Perceived Impacts of Beavers in City of Saskatoon

Supervisor - Dr. James Robson

Program Coordinator – Dr. Graham Stickert

Bhupinder Singh

Acknowledgment

I would like to express my special thanks of gratitude to my supervisor **Dr. James Robson** *as well as Program Coordinator* **Dr. Graham Strickert** *who gave me the golden opportunity to do this wonderful project on the topic* ***Perceived Impacts of Beavers in the City of Saskatoon****, which also helped me in doing design survey, analysis & writing report and I came to know about so many new things for which I am thankful to them. Besides my advisor, I would like to thank the rest of my project committee:* **Jan Shadick***, (Living Sky Wildlife Rehabilitation) for his encouragement, insightful comments, and questions. Secondly, I would also like to thank my parents and friends who supported me a lot in finalizing this project report within the limited time frame.*

ABSTRACT

In the Native of North America, the beaver, faces the threat of extinction, with its presence obliterated in Northern Mexico. Conservation efforts present with complexities due to human-animal conflicts. Establishing the perceptions and impacts of the beaver in the city of Saskatoon involved a pilot survey in the 2020 winter season through a weblink, where the University of Saskatchewan serves as a proxy. Quantitative data collected sought to enhance the understanding of community perceptions and impacts of the beavers. Respondents held mostly positive attitudes toward beavers, happily accepting to coexist with some tolerance. Respondents who experienced beaver-related problems expressed less favorable attitudes towards the beaver than those without beavers on their properties. Obtaining support for the conservation of beavers among the residents of Saskatoon requires the implementation of strategies that are responsive to the changing attitudes of urban communities. Better knowledge of public perceptions and impacts of the beavers on society will help to develop effective and socially accepted policies to change the attitude towards beavers.

Keywords: *beaver, perceptions, conservation, attitudes*

TABLE OF CONTENT

LIST OF FIGURES

INTRODUCTION

1.1 Background of the Study

The beaver is one of the endangered wildlife species. Found mainly in the North American region, this animal makes its habitat in water streams. Its body is covered by thick fur, which initially attracted a lot of interest from the clothing industry. The trade significantly affected the beaver population, with some regions being left without beavers. Aside from hunting for its fur, the beaver faces a considerable threat of extinction owing to human-beaver conflicts. By its tendency to cut down trees, the beaver is deemed as destructive by some human populations who find it necessary to exterminate it. Without a doubt, the beaver would already be extinct, was it not for the efforts of conservationists (Danilov & Kan'shiev, 1983)

Perhaps the most notable personality in spearheading efforts to conserve the beaver is Mr. Grey Owl. His writings and speeches gave rise to the movement for beaver conservation, which peaked at the end of the 1930s (Hinterland n.d.). With his work, Grey Owl convinced different stakeholders of the need to conserve the beaver due to the threat of extinction that faced it. His fervent discussions focusing on the deplorable situation of the Canadian forests with emphasis on the damaging effects to the beaver and other wildlife moved different entities to take conservation efforts. Governments took rapid measures such as terminating all activities involving beaver hunting for many years to allow its population to recover (Schwanky, 2016). In recent years, conservation strategies enacted by governments at the federal and local levels seem to bear fruits. Tangible results have been achieved, such as the successful reintroduction of beavers into various zones where trappers had exterminated the animal. Over time, the efforts have seen remarkable growth in the beaver population across Canada.

However, the beaver population poses some concerns to residents in certain areas. Having a highly thriving beaver population means that people must find ways of preventing the beaver's

damaging effects on tree plantations, roads, and farmlands (Johnson, 2017). Considering that beavers contribute significantly to the ecosystem, finding the right ways of conserving them while avoiding damages remains paramount. Achieving this requires understanding the people's perceptions towards the beaver, as it facilitates a constructive process. It is in the interest of establishing such information that the survey on the perceptions and attitudes of people towards beavers was taken (Hyvonen & Nummi, 2008). Beavers are large semi-aquatic and nocturnal rodents. They are amongst the world's biggest living rodents (MacDonald, 2018)

1.1.1 Beavers Worldwide

These animals are generally native to Eurasia and North America. Different species of beavers are found in these two parts of the world. The Eurasian beaver is commonly known by its specie name *Castor fib*re and is located in Asia and Europe. On the other hand, *Castor canadensis* is the beaver species found in North America. As such, beavers are only found in three continents of the world, namely Europe, North America, and Asia (Muller-Schwarze, 2011). In Eurasia, these animals used to be widespread throughout Asia and Europe. Even so, they were almost extinct by the end of the 1800s since humans had hunted them extensively. Their reintroductions in various countries throughout Europe, in addition to continuing conservation efforts, have resulted in their numbers increasing, reaching almost 640,000 by the early 2000s, most of which are located in the former Soviet Union (Muller-Schwarze, 2011). Now, populations of Eurasian beavers are found in Russia, Poland, Germany, Sweden, France, Belarus, Estonia, and Norway.

The North American species of these rodents are located in the forested regions of northern Mexico, the United States, and Canada. Over the past several years, the population of the North American beaver has declined significantly. They once numbered over 60 million but are now estimated to range from six to ten million individual animals (Dittbrenner et al., 2018). This drop-in population is mostly the result of various factors, including pest control, since these animals

often interfere with other land uses, as well as widespread hunting for their fur and glands (Johnson, 2017). Their glands are thought to have medicinal properties.

1.1.2 Beavers in Canada

In Canada, these animals are the biggest rodents. They live in large numbers in forested areas throughout the country and north to the tree line around streams and lakes but are few on the prairies. The average beaver dam in the country measures 10 – 100 meters long, and hardly ever reach the length of 500 meters. Even so, in the Wood Buffalo National Park, which is situated in northern Alberta, there is Canada's biggest beaver dam believed to have been constructed in the mid-1970s. It is 850 meters long (Muller-Schwarze, 2011). It is believed that several beaver generations have added to their size over the decades.

In various parts of Saskatchewan, there is an overpopulation of beavers. As a result, over 200 municipalities in rural regions of the province have offered bounties (Schwanky, 2016). In 2015, about 38,000 beavers were killed in Saskatchewan because of the bounty offers (Schwanky, 2016). The rodents are considered as burdening rural parts of Saskatchewan, and offering bounties are one of the solutions that the Saskatchewan Association of Rural Municipalities (SARM) is using for the beaver population problem. *Problem beavers,* along with their dams, according to SARM, can cause the flooding of properties and roads (Johnson, 2017). There is the claim that they have been damaging infrastructure.

1.1.3 Benefit of Beavers to the Environment

Without the dams created by these rodents, much of the water in a large number of small streams across the country would be flowing through the landscape unchecked. Beavers impounded the water and fell trees. In so doing, they provide themselves with twigs for food and wood to create their homes, over and above, opening dense woods that ultimately creates opportunities for various animals and plants (MacDonald, 2018). Owing to this fact, beavers are

renowned as an integral species in Boreal Forest and temperate aquatic ecosystems. Besides, wildflowers, sedges, and grasses spring up along pond margins. Land and aquatic insects thrive and offer food for cedar waxwings, tree swallows, song sparrows, and other songbirds. Kingfishers and duck species like mergansers feed in the shallow waters (Johnson, 2017). Trees that have been killed by beavers provide sites for certain types of birds to nest. Furthermore, newts, frogs, and toads thrive and breed within the ponds and provide food for raccoons and herons. Additionally, the shallow waters and the surrounding areas tend to draw otters, muskrat, moose, and mink (MacDonald, 2018). Overall, the activities of beavers increase the biodiversity of Canada's forested areas.

Moreover, beavers effectively maintain wetlands that sponge up floodwaters. In this way, they lessen droughts and floods since beaver dams are known for keeping water on the land longer. They also help to raise the water table, alleviate erosion, and serve as the *earth's kidneys* in purifying water, thus improving the quality of water (MacDonald, 2018). Water purification takes place since several feet of silt collect upstream of older dams created by these animals, and microbes in the wetlands created by beavers break down pesticides and other toxins. As a result, water downstream of beaver dams tend to be cleaner and thus does not necessitate substantial treatment before it can be used by humans (Dittbrenner et al., 2018). Overall, environmental benefits range from reducing downstream flooding by slowing the movement of water and minimizing pollutants, to improving biodiversity and increasing the complexity of the surrounding habitat. Beaver dams also help in the restoration of degraded streams (MacDonald, 2018). The wetlands established and maintained by these animals provide crucial habitat for a wide variety of sensitive animal and plant species.

1.1.4 Human Conflict with Beavers

The conflict between animals and human beings is a major threat affecting the survival of various animal species globally. Human-wildlife conflict takes place whenever animals pose a persistent and direct threat to people's safety and livelihood. People then retaliate against that animal species, resulting in a conflict as regards to what needs to be done to resolve that situation (Schwanky, 2016). In Canada, these conflicts occur when landowners, farmers, and the general Canadian public view beavers as animals that cause tree damage and flooding. Many farmers complain about the flooding of fields caused by beavers, and cottagers bereave the loss of their favorite trees thanks to these animals (Schwanky, 2016). Some roads in rural parts of Ontario and Saskatchewan have been flooded by beaver dams. Beaver dams can contribute to flooding that becomes a crisis mostly after very heavy rains and when the snow goes into water bodies with considerable blockages. Thanks to this conflict, humans are undoing beaver dams and even killing these animals.

1.1.5 Perception of Beavers

In many regions of the country, there is a perception among Canadians that these rodents are invading. They are considered an invasive species. Also, these animals are often seen as a nuisance pest, which is a disturbing misperception (Alice, 2014). This is because beavers are monogamous, family-oriented creatures whose provable intelligence astonishes scientists globally and provide important ecosystem services. Owing to the misperceptions, landowners, and municipalities in Saskatchewan and other provinces often hire trappers to kill beaver families.

1.1.6 Management Technique

To decrease the negative effects of beaver activity, several management techniques are recommended. Firstly, there is a need to conduct a process of beaver dam removal. This entails removing their dams with the use of explosives, heavy equipment, or hand tools. Nevertheless, the

dam would be repaired speedily unless the rodents are also removed (Gibson & Olden, 2014). Secondly is population control. As soon as beavers choose the location for building a dam, they can be unrelenting. When efforts to modify or remove a beaver dam become impossible or fail, the only possible way of controlling damage or addressing the problem is by removing the rodents. They can be trapped or shot dead where legal (MacDonald, 2018). There are various types of traps that can be used to trap them, ranging from lethal devices to those intended for live capture.

The third management technique is habitat management. This comprises various methods such as managing the level of water of a beaver pond and removing woody vegetation, including trees that attract beavers. Controlling the water level at beaver ponds must be done in such a manner that the beaver should not detect the leaking of their dams because if they do detect, they will quickly strive to repair it. As such, appropriate hollow pipes pushed through a dam can be used (Gibson & Olden, 2014). The fourth management technique is known as exclusion. Through this approach, valuable landscape shrubs and trees are wrapped with hardware cloth to prevent their loss to rodents (Alice, 2014). Even so, the wrapping must be carried out before the arrival of the beavers.

METHODOLOGY

2.1 Introduction

The current study will be guided by the following objectives; that the university of Saskatchewan staff and faculty and students are being used as a proxy for City of Saskatoon residents due to the limited time available and also due to COVID19, that the study will focus on piloting and revising the survey instruments for future studies and to document the perceived impacts both positive and negative caused by the beavers. It worth noting that the success of any survey would be the number of people that responded to the survey; that is, the response rate (Fanning, 2005). Web Link was used to collecting the responses through Survey Monkey, which significantly improve not only the response rate but also the accuracy (Fanning 2005).

When using the survey instrument in research, Draugalis, Coons, and Plaza (2008) pointed out that the instrument must be fully described, including the validity and reliability of the instrument. Evidence of validity demonstrates that the instrument measures what is intended to be measured. Evidence that supports the questionnaire survey's reliability suggests that the instrument measures the variables in a manner that is reproducible (Draugalis, Coons & Plaza, 2008). In survey research, phenomena that are often measured include evaluations, feelings, quantity, frequency, agreement, and satisfaction. In this research study, the questionnaires sent to the participants through weblink using PAWS announcements.

Since this is a quantitative study, the collected data was analyzed with the use of Quantitative Data Analysis (QDA) techniques. The analysis entails calculating the frequencies of variables and differences between the variables. In addition, the analysis provided quantifiable and easily understandable results. R software is used for analysis.

2.2 Significance of the Survey Questionnaire

As a data collection instrument, a questionnaire survey has several benefits. Firstly, it can be used to collect data quickly and easily from a large number of respondents within a short time. Because the surveys can be distributed to the participants via email, or they can fill it out online and then submit the results instantly. Secondly, surveys are of low cost. The researcher only pays for the production of the questionnaires for the survey (Stern, Bilgen & Dillman, 2014). Thirdly, the survey method brings about high representativeness; hence it is easy to obtain statistically significant results. Furthermore, many different variables can be analyzed effectively with the use of surveys (Stern, Bilgen & Dillman, 2014). Fourthly, these data collection instruments can be administered to the respondents in various ways, such as via the Internet, fax, email, or physically.

In this research study, the questionnaire survey comprises about 19 structured, closed-ended, and open-ended questions. The questions are a combination of multiple-choice questions and Likert scale questions. Each question in the survey is designed to elicit a specific response regarding the respondent's perceptions and attitudes towards beavers in Saskatoon, Canada. The multiple-choice questions in the questionnaire allow the participants to choose at least one option from a listing of pre-determined answers. These types of questions were used due to the fact that they are not only intuitive, but they also provide mutually exclusive choices and help in producing data that is easy to analyze (Fanning, 2005). With Likert Scale questions, the study subjects do not just choose *No* or *Yes*; there are particular choices based upon *Disagreeing* or *Agreeing* on a given question in the questionnaire (Draugalis, Coons & Plaza, 2008). These types of questions were asked as they help to measure the attitude or viewpoint of the participants toward the topic of this research study. Likert Scale is generally a nine, seven, or five-point agreement scale utilized in measuring participants' agreement with various statements.

RESULTS

3.1 Results

One hundred fifty respondents complete the pilot survey. The results of the study were organized into three major themes, which include the extent of people's first-hand knowledge of beavers, what people think about beavers, and finally, the appropriate measures for managing beavers.

3.2 Peoples first-hand information about Beavers

Almost 60% of people saw 1-10 beaver(s) in a year, and 10% saw more than 20 beavers, although there were 28% of people who also said they did not saw any beaver in last one year, but remains possible that someone by chance never directly saw a beaver. A large portion of people (51%) think Beavers are "Common" within city limits, and 36% think they either "Rare" or "Uncommon." There were 13% of people who "Do not know" about it. 37% of people confirm that they have seen Beaver in or around the university campus. Top 3 places which people mentioned in their open response:

3.3 Beliefs about Beavers

A large portion of surveyed people admits that no beavers were living on their or nearby property within the last five years, 86% to be precise. While those (14%) responded “Yes,” when asked about the extent to which they consider beavers as a problem, 8 of them replied with “No problem at all,” whereas 13 thinks of them as some type of problem.

Open responses by those who considered beavers as Major problem were:

Response
The beavers were not on our property in Saskatoon. They were on our farm near Indian Head. When water levels were high, they cut down virtually every living tree, and their population peaked at over 100. Without any culling, they are now down to 5 or 10, but now all the large trees are gone, restricting habitat for raptors, deer.

Response
damaging trails along the river
Destroying the trees along the riverbank

Furthermore, similar thought is being encoded in other open responses as most common words used are "tree," "beaver," & "damage," which suggests that people are concerned about damage beavers to do to the trees.

People who had no beavers on their or nearby property (86%), when asked about whether they would like beavers on it. The highest number of responses were those who were moderately interested (30+ responses) to have beavers living on or near to their property, while nearly 30 were neutral about it. People have mixed feeling towards beavers; they have used the “love” and “cute” word more often, but it should also be noted that they have used words such as “damage,” “destroy,” & “destructive.”

Some people with Ph.D. and master’s Education responded with:

Response
I like to see them and to wear them!
I like them. They're just part of the whole natural cycle.
Beavers have their role within the environment, they are a source of food for Indigenous peoples, and their fur is a source of clothing, i.e., fur trim on mitts or moccasins
Love them!

Some of the responses from people coming from the Environment and Sustainability background responded with:

Response
They are nice to see, but they are big rodents that will destroy their habitat. Carbon sequestration is important dead trees don't do that. Like gophers, they have some existence value, but too many beavers create huge issues for the environment. What they destroy their habitat, their numbers drop from a lack of food. It is better to have ten beavers living sustainably on the river rather than 200 and then 5, then 200, etc.
Sometimes view them as a pest, especially when their dams interfere with water systems that feed livestock. But also know that they do an excellent job of using dead/dying trees and help maintain the ecosystem in which they live.
They are an integral part of our local prairie riparian ecosystem (among many other habitats). They are also very resourceful animals, and I think they're kind of cute too.

A large portion of people agrees that Beavers have the right to exist, and they are the sign of a healthy environment. For the other three beliefs analyzing using Pie-charts as the proportions are visually indistinguishable.

60% of people disagree that Beavers are a nuisance. There is not much inclination on either side for the belief that Beaver populations should be controlled, with 34% agreeing, 30% disagreeing and rest 36% are neutral.42% of people agree with the belief that beavers should not be destroyed, while ~21% remain neutral and ~36% disagree with it.

3.3.1 Gender wise response on each- belief

For belief whether the beaver's population should be controlled, a large proportion of Males Strongly Agree for it, and a similarly large proportion of males can be seen who Strongly Agree that "Beavers are a nuisance" and Strongly Disagree that "No beaver should be destroyed." For the beliefs "Beavers are a nuisance," "No beaver should be destroyed" & "Beavers population should be controlled," contrasting proportions can be seen based on gender when comparing responses for "Strongly Agree" and "Strongly Disagree."

People of younger age group (18-25 year) are more in favor of beliefs which have support for beavers, as their proportion is quite significant in each of the supporting response. All people either responded "Moderately" or "Not at all" Concerned in terms of their health and safety, with most of them preferring latter. There are only a few people "Extremely Concerned" about the health and safety of their children, and almost 60% are "Not at all concerned." In respect of the health and safety of their pets or livestock, there are quite a few people who are "Moderately" or "Slightly" Concerned, but almost a quarter of responses were still "Not at all" concerned and some rare with "No Opinion."

Concerning Beavers Living within Saskatoon City Limits and what people think about their population. There are very few people (~11%) who think that Beavers population should decrease, whereas a little more than a quarter of people (~27%) suggests that it should increase and the almost same amount of people (~26%) responded with "No Opinion" whereas approximately 22% people think that population of Beavers should remain the same. The people who responded with Others, also should be considered to be under "No Opinion" category as the most frequent words which they used in the open answer is "don't," "not" & "comment" with "population," suggesting that they don't know about the current population:

3.4 Appropriate Measures for Managing Beavers

More than 100 responses were received to support that if the Beavers carry some harmful disease for humans, then lethal control is valid. 30 People do not find any of the given solution justified for the control of the Beaver population. And around the same amount of responses were received for two scenarios that it demands lethal action if "Beavers flood a public road" and "Beavers damage private property." Ten responses were also suggesting for lethal action if Beaver is seen in their yard.

Further, A large portion of people agrees that Beavers should exist, and people should be willing to tolerate some conflicts and that they are not afraid of Beavers. Although there was a total of 33 responses somewhat agreed for Beaver population management (culling), but 79 responses opposed it, and some remained neutral (40).

3.4.1 Gender wise response on Measures for Managing Beavers

Majorly the response for the statement that beavers population should be actively managed (culled) disagreed with 52% of responses, and 26.3% were neutral, but there were ~21% of people who agreed with it and the number responses agreeing were more of males than females. 69.4% of responses were strongly disagreed for the statement that they are afraid of beaver, it would be inappropriate here also to judge the proportion of gander for a single response as there are a large number of female respondents in the survey. 70% of the responses were supporting the importance of the existence of beavers, but the proportion of males increases as the support towards the statement decreases.

Further, almost 90% of responses agree towards steps to get or research information about coexistence with Beavers. ~65% of responses find it "Acceptable" to contact non-government groups about how to deal with beavers, a little reduction in that number when asked about raising a complaint with the government, but still, it is majorly "Acceptable." While the number of "Unacceptable" responses increase in the case of government involvement.

60% of responses are ok to install beaver tools, while 30% are neutral, and only 10% find it unacceptable. Regarding the removal of beaver dams or lodges in the area, there is no large majority to any response, highest being "Unacceptable" (~40%). The majority of responses to wrap trees for preventing beavers from chewing trees was "Acceptable" (~70%).

A large portion (~65%) of responses are "Unacceptable" for destroying the beaver (lethal control), and instead, people supported capturing and relocation of beaver more as responses for it being majorly "Acceptable" (55%). There is no clear outstanding majority for responses towards frightening the beave away, the highest number of responses were for "Unacceptable" (45%) followed by "Neutral" (~30%) and "Acceptable" (~28%).

3.5 Gender wise response on how beavers should be controlled

No major disproportionate of genders can be seen for responses of first three statements, ("Ask for, or research, information about how to coexist with beavers," "Capture and relocate the beaver to another location" & "Contact non-government groups about how to deal with beavers"). In the first statement, a little increase in the proportion of males for "Unacceptable" can be negligible as the total responsibility for that statement was dominantly "Acceptable." Out of the 14.2% who find it “Acceptable” to "Destroy the beaver (lethal control)," major responses come from male respondents, and those who find it “Unacceptable” are majorly female respondents.

Although a majority of the survey respondents were females, the "Acceptable" responses for "File a complaint with the government," which is the highest for this statement, had an almost equal number of responses from Males and Females. For the statement "Frighten the beaver away," the proportion of males who find it "Acceptable” is higher than in "Neutral" or "Unacceptable," suggesting a similar gender-biased trend against beavers as observed in response for population control.

A similar trend can be observed in the responses for the statements "Install beaver tools (exclusion devices or water level controllers)," "Remove beaver dams or lodges in the area" & "Wrap trees to prevent the beaver from chewing trees," where the proportion of males is higher in "Acceptable" responses than in "Neutral" or "Unacceptable."

3.6 Age wise response on how beavers should be controlled

Age-wise proportions in responses for two statements "Capture and relocate the beaver to another location" & "Destroy the beaver (lethal control)" are quite similar, where a large proportion of younger people tends to not accept both the statements. For the statement "Frighten the beaver away," almost equal proportions of younger people find it both "Acceptable" and "Unacceptable." The higher proportion of people with age 36+ years think it is "Acceptable" over "Neutral" or "Unacceptable" to "Remove beaver dams or lodges in the area" & "Wrap trees to prevent the beaver from chewing trees."

3.7 Regression Analysis

When regressing each category of response, Gender, Age, Education & In Environment Field against the Against Beaver Score using multiple linear regression model gives below estimates for each type of category: An estimate of Intercept is -2.22, which can be interpreted as the expected Against Beaver score if the person is Female, has aged in 18-25 years range, has a Bachelor's degree of education, and does not work or studies in environment or sustainability field. From the data, this intercept term is statistically significant, with up to 99.99% accuracy.

Estimate for gender male is 2.53, which means that if a person is Male and has all other conditions the same as above, then it is expected Against Beaver score will be -2.22 + 2.53 = 0.31. This estimate is also statistically significant; that means from surveyed data, we can say that for the general population, Males will have less affinity towards Beavers as compared to Females. Other than this category, the next significant category is those who have completed a post-secondary program as their education. From this survey data, it can be said with 94% confidence that a person with this education level is more against the beavers as compared to a person with a

bachelor's degree with 1.52 units more on the Against Beavers scale. The rest of the estimates are not statistically significant based on the data received in this pilot survey.

```
Coefficients:
                                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                                       -2.22347    0.57228  -3.885 0.000163 ***
genderMale                                         2.53080    0.53456   4.734 5.73e-06 ***
genderNonbinary                                    1.08791    1.68256   0.647 0.519060
educationCompleted a post-secondary program  1.52646    0.82169   1.858 0.065508 .
educationHigh school diploma or GED        -0.64348    0.70506  -0.913 0.363137
educationmaster's degree                    0.48409    0.69877   0.693 0.489702
educationPh.D. degree                       0.76781    1.26722   0.606 0.545655
age26-35                                   -0.72493    0.68352  -1.061 0.290875
age36-45                                   -0.23904    0.95048  -0.251 0.801833
age46-55                                   -0.76615    1.24091  -0.617 0.538063
age56-65                                    0.73906    1.06666   0.693 0.489641
age76-85                                    1.92486    3.13884   0.613 0.540805
env_sustYes                                -0.09919    0.58776  -0.169 0.866249
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.803 on 128 degrees of freedom
Multiple R-squared:  0.2352,    Adjusted R-squared:  0.1635
F-statistic: 3.281 on 12 and 128 DF,  p-value: 0.0003716
```

When regressing each category of response, Gender, Age, Education & In Environment Field against the Support Beaver Score using multiple linear regression model gives below estimates for each type of category: An estimate of Intercept is 4.45, which can be interpreted as the expected Support Beaver score if the person is Female, has aged in 18-25 years range, has a Bachelor's degree of education, and does not works or studies in environment or sustainability field. From the data, this intercept term is highly significant.

Estimate for gender male is -0.82, which means that if a person is Male and has all other conditions the same as above, then its expected Support Beaver score will be 4.45 – 0.82 = 3.63. This estimate is significant, with 99% of confidence, which means from surveyed data, we can say that for the general population, Males will have a lower Support Score as compared to females. From this survey data, the linear model also suggests that the age factor is also statistically significant, with almost 97% of confidence. A personage between 56-65 years will tend to have

Support Beaver score lower than the personage between 18-25 years by 1.5 units and while the person aged between 76-85 years will be lower by 4.41 unit on the same scale.

```
Coefficients:
                                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                                       4.451826   0.364086  12.227   <2e-16 ***
genderMale                                       -0.825164   0.340092  -2.426   0.0166 *
genderNonbinary                                   0.017692   1.070455   0.017   0.9868
educationCompleted a post-secondary program -0.033030   0.522763  -0.063   0.9497
educationHigh school diploma or GED         0.218286   0.448562   0.487   0.6274
educationmaster's degree                    0.007942   0.444560   0.018   0.9858
educationPh.D. degree                       1.019855   0.806211   1.265   0.2082
age26-35                                   -0.313421   0.434860  -0.721   0.4724
age36-45                                   -0.752543   0.604704  -1.244   0.2156
age46-55                                   -0.518563   0.789476  -0.657   0.5125
age56-65                                   -1.500025   0.678614  -2.210   0.0289 *
age76-85                                   -4.146517   1.996948  -2.076   0.0399 *
env_sustYes                                 0.246091   0.373935   0.658   0.5116
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.783 on 128 degrees of freedom
Multiple R-squared:  0.143, Adjusted R-squared:  0.06265
F-statistic:  1.78 on 12 and 128 DF,  p-value: 0.05808
```

Both the models don't give much significance to the variable "In Environment field," it may be because of the insufficient data.

DISCUSSIONS

4.1 Discussions

This research study sought to determine the perceptions and attitudes of the communities living in Saskatoon towards beavers. Understanding their views is integral in teaching tolerance towards these animals. A total of 150 respondents selected randomly took part. Slightly more females than males participated in the study. In addition, the vast majority of the participants were aged between 18 to 35 years and did not work or study in the field of environment and

sustainability. Most of these participants had seen beavers over the past 12 months. They had spotted them around the University of Saskatchewan campus and/or within Saskatoon City limits. Out of the 150 study subjects, only 21 indicated that beavers live on their property or close to their property. Out of the 21, 13 of them think that beavers cause problems while eight believe they are not a problem at all.

These findings are similar to what other researchers have also found. For instance, Taylor, Yarrow, and Miller (2017) reported that while beavers offer many benefits through dam building and foraging, these animals also create conflicts with human beings when damage is caused by their activities. Among those who consider beavers a major problem, their thoughts regarding these animals, as indicated by the open-ended questions, are that beavers cause substantial damage by cutting down trees, damaging trails along the river, and even destroying trees along the riverbank. These findings reveal that some people in Saskatchewan are concerned about the tree damage caused by beavers within their communities.

In describing how they feel about them, the study subjects used words such as *cute* and *loved* more often, although they also used words like *destructive*, *destroy*, and *damage*. Also, the findings of the current study showed that some respondents consider these animals as pests, particularly when their dams interfere with water systems that feed farmers' livestock. Despite this, they also view them as doing an excellent job of using dead and/or dying trees and, in so doing, helping to maintain the ecosystem in which they live. In essence, they are a crucial aspect of the local prairie riparian ecosystem. These mixed findings suggest that although people in Saskatoon are generally inclined to have positive feelings towards these animals, at the same time, they are also concerned about their harmful impacts on the environment since they are well aware of the damage and destruction that these animals can cause.

These results are comparable to those of other researchers. For example, in their study conducted in Massachusetts, Jonker et al. (2009) learned that the participants, in general, had positive attitudes towards these animals. They added that those who have experienced beaver problems in the past tended to have negative or less favorable attitudes towards the rodents compared to respondents who have never experienced beaver-related problems (Jonker et al., 2009). In essence, as the severity of damage experienced by the respondents grew, attitudes towards these rodents became more and more negative (Jonker et al., 2009). Siemer, Jonker, and Brown (2004) pointed out that while many people love beavers, they dislike the harm that these animals can cause on the environment. Moreover, the results showed that people, in general, have different beliefs towards beavers. While the vast majority of the respondents think that these rodents have a right to exist, should not be destroyed, and are a sign of a healthy environment, many others also view them as a nuisance, and their populations should be controlled.

Besides, the findings demonstrated that the vast majority of the study subjects are not concerned at all about their own personal health/safety or the health/safety of their children by the nearby presence of beavers. However, such a presence has made most participants slightly concerned about the health/safety of their livestock and/or pets. Such concerns are valid, considering that a beaver attack can cause harm to livestock and/or pets, including dogs (Siemer, Jonker & Brown, 2004).

Regarding the lethal control of beavers, most of the respondents stated that such control is justified only when these animals carry an illness that can harm people. A few of them supported lethal control if a beaver damages their private property or floods a public road. Other investigators have found comparable results. In their study, Siemer et al. (2013) found out that respondents who lived in regions with high beaver density supported lethal control of these animals as a way of

responding to beaver-related problems. In essence, individuals who have experienced wildlife damage tend to prefer a reduction in the population of the offending animal (Siemer et al., 2013).

Also, the vast majority of the study subjects hold the view that people should be willing to tolerate a certain level of conflict with beavers, and that even though they may never see a beaver, their existence is still important. Most of them are also in opposition to the culling of these animals. Besides, most of the participants agree toward steps to research or ask for information regarding how to coexist with beavers, contacting non-governmental groups concerning how to handle beavers, and filing a complaint with the government regarding beavers. Concerning preventing the damage caused by these animals, most participants are in support of measures such as wrapping trees to prevent them from chewing the trees and installing beaver tools like water level controllers and exclusion devices. The majority of them also find it acceptable to capture and relocate the beavers rather than killing them. Petro, Taylor, and Sanchez (2015) reported that the relocation of American beavers to desirable sites from unwanted sites was considered an appropriate method of preventing or reducing beaver-related damage and restoring salmon habitat.

4.2 Survey Questionnaire

Since this is a pilot study, the only tool that has been used to collect data was Weblink, and the only weblink was used because of the limited time that was available and also due to the presence of COVID 19, however in future, the concept of New Ecological Paradigm (NEP) refers which refers to a survey-based metric which is used by the environmental sociologist will be used to improve on the quality of the survey questionnaire. NEP has been made and specifically designed to measure the environmental concerns of groups of people who have been using other survey instruments for the purposes of collecting data; thus, it will be convenient when used with the survey questionnaire. For the case of the New ecological paradigm scale, the respondents in a study will be asked to indicate their strength of the agreement or strength of disagreement with the

statements, the responses which will be collected will be used to construct and develop other statistical measures of the environmental concerns in nature, the NEP has been considered as a new measure of the environmental sphere and considered as a framework of thought. Therefore the revised NEP scale will be a great fundamental metric of measuring progress towards a sustainable environment, it would assist with maintaining a sustainable educational campaign, however, for this success to be realized there will be a great need to accept its validity and reliability as an important metric of sustainability value.

CONCLUSIONS

5.1 Conclusions

Beavers are large rodents found in many parts of Saskatchewan. This research study aimed to determine the perceptions and attitudes of the communities living in Saskatoon City, Saskatchewan, towards beavers. Data were collected with the use of closed-ended and open-ended questions, respectively. The findings have helped to answer the research question and attain the objective of the research. Specifically, the findings reveal that people within the Saskatoon community generally have mixed feelings toward beavers, but the majority is in favor of the conservation of beavers. Some consider them as pests and a nuisance that cause damage and destruction to the environment. At the same time, many others view them as important to maintaining the ecosystem. Relevant management approaches include capturing and relocating them from undesirable to desirable locations, wrapping trees to prevent beavers from damaging them, and installing beaver tools such as exclusion devices.

REFERENCE

Alice R. W. H. (2014). Beavers causing problems at Fifty Point. *Hamilton Spectator, The (ON)*.

Dittbrenner, B. J., Pollock, M. M., Schilling, J. W., Olden, J., Lawler, J. J., Torgersen, C. E. (2018). Modeling intrinsic potential for beaver (Castor canadensis) habitat to inform restoration and climate change adaptation. *PLoS ONE,* 13(2): 19-29.

Draugalis, J. R., Coons, S. J., & Plaza, C. M. (2008). Best practices for survey research reports A synopsis for authors and reviewers. *American Journal of Pharmaceutical Education*, 72(1): 1-6.

Fanning, E. (2005). Formatting a paper-based survey questionnaire: Best practices. *Practical Assessment, Research, and Evaluation*, 10(12):1-14.

Gibson, P. P., & Olden, J. D. (2014). Ecology, management, and conservation implications of North American beaver (Castor canadensis) in dryland streams. Aquat Conserv Mar Freshw Ecosyst. 20(24): 391–409.

Hyvonen, T., & Nummi, P. (2008). Habitat dynamics of beaver *Castor Canadensis* at two spatial scales. *Wildlife Biology,* 14(3): 302-308.

Johnson, A. (2017). Rural Sask. Municipalities look to solve big beaver problems. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/saskatchewan/sarm-beavers-1.4393349

MacDonald, J. (2018). The busy, beneficial beaver. *JSTOR*, 12(43): 7-14.

Muller-Schwarze, D. (2011). *The beaver: Its life and impact* (2nd ed.). Ithaca, NY: Cornell University Press.

Alice R. W. H. (2014). Beavers causing problems at Fifty Point. *Hamilton Spectator, The (ON)*.

Dittbrenner, B. J., Pollock, M. M., Schilling, J. W., Olden, J., Lawler, J. J., Torgersen, C. E. (2018). Modeling intrinsic potential for beaver (Castor canadensis) habitat to inform restoration and climate change adaptation. *PLoS ONE,* 13(2): 19-29.

Draugalis, J. R., Coons, S. J., & Plaza, C. M. (2008). Best practices for survey research reports A synopsis for authors and reviewers. *American Journal of Pharmaceutical Education*, 72(1): 1-6.

Fanning, E. (2005). Formatting a paper-based survey questionnaire: Best practices. *Practical Assessment, Research, and Evaluation*, 10(12):1-14.

Gibson, P. P., & Olden, J. D. (2014). Ecology, management, and conservation implications of North American beaver (Castor canadensis) in dryland streams. Aquat Conserv Mar Freshw Ecosyst. 20(24): 391–409.

Hyvonen, T., & Nummi, P. (2008). Habitat dynamics of beaver *Castor Canadensis* at two spatial scales. *Wildlife Biology,* 14(3): 302-308.

Johnson, A. (2017). Rural Sask. Municipalities look to solve big beaver problems. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/saskatchewan/sarm-beavers-1.4393349

MacDonald, J. (2018). The busy, beneficial beaver. *JSTOR*, 12(43): 7-14.

Muller-Schwarze, D. (2011). *The beaver: Its life and impact* (2nd ed.). Ithaca, NY: Cornell University Press.

Schwanky, T. J. (2016). How Saskatchewan's beaver derby benefits hunters and trappers. *Outdoor Canada.* Retrieved from https://www.outdoorcanada.ca/how-saskatchewans-beaver-derby-benefits-hunters-and-trappers/

Stern, M. J., Bilgen, I., & Dillman, D. A. (2014). The state of survey methodology: Challenges, dilemmas, and new frontiers in the era of the tailored. *Field Methods,* 26(3): 284-301.

Hinterland Who's Who - Beaver. (n.d.). Retrieved from https://www.hww.ca/en/wildlife/mammals/beaver.html

APPENDIX

Appendix 1: Extent of people First-Hand information on Beavers

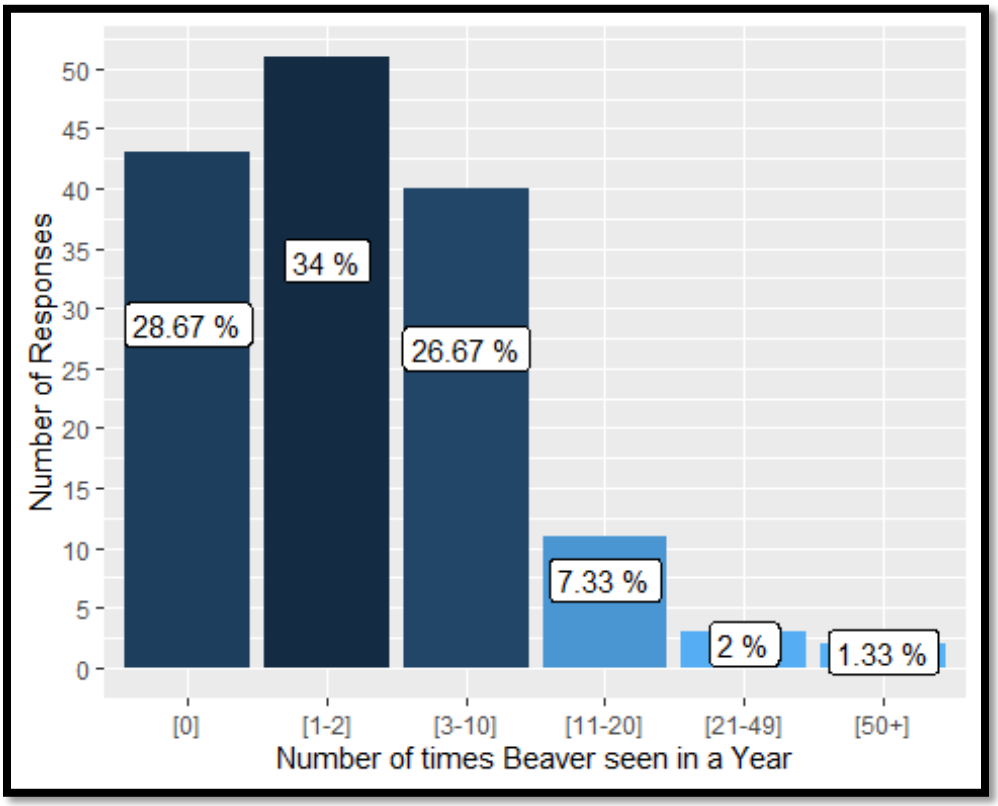

Figure 1Number of Beavers Seen by People

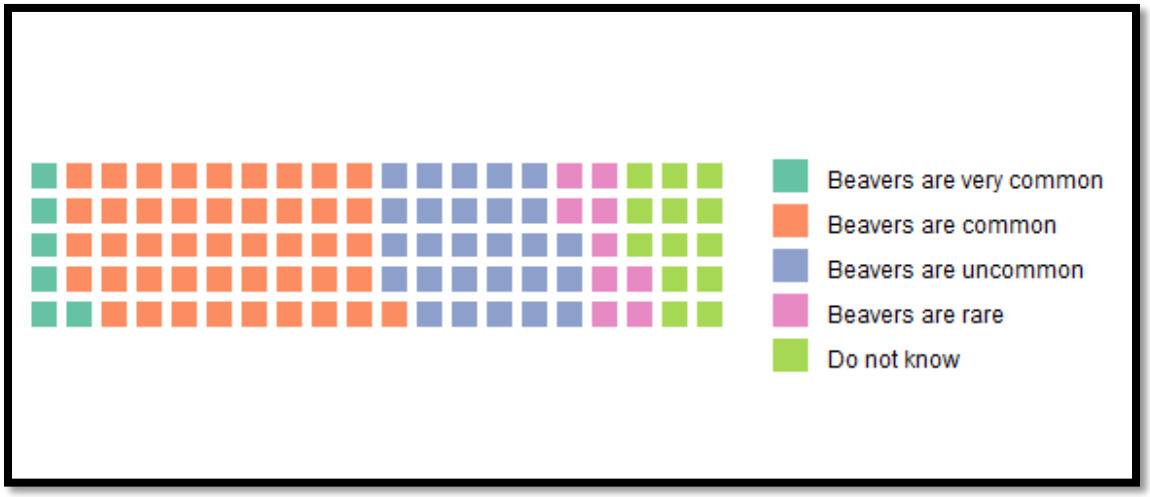

Figure 2 People thought about the presence of Beavers in Saskatoon City.

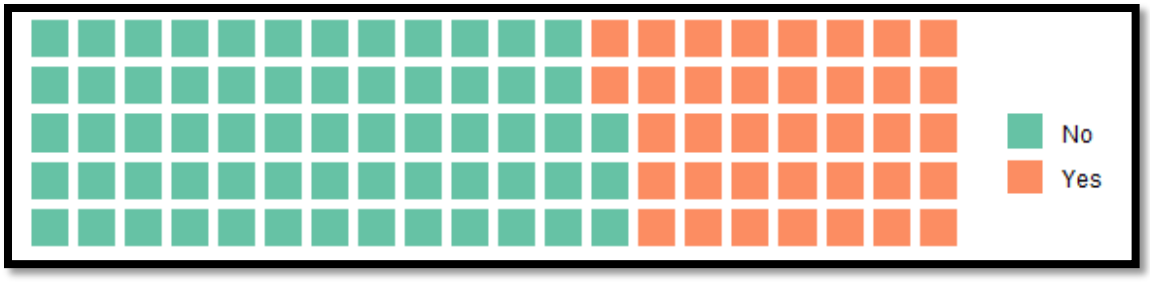

Figure 3 Response on Presence of Beavers near Saskatoon

Appendix 2: What people Think about Beavers

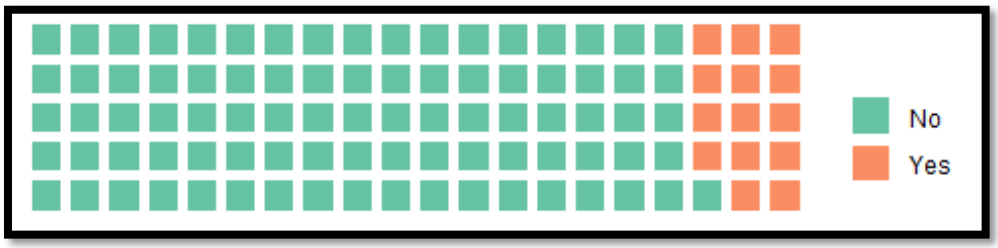

Figure 4 People's Response to Weather Beavers were living on their Property.

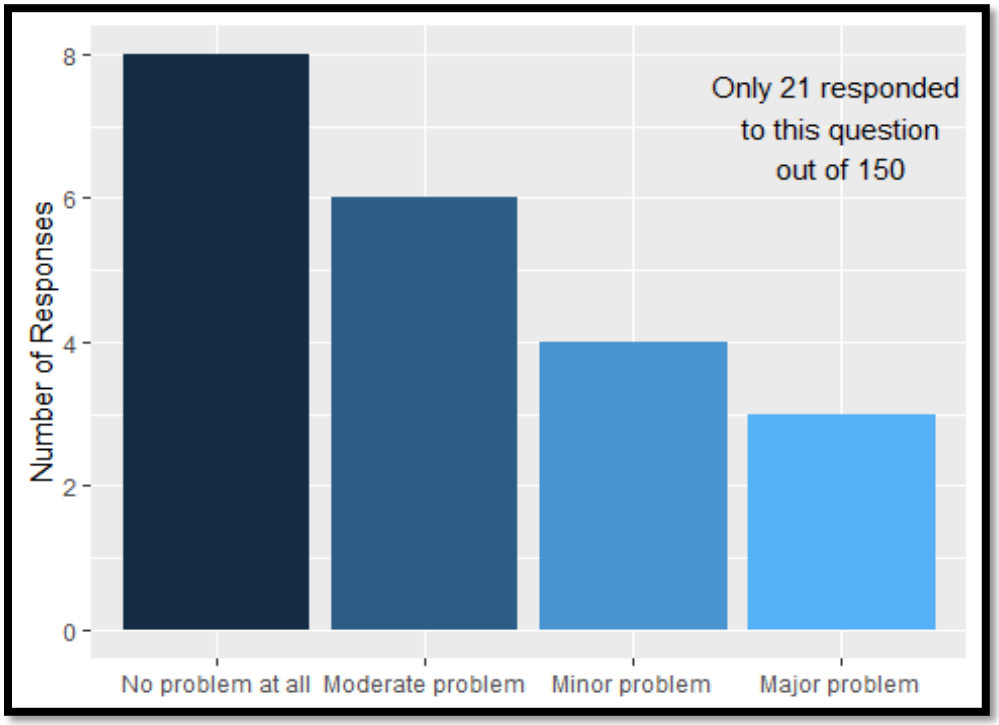

Figure 5 Response on whether People Considered Beavers as a problem

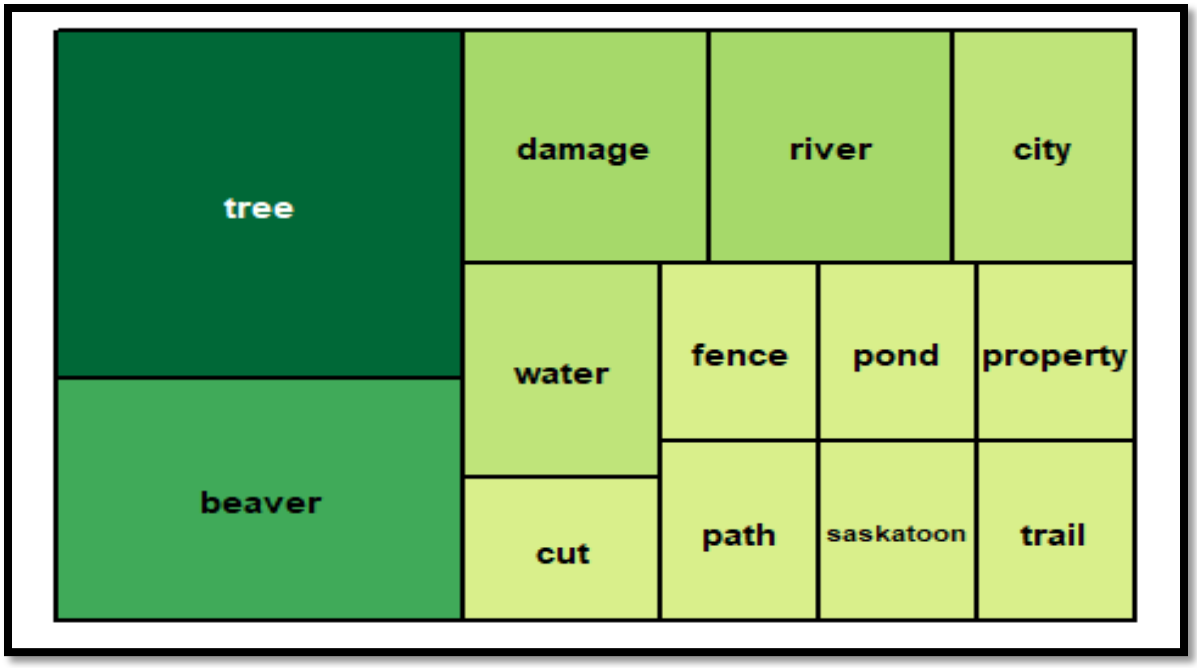

Figure 6People reactions on Destructions Caused by Beavers

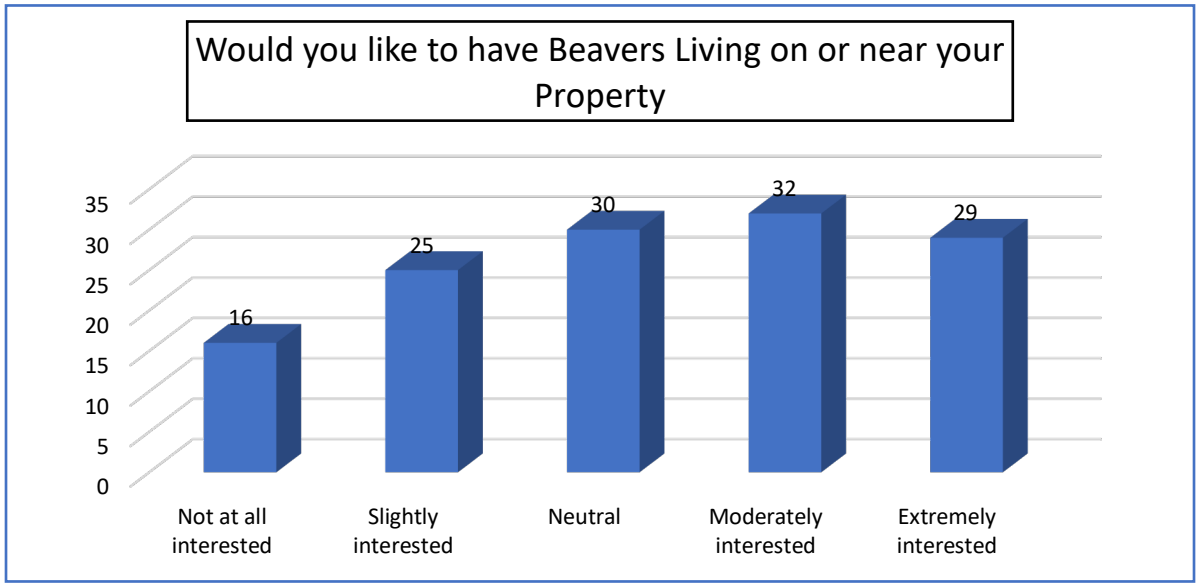

Figure 7People response on whether they would like Beavers near their Properties

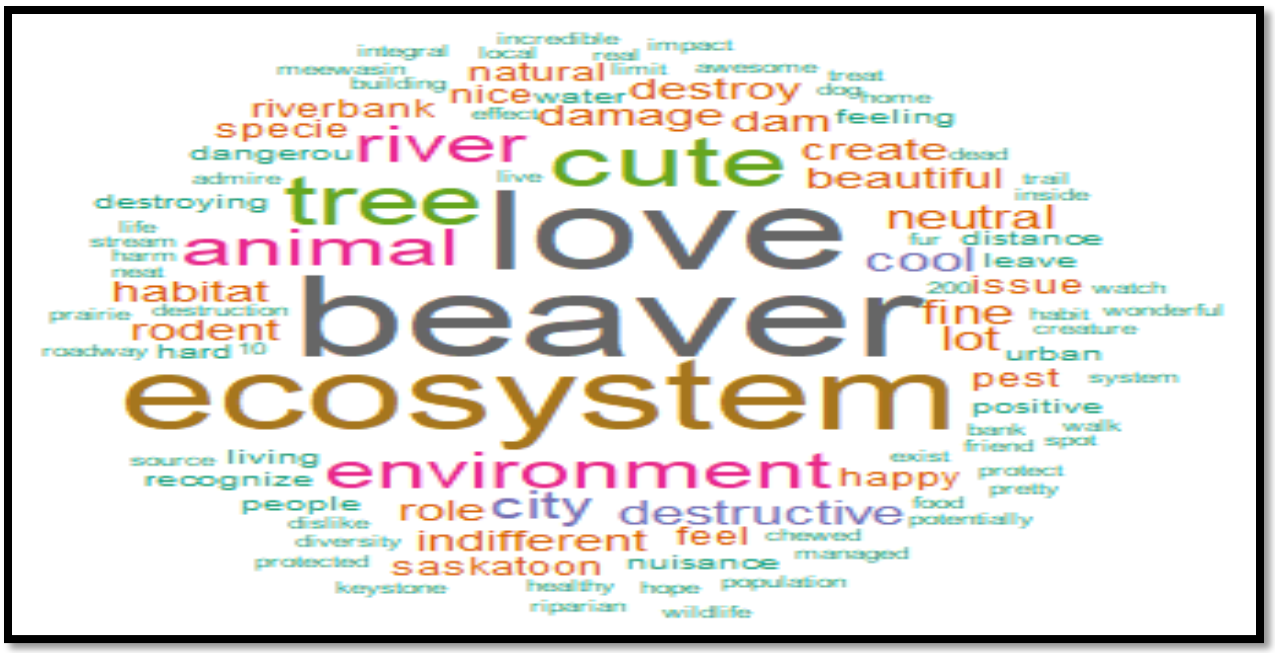

Figure 8 how people feel about Beavers in General

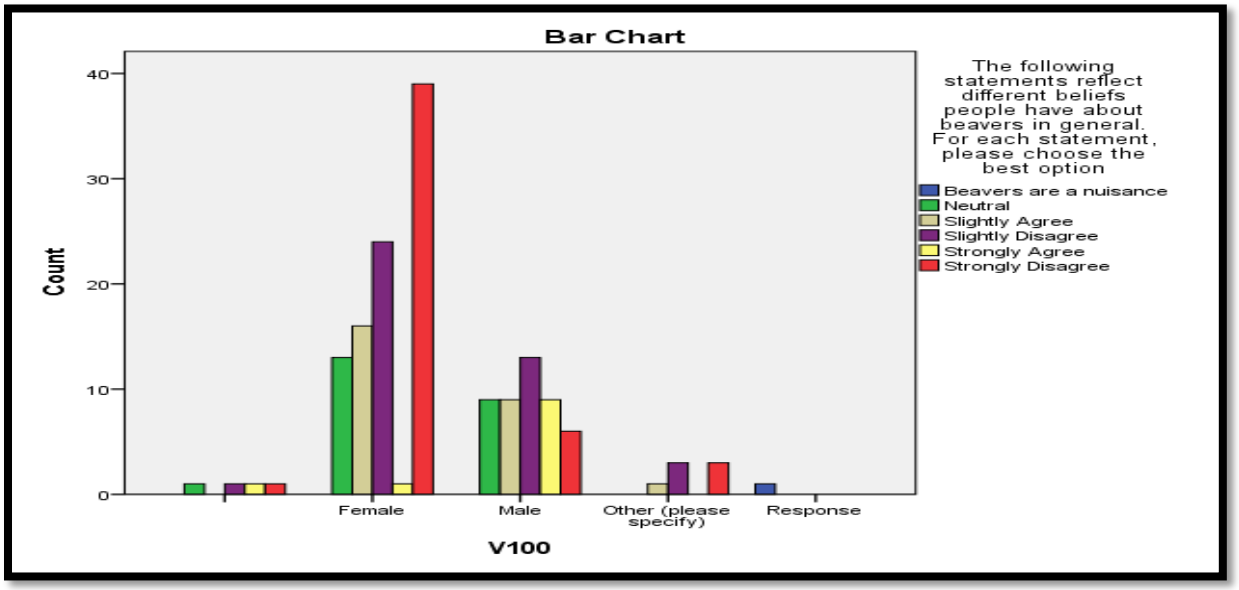

Figure 9 Response by Gender on Beavers being a nuisance.

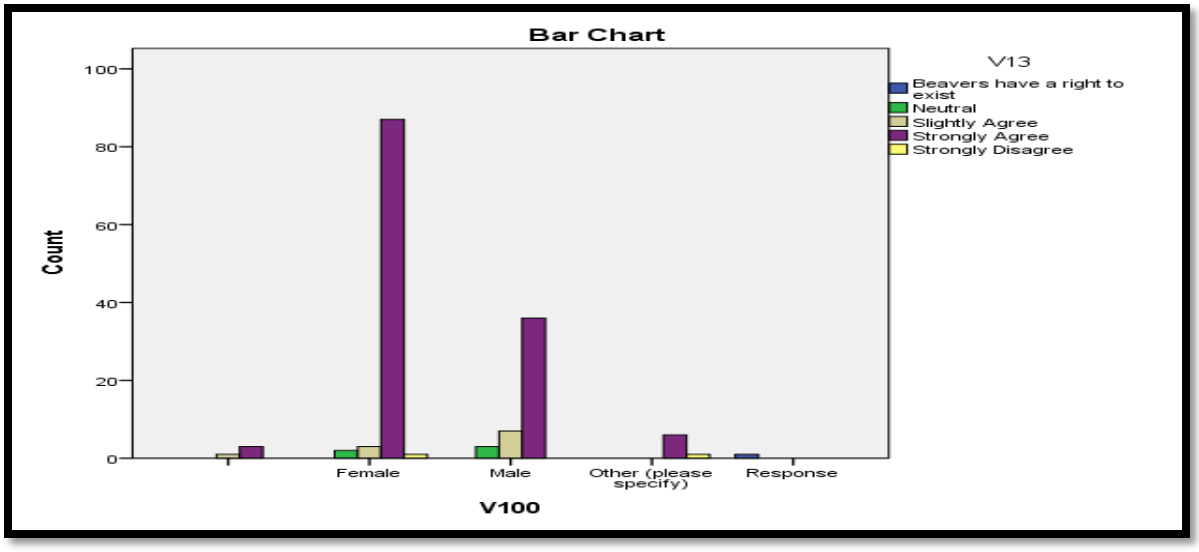

Figure 10 Response by Gender on Beavers Having rights to exist

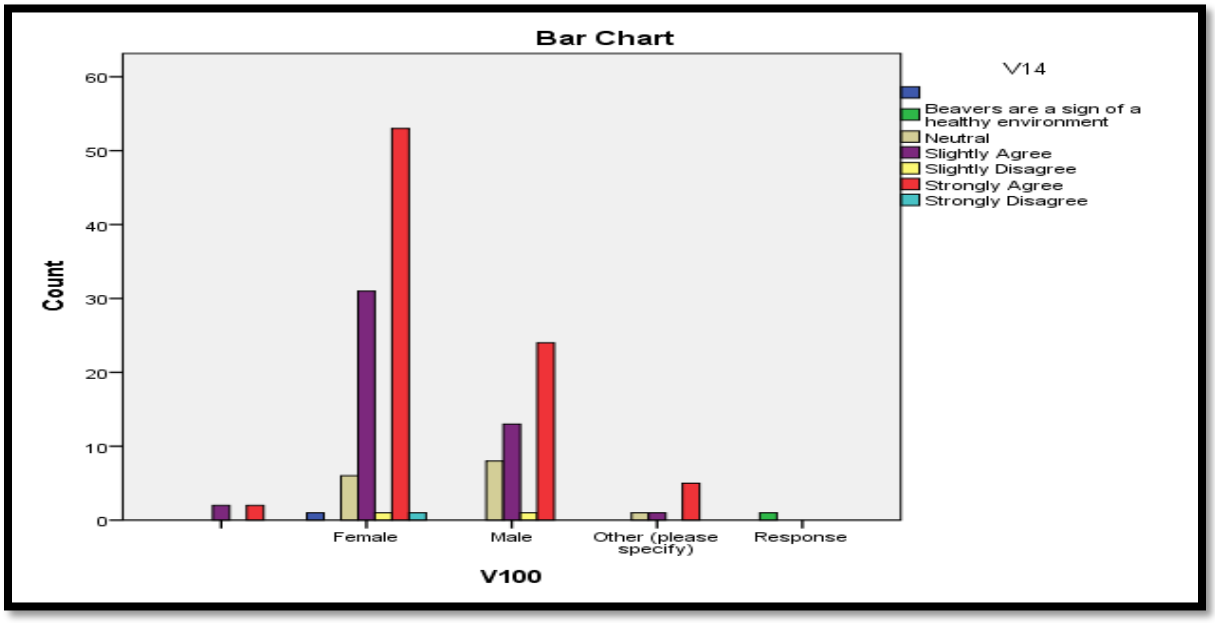

Figure 11 Response by Gender on Beavers being a sign of a healthy environment.

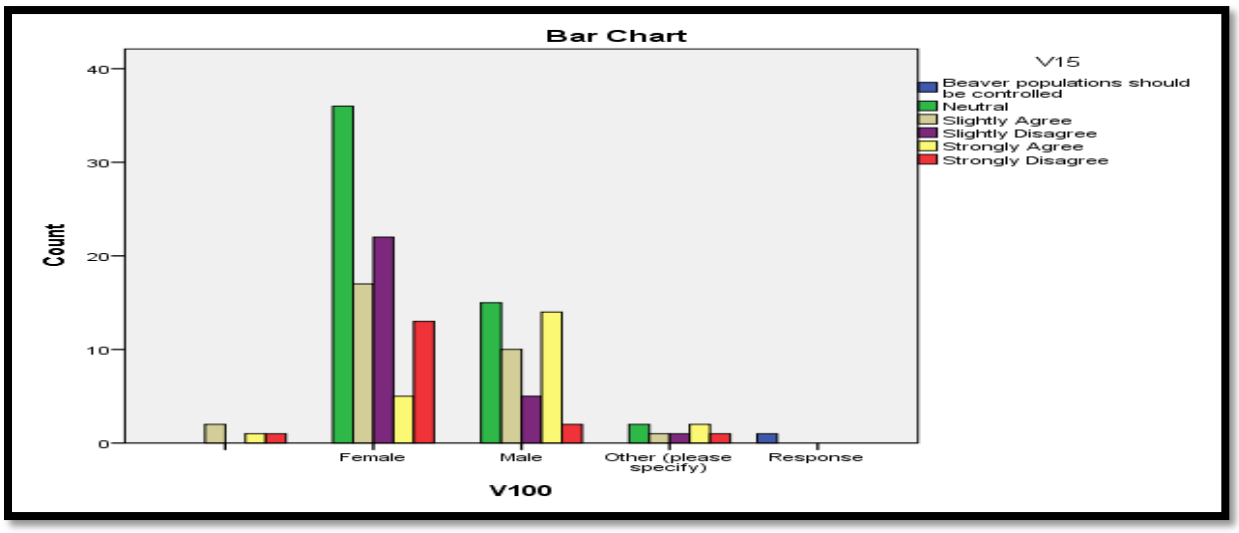

Figure 12 Response by Gender on Weather Beavers Population should be controlled.

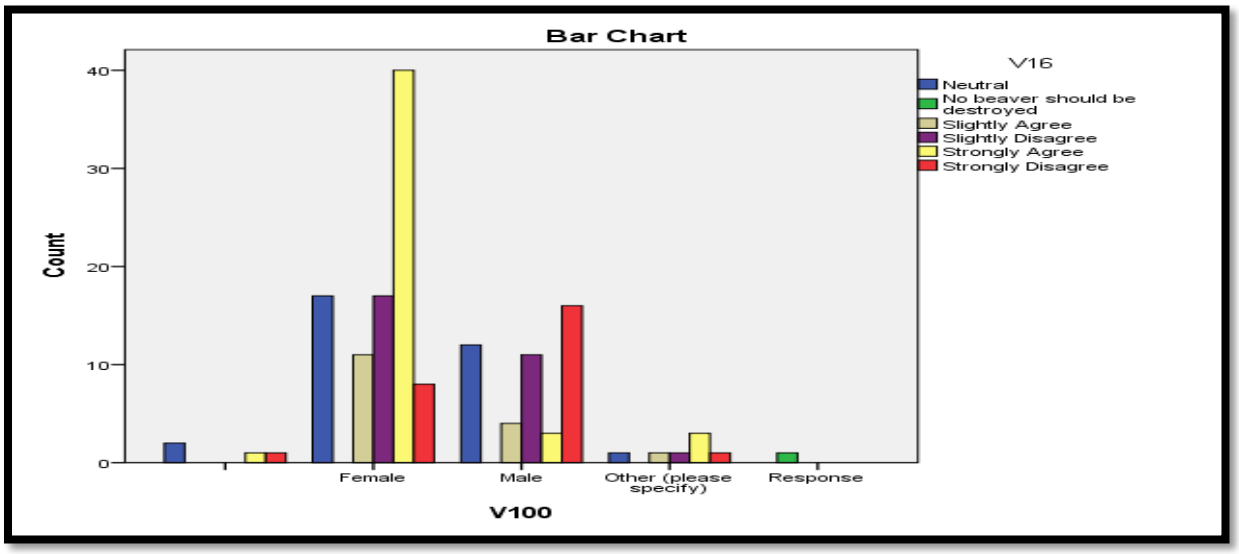

Figure 13 Response by Gender on Weather Beavers should be destroyed.

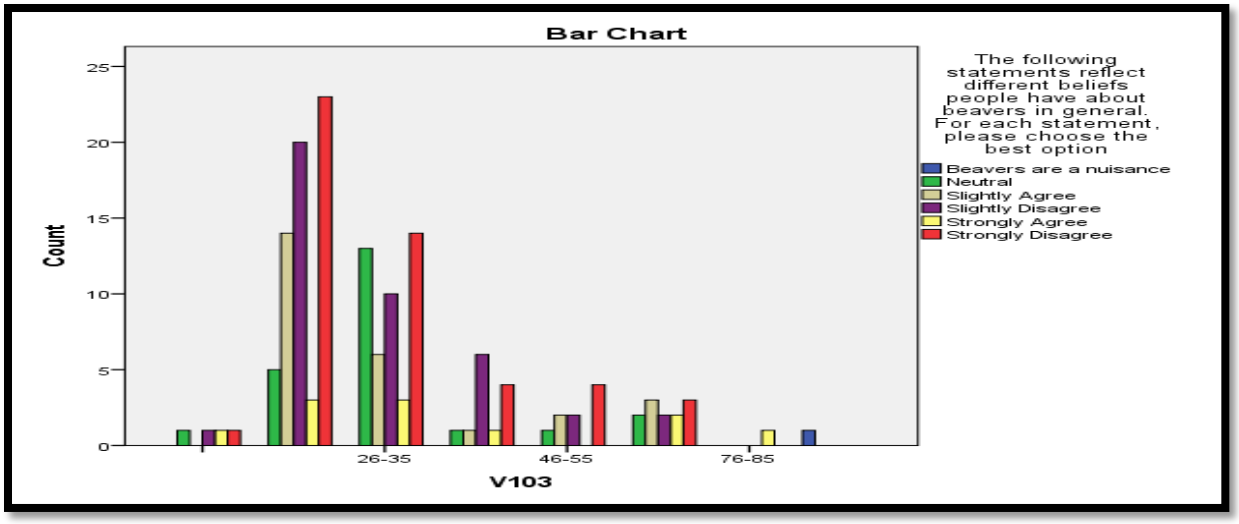

Figure 14 Response by Age Bracket on Beavers is a nuisance.

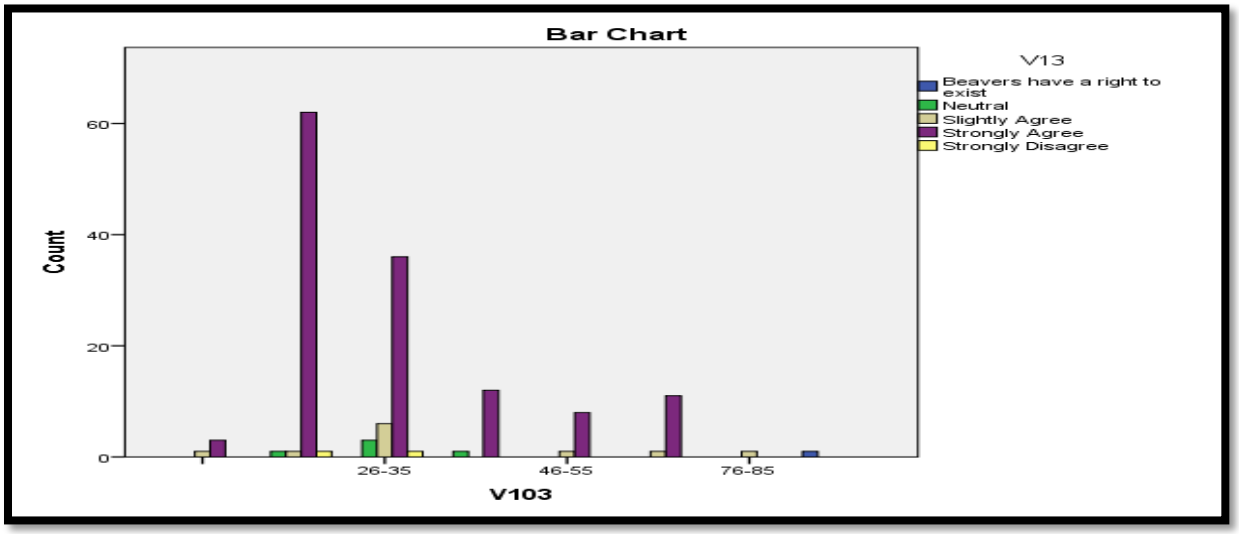

Figure 15 Response by Age Bracket on Weather Beavers has the right to live.

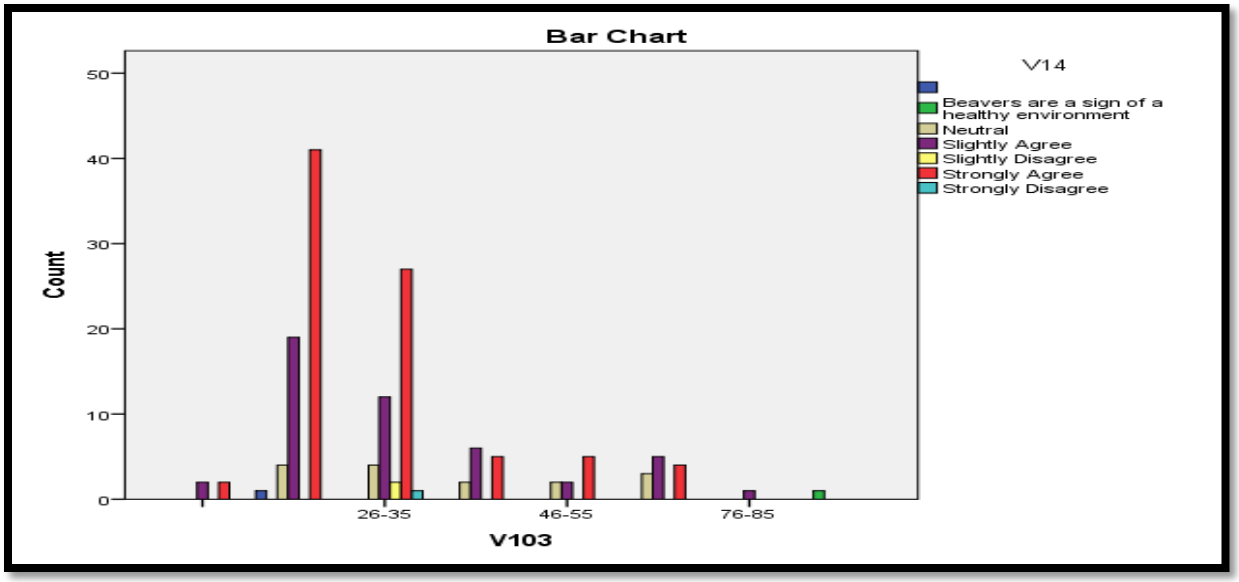

Figure 16 Response by Age Bracket on Beavers being a sign of a healthy environment.

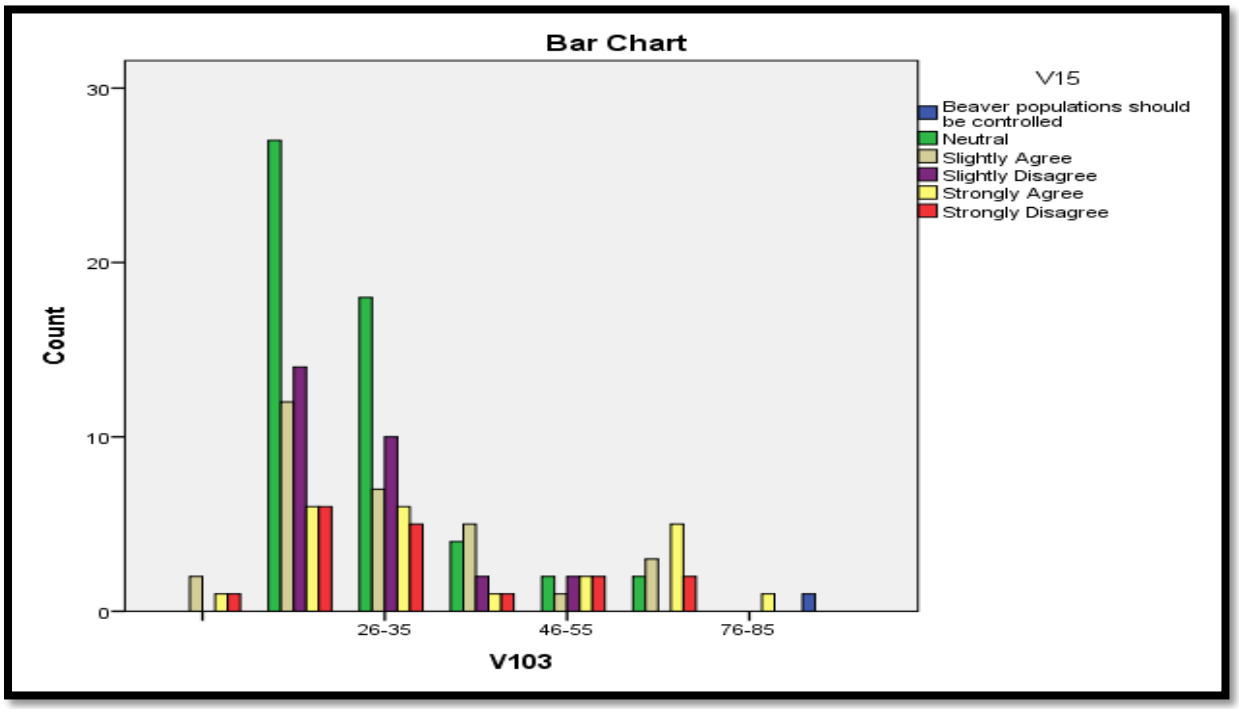

Figure 17 Response by Age Bracket on Beavers population Control

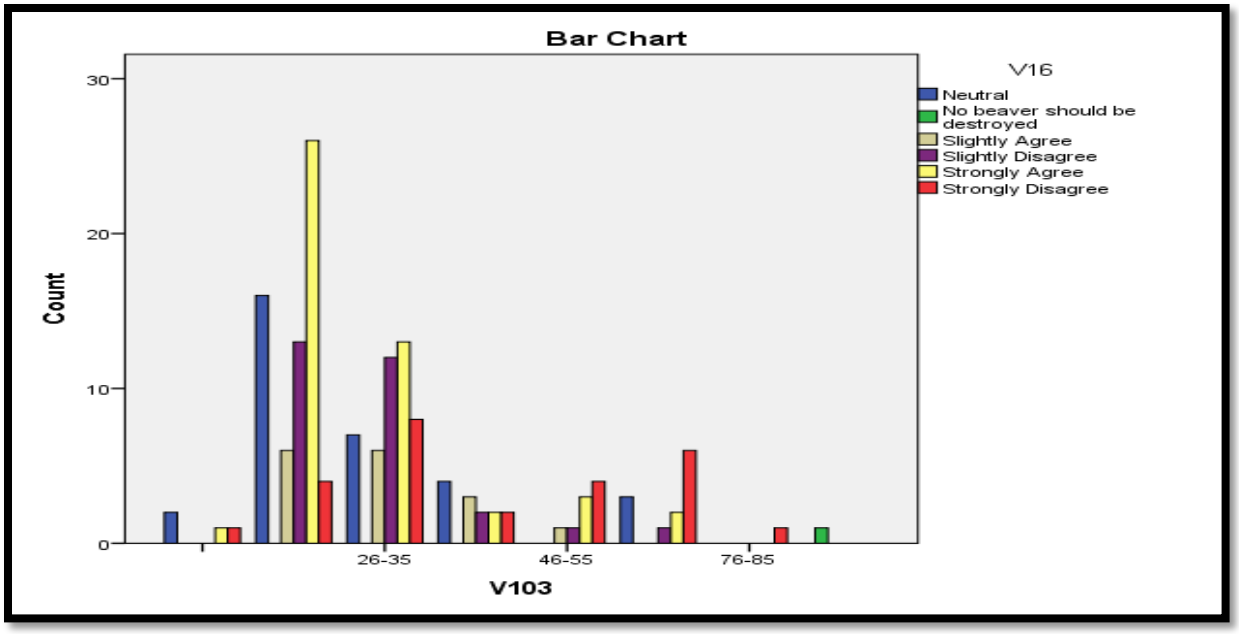

Figure 18 Response by Age Bracket on whether Beavers should be destroyed

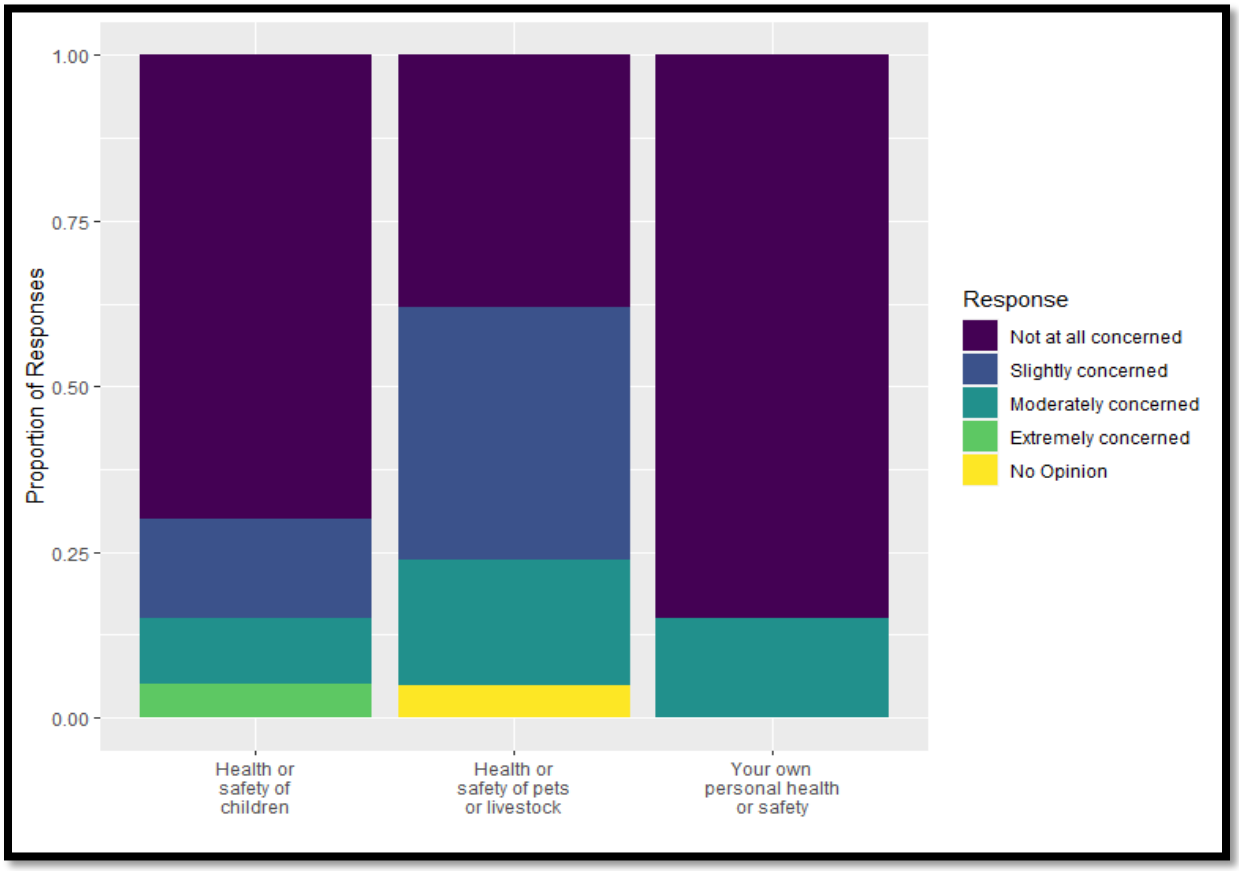

Figure 19 Concerns on Health and Safety due to presence of Beavers

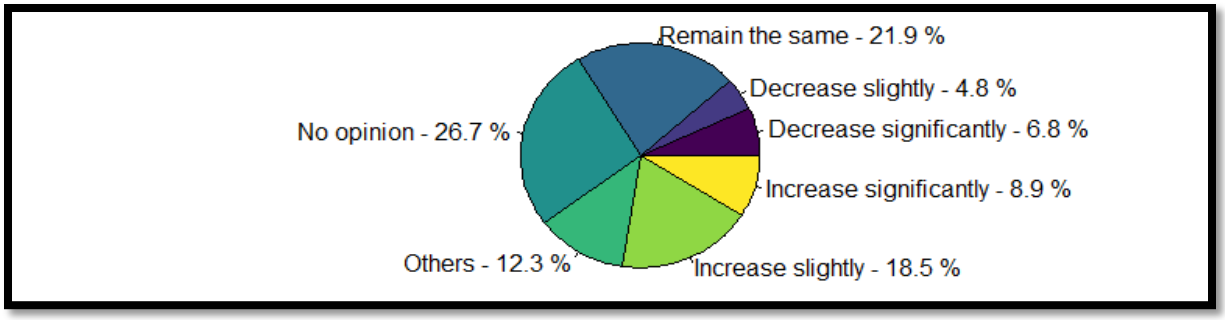

Figure 20 People Concern about Beavers Population

Figure 21 Other responses on Beavers Population

Appendix 3: Appropriate Measures of Managing Beavers

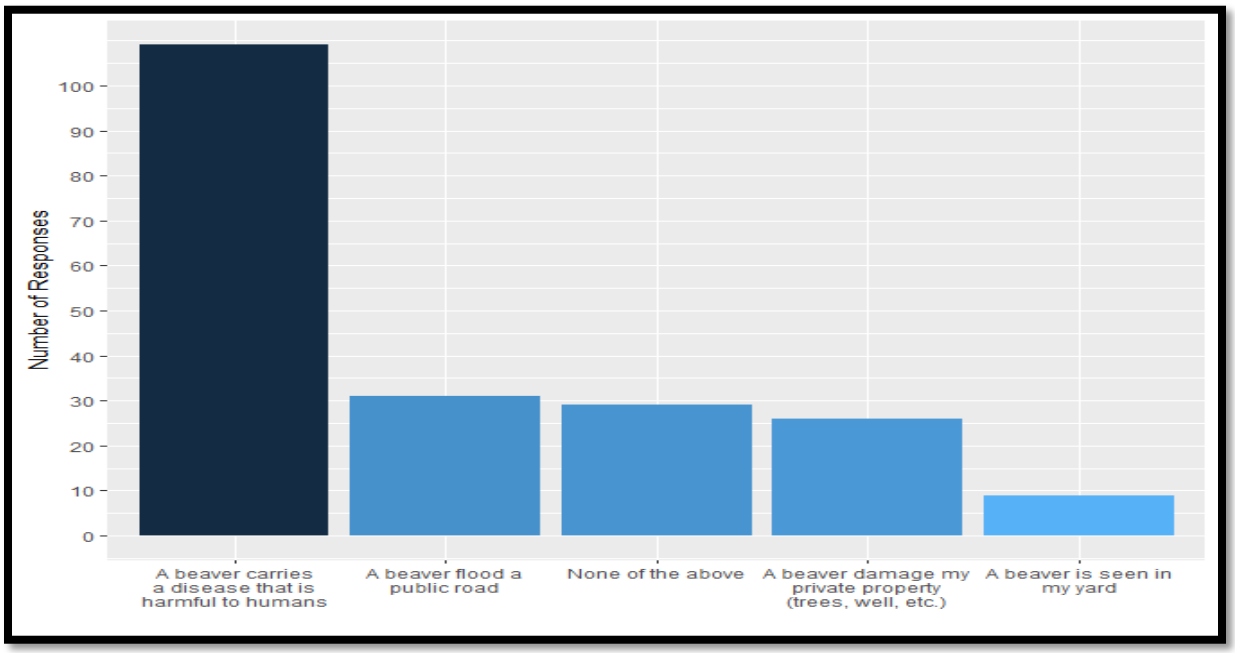

Figure 22 Response on whether Lethal Control of Beavers would be Viable

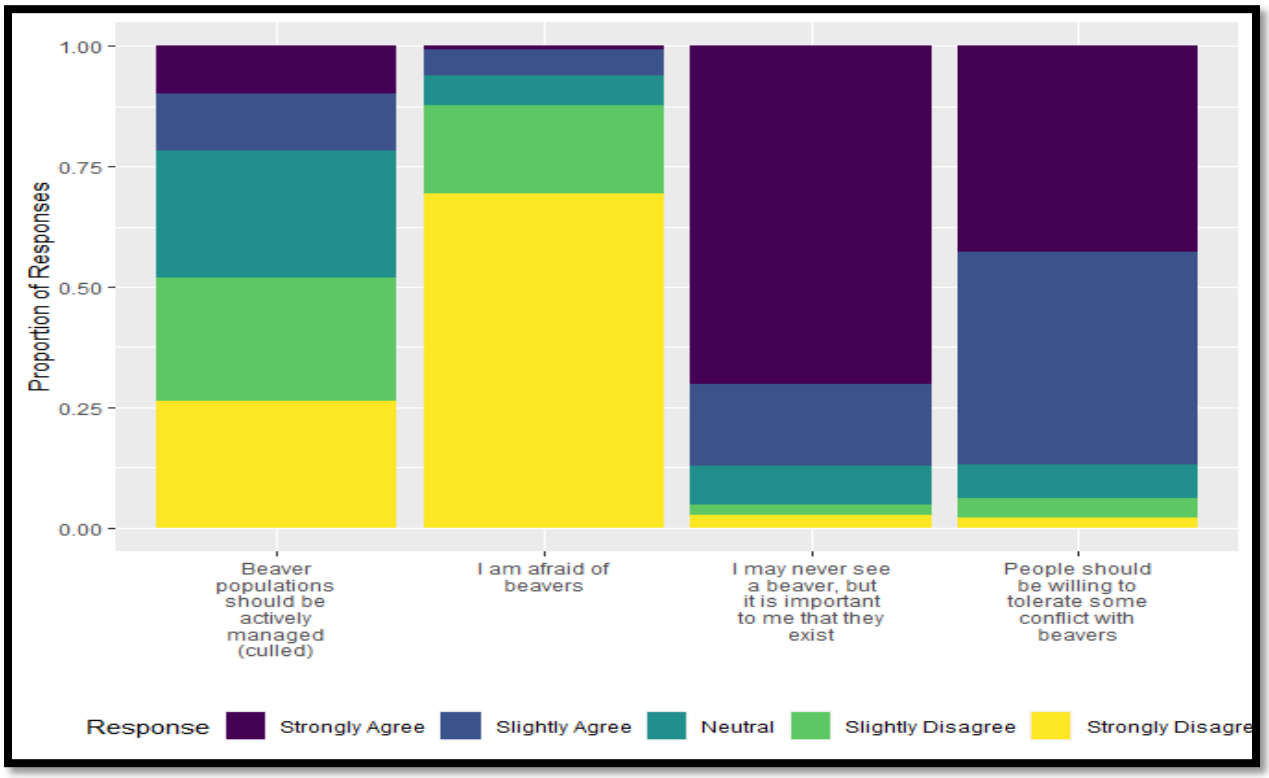

Figure 23 Response on Different Aspects of reactions towards Beavers

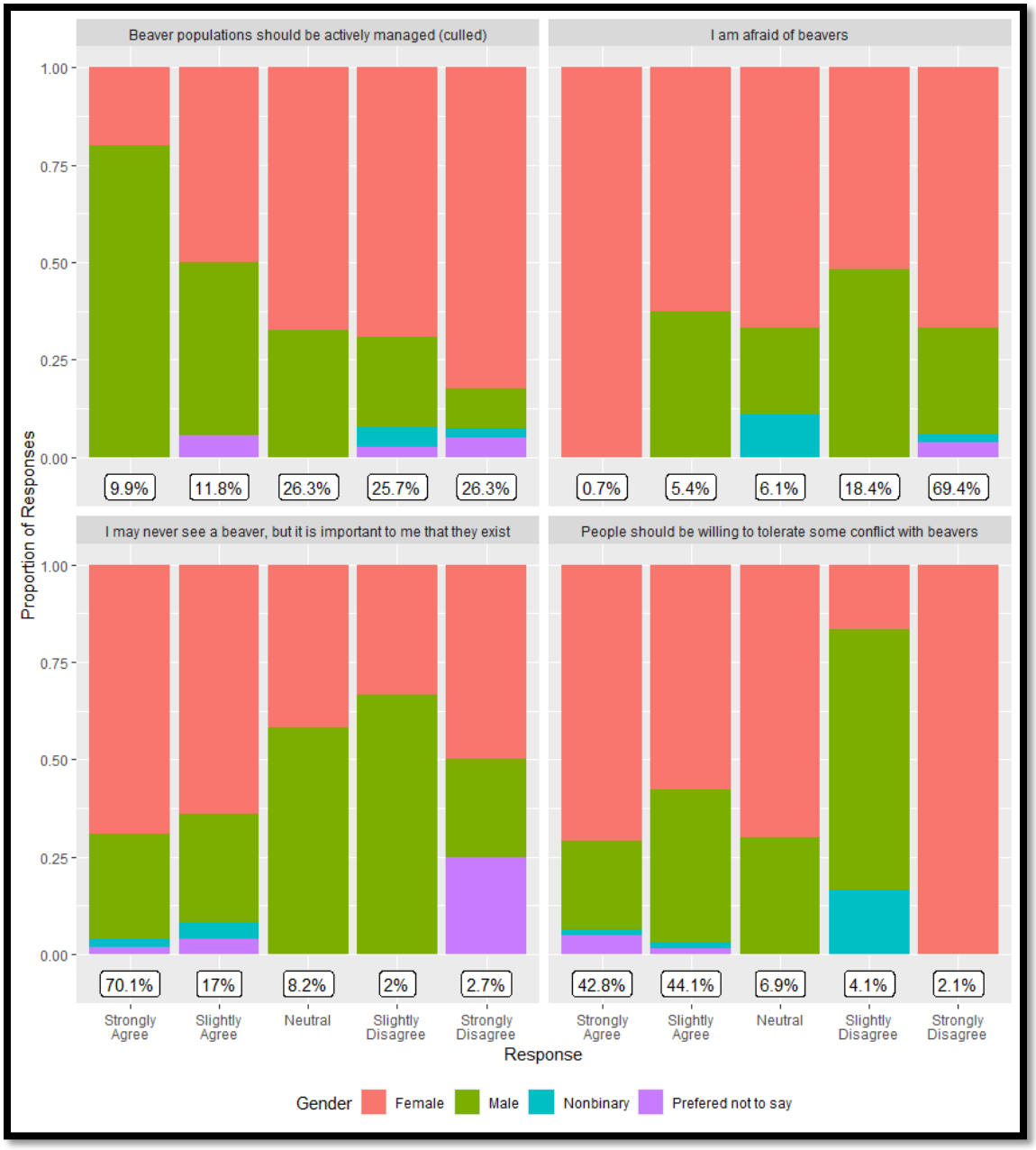

Figure 24 Gender wise Response on Different Aspects of reactions towards Beavers

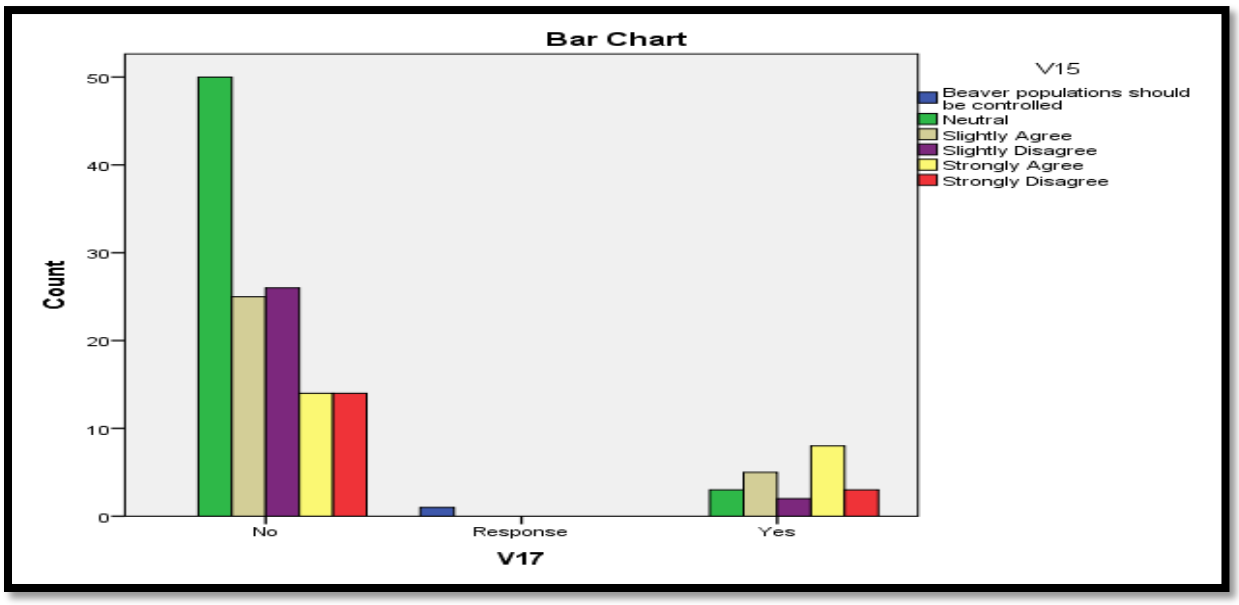

Figure 25 Cross-Tabulation Table on Respondents YES" Towards Population Control

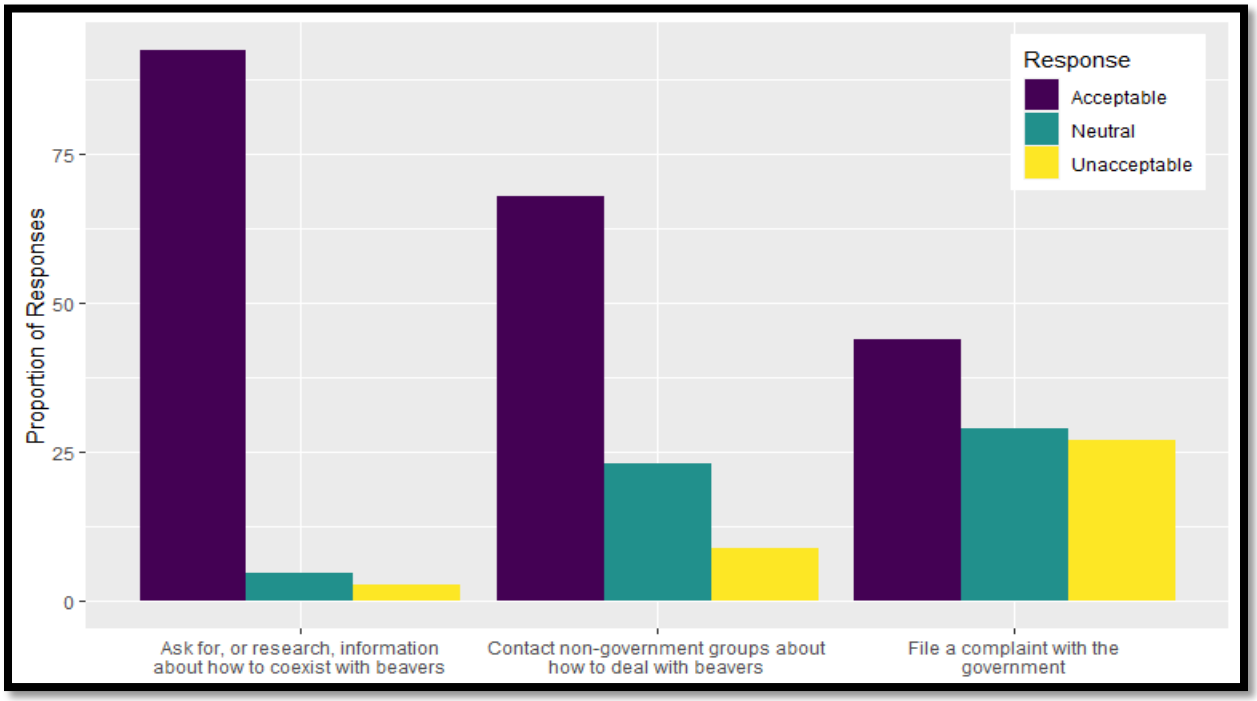

Figure 26 Response to People's Reactions to possible reactions to Beavers

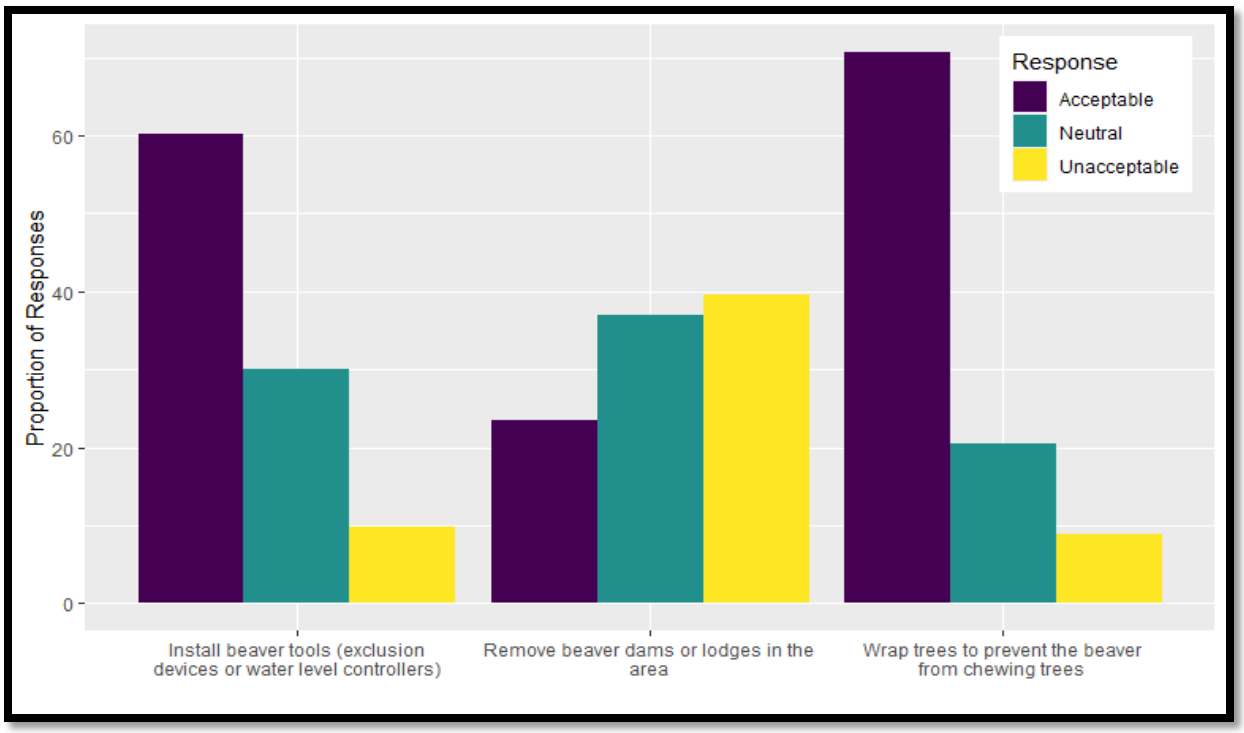

Figure 27 Response to Beavers Control Mechanisms

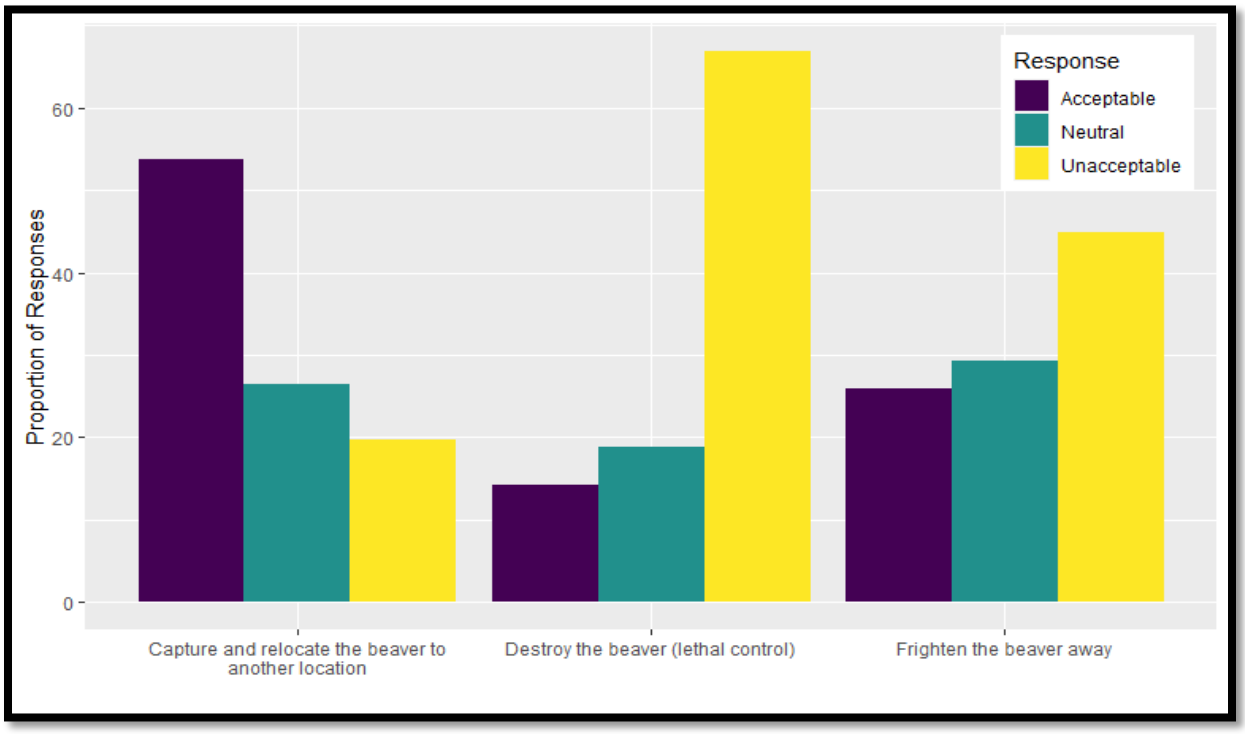

Figure 28 Response to Beavers Mitigations Mechanisms

Figure 29 Response by Gender on how to co-exist with the Beavers

Figure 30 Response by Age bracket on how to co-exist with the Beavers

Appendix 4: Regression Analysis

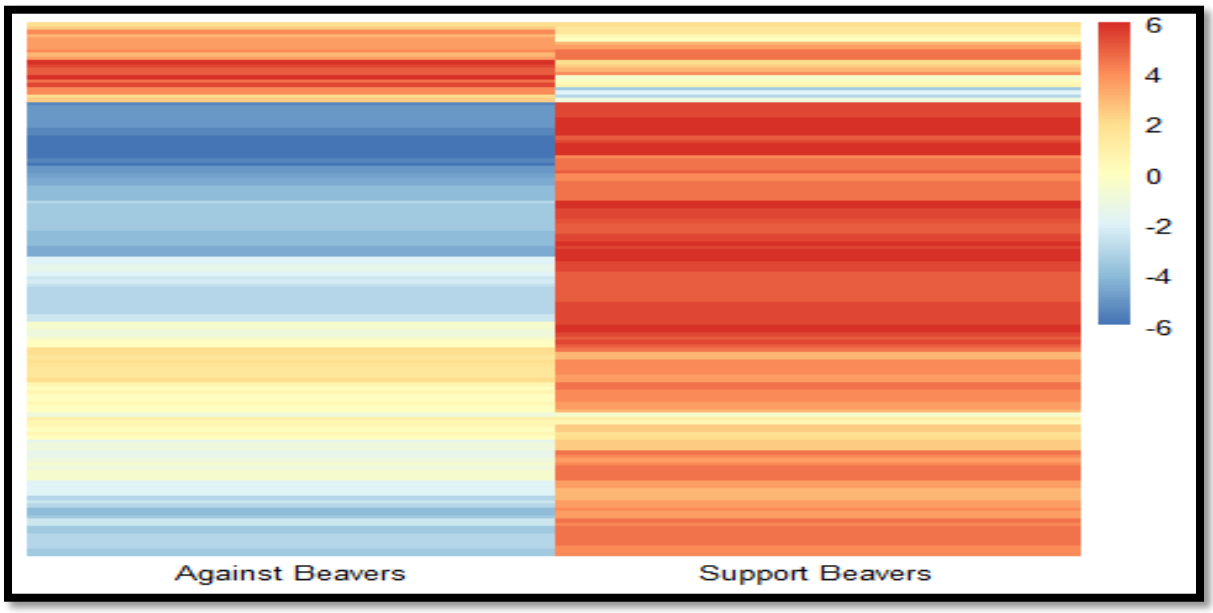

Figure 31 Correlation Matrix Pearson's Method

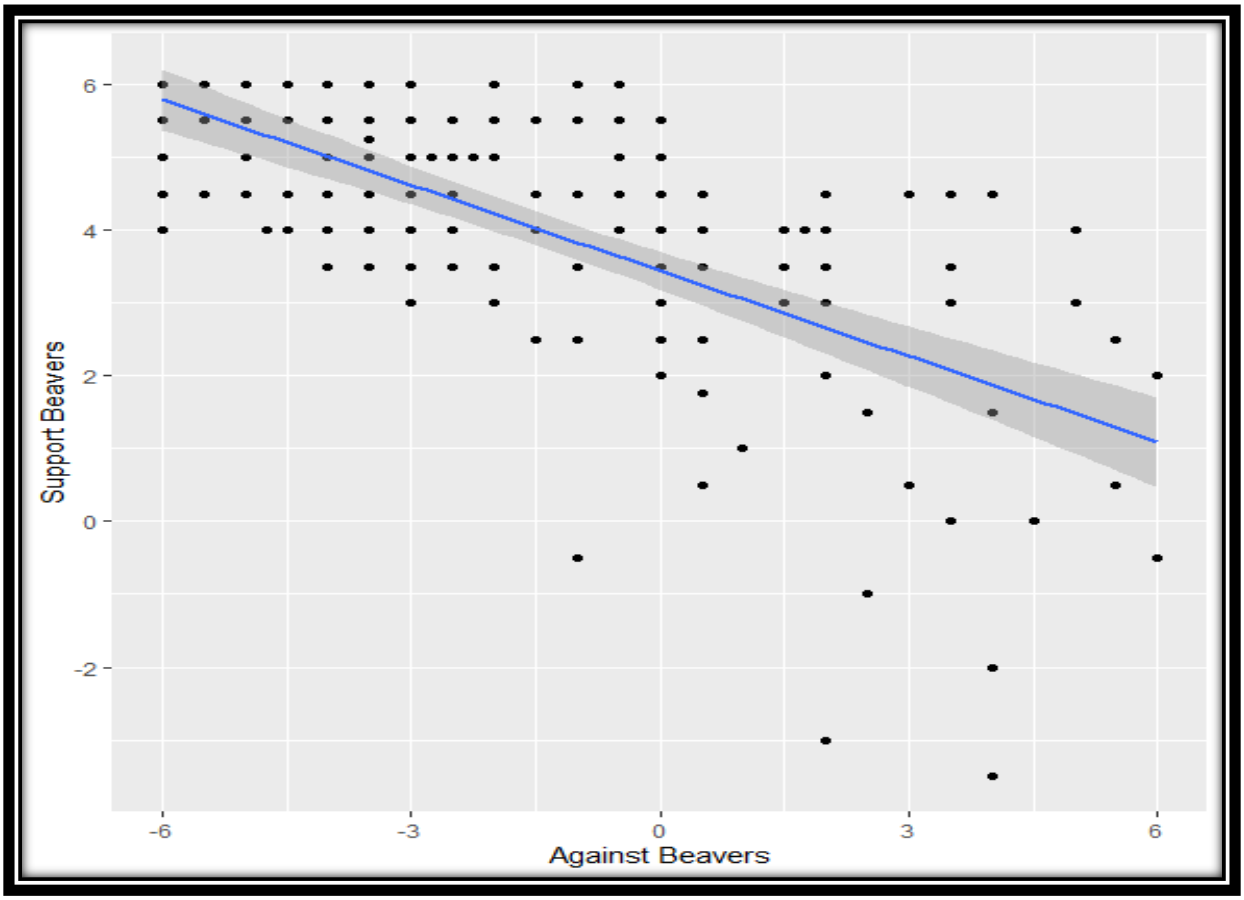

Figure 32 Scalar Plot Based on Gender

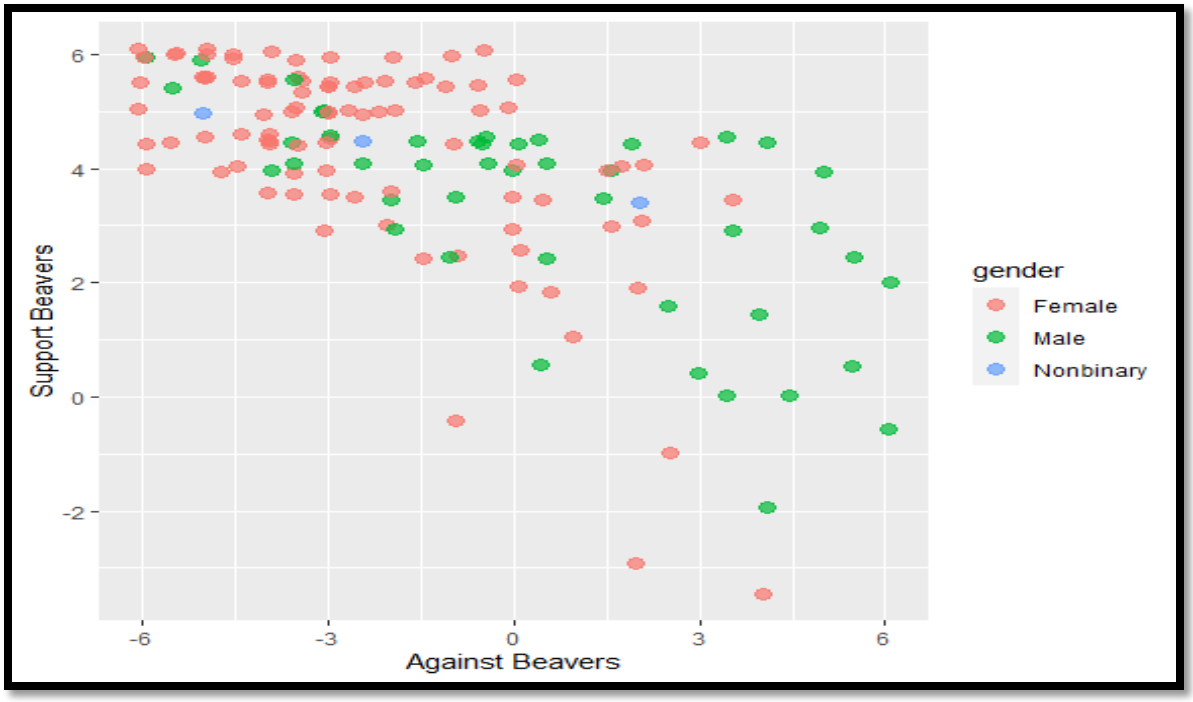

Figure 33 Scalar Plot2 Based on Gender

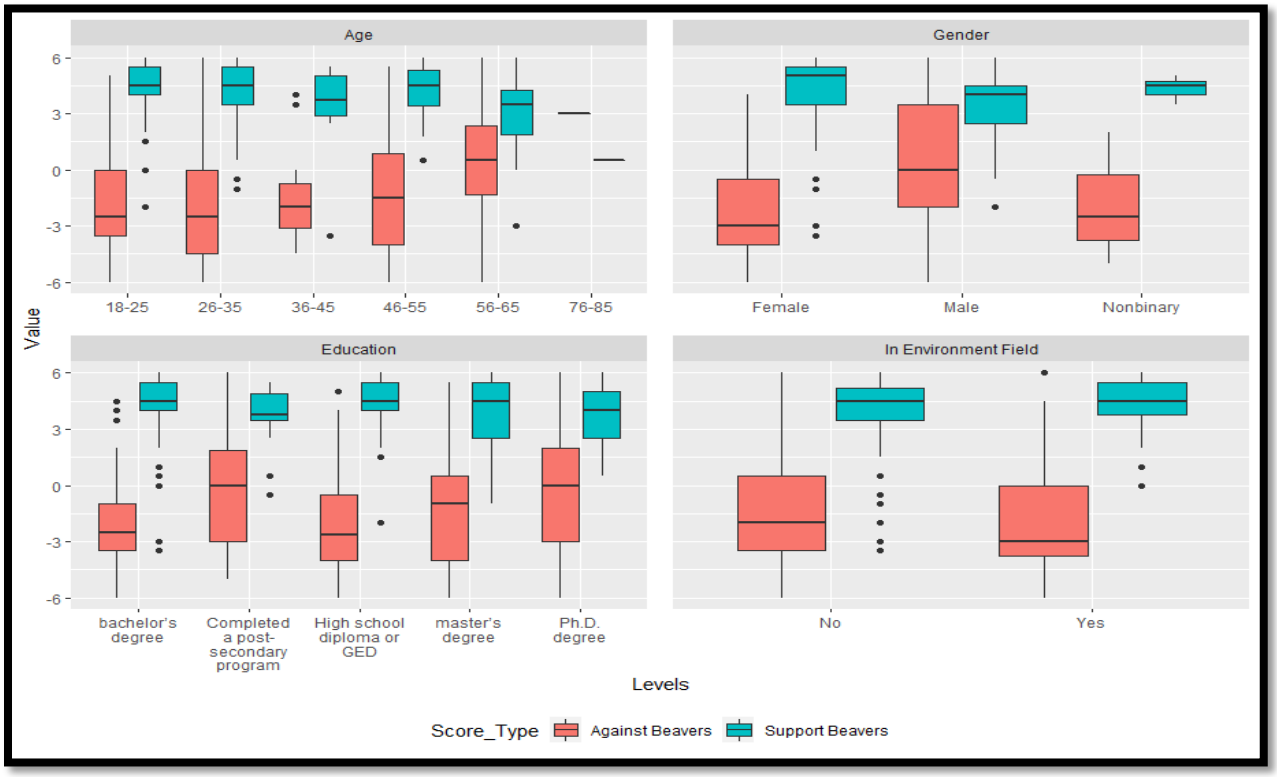

Figure 34 Box Plots

Appendix 5: Scales for Against and in Support of Beavers

Responses to the below two sets of 6 questions each are encoded numerically to generate a scale measuring the strength of Against Beavers and Support Beavers behavior of respondents:

Questions which were used to measure Against beavers behavior:
- Beavers are a nuisance
- Beaver populations should be controlled
- Beaver populations should be actively managed (culled)
- Destroy the beaver (lethal control)
- Remove beaver dams or lodges in the area
- Frighten the beaver away

Questions which were used to measure "Support beavers" behavior:
- Beavers have a right to exist
- Beavers are a sign of a healthy environment
- No beaver should be destroyed
- I may never see a beaver, but it is important to me that they exist
- People should be willing to tolerate some conflict with beavers
- Ask for, or research, information about how to coexist with beavers

Based on these, the score from each set of questions is generated:
1. Against Beavers
2. Support Beavers

Note: Where a respondent had chosen multiple responses for a specific question, the average score for that question was calculated and then added with scores of all other questions to create the resulting total score.

As expected, there is a significant correlation between these scores:

The exact correlation between the scores using Pearson's method:

```
## [1] -0.6515668
```

A scatter plot of both the scores also suggests a negative correlation (blue line is the line of regression): ## `geom_smooth()` using the formula 'y ~ x.'

Highlighting each point on scatterplot based on gender:

The higher concentration of points having type "Female" can be seen near the top-left corner, and a greater number of points of type "Male" can be seen in the bottom-right corner.

Average “Against Beaver” and “Support Beaver” scores in each type of category:

Visualizing the same data using boxplots (the solid line between the rectangles are medians, not means)