SURVEY OF NORTHERN VIRGINIA RESIDENTS ON THEIR AWARENESS,
KNOWLEDGE & ATTITUDE TOWARD BLACK BEARS

by

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A Thesis
Submitted to the
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of
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Toward Black Bears

A Thesis submitted in partial fulfillment of the requirements for the degree of Master of
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by

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Bachelor of Science
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DEDICATION

This paper is dedicated to my grandfather, Terrance Shea, who unfortunately passed away before he had a chance to read this. I know that he would be proud of me for the work that I've done, and will continue to watch over me in the future. I love you Grandpa, and I miss you.

ACKNOWLEDGEMENTS

I would like to thank the many family, friends, and supporters who have made this happen. My parents, Kevin and Bridget Beichler, have always supported me through my work and school and I know they are very proud of me for this accomplishment. My brother Ian and my sister Heather have also been there for me when I've needed them, and they will continue to be there for me into the future. I also want to thank all of my extended family who have continued to encourage me to bigger and better things.

I want to thank all of my friends who have helped me through these tough three years of graduate school. Whenever I needed to step away from my work or writing, I had friends who I could go to wind down. They also made sure I went back to my work, too. I want to thank Vaughn David, who has been one of my strongest pillars of support even before I started at George Mason. Wish you had been able to make it to my defense, buddy. I want to especially thank Nathan Trexler, who lent me a laptop to finish my paper when mine broke down. I also want to thank Katie Froiland, who encouraged me to go back to school, and supported me throughout my graduate program.

I want to thank Dr. Lynn Rogers for giving me the opportunity to learn more about black bears first hand. I will cherish the short time I spent up in Ely, MN, for the rest of my life. I hope that this study helps to to the kind of future of wildlife conservation that you have always worked towards.

I would like to thank my committee members, who have coached me through the writing process and deserve just as much of the credit for this study. I would like to especially thank Dr. Tom Wood who has guided me every step of the way. He took me under his wing, and he has taught me so much in this short few years we've known each other. I would never have made it this far without his help. Thank you.

To everyone, named and unnamed, thank you so much for supporting and encouraging me to become the best me that I can be.

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ABSTRACT

SURVEY OF NORTHERN VIRGINIA RESIDENTS ON THEIR AWARENESS, KNOWLEDGE & ATTITUDE TOWARD BLACK BEARS

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George Mason University, 2017

Thesis Director: Dr. Thomas Wood

Within the past 20 years, the range of black bears (*Ursus americanus*) in Virginia has expanded significantly. Today, they can be found in almost every county of the state, including heavily populated regions of Northern Virginia. This means that the possibility of human-bear interactions is much higher, which can lead to property damage or physical harm for either man or animal. Using a modification of a 2010 general survey from the VA Dept. of Game & Inland Fisheries as a basis, we surveyed residents of Northern Virginia counties on their awareness, knowledge, and attitudes towards black bears. The survey was conducted online through Qualtrics ©, and was distributed to Mason students, faculty, and staff via email. We specifically targeted residents of Loudoun, Prince William, Fairfax, and Fauquier counties. When comparing our results with the 2010 survey, our respondents' answers did not have significant differences with those from the other survey. Northern Virginia residents and Virginia residents generally

do not understand very much about bear behavior, but have a positive attitude towards black bears in their state. The vast majority of our respondents disagree that shooting a bear that's been attracted to their property will solve the problem, and say they are comfortable having bears in their counties or closer. At the same time, Northern Virginia residents are not very aware of how common black bears are in their counties. Based on our results, there is an open need for a black bear education program for Northern Virginia residents to help ensure positive co-habitation of our species.

INTRODUCTION

In the past decade, the range of black bears (*Ursus americanus*) in Virginia has expanded significantly, which has led to concerns about their increased interaction with humans. Although they were found in all regions in Virginia at the beginning of English colonization, by 1900 the majority of bears could only be found in the Dismal Swamp and mountainous regions of western counties. However, the early 1900s saw the beginnings of protected public lands and national parks, which led to population recovery of Virginia black bears. By 1950, black bears could be found in 35 of 95 counties in Virginia. Today, black bears have been seen in every county in Virginia. While the average number of bear complaints in the 1990s was about 100 per year, the number of complaints almost quintupled in the 2000s (*Black Bear Management Plan: 2012-2021;* Spencer et al., 2007; Masterson, 2016). Black bear kills from hunting have been steadily increasing every year for at least the past two decades. Hunters killed 517 bears in 1994, 1,440 in 2005, and more than 2,300 in 2014 (Lynch, 2006; Rathke, 2014). The Virginia Department of Game & Inland Fisheries (VDGIF) reported that the number of black bear kills in the 2015-2016 season were the second highest on record (Associated Press, 2016). The number of bear road kills has also been increasing (Associated Press, 2013; Price, 2014). Despite the increased incidences of bear deaths, the implementation of conservation measures has ensured that overall the populations continue to increase.

Estimates suggest the black bear numbers in Virginia are now the highest they have been since the Civil War (Lynch, 2006).

Black bears have been recently reported near residential areas in Front Royal, Hillsville, Stafford County, Loudoun County, Fairfax County, and Virginia Beach (Hooper, 2016; Worrell, 2014; Sidersky, 2015; Reed, 2016; Hedgpeth, 2016; Associate Press, 2012). The most likely human residential areas to see an increase in human-black bear encounters are exurban-type land uses. (Evans et al., 2014) Exurban refers to residential areas that have housing densities between rural and urban areas, are embedded within natural cover; and in which the majority of the workforce commutes out of the community. These areas have a high forest edge density, which have a higher likelihood of encounters. Fairfax, Loudoun, Prince William, and Fauquier County all have this type of land use.

As the black bear population and exurban land use in Virginia increase, a black bear education program is becoming increasingly important. David Shelor, a committee member for Virginia State Black Bear Management Plans of 2001-2010 and 2012-2021, says that education of the public will be key for the State's 2012-2021 plan (Taylor, 2012). A study in New Mexico found that widely distributing safety information resulted in notable areas with higher scores in knowledge. Residents in these information-distributed areas, in fact, scored the highest in knowledge amongst all sample groups (Dunn et al., 2008). Another study in Montana observed changes in behavior and attitudes of residents over four years of exposure to information and education efforts (IEE). After the four years, fewer residents stored their garbage outdoors, which can

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potentially attract bears in residential areas, and residents became more supportive of bear management actions (Merkle, Krausman, Booth, 2011). Education plans have been successful in the past, such as the ones in Colorado, Yosemite National Park, British Columbia, Alberta, Minnesota and Florida (Draheim, 2012; Masterson, 2016). With the aid of new policies, they have made strides in the relationship between the residents and the local bears. Canmore, Alberta, saw a sharp decline in the number of bear incidents in their first year. In Ely, Minnesota, although the people live deep in bear country, there are rarely any complaints or conflicts with bears. This is because the people living there understand one of the most important lessons found in any black bear education program: that having bears living in the area is not a problem (Beckman et al., 2008).

The expanding bear population into well-populated exurban areas raises concerns of what the outcomes will be after bear encounters. It is predictable that exurban and/or suburban Northern Virginia denizens are not knowledgeable about black bears and are subsequently not prepared for how to appropriately handle bear encounters. The goal of this research is to organize an educational program on black bears, specifically targeted towards residents in Fairfax, Loudoun, Prince William, and Fauquier counties. To estimate the level of awareness, knowledge, and general attitudes towards black bears, we designed an online survey. The survey responses can be applied toward the development of a Northern Virginia Black Bear Education program. Determination of whether the public has a positive or negative attitude on human-bear interactions will be evaluated through the frequency and strength of survey positive and negative responses. We estimate that Northern Virginia residents will have a similar level of knowledge

compared to state respondents, but will have a different level of attitude towards black

bears.

METHODS

The survey consisted of 48 questions, was approved by the George Mason University IRB through the Office of Research Integrity and Assurance after determining the project is "exempt from IRB review.". The following questions were based on a 2010 survey conducted for the Virginia Department of Game & Inland Fisheries by Responsive Management (Table 1).

Table 1. List of survey questions (2016) and their choices based on Responsive Management survey questions (2010)

Questions:	Survey Choices:
"Which species of bear currently live in Virginia?"	- Black bear - Brown bear - Grizzly bear - Sloth bear
"Do you think black bears living in Virginia eat mostly meat, mostly plants, or both about equally?"	- Mostly meat - Both about equally - Mostly plants
"Do black bears currently live in your county of residence?"	- Yes - No
"How many people would you say have been killed by black bears in the past 100 years?"	Open-ended Question
"Which of the following statements best describes your feelings about black bears around your primary home and in your area?"	"I want to see and have black bears in my yard." "I want to see and have black bears in my neighborhood but not in my yard." "I want to see and have black bears in my country or city but not in my neighborhood." "I feel uncomfortable about having black bears even in my country."

"How much of a problem would you say black bears are in your neighborhood?"	- A major problem - A minor problem - Not at all
"How much would you say you know about black bears in Northern Virginia?"	- A great deal - A moderate amount - A little - Nothing
"What is your gender?"	- Male - Female - Other
"Please specify your ethnicity."	- White - Hispanic or Latino - Black or African American - Native American or American Indian - Asian/Pacific Leader - Middle Eastern - Other [Please Specify]
"What is the highest degree or level of school you have completed?"	- No schooling completed - Nursery school to 8th grade - Some high school, no diploma - High school graduate, diploma or equivalent - Some college credit, no degree - Trade/technical/vocational training - Associate degree - Bachelor's degree - Master's degree - Professional degree - Doctorate degree

The survey was run as an email-based web survey through Qualtrics (*Qualtrics*, 2016). Emails were sent to several Mason academic departments and colleges with a link to the survey to distribute to students, faculty, and staff (Table 2). In the email, we mention that we are only looking for responses from permanent residents of Fairfax county, Loudoun county, Prince William county, and Fauquier county. We repeat this

requirement again in the Informed Consent page of the survey and a question halfway

through the survey. The survey was conducted from April 19th to June 8th 2016. When

we closed the survey, we had responses from 313 individuals. Afterword, we separated

surveys into two groups by department; surveys completed by non-biology affiliates and

surveys completed by biology affiliates. We waited to send the email to the Department

of Biology until a month had passed and Qualtrics recommended to close the survey.

This way we were able to separate the biology affiliate surveys from the other surveys by

date.

Table 2. List of academic colleges, schools, and departments that received survey email.

College of Health and Human Services
College of Humanities and Social Sciences
College of Visual and Performing Arts
School for Conflict Analysis and Resolution
School of Law, School of Management
School of Public Policy
Department of Accounting
Department of Anthropology
Department of Sociology
Department of Art and Visual Technology
Department of Art History
Department of Art Management
Department of Atmospheric, Oceanic, and Earth Sciences
School of Policy, Government, and International Affairs
Department of Chemistry and Biochemistry
Department of Communication
Department of Computational and Data Sciences
Department of Physics and Astronomy
Department of Criminology, Law and Society
Department of Dance
Department of Economics
Department of English
Forensic Science Program
Department of Geography and Geoinformation Science
Department of Modern and Classical Languages
Department of Global Affairs

Department of Mathematics
Department of Music
Department of Psychology
Department of Philosophy
Department of Religious Studies
Department of Theatre
Department of Women and Gender Studies
Department of Environmental Science & Policy
Department of Biology

The completed surveys were reviewed to determine if their responses were valid. Several survey questions were placed as reverses to other questions in order to weed out surveyors that answered questions without reading them or trying to finish quickly. If a question and its foil had similar responses, then the survey responses were removed from the results. The same process was done depending on how surveyors answered the open question, "What is your county of permanent residence?" If the question was answered with a conflicting response to our target audience, then their responses were removed. Eight surveyors answered with "United States", "USA", or "United States of America" when asked about county of residence. Those who answered the question like this did not have their responses removed because it was previously mentioned in the email and the consent form of our target audience, and these answers do not definitively prove that they are not from the four counties we are attempting to survey.

After cleaning the responses, we ran used chi square and t-tests in order to find any significant differences between non-biology affiliates & biology affiliates, as well as 2010 respondents and 2016 respondents. The chi square tests and t-tests were run using online calculators recommended by George Mason University's Data Services (Kirkman,

1996). Chi square tests were run for categorical questions, and t tests were used for questions with a Likert scale. Cross tabulations were then run through Qualtrics using the questions listed in Table 3. These questions were picked out of the group because they were considered questions whose responses would be relevant to a black bear education plan. We also ran cross tabulations for the demographic questions in order to see if there were any biases unrelated to knowledge or attitude. After making the cross tabulation, we tested for significant differences between question responses using both chi square tests and t-tests. Differences were considered significant if $p \leq 0.05$.

Table 3. List of survey questions (2016) used in cross tabulations.

Questions:	Survey Choices:
"Which of the following statements best describes your feelings about black bears around your primary home and in your area?"	• "I want to see and have black bears in my yard." • "I want to see and have black bears in my neighborhood but not in my yard." • "I want to see and have black bears in my country or city but not in my neighborhood." • "I feel uncomfortable about having black bears even in my country."
"Black bears in Northern Virginia are dangerous to humans."	• Disagree • Agree
"Encountering a female black bear with cubs is dangerous to humans."	• Disagree • Agree
"Humans and black bears can live in the same area without conflict."	• Disagree • Agree
"Shooting a bear that has been attracted to your property because of food will solve the problem."	• Disagree • Agree
"A black bear standing on its hind legs means the bear is about to attack."	• Disagree • Agree
"Do black bears currently live in your county of permanent residence?"	• Yes • No

"What is your gender?"	- Male - Female - Other
"Please specify your ethnicity."	- White - Hispanic or Latino - Black or African American - Native American or American Indian - Asian/Pacific Leader - Middle Eastern - Other [Please Specify]
"What is the highest level of education you have completed?"	- No schooling completed - Nursery school to 8th grade - Some high school, no diploma - High school graduate, diploma or equivalent - Some college credit, no degree - Trade/technical/vocational training - Associate degree - Bachelor's degree - Master's degree - Professional degree - Doctorate degree
"How long have you lived in your county of permanent residence?"	< 1 year 1-2 years 3-4 years 5+ years

RESULTS

After reviewing all the surveys and removing those with conflicting responses, our sample size (N_S) was 267 with an 85% completion rate. The population size (N_P) was 2,038,366 people. The population size was taken from the 2015 population estimates for Loudoun County, Fairfax County, Prince William County, and Fauquier County from the United States Census Bureau, Population Division ("American FactFinder", 2016). Using the sampling error equation below, the maximum sampling error (B) is 0.05997, or ~6%. The findings of the survey are reported at a 94% confidence interval (or higher). This means that if the survey were conducted 100 times on different samples that were selected in the same way, the findings of 95 out of the 100 surveys would fall within plus or minus ~6%.

Equation 1 Sampling Error

$$B = (1.96) * \sqrt{\frac{\frac{N_P(0.25)}{N_S} - 0.25}{N_P - 1}}$$

B = maximum sampling error (as decimal)
N_P = population size (i.e. total number who could be surveyed)
N_S = sample size (i.e., total number of respondents surveyed)
Derived from formula: p. 206 in Dillman, D.A. 2000. Mail and Internet Surveys. John Wiley & Sons, NY.

Biology Affiliated & Non-Biology Affiliated Respondents

In this study, there were almost no significant differences between the knowledge and attitude responses of biology affiliates and non-biology affiliates. The only questions that had a significant difference were "How many people have been killed by black bears in Virginia in the last 100 years." (p=0.018, χ^2=5.59), and "Relocating a bear that has been attracted to your property because of a food source will solve the problem. Disagree – Agree." (p=0.03, t=3.62). Since there were almost no statistical differences between responses, we are confident we can pool the survey results together and treat them as George Mason affiliates for this study.

2010 Survey & 2016 Survey

In this study, there were only a few questions between the 2010 survey & 2016 survey with significant differences between responses: "Do you think black bears living in Virginia eat mostly meat, mostly plants, or both about equally?" (p=0.003, χ^2=11.4), "Which of the following statements best describes your feelings about black bears around your primary home and in your area?" (p=0.00, χ^2=60.1), and "How many people have been killed by black bears in Virginia in the last 100 years." (p=0.00, χ^2=14.2).

Cross Tabulations: 2016 Survey

Knowledge & Attitudes

Significant differences were observed in all of the knowledge & attitude questions that were tested. There were significant differences in responses to knowledge questions between respondents who answered positively to attitude questions and those who

answered negatively. Significant differences were also found in responses to attitude questions between respondents who answered correctly to knowledge questions and those who answered incorrectly. Answering knowledge questions correctly was correlated with answering attitude questions more positively, and vice versa. Answering knowledge questions incorrectly was correlated with answering attitude questions more negatively, and vice versa. Examples of this can be seen in Figures 1-5. Respondents that answered attitude questions were observed to be consistent in how they answered.
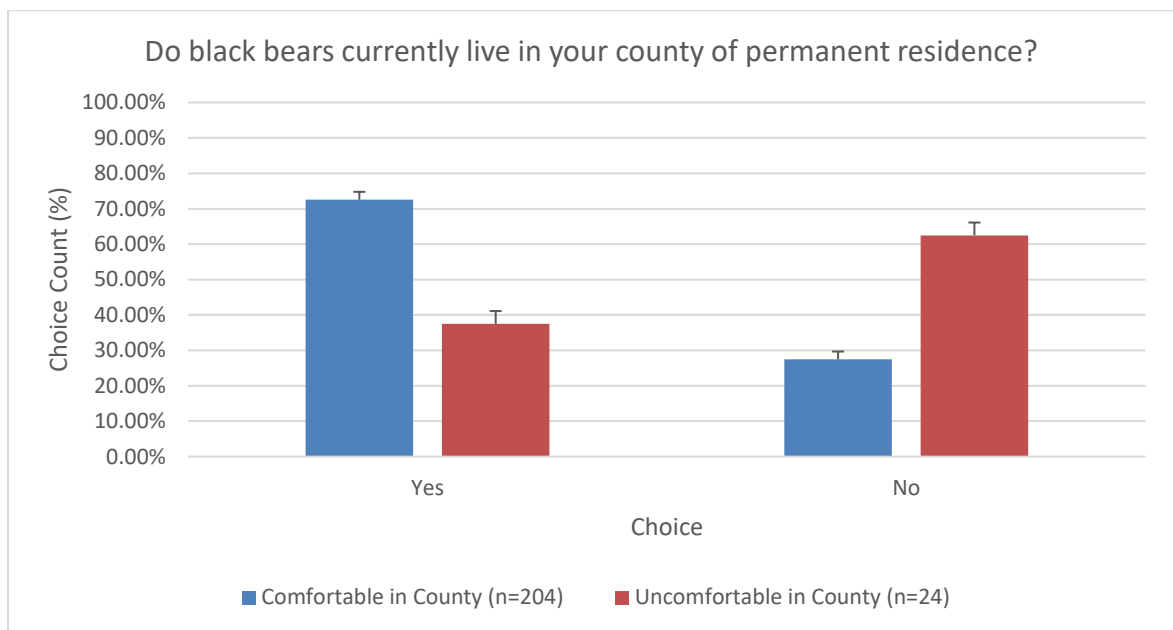
Figure 1. Cross tabulation: "Which of the following statements best describes your feelings about black bears around your primary home and in your area?" & "Do black bears currently live in your county of permanent residence?" (p=0.00, χ^2=12.30)
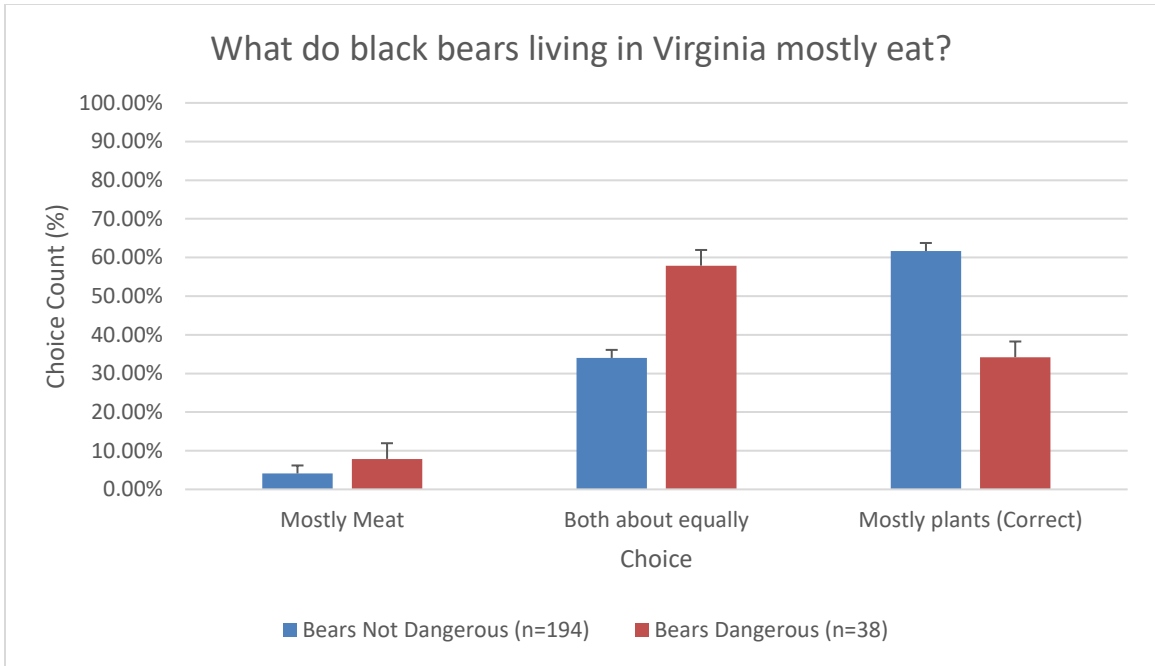
Figure 2. Cross tabulation: "Black bears in Northern Virginia are dangerous to humans. - Disagree vs Agree" & "What do black bears living in Virginia mostly eat?" (p=0.01, χ²=9.96)

Figure 3. Cross tabulation: "Black bears in Northern Virginia are dangerous to humans. - Disagree vs Agree" & "A black bear standing on its hind legs means the bear is about to attack. – Disagree vs Agree" (p=0.01, t=2.87)

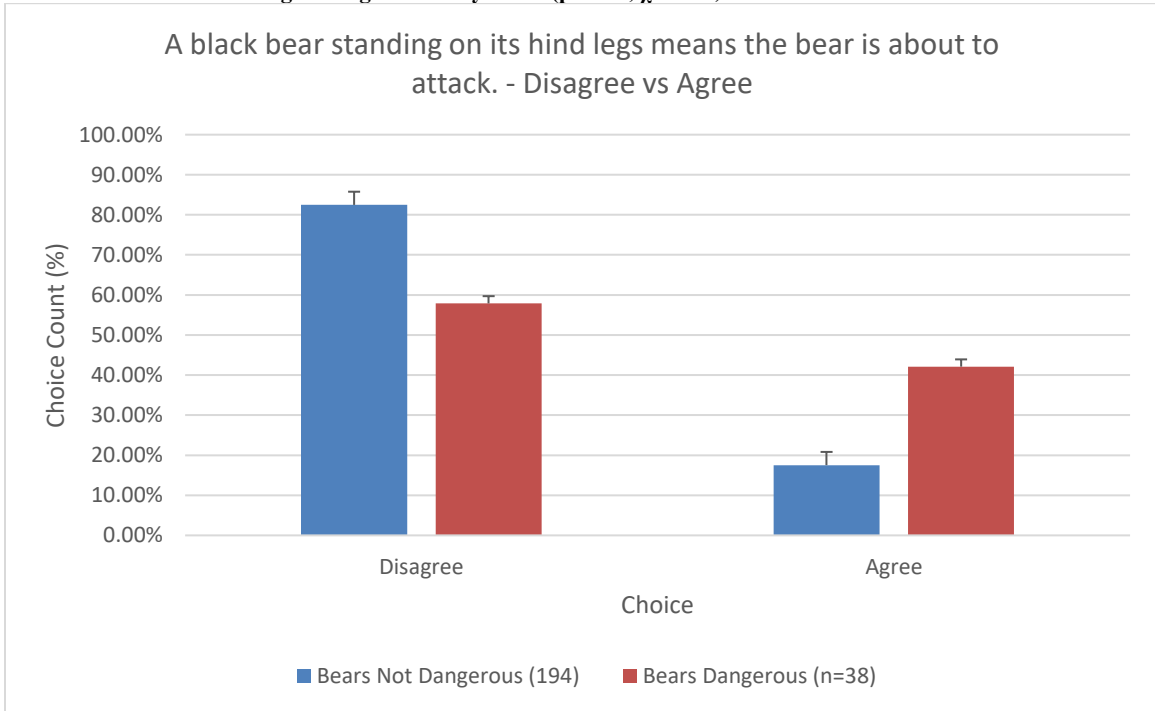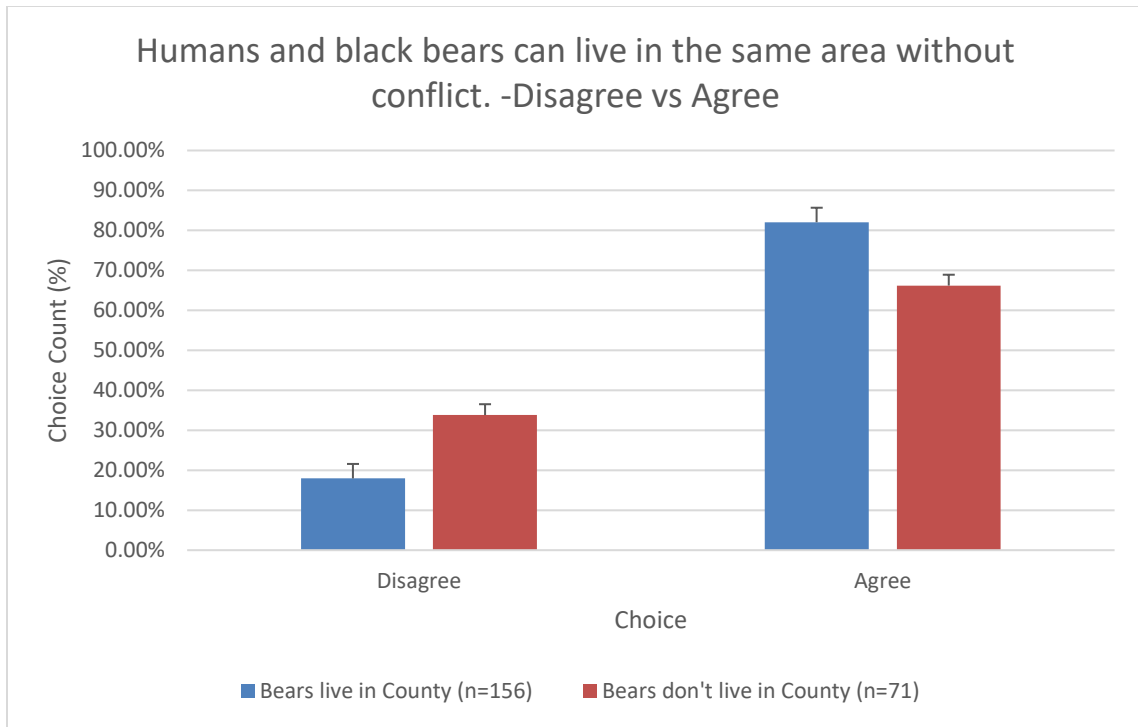**Figure 4. Cross tabulation: "Do black bears live in your county of permanent residence?" & "Humans and black bears can live in the same area without conflict. - Disagree vs Agree" (p=0.02, t=2.46)**
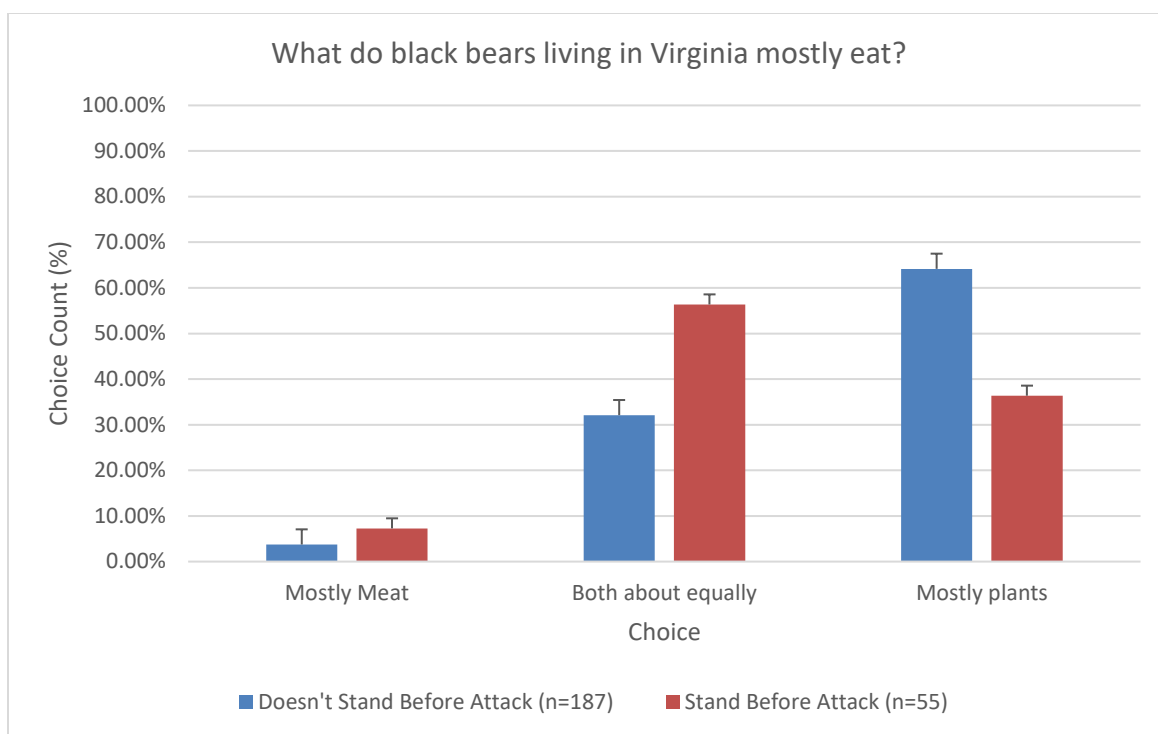
Figure 5. Cross tabulation: "A black bear standing on its hind legs means the bear is about to attack. – Disagree vs Agree" & "What do black bears living in Virginia mostly eat?" (p=0.00, χ^2=13.51)

However, there was a different relationship observed between how respondents answered attitude questions and how they answered, "How common are black bears in Northern Region of Virginia?" Respondents that answered more positively were also the respondents who said that black bears are very common or common, where as those that answered more negatively said that black bears are rare or absent. This can be seen as an example in Figure 6.

Figure 6. Cross tabulation: "Which of the following statements best describes your feelings about black bears around your primary home and in your area?" & "How common are black bears in the Northern Region of Virginia?" (p=0.03, χ^2=4.58)

Below is a list of the other knowledge and attitude questions we found that had significant differences in their responses through cross tabulations:

Cross tabulation: Which of the following statements best describes your feelings about black bears around your primary home and in your area? &:
- Black bears are an important part of Virginia's ecosystem. - Disagree vs Agree (p=0.01)
- Black bears will charge and stop short in order to intimidate a potential threat. - Disagree vs Agree (p=0.04)
- Humans and black bears can live in the same area without conflict. - Disagree vs Agree (p=0.00)
- Black bears in Northern Virginia are dangerous to humans. - Disagree vs Agree (p=0.01)
- How often do you see black bears in your county? (p=0.02)
- How often do you hear about black bears in your county? (p=0.03)
- How willing are you to learn more about black bears? - Unwilling vs Willing (p=0.05)

Cross tabulation: Black bears in Northern Virginia are dangerous to humans. - Disagree vs Agree &:
- Shooting a bear that has been attracted to your property because of food will solve the problem. - Disagree vs Agree (p=0.03, t=2.19)
- Encountering a female black bear with cubs is dangerous to humans. - Disagree vs Agree (p=0.00, t=4.71)
- Humans and black bears can live in the same area without conflict. - Disagree vs Agree (p=0.00, t=3.01)

Cross tabulation: Encountering a female black bear with cubs is dangerous to humans. - Disagree vs Agree
- Shooting a bear that has been attracted to your property because of food will solve the problem. - Disagree vs Agree (p=0.00, t=4.15)
- It is not possible for humans and black bears to coexist in the same area. - Disagree vs Agree (p=0.0, t=4.56)

Cross tabulation: Humans and black bears can live in the same area without conflict. - Disagree vs Agree
- Black bears are an important part of Virginia's ecosystem. - Disagree vs Agree (p=0.01, t=2.64)
- Black bears will charge and stop short in order to intimidate a potential threat. - Disagree vs Agree (p=0.01, t=2.62)
- Black bears in Northern Virginia are dangerous to humans. - Disagree vs Agree (p=0.00, t=2.93)
- How common are black bears in the Northern Region of Virginia? (p=0.04, χ^2=4.11)
- Do black bears currently live in your county of permanent residence? (p=0.01, χ^2=6.94)
- Have you personally had any positive experience with black bears in the past two years? (p=0.04, χ^2=4.44)
- How willing are you to learn more about black bears? - Unwilling vs Willing (p=0.03, χ^2=6.52)

Cross tabulation: Shooting a bear that has been attracted to your property because of food will solve the problem. - Disagree vs Agree
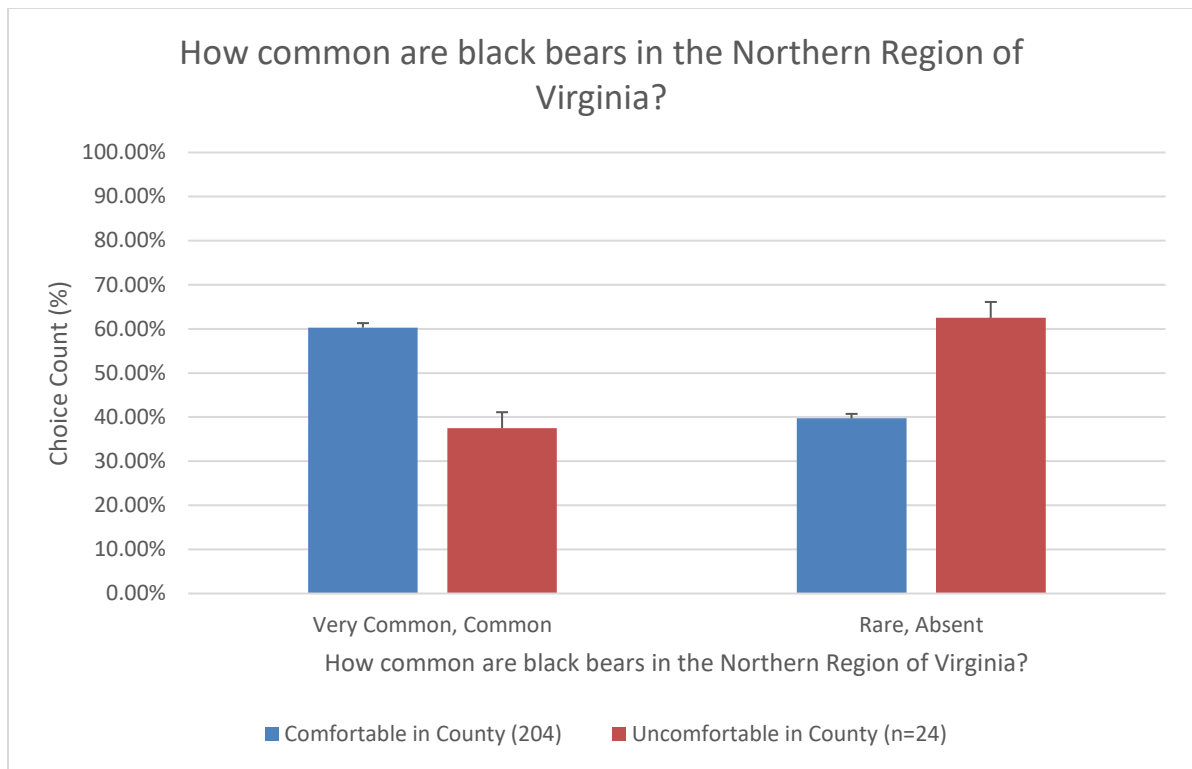- Black bears in Northern Virginia are dangerous to humans. - Disagree vs Agree (p=0.01, t=2.39)
- Which of the following statements best describes your feelings about black bears around your primary home and in your area? (p=0.00, χ^2=8.80)

Cross tabulation: Do black bears currently live in your county of permanent residence?

- How common are black bears in the Northern Region of Virginia? (p=0.01, χ^2=6.96)
- Which of the following statements best describes your feelings about black bears around your primary home and in your area? (p=0.00, χ^2=12.30)

Cross tabulation: A black bear standing on its hind legs means the bear is about to attack. - Disagree vs Agree

- What do black bears living in Virginia mostly eat? (p=0.00, χ^2=13.51)
- Overall, what do you think the status of the current black bear population is in Virginia? (p=0.01, t=2.75)
- Black bears in Northern Virginia are dangerous to humans. – Disagree vs Agree (p=0.01, t=2.81)

Demographics

Cross tabulations were run through Qualtrics for the following demographic questions: "What is your gender?", "Please specify your ethnicity.", "What is the highest level of education you have completed?", and "How long have you lived in your county of permanent residence?" Other than "What is your gender?" none of the demographic questions had significant differences in their answers that would be relevant to our education program. It is notable that the ratio of male to female was 1:2. Statistical differences were observed in the gender cross tabulations with "What species of bear currently live in Virginia? Mark all that apply:" (p=0.02, χ^2=7.46), "Black bears are not crucial to Virginia's ecosystem. – Disagree vs Agree" (p=0.02, t=2.30) (Figure 8), "How common are black bears in the Northern Region of Virginia?" (p=0.00, χ^2=11.27) (Figure 7), and "Do you support or oppose requiring or oppose requiring people to use bear-proof garbage containers in areas frequented by bears?" (p=0.01, t=2.53).
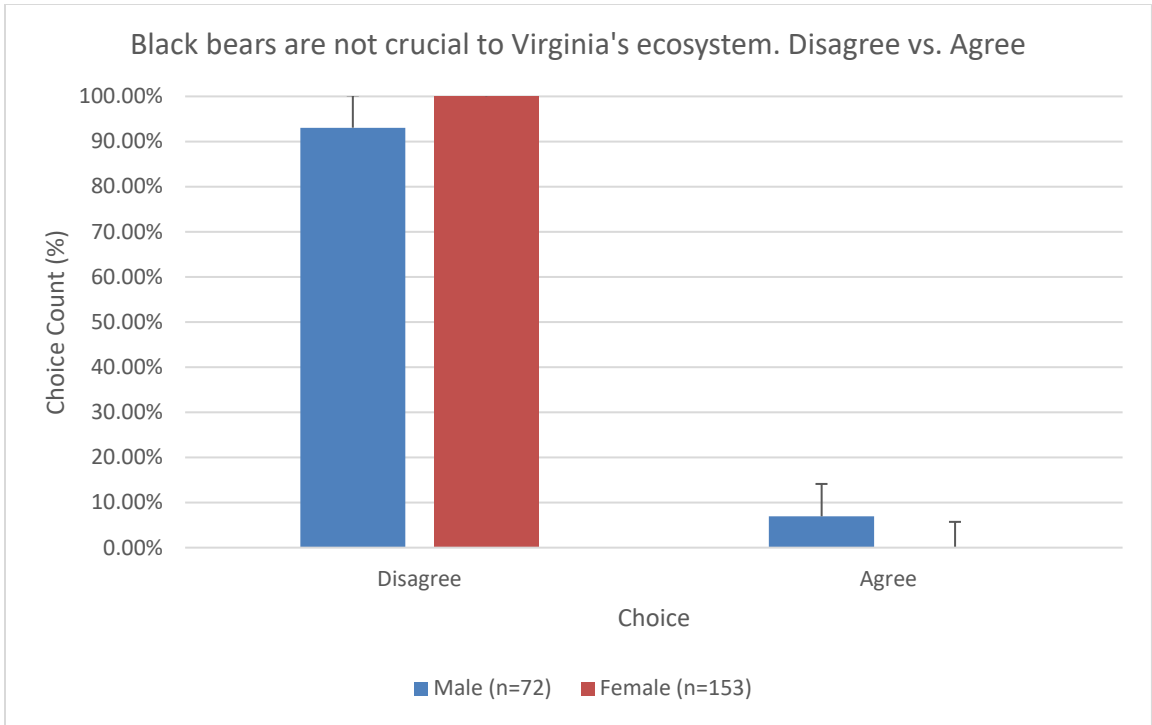
Figure 7. Cross tabulation: "What is your gender?" & "Black bears are not crucial to Virginia's ecosystem. Disagree vs Agree" (p=0.02, t=)
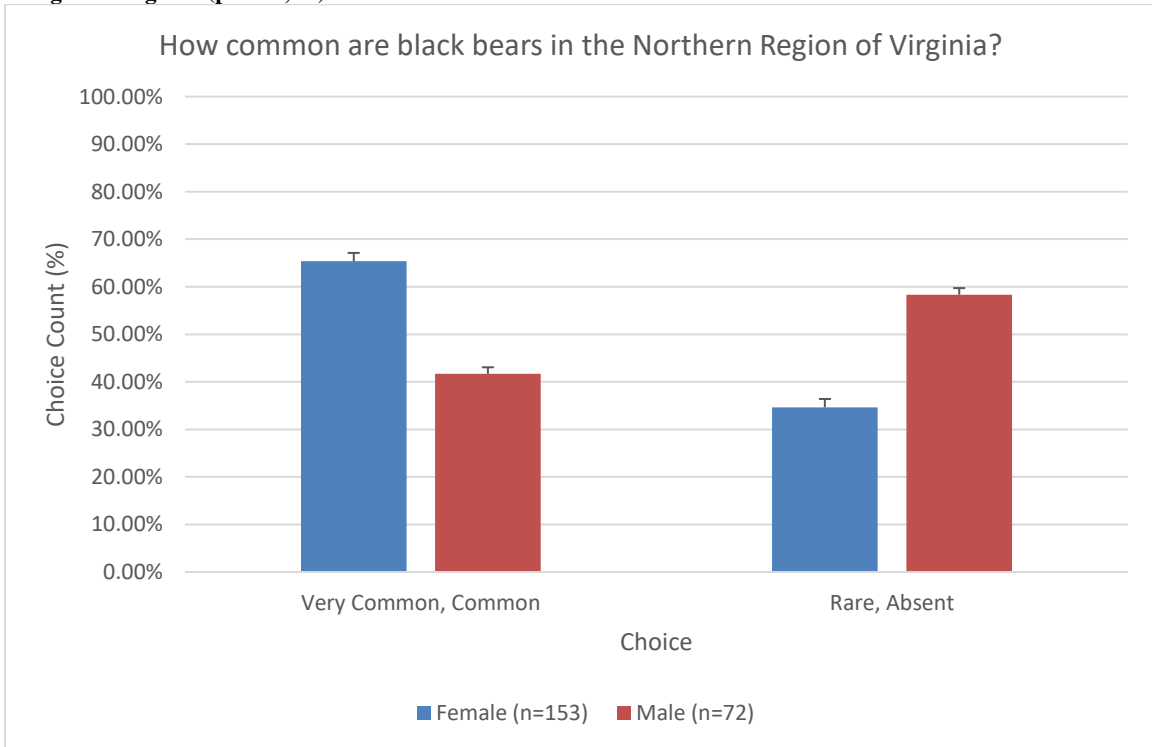

Figure 8. "What is your gender?" & "How common are black bears in the Northern Region of Virginia? (p=0.00, χ^2=)

DISCUSSION

Based on the survey results, there is an open opportunity for a black bear education program for Northern Virginians. Although George Mason affiliates surveyed well on questions of black bear knowledge, there were still several questions that the majority/plurality answered incorrectly. The questions that were answered incorrectly by most respondents related to how dangerous black bears are to people, and to the perception of bear abundance in the respondents' counties of residence. The majority of respondents agreed that encountering a female black bear with cubs is dangerous to humans, despite scientific evidence suggesting the opposite (Masterson, 2016). Cubs will climb the nearest tree when they think they are in danger, and mothers will either remain nearby or run in a random direction to distract. The danger of a mother bear and her cubs is a very pervasive myth, and an important one to tackle in an educational program. It is necessary to educate people living in bear-inhabited regions that the bear population in the area does not need to be a problem (Beckman et al., 2008). In regards to awareness, almost a third of respondents said they do not have black bears in their county of residence. Sightings of black bears have already been reported in our target counties, so more sightings and interactions are likely to occur. It is important for Northern Virginia residents to know that black bears live in their county; otherwise, they may be less likely to react properly when they encounter a black bear.

A black bear education program would perform well in Northern Virginia, as well, because most of our respondents tended to answer positively on questions concerning their attitudes towards black bears. The majority of respondents said they would be willing to learn more about black bears, and they want to see and have black bears in their county or city but not in their neighborhood. Although there were statistical differences between those disagreed or agreed shooting a bear would solve the problem, only a small minority of the respondents agreed (~7%). The effectiveness of a program can rely on the attitudes of the residents. Feeding bears was once a regular thing for Crystal Lake residents. However, after a bear was euthanized for breaking into homes, the community organized and made the decision to make sure not one more bear was killed due to negligence (Masterson, 2016). If Northern Virginia residents already have a positive attitude, then they are more open to changes that would benefit themselves and black bears.

In our data analyses, we observed significant differences in responses between those who answered differently to knowledge and attitude questions in regards to black bears. This is important to know when establishing an education plan, since we can better focus on what affects attitudes and knowledge about black bears. The respondents that answered negatively were also those who were more likely to answer knowledge questions incorrectly, in comparison to positive attitude respondents. For example, in Figure 2, the majority respondents that said black bears are dangerous also incorrectly said black bears eat both plants and meat about equally. According to this study, there is a possible relationship between how people perceive black bears' diets and how people

perceive them as a threat or not. It would then be important to include black bear diets into the education program.

In our survey, we did not observe many significant differences between respondents of different demographics, other than a few examples between men and women. There were some differences when comparing PhD respondents and non-PhD respondents, but we did not find these results relevant to our education plan as PhD holders are not a target audience or an adequate example of a typical Northern Virginia resident. In similar studies, there have been significant differences in responses based on gender, age, highest education level, and type of residency (permanent, part-time, vacation) (Mazaika, 2013). In a study on human-coyote interactions, having children and political affiliation correlated with support for lethal control of coyotes (Draheim, 2012). In regards to demographics, there were differences noted in age distribution, male-female ratio, and education level between the 2010 & 2016 respondents. These differences are understandable as the original survey sampled from the whole state of Virginia, and our survey sampled Northern Virginia residents affiliated with George Mason University.

Before organizing an educational program, it is important that we consider what has been successful in the past. The most effective education programs provided detailed guidelines about securing food and trash from bears (Beckman et al., 2008). Black bear conservation programs have had success in Colorado, British Columbia, Yosemite National Park, Great Smoky Mountains National Park, Pennsylvania, Alberta, and Florida (Masterson, 2016). These programs went beyond just education, and incorporated enforcement and policy changes in order to make long-term changes in human

behavior. These cities made the change to bear-resistant trashcans and dumpsters, and changing the times for when to put garbage out for collection. In Whistler, British Columbia, Canada, the local landfills set up electric fences and even removed trees inside the fence to prevent bears from getting out if they snuck in. Wildlife officials can then do an on-site release, which has a higher rate of deterring bears from returning to that location. In Canmore, Alberta, removing curbside trash collection and installing bear resistant dumpsters resulted in the number of bear incidents to fall from 300 to 0 in one summer.

Regular reevaluation and revision is important for a long-term education program to remain effective. Education efforts have a tendency to help shape good habits in the short term, but fail to permanently change human behavior (Merkle, Krausman, Descesare, Jonkel, 2011; Baruch-Mordo, 2011). Out of six North American education programs, five of them measured the effectiveness of the program by the number of complaints filed to wildlife authorities (Gore et al., 2006). The number of complaints did not take into account changes in human behavior or environmental factors. There may be a correlation between when the program was conducted and number of complaints the following year, but the evaluations do not justify causation. There may have had more rich and plentiful natural resources, which would mean less black bears are seeking food near humans. The number of public complaints could have been related to human behavior instead of bear behavior. In one case, the number of public complaints was due to the cancellation of spring hunting season of bears (Howe, 2010). An evaluation of the education program would benefit from explanatory variables like food availability,

number of bears translocated/euthanized, number of bears harvested, changes in habitat or residential areas, weather patterns, ecology, and changes in human attitudes or motivations.

In addition to our primary goals, we were also interested in how Virginians feel about supplemental feeding of black bears. Supplemental, or diversionary, feeding is artificially introducing nutrients into an animal's environment in order to deter them from seeking food from human settlements (homes, garbage cans, landfills, bird feeders, etc.). We found that a majority of responders (88.94%) would support a supplemental feeding program. Although intentional feeding of bears is illegal in the state of Virginia, there are supplemental feedings programs run by other state wildlife departments. These programs, particularly in Minnesota and Washington State, have been successful. The main worry of feeding black bears would permanently alter the bears' foraging behaviors and become reliant on artificial resources. A report from Dr. Lynn Rogers, however, suggests that this is not the case (Rogers, 1987). In his observations, it was found that bears still spend more than 80% of their time foraging, and only seemed to increase supplemental feeding when natural resources were scarce. In Washington State, feeding stations are used to reduce damage to timber stands, and studies have found that the bears typically do not display aggressive behavior at these stations (Nolte et al. 2001). The average duration of time spent at the feeding station is less than 15 minutes, and bears are usually by themselves except for the occasional mother and cubs. In terms of diet, scat analysis has found that the bears are still eating mostly natural food resources and showing little to no signs of weight gain (Rogers 1987, Ziegltrum 2008). With literature and a potentially

supportive public, there may also be an opportunity to explore supplemental feeding as part of black bear conservation alongside an education program.

It is going to take a conscious effort from Northern Virginia residents to make long-term changes in their own behavior. What the program described in this study will be designed to do is to provide the tools and guidelines to prepare residents for encountering and living with black bears. Black bears are Northern Virginia residents, and they are not going anywhere anytime soon. What is best for Northern Virginians is to work towards coexistence with our local bear populations. Similar education and conservation efforts have been successful in other states before. If the black bear population trend continues as it has been, then there will be higher chances of human-bear interaction and the need for proper black bear education will increase.

APPENDIX

Black Bear Survey Questions (2016)

- **Which species of bear currently live in Virginia?** *Mark all that apply:*
  - o Black bears
  - o Brown bears
  - o Grizzly bears
  - o Sloth bears

- **How much would you say you know about black bears in Northern Virginia?**
  - o A great deal
  - o A moderate amount
  - o A little
  - o Nothing

- **What do black bears living in Virginia mostly eat?**
  - o Mostly meat
  - o Both about equally
  - o Mostly plants

- *(Answer only if you chose "Mostly meat")* **Roughly how large are the prey that black bears eat?** *Mark all that apply:*
  - o Insect-sized
  - o Mouse-sized
  - o Dog-sized
  - o Deer-sized

- *(Answer only if you chose "Mostly meat")* **How do black bears catch their prey?**
  - o Foraging in trees
  - o Ambush
  - o Stalking
  - o Scavenging

- **Overall, what do you think the status of the current black bear population is in Virginia?**
  - Declining ← 1   2   3   4   5   6   7 → Increasing

- **How many people have been killed by black bears in Virginia in the last 100 years?**

Next you will be given a series of statements. Please answer how strongly you agree or disagree with each statement:

- **Shooting a bear that has been attracted to your property because of food will solve the problem.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **A black bear standing on its hind legs means the bear is about to attack.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Black bears are an important part of Virginia's ecosystem.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Black bears have poor eyesight.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Encountering a female black bear with cubs is dangerous to humans.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Black bears will charge and stop short in order to intimidate a potential threat.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Humans and black bears can live in the same area without conflict.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Black bears are unpredictable.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Preserving habitat that black bears depend on is important.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **It is not possible for humans and black bears to coexist in the same area.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Black bears in Northern Virginia are dangerous to humans.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Black bears are not crucial to Virginia's ecosystem.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **Relocating a bear that has been attracted to your property because of food source will solve the problem.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **It is unnecessary to preserve black bear habitats.**
  - Strongly disagree ← 1   2   3   4   5   6 → Strongly Agree

- **When black bears are nervous, they will...?** *Mark all that apply:*
  - Retreat
  - Charge
  - Lunge
  - Stand on hind legs
  - Huff loudly
  - Slam front feet on the ground

- **When black bear are about to attack, they will...?** *Mark all that apply:*
  - Show their teeth
  - Roar
  - Charge
  - Huff loudly
  - Stand on hind legs
  - Make direct eye contact

- **How common are black bears in the Northern Region of Virginia?**
  - Very Common
  - Common
  - Rare
  - Absent

- **What is your county of permanent residence?**

- **How long have you lived in your county of permanent residence?**
  - < 1 year
  - 1-2 years
  - 3-4 years
  - 5+ years

- **Do black bears currently live in your county of permanent residence?**
  - ○ Yes
  - ○ No

- **Which of the following statements best describes your feelings about black bears around your primary home and in your area?**
  - ○ "I want to see and have black bears in my yard."
  - ○ "I want to see and have black bears in my neighborhood but not in my yard."
  - ○ "I want to see and have black bears in my county or city but not in my neighborhood."
  - ○ "I feel uncomfortable about having black bears even in my county."

- **How often do you see black bears in your county?**
  - ○ Frequently
  - ○ Sometimes
  - ○ Rarely
  - ○ Never

- **How often do you hear about black bears in your county?**
  - ○ Frequently
  - ○ Sometimes
  - ○ Rarely
  - ○ Never

- *(Skip if answered "Never")* **How much of a problem would you say black bears are for you in your neighborhood or on your property?**
  - ○ A major problem
  - ○ A minor problem
  - ○ Not a problem at all

- **Have you personally had any positive experience with black bears in the past two years? If yes, what was your experience like?**
  - ○ Yes
  - ○ No

- **Have you personally had any negative experience with black bears in the past two years? If yes, what was your experience like?**
  - ○ Yes
  - ○ No

- **Do you consider yourself a hunter?**
  - ○ Yes
  - ○ No

- **Have you ever hunted in Virginia?**
  - Yes
  - No

- **Have you ever hunted black bears in Virginia?**
  - Yes
  - No

- **Do you support or oppose legal, regulated hunting in general?**
  - Strongly Oppose ← 1   2   3   4   5   6 → Strongly Support

- **Do you support or oppose legal, regulated hunting of black bears in Virginia?**
  - Strongly Oppose ← 1   2   3   4   5   6 → Strongly Support

- **Do you support or oppose requiring people to use bear-proof garbage containers in areas frequented by bears?**
  - Strongly Oppose ← 1   2   3   4   5   6 → Strongly Support

- **Have you heard of supplemental feeding before and know what it is?**
  - Yes
  - No

- **If implemented, would you support the use of supplemental feeding?**
  (*Supplemental feeding is when food sources are provided for wild animals when their natural resources are low. Supplemental feeding is done in the animal's natural habitat in order to reduce interactions with humans.*)
  - Yes
  - No

- **If implemented, who should have the primary responsibility of managing supplemental feeding?**
  - Virginia Department of Game and Inland Fisheries
  - Property owner/resident whose feeder, garbage, etc., attracts bears
  - City or county governments
  - Community groups like homeowners' associations
  - Other state government
  - Not Sure

- **If implemented, should hunters be allowed to use supplemental feeding to bait black bears?**
  o Yes
  o No

- **How willing are you to learn more about black bears?**
  o Strongly Unwilling ← 1   2   3   4   5   6 → Strongly Willing

A few final questions about yourself:

- **What is your gender?**
  o Male
  o Female
  o Other [Please Specify]

- **What is your age?**

- **Ethnicity origin (or Race): Please specify your ethnicity.**
  o White
  o Hispanic or Latino
  o Black or African American
  o Native American or American Indian
  o Asian/Pacific Islander
  o Middle Eastern
  o Other [Please Specify]

- **Education: What is the highest degree or level of school you have completed?**
  If currently enrolled, highest degree received.
  o No schooling completed
  o Nursery school to 8th grade
  o Some high school, no diploma
  o High school graduate, diploma or equivalent
  o Some college credit, no degree
  o Trade/technical/vocational training
  o Associate degree
  o Bachelor's degree
  o Master's degree
  o Professional degree
  o Doctorate degree

REFERENCES

American FactFinder – Results. (2016, June). *United States Census Bureau, Population Division.* Retrieved from https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

Associated Press. (2013, December). Bear road kills rise in Va. as animals seek food. *AP Regional State Report – Virginia.*

Associated Press. (2012, May). VA Beach residents asked to report bear sightings. *AP Regional State Report – Virginia.*

Associated Press. (2016, February). Virginia game officials say bear, deer, turkey kills all up. *WMDT News.*

Beckmann, J.P., Karasin L., Costello C., Matthews S., & Smith, Z. (2008). Coexisting with Black Bears: Perspectives from Four Case Studies across North America. *Wildlife Conservation Society Working Paper, 33,* 53-64.

Baruch-Mordo, S., Breck, S.W., Wilson, K.R., & Broderick, J. (2011). The Carrot or the Stick? Evaluation of Education and Enforcement as Management Tools for Human-Wildlife Conflicts. *PLoS One, 6,* 1-8.

Black Bear Management Plan: 2012-2021. (2012). *Virginia Department of Game and Inland Fisheries.* Retrieved from https://www.dgif.virginia.gov/wp-content/uploads/blackbearmanagementplan.pdf

Dunn, W., Elwell, J.H., & Tunberg, G. (2008). Safety education in bear country: Are people getting the message? *Ursus 19,* 43-52.

Draheim, M. M. (2012). *Social conflict and human-coyote interactions in suburban denver* (3506253). Available from Dissertations & Theses @ George Mason University - WRLC; ProQuest Dissertations & Theses Global. (1015163013). Retrieved from https://search.proquest.com/docview/1015163013?accountid=14541

Evans, M.J., Hawley, J.E., Rego, P.W., & Rittenhouse, T.A.G. (2014). Exurban Land Use Facilitates Human-Black Bear Conflicts. *The Journal of Wildlife Management, 78,* 1477-1485.

Gore, M.L., Knuth, B.A., Curtis, P.D., & Shanahan, J.E. (2006). Education Programs for Reducing American Black Bear-Human Conflict: Indicators of Success? *Ursus, 17,* 75-80.

Hedgpeth, D. (2016, April) Two bear sightings reported in Fairfax County. *The Washington Post.*

Hooper, B. (2016, May) Virginia woman wakes to bear fight on her back porch. *United Press International, Inc.*

Howe, E.J., Obbard, M.E., Black, R., & Wall, L.L. (2010) Do public complaints reflect trends in human-bear conflict? *Ursus, 21,* 131-142.

Kirkman, T.W. (1996) Statistics to Use. Retrieved from http://www.physics.csbsju.edu/stats/

Lynch. P. (2006, December). State bear population rapidly rising: Hunters are killing more of them, but bears are increasing by as much as 7 percent per year. *Daily Press.*

Mazaika, K. (2013). *Beyond the bear necessities: A mixed methods analysis of the conflicts arising in human-black bear encounters* (3588792). Available from Dissertations & Theses @ George Mason University - WRLC; ProQuest Dissertations & Theses Global. (1428746724). Retrieved from https://search.proquest.com/docview/1428746724?accountid=14541

Masterson, L. (2016) *Living With Bears Handbook (2nd ed.).* Masonville, CO: PixyJack Press.

Merkle, J.A., Krausman, P.R., & Booth, M.M. (2011) Behavioral and attitudinal change of residents exposed to human-bear interactions. *Ursus 22,* 74-83.

Merkle, J.A., Krausman, P.R., Decesare, N.J., & Jonkel, J.J. (2011). Predicting Spatial Distribution of Human-Black Bear Interactions in Urban Areas. *The Journal of Wildlife Management 75,* 1121-1127.

Nolte, D.L., Veenendaal, T.J., Ziegltrum, G.J., & Fersterer, P. (2001). Bear Behavior in the Vicinity of Supplemental Feeding Stations in Western Washington. *USDA National Wildlife Research Center - Staff Publications, Paper 558,* 106-111.

Qualtrics software, Version Insight Platform. (2016). Provo, UT. Retrieved from
http://www.qualtrics.com

Price, M. (2014, June). Car hits bear in Virginia Beach, animal euthanized. *AP Regional
State Report - Virginia.*

Rathke, L. (2014, February). Deer, bear, turkey kills up in Virginia. *AP Regional State
Report – Virginia.*

Reed, S. (2016, August). Multiple Bear Sightings in Ashburn. *Ashburn Patch.*

Rogers, L. L. (1987). Effects of food supply and kinship on social behavior, movements,
and population dynamics of black bears in northeastern Minnesota. *Wildlife
Monograph 97,* 72.

Sidersky, R. (2015, August). Black bear spotted in Stafford. *The Free Lance-Star.*

Spencer, R.D., Beausoleil, R.A., & Martorello, D.A. (2007). How Agencies Respond to
Human-Black Bear Conflicts: A Survey of Wildlife Agencies in North America.
Ursus, 18, 217-229.

Taylor, M. (2012, July). Education key in new bear plan. *The Roanoke Times.*

Virginia Residents' Opinions On Black Bears and Black Bear Management. (2010).
Responsive Management. Retrieved from
http://www.responsivemanagement.com/download/VABear/VABear_2010_Publi
c_Opinion_Survey_Report.pdf

Worrell, A. (2014, July). Bear sightings increasing locally. *Carroll News.*

Ziegltrum, G.J. (2008). Impacts of the black bear supplemental feeding program on
ecology in western Washington. *Human-Wildlife Conflicts, 2,* 153-159.

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