impact of said interaction either with by humans or with animals: 4

Including the keyword “interaction” and referencing the impact of said interaction with and by both humans and animals: 5

Requirement listed in 5 ranking with addition of ways to affect the stated impact: 6

3. Name 3 things you can do to improve the safety of pet cats or wildlife:

Included in the lesson are several practices students can adapt in order to positively impact pet cat and wildlife safety. For the third question we are looking for the students to list at least three of these practices. Selected from a. keeping pet indoors b. keeping cat on a leash c. neuter/spay/fix d. vaccinate/take to veterinarian/animal doctor e. send to no kill shelter for proper treatment and chance at a loving home.

Unrelated Answers: 1

One stated practice: 2

Two stated practices: 3

Four stated practices: 4

4. What is something that surprised you?

5. What was the most interesting thing you learned?

The following two questions are more open ended. This allows students to form a personal answer while providing some insight on what information resonated better with them. No specific keywords or category is being expected, rather that the answer indicates some form of informational impact.

Unrelated Answers: 1

Statement marginally related to material: 2

Statement fully related to the material: 3

Statement Fully related to the material and expanded upon: 4

6. What is the most helpful thing you learned?

This question once again prompts a response that is more relevant to the individual student. However, there is a tighter constraint in that the answer is expected to be something applicable in their daily life or to their direct acquaintances. Looking specifically for any information included in the last three pages of the presentation.

Unrelated Answers: 1

Statement marginally related to material: 2

Statement fully related to the material: 3

Statement Fully related to the material and expanded upon: 4

7. Name three or more things you learned in this lesson that you have not previously mentioned:

The final question further tests retention and lesson effectiveness. Any further information presented in the lesson is to be expected here. The more items listed the better the reception to the lesson. A rank of 3 represents the number of answers requested.

Unrelated Answers: 1

Statement of one fact or practice learned: 2

Statement of two facts or practices learned: 3

Statement of three or more facts or practices learned: 4

Example of “Informational” response with a ranking of 4 (‘What role do cats play in local ecology?’): The cats interact with mammals and birds by eating them and you can put a cone or bib to stop them from making some go extinct.

Example of “Informational” response with a ranking of 1 (‘What role do cats play in local ecology?’): They act bad.

Example of “Attitudinal” response with a ranking of 4 (‘What was your favorite part of the lesson?’): I liked when Mr. Christian and his partner showed us how we can help cats with no-kill shelter for them to have a family. About diseases too.

Example of “Attitudinal” response with a ranking of 1 (“What was your favorite part of the lesson?”): When I got candy.

Example of “Combined” response with a ranking of 4 (“What is the most helpful thing you learned?”): If I had a cat that is bad or have to say bye, I would send them to the no-kill shelter so they won’t be dead or get disease. Also to keep inside.

Example of “Combined” response with a ranking of 1 (“What is the most helpful thing you learned?”): I can use a cat to play

Appendix F: Informational Brochure

The brochure is divided into three vertical panels with a light green border. The left panel has a blue header 'General Q&A' and contains text about the impact of outdoor cats on wildlife, the importance of spaying/neutering, and the benefits of indoor cats. The middle panel has a white header 'Helpful links to outside sources:' and lists four organizations with their websites. Below the links is a 'Citations' section with five numbered references. The right panel has a dark grey header 'Predator and Prey: Cats vs. Wildlife' and features a photograph of a tabby cat walking. Below the photo is the text 'The unexpected impact domestic cats have on wildlife'.

General Q&A

Do outdoor cats have a real impact on wildlife?
Yes, it is estimated that cats kill between 1.4-3.7 billion birds and 6.9-20.7 billion mammals in the U.S. alone¹.

How important is it to spay/neuter my cat?
It's very important. Only about 2 percent of the 30 to 40 million feral and stray cats in the U.S. have been spayed or neutered. Although roughly 85 percent of pet cats are spayed and neutered the remaining percentage and their kittens can contribute to unwanted population growth if allowed outdoors².

I do not own a cat. What can I do to reduce this problem?
Encourage cat-owning neighbors to keep their cat indoors. It's a win-win solution for cats and wildlife³!

Helpful links to outside sources:

American Bird Conservancy
www.abcbirds.org/cats

Rouge River Bird Observatory
<http://www.rrbo.org/in-the-field/bird-stuff-you-should-know/cats/>

Huntington-Oyster Bay Audubon Society
<http://www.hobaudubon.org/cats-indoors.asp>

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- 3.) K. A. T. Lloyd, S. M. Hernandez, J. P. Carroll, K. J. Abernathy, and G. J. Marshall. 2012. Quantifying Free-roaming Domestic Cat Predation Using Animal-borne Video Cameras. *Biological Conservation* 160: 187-99. Web.
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- 5.) C. R. Dickman. 2009. House cats as predators in the Australian environment: impacts and management. *BioScience* 59(4):616-620. doi:10.1641/B08-091.1.

Predator and Prey: Cats vs. Wildlife

The unexpected impact domestic cats have on wildlife

6



Outdoor cats are an active part of wildlife ecology. They kill small mammals, birds, and insects, which can lead to declining prey populations; in particular bird species that are endangered⁴.

Cats have been identified as a major cause in population declines of mammals and birds alike, especially bird species native to their geographical area. Unfortunately the impact they have on wildlife will not go away with time so proactive steps have to be taken to limit the effect they have on local wildlife ecology⁵.

However, there are many ways cat owners can lessen the impact cats make on local wildlife⁴.

The simplest way to make an impact is to spay or neuter your cat. This responsibly prevents unwanted population growth¹.

Keeping your cat indoor is another important way to reduce the amount of wildlife they kill¹. This is also beneficial to your cat, who is susceptible to many dangers that come with the environment. This can include hunters like coyotes and dogs, cars and trucks, incurable diseases such as rabies and FIV (feline immunodeficiency virus), or parasites such as fleas or worms¹. These problems can cost a lot of money to treat, and many parasites can be passed onto human hosts⁴.

Cat Owners Q&A

My cat does not bring prey home, doesn't that mean they are not catching wildlife?

Not necessarily! Less than 25% of prey is brought back to the cat's household. The majority of prey is left where the cat captured the animal².

My cat is well fed so he doesn't need to hunt. Why should I keep him inside?

It has been proven in many scientific studies that a cat hunts because of their instinct to do so, meaning a well-fed cat will still hunt⁴.

My cat has a bell on her collar to alert birds. Why should I restrict her time outside?

Cats with bells on their collars still hunt successfully, as they learn to stalk their prey silently with the bells. Also, defenseless young wildlife are not able to escape a cat even if they are alerted⁴.

My cat only hunts pests such as mice. Why should I prevent him from hunting?

Even though cats do hunt mice, they also hunt other animals, many of which are endangered. This predation can also take a way food sources for native predators of mice⁴.