The Socio-Economic Impacts of Propane Cannons on Residents in the Fraser Valley

A Survey on the Willingness-To-Pay to Curb Negative Externalities Resulting from Deterring Avian Predation of Blueberries

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Executive Summary

A study was commissioned in the summer of 2009 to survey residents living near to blueberry fields about their opinions and experiences with propane cannons noise in the Fraser Valley. A total of 135 residents were interviewed and completed the survey between late July and late September in Abbotsford, Chilliwack and the Hatzic/Nicomen areas of Mission.

A common economic valuation technique for valuing non-market goods, contingent valuation (CV), was used to assess the damages caused by propane cannon noise on nearby neighbours. CV techniques express all values in dollars – a comparable metric across people. By using these techniques, this survey revealed that the average willingness-to-pay (WTP) for halting propane cannon noise is $70.38 per household annually, though this distribution is quite skewed (as almost half the households have a $0 value for eliminating propane cannon noise). By aggregating this number by the total number of households that live within 900 meters of a blueberry field, we can say there is an annual societal WTP for halting propane cannon noise of $577,607.

Using various models and other statistical techniques, it was determined that WTP is not affected by gender or whether the respondent knows someone in the berry industry, but is affected by where they live (with Abbotsford residents having significantly higher WTP amounts than residents in other areas). Regression models further show that WTP is affected by how many years a respondent has lived at the address (with higher WTP the longer the time) and by employment status (with higher WTP by those working full-time for income).

This survey also asked many opinion questions about how people compare propane cannon noise to other common noises they experience (such as air traffic and barking dogs) and also asked for comments on a (hypothetical) policy to ban propane cannons in the FVRD. These questions revealed a wide diversity of opinions on the propane cannon issue with approximately one-third of respondents being in favour of a ban on propane cannons and approximately half being opposed to a ban on propane cannons with the remaining respondents either neutral or ambivalent. Of those in favour of a ban, some respondents felt very strongly and expressed considerable anger toward farmers who use propane cannons. Of those who oppose a ban, some respondent felt very strongly and expressed considerable anger toward those who favour a ban. About 40% of the respondents said that they are bothered by the cannons in general.

Clearly, a policy change with regards to propane cannon use will not be uniformly popular or approved. It is hoped this survey will inform the policy process by providing scientifically-collected and analysed data, as opposed to policymakers having to rely on anecdote. Further research into the costs to farmers associated with changing propane cannons regulations would need to be done before a cost-benefit analysis of the propane cannon issue could be conducted. This survey shows only one side of the equation: that measurable value would accrue to nearby residents if propane cannon noise was eliminated.

Introduction

British Columbia's Fraser Valley is home to some of the most fertile land in Canada and is especially well-adapted to growing several types of berries due to the nature of the soil. Raspberries, cranberries, and blueberries have long been grown in the valley but the blueberry industry has seen impressive growth over the last few decades and is currently the second-largest blueberry-growing area in the world. This growth has not come without costs however.

As more and more agricultural land in the Fraser Valley is converted to other uses, including suburban residential development, more non-farmers are in close proximity to commercial agricultural operations. Negative externalities (or spill-overs) are rife between farms and urban development, flowing in both directions. Residential development fragments farmland, increasing farmers' costs as their fields are often not adjacent anymore. They also have to put up with vandalism, complaints and other nuisance issues from their non-farming neighbours. Residential households meanwhile face slow-moving farm traffic on roads as well as the sights, sounds and smells that accompany large agricultural operations.

Blueberry farm externalities

Negative externalities are present in the blueberry industry on both sides. In particular, nearby residents complain about the use of pesticides and fungicides (which are often delivered by spraying) and about the noise from audible deterrents used by blueberry farmers to protect their crop from avian (especially starling) predation. One negative externality which is particularly wide-spread and has attracted a lot of attention is the noise from propane cannons used to frighten starlings away from blueberry bushes.

Propane cannon noise issues regularly appear in local newspapers in the Fraser Valley and occasionally hit the major media outcomes as well. Citizen groups such as *Ban the Cannons* have formed to advocate for new regulations prohibiting noisy bird deterrents. The BC Blueberry Council (representing more than 650 blueberry farmers) employs a liaison who works full-time in the summer trying to minimize the impacts of cannons on neighbours by encouraging the farmer to alter his or her hours of use or intensity of cannons or to change the positioning of their canons. Despite these actions, canon controversies continue. In 2008, 146 complaints lodged. In some cases, vandalism of cannons has occurred and heated arguments have soured relationships between some neighbours. One facet of this issue is that it is not just a suburban-farmer divide – in some cases, the most vocal opponents of cannons are those living in rural areas (and who are sometimes farmers themselves).

Though this issue is undoubtedly controversial and ignites passionate rhetoric on both sides, the question remains as to how widespread the feelings about canons are among nearby residents. Is it that a small minority of neighbours are complaining about a mountain, whereas the majority see a molehill? Or do most neighbours of cannon-using blueberry farms feel fairly-intense annoyance and concerns about their health? Besides being aware of

the distribution of feelings and opinions, understanding which factors are associated with the strongest feelings can help government respond to this issue more effectively.

Background to this study and objectives

This study is part of a series of studies commissioned jointly by the BC Ministry of Agriculture and Lands (MAL) and the Fraser Valley Regional District (FVRD). During the summer of 2008, Trinity Western University biology professor Karen Steensma conducted a pilot study involving experiments with various auditory bird deterrent devices to determine which deterrents are most effective with starlings. To address the societal impacts, Dr. Tracy Stobbe of the TWU School of Business was commissioned with conducting a literature review of socio-economic effects of agricultural noise during the fall of 2008. This review, published elsewhere, found that though noise can have detrimental impacts on human health and on property values depending on the intensity and duration of the noise, there are large disparities in sensitivity to noise among people. It is estimated that only 20% of the variation in impact levels from noise is due to variations in the absolute magnitude of the noise (measured in decibels) and the other 80% is due to variations in individuals' sensitivity levels. This finding, among others, helped inform the current project.

In the spring of 2009, this survey was commissioned to seek to provide a picture of the distribution of feeling toward canon noise and also to estimate a societal cost associated with cannons. As stated above, one possibility is that most people are not bothered by cannons or want their use curtailed or halted, with only a small minority of people feeling strongly about them. Another possibility is that anti-cannon sentiment is prevalent throughout the Fraser Valley. The current survey was developed in May of 2009, tested and refined during June of 2009 and was administered during July, August and September of 2009 in all productive blueberry-growing areas of the Fraser Valley.

Methodology

A survey methodology was selected to furnish primary data concerning the distribution and magnitude of opinions and experiences with propane cannons. As part of this primary data collection phase, the survey was scrutinized by the Trinity Western University Research Ethics Board to ensure the instrument complied with federal standards of research ethics in Canadian universities.

Because it is infeasible to survey the whole population of interest (all households living nearby blueberry fields), a random sample of households was chosen. Random sampling has the useful property of being able to infer the results of the sample back to the broader population in ways that non-random sampling does not. (For instance, using a "convenience sample" of people passing by on a sidewalk or in a shopping mall would not allow us to assume we have a representative sample of opinions, since people who use sidewalks or shop in malls may be systematically different from other groups.) By randomly sampling a few hundred households, we can create confidence intervals and other statistical tools which apply to the population of several hundred thousand.

> "The idea that the examination of a relatively small number of randomly selected individuals can furnish dependable information about the characteristics of a vast unseen universe is an idea so powerful that only familiarity makes it cease to be exciting."
>
> *Helen Mary Walker (1891 - 1983)*

Selection of farms and households in the sample

Using computer GIS (geographic information systems) programs, a random sample of households meeting certain criteria were selected to take part in this study in a multi-stage process. The first stage involved updating existing maps provided by the Blueberry Council of which particular farms were known to use auditory deterrents. Since comprehensive current data is not available as to which farms are using cannons, this updating was accomplished by tapping the anecdotal and experiential knowledge of Nazum Dulat (Blueberry Council liaison) and Mark Sweeney (MAL). Next, a collection of these farms were selected in four different geographic areas (Abbotsford, Chilliwack, Nicomen and Hatzic) to roughly correspond to the proportion of the population in each area. (A total of 15 farms were selected in Abbotsford, 3 in Chilliwack, 2 in Hatzic and 2 in Nicomen.) Effort was made to ensure that farms near to suburban areas were selected as well as those in completely rural areas, and to ensure a fairly uniform spatial coverage over the FVRD.

After selecting the blueberry farms, households around those farms were randomly selected. The number of households selected per farm varied between 4 and 24 households and depended on the population density in that area – more households were selected for farms near suburban development (with relatively higher population density) and fewer households were selected for farms in rural areas (with relatively lower population density).

Households were selected with ArcGIS and Excel and either fell within 300m, 300m to 600m, or 600m to 900m of a blueberry farm.[1]

Surveying procedures

In order to achieve consistency in the data, all surveyors were trained and followed the same procedures for administering the survey. After introducing themselves, the surveyors briefly stated the purpose of the survey and invited participation. If the respondent agreed to take the survey but could not at that moment, a follow-up visit was arranged. If no one was home at a household selected in the sample, a second visit was made on a different night. After two visits with no one home, a sheet was left which explained the project and requested the household contact Tracy Stobbe either by phone or email to arrange a convenient time to do the survey. If the household refused to do the survey, the surveyor thanked them for their time and left immediately.[2] Occasionally a surveyor was unable to survey a house due to the presence of aggressive dogs on the property or due to a locked gate to the property. In these cases, a sheet was mailed to the address which explained the project and requested the household contact the research team.

There was significant variation in how long it took to administer a survey depending on how long respondents thought for and how "chatty" they were. Generally surveys were completed in 10 to 15 minutes but took up to 45 minutes in some rare cases when the respondent was interested in "visiting". Surveyors were instructed to maintain a neutral tone of voice and to not offer personal opinions about cannons or agricultural issues so as not to influence the respondent.

Bias issues

In order to maintain the random sample, it was important to not survey households that were not randomly chosen. For instance, sometimes an alert neighbour would inquire why we were visiting a home when no one from that home answered the door, and would then volunteer to take the survey. These volunteers were (politely) denied. Had they been

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[1] These distances were chosen somewhat arbitrarily. Ideally, noise measurements would have determined how far the sampling area should have extended around each farm. Because noise travels differently over different topographies and different types of vegetation and land use, propane cannon noise may extend much farther than this in some areas and may not be heard well by residents within those circles in other areas. However, taking propane cannon noise readings at various distances around each farm was not logistically feasible for this project. To help address this problem, a question on the survey, "Do you hear propane cannon noise at your residence?" was asked. In the results section, we will examine if the results are sensitive to whether people hear cannons or not for their stated willingness-to-pay or other opinions.

[2] Oftentimes people refusing to take part in the survey would offer spontaneous comments or reasons for not wanting to take part. Surveyors recorded these comments. In many cases, it is possible to get a sense of their opinions from their comments and these opinions help to predict the direction of the bias that may occur from non-response. See the results section for more details.

surveyed, a particular type of bias known as *selection bias* would have entered the data. Selection bias occurs when the likelihood of being included in a sample is not the same for every element in the population. In this case, households who are home more often, more cognizant of their neighbour's activities, more willing to take surveys, or who are interested in the propane cannon issue would be more likely to be surveyed than other households. Though some of these qualities are likely harmless, the last quality would inject potentially distorting selection bias into the survey data.

A related issue is the bias that can result from some people ignoring our request to take the survey. If a "not home" sheet was left at a household and the household did not choose to make contact with the research team, this injects what is known as *non-response bias* into the data. Non-response bias is endemic to all forms of surveying and primary data gathering and is particularly problematic with mail-out surveys. (It is not uncommon for a mail-out survey to have a 10 percent response rate or even less.) For this reason, an interview-style survey was chosen, which tends to have the highest response rate. (The results section will discuss the theorized direction of the non-response bias in this survey.)

Survey instruments

The survey was designed with multiple objectives (and data analysis methods) in mind. In order to be able to create statistical models from the resulting data, obtaining quantitative data was essential. (See the section below on CV methodology for more on the quantitative data.) The survey also asked a variety of questions using ordinal (opinion) scales and asked respondents for general comments on their experience with cannons. Though not as useful in the statistical modeling stage, these data help paint a picture of feelings across the study area. (See a list of comments offered in Appendix B, grouped into broad categories of opinion.) Finally, respondents were asked a number of demographic questions which can provide information about factors that affect feelings toward cannons. (See a copy of the survey used in Appendix C.)

After completing the survey, participants were debriefed by leaving an information sheet with them that gave additional description of the project and provided some contact information if they needed further information about the project (in accordance with TWU's Research Ethics Board). (See a copy of this sheet in Appendix D.)

Contingent Valuation methodology

One of the biggest challenges in this project is trying to place a socio-economic value on goods or services that are not traded in markets. Anyone can find out the price of bread by empirically examining its price on the open market. The good in question here, *quiet*, is not a good that is bought and sold and so its value is difficult to measure. The discipline of economics has developed methods for the valuation of non-market goods. The form used in this study is called *contingent valuation* (CV); it is a stated-preference method, which means

people are directly communicating how much they value something. The main difficulty in valuing quiet lies in using a metric or scale that is comparable across individuals. (If ordinal opinion scales are used, it is impossible to compare across individuals because what one person subjectively defines, for instance, as "very important", may have the same value to another person who merely defines it as "important".) The answer is to use a metric that is common to everyone – money. By asking people to state in dollars how much they value something, it is possible to both compare across individuals and to aggregate up how much a good is worth to society. In this way, studies using CV have estimated values for everything from endangered species protection, clean water and watersheds, hunting and angling to the damage caused by oil spills. (McCollum 2003) CV studies have been undertaken by academic researchers, government policy analysts, and for determining damages in court cases.[3]

There are many different types of study designs in CV which have different ways of phrasing the valuation questions. In open-ended questions, respondents are simply asked to state in dollar amounts how they value the good in question. Dichotomous-choice questions ask them if they would pay a certain amount or not. Iterative bidding is similar to dichotomous-choice, but continuously raises or lowers the amount depending on if the person said yes or no in the previous round. Payment cards and multiple-bounded questions ask the respondents about a variety of possible values at once. This study uses a hybrid of these techniques. In the survey, respondents are asked how likely they would be to vote for a policy that bans propane cannons if they were required to pay annually increasing amounts. Respondents are shown the entire range they will be considering when the question is posed to try to minimize anchoring effects. (Boyle 2003) After using this iterative method, respondents are also asked for the open-ended amount they would be willing to pay. It is the hope that respondents are able to give more accurate estimates to the open-ended question after they have thought through the iterative amounts and considered how valuable the good is to them.

One criticism of CV has been that people will not value the good accurately because they are not capable or prepared enough to give true valuations for abstract, non-market goods and because they do not actually need to pay the amounts they state. As stated by one (early) critic, "ask a hypothetical question and you get a hypothetical answer." (Scott 1965) Contingent valuation is not a perfect method for eliciting values for non-market goods, but perfection should not be a criterion for evaluating the efficacy of CV because perfection does not exist even in actual market decisions. (Ariely 2008)

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[3] A landmark in the history of the use of CV techniques occurred when it was used to determine damages from the Exxon Valdez oil spill which prompted much controversy. In response to this, the US National Oceanic and Atmospheric Administration (NOAA) commissioned a blue ribbon panel to study and evaluate CV credibility. (NOAA 1993) Though their report recommended specific procedures for designing and running a CV study, it has been suggested that their recommendations were not grounded in CV literature and should be interpreted as informed opinions. (Boyle 2003) Since then, increasing numbers of disciplines and journals are replete with CV studies examining both the technique of constructing a CV study and the credibility of such results.

Economic literature has highlighted some problems and issues with CV techniques which have served to help improve the design of CV studies and analysis. One issue is the fact that some respondents give misleading values, either because they are protesting against some aspect of the technique or question, they misunderstand the question, or they are acting strategically to influence the results. (The results section includes a discussion of protest votes and how they are handled in this study.)

A plethora of studies have compared CV values to market estimates using other techniques and have found that CV values can be valid and consistent at times, but can also tend to overstate the value of the good at other times. The type of question employed does seem to have an effect on the final value and the best estimates have been obtained from payment-card multiple-bounded questions (Boyle 2003) which is why they were selected for use in this study.

Another way to approach the question of how to value quiet would be to look at market values for goods which contribute to quiet. For instance, one could examine the expenditures by households on new windows, insulation and other sound-dampening household improvements. If a household claims on a CV survey it would be willing to pay $500/year for the cessation of cannon noise but has not spend a cent on reducing the noise experienced inside the house, it may call into question their true value for banning propane cannons. The current survey did not ask about household expenditures to reduce noise however, so this question must be left to future research.

Data and Results

Response rates

Surveying began in late July and ran until late September. In total, 225 households were randomly selected to be part of the sample.[4] From this pool, 135 households (60%) completed the survey, 23 households (10.2%) refused to participate and 67 households (29.8%) were not home for both visits and did not respond to the information sheet left at the house inviting participation by calling or emailing the researchers. See Table 1 and Table 2 for a breakdown of response rates.

Table 1: Response rates by category

	Selected	Not home	Refused	Completed
Total	225	67	23	135
Abbotsford	141	38	9	94
Chilliwack	43	16	8	19
Hatzic	33	10	6	17
Nicomen	8	3	0	5

Table 2: Response rates by area

	Abbotsford	Chilliwack	Hatzic	Nicomen	Total
Not Home	38 (26.95%)	16 (37.21%)	10 (30.30%)	3 (37.50%)	67 (29.78%)
Refused	9 (6.38%)	8 (18.61%)	6 (18.18%)	0 (0%)	23 (10.22%)
Completed	94 (66.67%)	19 (44.19%)	17 (51.52%)	5 (62.50%)	135 (60.00%)
Selected	141	43	33	8	225

GIS was used to calculate spatial variables for each household, in particular the distance to the nearest blueberry farm. This variable, along with other information provided by the provincial government was added to the survey data for analysis purposes.

Demographic information of respondents

Of the 135 respondents, 52.6% were males and 47.4% were females. Most were home-owners (89.6%) but 14 people (10.4%) identified themselves as renters. The average

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[4] Originally 263 properties were selected but 38 properties were dropped throughout the surveying process due to errors in the GIS cadastre map. These errors included non-residential properties being mislabeled as residential and addresses incorrectly linked to properties. For each of the 21 farm areas surveyed (which had between 3 and 24 households selected for each), between 0 and 4 errors were detected per area. As there is no reason to think that these errors were systematic, there is no cause for concern from bias issues.

Figure 1: Distribution of respondents' ages
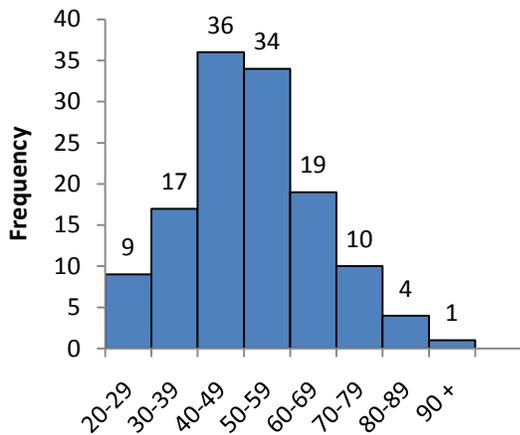
Figure 2: Distribution of years lived at address
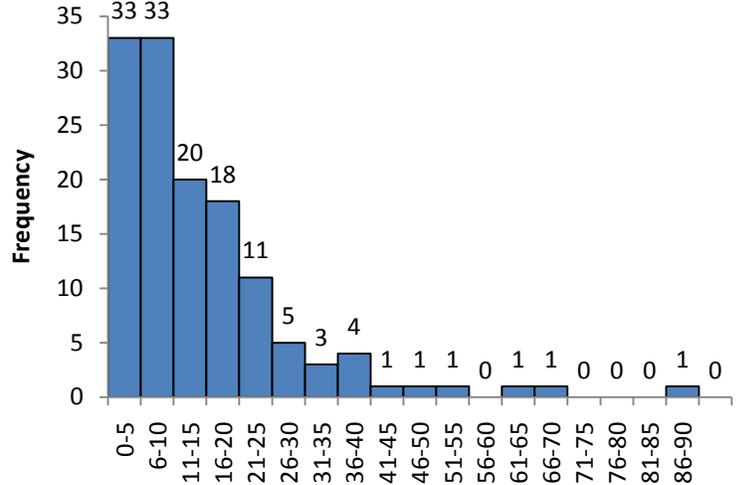
Figure 3: Pie chart of education levels
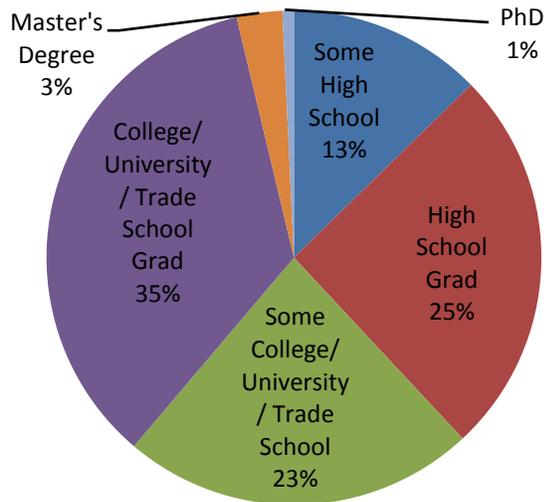
Table 3: Work situation of respondents and spouses

	Respondent	Spouse/Partner
Full-time	75 (56.39 %)	65 (61.90 %)
Part-time	19 (14.29 %)	8 (7.62 %)
Retired	25 (18.80 %)	17 (16.19 %)
Parenting/ homemaking	12 (9.02 %)	14 (13.33 %)
Unemployed	2 (1.50 %)	1 (0.95 %)
Total reporting	133	105

age of respondents was 51 years old.[5] (See Figure 1) The average number of years that respondents have lived at the address was 14.85 years (with a median number of years of 11 due to significant skewness in the distribution). (See Figure 2) The number of people living in the household ranged from 1 to 8 and the average was 3.17 household members.

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[5] Five people declined to give their age and instead reported "older", "up there" or something similar.

Education levels in the sample were slightly higher than the population as a whole with 61.94% of respondents having a level of education past high school. (See Figure 3) Statistics Canada census data reveals that 60% of the BC population aged 25 to 74 have attained a level of education past high school but only 51% in Abbotsford have (Statistics Canada 2006). Table 3 summarizes the work situation and that of the respondent's partner or spouse (if applicable).

In terms of hours spent at home, respondents reported an average of 17.73 hours per day, both inside and outside. Since 41 of the properties have (self-reported) farm-class status and many are commercial farms, this number is likely influenced by the presence of farmers in the sample who leave the property for fewer hours per day than commuters. We know that 60% of the completed surveys came from residences that are located within the Agricultural Land Reserve (ALR) and 40% were from non-ALR land. The ALR-status of a property is an imperfect proxy for whether that property could be classified as "rural" or "suburban". Thus, the sample is quite balanced in sampling both of these types of properties.

With regard to the berry industry, 46.27% of respondents know someone who works on a berry farm or is directly impacted by the berry industry for their livelihoods, and 91.85% of respondents' households consume blueberries either fresh or frozen. A large majority of respondents were aware of the nearby farmland and its implications when they moved in – 87.31% knew the property was in close proximity to commercial agriculture, 86.05% knew that new commercial agricultural operations could be established in the future, and 96.99% knew that commercial agricultural can produce noise, dust and odour as part of its ongoing operation.

Descriptive statistics of opinion questions

While 106 respondents (78.52%) said they hear cannons firing during cannon season, only 55 respondents (40.74%) said "yes" to the question, "In general, do the sounds of propane cannons bother you?" When you consider just those who actually hear cannons, 48.11% of those respondents say they are bothered by cannons in general.

Tables 4, 5, and 6 contain an overview of the responses to some other questions on the survey. Table 4 points out that noise of many sorts is prevalent across neighbourhoods in the study area. Asking about other noises allowed respondents to reflect on the role that propane cannon noise plays in their lives and to compare it to other common noises. Table 5 shows the months of reported cannon noise. Table 6 shows what respondents are doing when they hear cannon noise.[6]

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[6] Table 4 reports the responses for all 135 respondents. Table 5 reports 103 responses (just those who hear cannon noise minus a few who hear cannons but did not answer this question). For the same reason, Table 6 reports 104 responses.

For those who hear cannon noise, it is interesting to see how they compare the annoyance (or pleasure, in a few cases) they get from hearing cannons to the other common noises heard from their residence. In appendix A, a series of histograms is presented which shows the distribution of feelings towards cannons (compared with other noises). One

Table 4: Frequency of other sounds heard from respondents' residences

	Frequency	Percentage
Bird song or other morning wildlife	123	91.11 %
Lawnmowers	103	76.30 %
Barking dogs	103	76.30 %
Agricultural sounds	100	74.04 %
Air traffic	99	73.33 %
Bull frogs or other evening wildlife	99	73.33 %
Trains	78	57.78 %
Highway traffic	66	48.89 %
Gun shots	35	25.93 %

Table 5: Months of reported cannon noise

	Frequency	Percentage
May/early June	8	7.77 %
Late June	42	40.78 %
July	94	91.26 %
August	88	85.44 %
Early Sept.	24	23.30 %
Late Sept./early Oct.	2	1.94 %

Table 6: Activities during which cannon noise is heard

	Frequency	Percentage
Sleeping	37	35.58 %
Working indoors (including work for income or chores)	60	57.69 %
Time outdoors (including farming, gardening or chores)	101	95.28 %
Relaxing indoors	56	53.33 %
Hosting social functions	58	55.77 %

observation that can be made from these graphs is that respondents are not uniformly affected by cannon noise. Though most rate cannons on the negative side, a significant minority rate them as only "somewhat negative" or "no feeling". The wildlife sounds (both morning and evening) are rated as the best compared to cannons. Highway traffic, air traffic,

barking dogs, lawn mowers and agricultural sounds all show a wide diversity of feelings and most of these show that more people are in the neutral category (cannons give the same feeling as this sound) than in any other category. This indicates that to manypeople, cannon noise has become an accustomed part of the auditory background of their residence. However, there is a sizable group of respondents for whom cannon noise is extremely distressing and who consistently rank cannons as much more strongly negative than any other sound.

　　Not surprisingly, respondents were the most negative toward cannons when cannons are heard when they are sleeping. Negative feelings are also quite strong during times people are relaxing indoors or hosting social functions. The working indoors and spending time outdoors categories show more people in the "somewhat negative" or "no feeling" categories than in the "negative" or "very negative" categories, indicating that cannons cause less negative feelings, on average, for these activities . (See Figure 4)

Figure 4: Opinions on hearing cannons during various activities[7] [8]
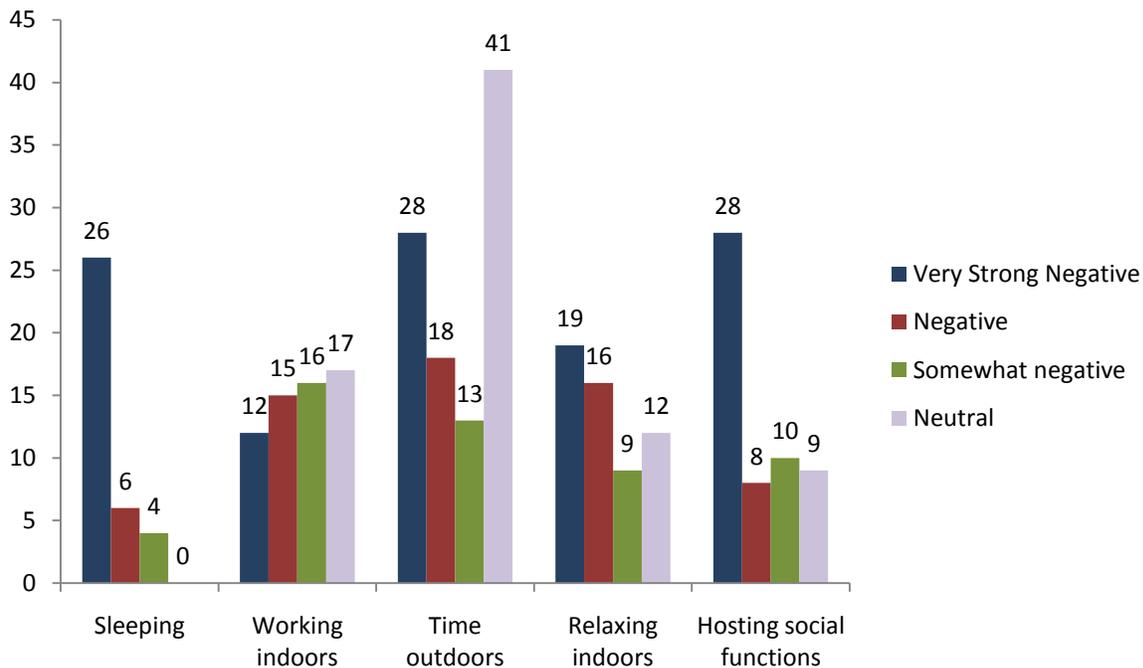
Contingent valuation results

　　Two different types of contingent valuation questions were asked. The first was a willingness-to-pay (WTP) question which asked how much people would be willing to pay

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[7] One response is not pictured here. One respondent said cannons give him a positive feeling when hosting social functions as they are a novelty to his guests.

[8] The totals for each activity are different from the frequencies given in Table 5 because some people declined to give an opinion on their feelings.

annually to halt all cannon noise. The story which accompanied the question (in which a fee is charged to all households concurrent with a policy banning cannon use), was designed to help an average person place an abstract question (essentially, "how much do you value quiet") into a concrete frame of reference. By and large, this story was successful and a majority of people gave what appeared to be honest and thoughtful (though varied) answers.

A few people's responses, however, can clearly be labelled as *protest votes*. For instance, one man claimed he would pay $1 million per year if cannons were banned as long as everyone else had to pay it too, so that "it would shut up all those people who complain about cannons". Another person claimed their value was $0 even though they would be willing to pay higher blueberry prices. Several people were strongly in favour of banning but balked at the thought of higher taxes.[9] By reading through the comments, it is possible to identify those people who are protesting against the thought of more government regulation or who believe they "have a right to quiet" and shouldn't have to pay for it. It is clear from their comments however, that they do place a high value on quiet, and so it is an unavoidable pity that their data must be dropped.[10] (Boyle 2003) A total of 17 responses (15 responses with $0, one response with $1, and one response with $1 million) were dropped from further analysis on this question.

The average annual WTP for banning cannons was $70.38. However, because 57 of the 118 responses were $0 (legitimately), the distribution of WTP is quite skewed. (See Figure 5) Due to the large standard deviation (variability) in responses, a 95% confidence interval for the point estimate is [$35.08, $105.68] which means we are 95% sure that this interval will contain the true population average WTP.

Figure 5: Distribution of annual WTP for the absence of cannon noise
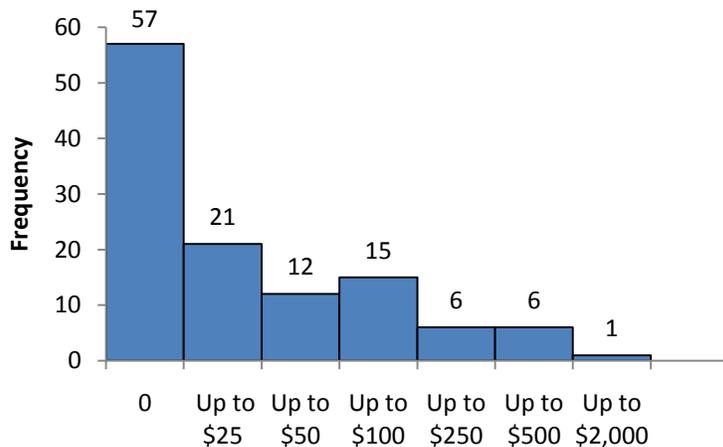
The next common step in CV studies is to aggregate this individual point-estimate to reflect the societal WTP. In this case, there is some difficulty in doing so because it is not

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[9] This is despite the fact that the survey question intentionally used the word "fee" instead of tax.

[10] Efforts were made to explain to these respondents that the intention of the question is to express a value for quiet using a metric common to everyone, and not as a way of adding to their taxes.

clear who should be considered part of the population. It is not reasonable to assume that all FVRD residents would have this WTP on average, since most of them do not hear cannons and do not live relatively near agriculture. One option is to consider the population as just those households located within 900 m of a noise-producing blueberry farm. Another option would be to consider the population as all households within 900 m of a blueberry farm (noise-producing or not). The latter group would be larger and give a larger societal aggregate WTP. One argument in favour of using the larger group is that there was no statistically significant difference in WTP between those who heard cannons and those who did not (see t-test results below). Perhaps those who do not hear cannons have positive WTP equal to those who do because they feel empathy for those bothered by cannons or because they fear that a blueberry field near to them will begin using cannons in the future.

One additional issue with aggregating this WTP number is the quality of the available data. As mentioned at the beginning of the Data and Results section, numerous errors were detected in the cadastre GIS maps. Since these same files are used to determine the population size, the resulting numbers are likely imperfect. Another source of uncertainty is the fact that recent, scientifically-collected data on which farms are cannon-users is not available, and this study relies upon a combination of an older list (approximately 5 years old) with new reports and observations of the blueberry council liaison and Ministry of Agriculture personnel. *All of these factors mean that any aggregated WTP number should be used cautiously for policy purposes.*

If the population is considered to be just those households that live within 900 m of a noise-producing blueberry field, the population size is 2,613 which would give an aggregated annual WTP of $183,903 (with a 95% confidence interval of [$91,664 , $276,142]).[11] If the population is considered to be all households within 900 m of a blueberry field, the population size would be 8,207, giving an aggregate annual WTP of $577,608 (with a 95% confidence interval of [$287,902 , $867,316]).[12]

Aggregates such as these are often used in cost-benefit studies as a proxy for the benefit from a policy change affecting non-market goods. Governments also use these estimates occasionally as a starting point when considering taxation implications. In this case, however, due to the uncertainty of the data, these aggregates may be less useful.

Willingness-to-pay models and tests

By dividing up the data along various demographic and other factors, we can test if the average WTP of various groups is significantly different from each other. Using standard

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[11] There were more than 300 properties within 900 meters of a noise-producing blueberry field which did not have a use description in the GIS data files. If *all* these properties were in fact residential, the total WTP could be as high as $206,495 (with a 95% confidence interval of [$102,925 , $310,065]).

[12] There were more than 3,000 properties within 900 meters of a blueberry field which did not have a use description in the GIS data files. If *all* these properties were in fact residential, the total WTP could be as high as $800,573 (with a 95% confidence interval of [$399,035 , $1,202,110]).

t-tests, we see that the WTP is no different for those who hear cannons compared to those who do not hear cannons (p-value of 0.17).[13] There is a statistically significant difference however, between those who say they are bothered by cannons ($147.95) and those who say they are not bothered by cannons ($25.20) (p-value of 0.014). Gender does not seem to play a role as the average for men is no different than the average for women (p-value of 0.523), and whether the respondent knows someone who is dependent on the berry industry for their livelihood also does not make a difference (p-value of 0.482). T-tests for location show that the WTP for respondents in Abbotsford ($83.33) is significantly higher than the WTP for respondents in Chilliwack ($18.75) (p-value of 0.078) but that there is not a significant difference between Abbotsford and Hatzic/Nicomen ($59.72) (p-value of 0.524) or between Chilliwack and Mission (p-value of 0.188).

Using regress techniques, we can examine which factors are significant in predicting WTP. Regression models are powerful because they tell you the effect of one variable while holding constant the effects of all others in the model. Thus, you are able to isolate the effect of your variable of interest. The best model that fits the WTP data consists of five variables: whether the household is located in Abbotsford (as opposed to one of the other municipalities), whether the household said they are bothered by cannons, whether the household has ever made a complaint to the Blueberry Council, how many years the household has lived at that address, and whether the respondent works full-time for income (as opposed to being in some other category of work situation). (See Table 7)

Table 7: Linear regression model (WTP ($) as dependent variable); n=118

Variable	Coefficient	P-value
Living in Abbotsford	70.07925	0.075
Bothered by cannons	64.67281	0.087
Made a complaint	252.9425	0.000
Years at address	3.033731	0.020
Work full-time for income	66.20161	0.071
Constant term	-106.4014	0.027
Adjusted R^2	0.2193	0.000

We can interpret the coefficients of the model in Table 7 in very concrete ways. Respondents living in Abbotsford are willing to pay $70.08 more on average than respondents in other areas; those who said they were bothered by cannons in general are

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[13] P-values express the percentage chance that an error was made and the two groups have no difference in their WTP. In this case, there is a 17% chance that those who hear cannons have the same WTP as those who do not hear cannons. In statistics, a result is not considered statistically significant unless the p-value is below pre-set levels. Conventionally either 10%, 5% or 1% levels are chosen, depending on the "cost" of being wrong. In this study, 10% is considered a significant result but the p-values are given so that the readers can interpret the result for themselves.

willing to pay $64.67 more; those who have made a complaint are willing to pay $252.94 more; and those who work full-time for income are willing to pay $66.20 more than those in other work situations. Finally, for every year the respondents have lived at the current address, they are willing to pay $3.03 more on average.   The adjusted R^2 statistic tells us that though these variables are statistically significant in explaining willingness-to-pay, they do not tell the whole story as just over 78% of the variation in WTP is not explained by this model.

One interesting variable that does not appear in this model to explain WTP is distance to the closest noise-making berry farm; it was found to be insignificant.[14] This has two likely possibilities for interpretation. Either people's sensitivity to noise is not affected by how close they are to the noise source (within a 1 km range, roughly), or else the topography of the different farm landscapes means that volume (and presumably annoyance) is not related to distance in a simple way.

We can construct another model which uses the collected data to help explain which factors are correlated with whether someone says cannons bother them or not. Table 8 presents a binary regression model which includes five variables that proved to be significant: whether respondents say they hear cannons when they are asleep, working indoors, or hosting social functions, whether they hear them in late June, and whether they indicated they are in favour of banning cannons. The first three variables all have positive coefficients which indicate that if the respondents said they hear cannons during that activity, the chance they said cannons bothered them increased, whereas the negative coefficient on late June indicated that if respondents said they hear cannons in late June, it decreased the probability that cannons bother them. Not surprisingly, if they are in favour of banning cannons, there was an increased probability of saying cannons bothered them. Similar to the linear regression model, and probably for similar reasons, this model did not find distance to the nearest noise-making farm to be significant in explaining if someone is bothered by cannons.

Table 8: Probit regression model (bothered by cannons is dependent variable); n=107

Variable	Coefficient	P-value
Hear cannons during sleep	1.674928	0.000
Hear cannons working indoors	1.05623	0.003
Hear cannons while hosting social functions	1.126982	0.001
Late June	-0.6274077	0.081
Wants to ban cannons	0.997377	0.006
Constant	-2.03069	0.000
Pseudo R^2	0.4683	0.000

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[14] The average distance was 523 meters (with a median of 456 meters).

By coding the opinions expressed in the comments section of the survey, it is possible to examine how opposition to or support for banning propane cannons differs across demographic segments of the population. Since this question ("Do you support or not support a proposed policy to ban propane cannons?") (see Appendix C) was not directly asked of respondents, this data should be used with some caution. It is possible that the surveyor failed to note tone and what appears to be positive or negative comment on banning may have been said with a sarcastic or ironic tone. So with this caveat in mind, we can proceed to test these results.

Table 9 shows how those households inside and outside the ALR differ on their opinions of banning propane cannons. By conducting a chi-square test on this data, we can conclude that there is a statistically significant relationship between living in the ALR or not and the type of opinion held (p-value of 0.0592). Households in the ALR are significantly more likely to oppose banning.

Table 9: ALR status and broad opinion on banning cannons

	Against Banning	Other	For Banning	Total
ALR	41	12	29	**82**
Not in ALR	18	16	19	**53**
Total	**59**	**28**	**48**	**135**

ALR status can be used as a proxy for agricultural producers, but it is an imperfect measure since some residents in the ALR are non-farmers. Another way to test the sentiments of farmers against non-farmers is to look at the self-reported tax status of the farm where 41 households identified themselves as having farm class status. Table 10 shows the breakdown of opinion and farm class status. The chi-square test does not show a relationship though between farm class status and opinion on banning cannons (p-value of .4823).

Table 10: Self-reported Farm Class Status and broad opinion on banning cannons

	Against Banning	Other	For Banning	Total
Farm Class	21	8	12	**41**
Not a farm	38	20	36	**94**
Total	**59**	**28**	**48**	**135**

Similarly, we can analyse if people who hear cannons are more likely to want them banned compared to those who do not hear cannons. Using a chi-square test on the values in Table 11, we conclude that there is insufficient evidence to say that opinions differ significantly based on whether one hears cannons or not (p-value of 0.2702). Usually

significant results are of interest, but in this case, the insignificant result is illuminating. One might think that people who hear cannons would be more disposed to wanting them banned (and those not hearing them would feel less strongly), but we can' t conclude that based on this data (and conventional significance levels). People's opinions on whether cannons should be banned or not may be based on other factors (including perhaps their ideological views on farming and government).

Table 11: Hearing cannons and broad opinion on banning cannons

	Against Banning	Other	For Banning	Total
Hear cannons	49	19	38	**106**
Don't hear cannons	10	9	10	**29**
Total	**59**	**28**	**48**	**135**

Since being awoken by cannons was mentioned by several respondents as being particularly distressing or annoying, analysis was done to determine if hearing cannons during sleeping led to different opinions on banning cannons or not. Table 12 shows the break-down of response. A chi-square test reveals that hearing cannons when sleeping is significantly related to opinion on banning them (p-value of 0.0091). However, a t-test on the WTP of people who hear and do not hear cannons while sleeping reveals that there is no significant difference in WTP between the two groups (p-value of 0.1899).

Table 12: Hearing cannons while sleeping and broad opinion on banning cannons

	Against Banning	Other	For Banning	Total
Hear cannons while sleeping	9	9	20	**38**
Do not hear while sleeping	50	19	28	**97**
Total	**59**	**28**	**48**	**135**

Non-response bias

Since 40% of selected households in the sample did not complete the survey, it is worth thinking about the possibility of non-response bias. This would occur when the non-responding households are systematically different on one or more factors from the

responding households. We'll look at the potential non-response bias from refusing households first, and then consider the non-response bias from the not-home households.

The refusal rate was just 10.2% and about half of the refusing households offered spontaneous comments that indicated they were not interested in participating because they either are not bothered by cannons, do not have the time or inclination to do a survey on this issue, or (more rarely) believed this survey was prejudiced against cannons and they did not support that view.[15] Assuming the refusing households which did not comment had similar reasons to the households which did comment, the direction of non-response bias may indicate that these households do not care about the cannon issue.[16]

The not-home rate was 29.8% and forms were left at these households explaining the project and inviting participation by contacting the researchers via either phone or email. Of all the forms left at houses, only a single household responded to this request (and subsequently received a third visit and completed the survey). It is impossible to know for certain why these households ignored this request but it would seem reasonable to surmise a few possible options. Households may have a) lost the form, b) been unable to read it (if English was not their first language) or c) discarded it without reading it. Or, they may have d) read it but decided they were not interested in the issue enough to warrant making contact. Finally, they may have e) "survey burnout" if they receive many requests for research participation. (This last one is particularly pertinent with farmers who are requested to fill out forms and surveys each year from different levels of government and other farm organizations.) However, as footnote 16 documents, there is reason to believe that households which are aware of and interested in this issue are more likely to respond. Thus, this may indicate the not-home households feel less strongly about this issue than the average respondent.

Being not home for two visits may also indicate that these households do not spend much time on their property and thus, may be less affected by cannon noise than households that do spend more time on their property. The crucial piece of information that is missing is what proportion of the non-responding households fall into the various categories, especially categories d) and e). The response rate for this survey (60%) is considered very good.[17] Though it would seem reasonable to conclude that any non-response bias runs in the direction of feeling less strongly about cannons than the average respondent, due to the strong response rate and representative sample, it is assumed to be neutral for these conclusions.

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[15] Efforts were made to be clear about the intention of the survey and its funding at the time the surveyor was inviting participation. However, under federal ethics regulations on university research involving human subjects, once a subject has given a clear refusal, the researcher is not permitted to try to convince them to participate and instead must leave promptly.

[16] Several responding households offered comments such as, "I usually don't do surveys, but I'll do this one because I think this is interesting/important". Comments like this suggest that refusing households are less likely to be keenly aware of the issue or have strong opinions on cannons either way.

[17] Studies with response rates as low as 12% have been published in journals.

Summary of Quantitative Findings

Survey Demographics
- 135 respondents
- 52.6% males and 47.4% females
- 89.6% homeowners and 10.4% renters
- Average age of respondent: 51 years old
- Average years lived at address: 14.85 years (median of 11 years)
- Household members: average of 3.17 people
- 61.94% have a level of education past high school
- Average number of hours spent at home daily: 17.73 hours
- 60% of completed surveys from households in the ALR (40% non-ALR)
- 46.27% of respondents know someone who works on a berry farm or directly impacted by berry industry for their livelihood
- 91.85% of households consume blueberries either fresh or frozen
- 87.31% of households were aware property was in close proximity to commercial agricultural operations when they moved in
- 86.05% of households knew that new commercial agricultural operations could be established on the farmland in the future when they moved in
- 96.99% of households knew that commercial agricultural operations can produce noise, dust and odour as part of their ongoing operations when they moved in

Survey Opinions
- 106 respondents (78.52%) said they hear cannons firing
- 55 respondents (40.74%) said in general, the sounds of propane cannons bother them
- 51 respondents, or 48.11% of those who hear cannons, say they are bothered by them in general
- July is the most frequent month for hearing cannons with 91.26% hearing them
- 35.58% of respondents who hear cannons hear them during sleep
- Hearing cannons during sleep and while hosting social functions have the strongest negative feelings
- Average annual willing-to-pay (WTP) to halt all cannon noise: $70.38
- No statistically significant difference in WTP for those who hear cannons and those who do not
- There is a statistically significant difference in WTP for those who are bothered by cannons and those who are not
- No statistically significant difference in WTP for males and females
- Abbotsford households have significantly higher WTP than Chilliwack households

- Factors that predict WTP: living in Abbotsford, being bothered by cannons in general, having made a formal complaint, working full-time for income, and having lived longer at the address
- Factors that positively predict if someone is bothered by cannons: if they hear them during sleep, working indoors or hosting social function, if they favour banning cannons; factor which is negatively correlated with being bothered by cannons: hearing cannons in late June
- 35% of respondents are for banning propane cannons (based on comments)
- Households in the ALR are significantly more likely to oppose banning
- Opinions on banning cannons do not differ significantly based on whether one hears cannons or not
- Hearing cannons during sleep is significantly positively related to wanting to ban cannons

Discussion and Implications for Future Research

The objectives of this survey were to place a societal value on the socio-economic costs associated with propane cannons and to provide a picture of the distribution and intensity of feelings toward propane cannons on the part of nearby neighbours. The results show that about 40% of respondents say they are bothered by cannons while almost half of people who hear cannons say they are bothered by them in general. Almost half the people were opposed to a ban on propane cannons including 5% of respondents who were against banning but supported more restrictive regulations. About 35% of respondents supported banning propane cannon use in the Fraser Valley Regional District. The rest of the respondents (about 15%) were neutral on banning.

It is possible that people may be acting strategically and stating their opinions more strongly than they feel because they haven't accepted cannons as a part of their auditory backdrop in the same way that they have accepted trains, air traffic or highway traffic. The fact that the cannon issue has been in the newspapers and the fact that this survey is being conducted tells people that this noise may not be permanent and thus their incentive is to over-state their displeasure or their WTP to try to eliminate the noise (since to most people, minimizing noise is a goal). Most people said that the other noise they experience doesn't bother them or "you get used to it". This may be because they know the chance of changing the noise level from trains, planes or automobiles is remote, whereas they perceive that it may be possible to eliminate cannon noise. The point of this discussion is that it would seem reasonable to view the values stated in this survey as an upper bound.

Similarly, CV literature has pointed out that can be gaps between what people *say* they are willing to pay and what they are *actually* willing to pay when it comes time to hand over the money. This is another reason why CV values should be viewed as an upper bound.

The CV values found in this study can be used by policy-makers to estimate the potential value from a policy change. Generally speaking, the costs of a policy can often be more easily measured than the benefits, especially when dealing with non-market goods. Thus, CV has filled a crucial gap in the cost-benefit analysis.

In this case, policy-makers will want to weigh the benefits from a change in cannon regulations (including banning) with the cost of a change. The benefits can be partially measured by the CV values found in this study. It is only one (major) piece of the puzzle, however. Policy-makers would need to consider other benefits such as the savings in public health costs of cannon noise (from some people suffering from increased stress and other noise-related conditions). The other side of the coin is the costs of a policy shift including the value placed on cannon-use by farmers and the precedent that such a move would create for restricting farming activity. As economic research has shown, actors in the economy respond to expectations of what they think will happen in the future. In this case, restricting farm operations could contribute to a decline in farming because future or potential farmers expect that their activities will be limited and their profits curtailed as a result.

Since public policy is usually aimed at creating the most benefit for the largest number of people, it is possible that by changing propane cannon regulations (including banning propane cannons) could have greater benefits to the nearby residents than costs to the blueberry farmers. However, this study is aimed solely at assessing only one side of that equation and has not addressed the potential hardship to farmers that changing propane cannon use may have. Further research would need to be done on this point before a full cost-benefit analysis could be completed on any proposed policy changes.

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Appendix A – Histograms of noise comparison responses

Figure A1: Comparison of cannon noise to birdsong and morning wildlife
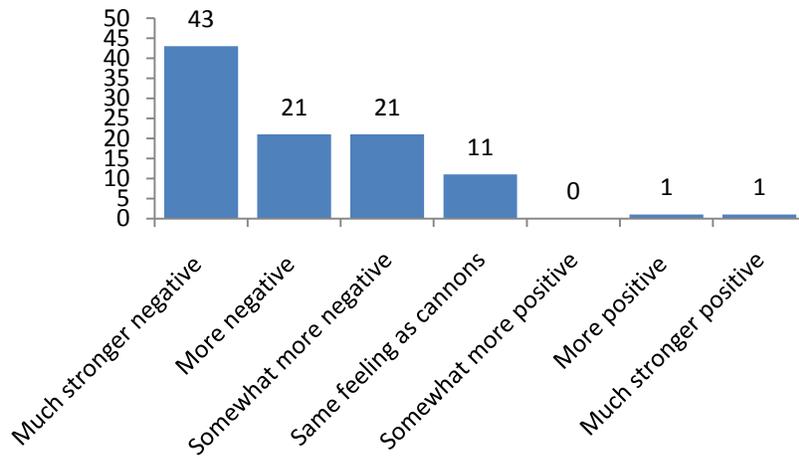
Figure A2: Comparison of cannon noise to lawnmowers
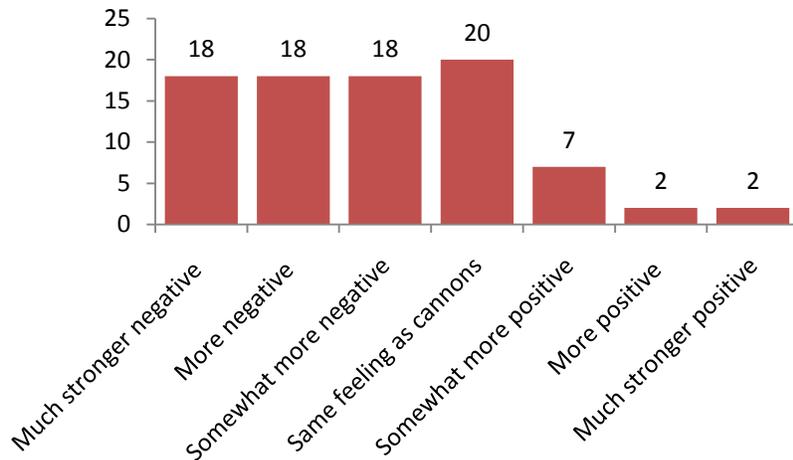
Figure A3: Comparison of cannon noise to barking dogs
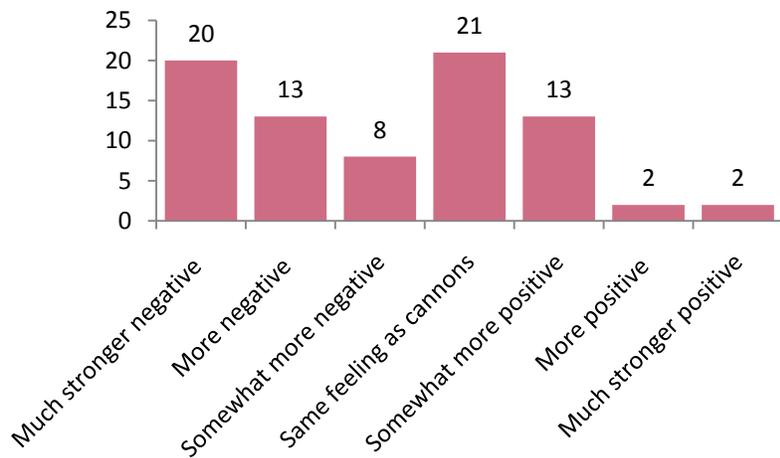
Figure A4: Comparison of cannon noise to agricultural sounds

Much stronger negative: 14
More negative: 22
Somewhat more negative: 15
Same feeling as cannons: 29
Somewhat more positive: 2
More positive: 1
Much stronger positive: 1
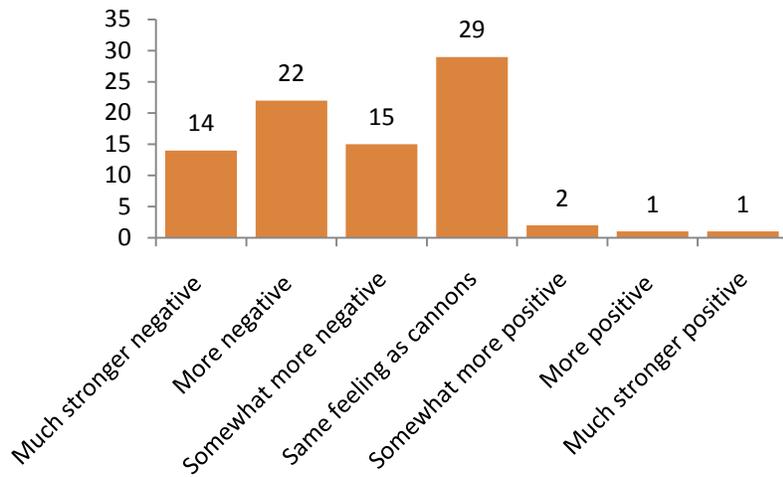
Figure A5: Comparison of cannon noise to air traffic

Much stronger negative: 17
More negative: 17
Somewhat more negative: 20
Same feeling as cannons: 25
Somewhat more positive: 2
More positive: 2
Much stronger positive: 0
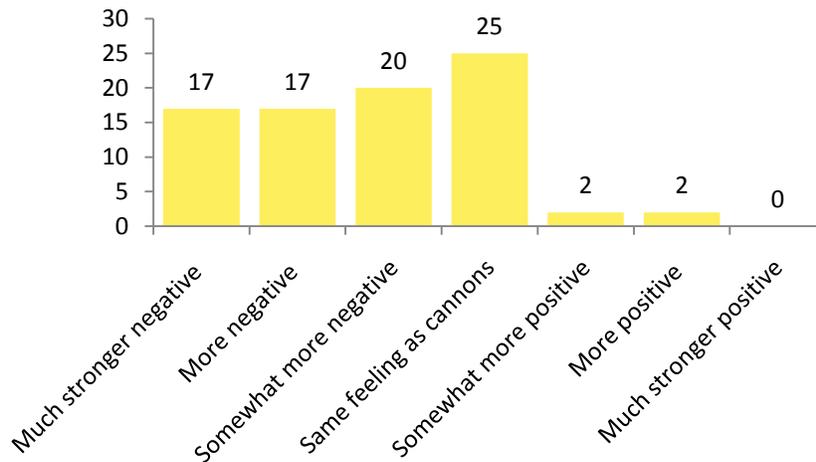
Figure A6: Comparison of cannon noise to bull frogs and evening wildlife

Much stronger negative: 33
More negative: 17
Somewhat more negative: 19
Same feeling as cannons: 9
Somewhat more positive: 1
More positive: 2
Much stronger positive: 1

Figure A7: Comparison of cannon noise to trains

Figure A8: Comparison of cannon noise to highway traffic
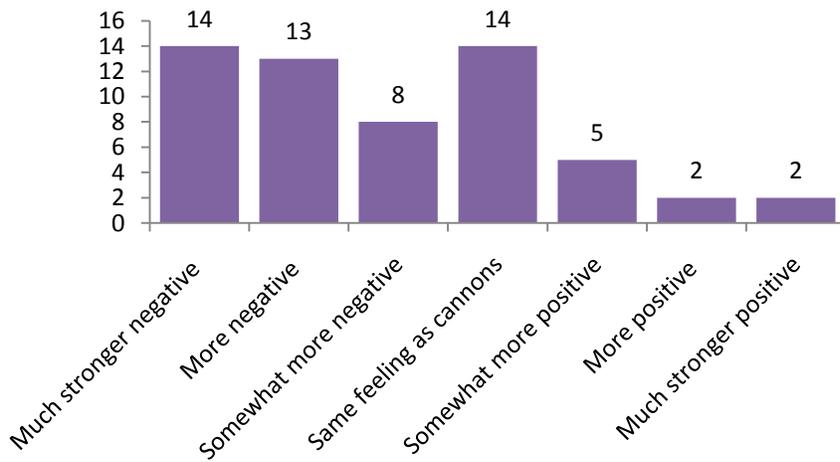
Figure A9: Comparison of cannon noise to gunshots
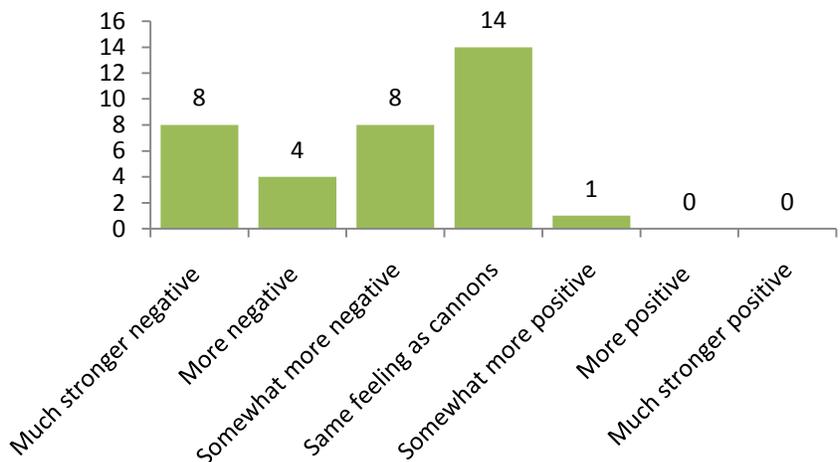
Appendix B – Comments sorted into broad categories

Does not support policy to ban (59)

1. "When the cannons were first brought in five or six years ago, it was like a war zone, so I hardly even notice it now"; opposed to banning.
2. "[Hearing agricultural sounds is] the price you pay for living in the country"; farmers have to have a way of sustaining their livelihoods; doesn't encourage putting more regulations just for a noise annoyance - unless there's an alternative that works for farmers that's better and more economical.
3. Cannons are better than nets because birds get caught; cannons don't bother me.
4. "Policy would hurt berry industry" and farmers might resort to worse things if cannons were gone.
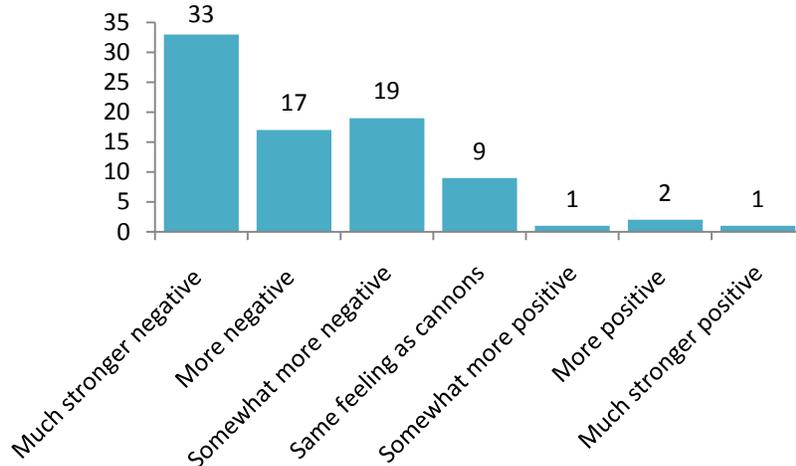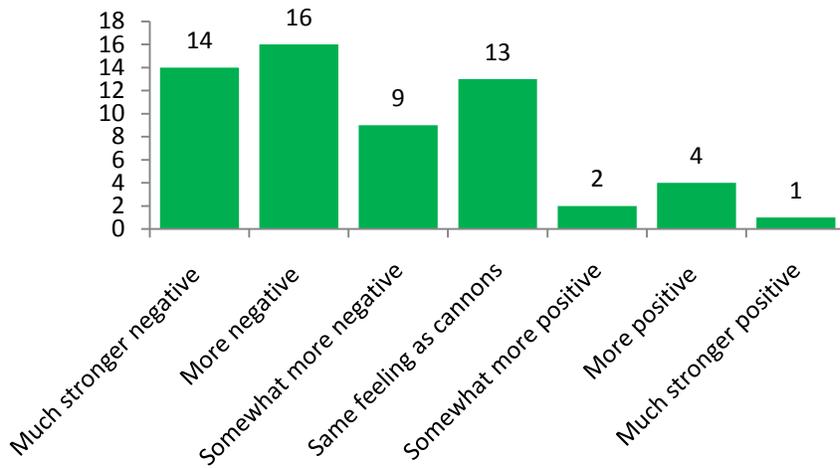5. "The cannons are a minor annoyance and are probably necessary for successful blueberry crops. I would encourage the berry farmers to find a quieter way to deter the birds, but the noise is only one of the minor noises of living in the farm."
6. "They need cannons, we need to spread manure – everyone has to farm around here."
7. "They need to have their berries and cannons help them." "Should do everything possible to make it nice for the neighbors but shouldn't ban them." "We're all guilty of making noise" or spreading manure (necessary evil). "Price of food will go up if they limit farmers." City people come out and then complain.
8. "Cannons do bother me, but I understand they have to make a living. Would rather canons than bird distress caller." "[Farmers] have a living to make."
9. "Rather hear cannons than see dead birds in nets." Policy [to ban] "unnecessary." "Only newcomers complaining around here."
10. Thinks banning propane cannons is bad unless there's a better way; would rather hear cannons than shooting/killing [birds].
11. Really not bothered by the sound. "Farmer's here first."
12. Farmers have right to use appropriate methods - neighbours should "live and let live."
13. "I don't love cannons" but understand necessity for some people; "[Policy to ban] not fair" - not too disturbed overall.
14. Don't care regarding cannons; ban not necessary. "Farmers have rights - birds are a serious nuisance."
15. [Policy to ban] not appropriate. "Farmers need this tool." Not fair for people to move in and make demands; noise not great, but only a few months of the year.
16. Don't want additional bureaucracy on farmers, won't help; woken up in morning, but that's biggest complaint; not too bothered, but can be annoying.
17. Dislike cannons, but live in farming area!! Empathetic about farmers' rights; noise only couple months of year; new methods should be researched; farmers shouldn't be taxed or limited.
18. "It's their right to have something to protect crops; it's only a short season."
19. Wouldn't vote [to ban] - no blueberry farms around here, quiet area. Farmer's need [cannons].
20. "Doesn't need policy. Give farmers rights. Take smell of manure for instance." "Policy [to ban] is crazy."

21. "Let farmers make noise. It's a farming community. Let [cannons] be feasible for farmers, better than nets."
22. Wants all farmers to pay nothing. Realizes that living in farm country comes with noise and smell.
23. "Nets are more harmful than cannons - cannons are irritating, not harmful." "[Cannons] are a necessary evil."
24. "Farmers have to use what they can to grow crops but it should be within regulations." "Need to do what they have to do."
25. "Blueberry farmers much more considerate in this area with netting, etc." "As is here - you can't make farmers pay for growing crops." "If you built your house too close to us, that's tough, it's like complaining about the smell in spring." "Have to be based on rationale it can be done without creating a bigger problem." Has to be fair to everyone.
26. Policy [to ban] unnecessary. "I don't think that this is that big a deal personally."
27. Farmers have to make a living. Not complaining. Don't like nets.
28. No nets. Not in favor of policy [to ban]. Have good blueberry growers. More in favored of measured approach – ban should be last resort.
29. "Would not promote NIMBY (Not In My BackYard) policies." "Not fair for non-farmers to move in and complain."
30. No need for policy to be done.
31. Pro-farming; pro-doing whatever needs to be done to have the birds not eat the berries.
32. Not in favor of ban. Aware of the problem but not in favor of policy.
33. "Don't think I would [support policy]." "They need something to protect their livelihood." "We understand [noise] has to happen." Wouldn't want [cannons] banned.
34. Does not support [policy]. [Cannons] help blueberry farmers. "I see the birds taking off."
35. "Against [policy]." "Should be able to use [cannons]." "If they figure that works for a better harvest, go for it."
36. "Wouldn't ban them - their trying to make a living and they got to protect their crops." Made a complaint to bylaws offices about dogs but got no response.
37. "Doesn't bother me." "Farmers here before the subdivisions so let's give a break to farmers."
38. Wouldn't agree with policy [to ban]. [Cannons] bother me, but still I understand they need to use them. If there was a better alternative…
39. Would expedite a solution some other way [than banning]!
40. Policy [to ban] is not helping the farmers in any way.
41. "I realize that the farmers have to do their thing. As long as [cannon use is] according to regulation and used properly, then I have no problem."
42. "Don't agree with policy [to ban]. [Cannons] used for a good reason."
43. Cannons don't bother me. "If you don't like agriculture, go away. Don't need banning."
44. Cannons don't bother me because it's off in the distance… better than other things. Don't need banning.
45. Rather use cannons than pesticides.
46. Does not believe in policy [to ban]. "It is negative because they need the cannons. That's their livelihood."
47. "[Starlings] poop everywhere; if [policy] was kill birds, then sure." Doesn't agree with policy to ban cannons. Farmers need to protect crop.

48. "It's like telling a farmer to shut his tractor off. Leave the farmers alone. Let the bureaucrats do their own thing." FVRD created hardship. Too many rules, don't make sense.
49. No problem with cannons; expect it with this area; "Would vote for any compensation to shut up complainers, but I don't need any myself." "Ridiculous to ban them because they're farmers in an agricultural land - it's a safe, cheap, inexpensive way to keep crops safe from wildlife, which keeps the price down in the grocery store."
50. Sound startles him when he's driving with the windows down. "People have the right to farm – [the noise] is not too much of an inconvenience."
51. "No - they got to look after their berries." "When you move to farm country, you have to expect the sounds or else move to the city." [Cannon] noise doesn't bother at all, but spraying does.
52. "I don't like [cannons], but you put up with them." "When you live in the country, you have to be used to noise: coyote barking, crows, it's part of country life."
53. "Not for [policy]." "[Cannons] used sparingly is fine." "Sometimes a huge flock descends and then they have to use it."
54. "I prefer cannons to any other methods they use." "I've seen the birds in the nets." "When you move somewhere, you have to do your research and find out what's around it."
55. "I get used to it and it doesn't bother me." "Friends with berry farms use ATVs." "Dislike nets worse than cannons." Doesn't like blueberry farms with their environmental harm with chemicals.
56. "Shouldn't ban [cannons]. Would be nice if they started later, at 8 say." "If you live in country, you're going to hear stuff." "They don't bother me - there's a lot more things worse than cannons, for instance the nets with all the birds hanging dead."
57. "I understand they need to keep birds away… but I'm not convinced cannons are the best method. Best would be net streamers." "Not against cannons. Agricultural community has to make money." "Need to work together to find best possible solution without harming [the farmers] or antagonizing them." Cannons are not the best way to get rid of birds, but not everyone can afford to pay for nets.
58. Would not like the policy [to ban] too much.
59. Opposed to [policy] on principles.

Supports change in regulations but not banning (7)
1. "Total ban not beneficial but need to change hours. 6:30 is too early. Should start at 8 and end at 7." Annoying to be woken up at 6:30 every morning in the summer.
2. "Don't think they [cannons] should be banned but should be different." "I don't have the right to make policy for another farmer who's trying to protect his crop." "Should be limits on when they go." "Accept [noise] if they [cannons] are good methods to protect their crops." "People in agriculture don't want someone dictating how to protect their crops."
3. I don't like [cannons], but think it should be regulated - not banned; I wake up from sounds - can't have BBQ in the summer; best way is to decrease hours.
4. Quite negative against the policy [to ban]. [Cannons] aren't in non-rural areas. They are already zoned for farmers. Cannons could be placed better. Guns going off in the morning are illegal - not cannons. Cannons sometimes violate rules - should be policed better. Fine-tuning of regulations needed.

5. [Policy to ban] not fair; regulating maybe.
6. Recognize need [for cannons]. Don't agree with hours.
7. Current regulations are not enough.

Supports policy to ban (48)

1. Good policy [to ban] because other famers have found other ways (with hunting birds).
2. Like to see alternatives like nets or birds [falcons]; would like to see cannons stopped under right conditions (good alternatives).
3. Good policy; cannons are disruptive; has to be alternative (nets); cannons don't work anyhow.
4. "I'd like it [policy to ban]." "It's not fair we have to listen to it for two months of the year."
5. "We're in a farming community. We moved in the farming area, you have to expect [noise]." Okay with policy – as long as taxes don't pay for it.
6. [Person really angry.] Fellow north of her doesn't follow guidelines. Too loud, too frequent, said to her "we want to blast you white people out of here" - no intention of following guidelines. Thinks the policy [to ban] is "wonderful." This has been a easier summer, but has had rude comments from neighbours (when she offered to help put up nets).
7. "Cannons unnerving and serve no purpose." "In favor of it [policy]." "Should be firm monitoring in place [of regulations]."
8. In favour of it [policy]. "Want to ban them."
9. "Yeah, ban them; cannons don't help." "Nets are expensive but they are the answer to keep the birds out."
10. "If you live in a farming community, you expect some noise. That is why we have libraries and parks and headphones. Sure it's annoying but everyone's gotta make a living." "For [policy]. There are other ways of doing berry farming - netting, falcons."
11. "No amount [compensation] is enough for noise." Recognize farmers need crop but very inconsiderate – gets woken up, gets stressed out by noise.
12. "Cannons should just be banned" - hates noise and wakes up from it all the time.
13. Would rather have cannons gone than [compensation]; [noise] invades personal time and space in summer - can't have people over.
14. Very tired of being woken up - baby wakes up 6:30 a.m.; but never know the cannon time/location because it changes; can't get used to it.
15. "Don't bug me but don't want them [cannons] around."
16. In favor of banning because must be more effective ways to deter birds. He has neighbors who have stopped using cannons.
17. "More annoyed with the guy setting it for 6:30 a.m. than the cannons." "If get on the quieter setting wouldn't be as bad but it sounds like a gun going off." "In favor of banning." "There are other ways of doing it - it's noise pollution."
18. "Go for it [policy]." "Yes, it's noise pollution." "It doesn't affect me" but worried that more will come in near here.
19. "I shouldn't have to pay for it [policy], at least not directly - if I have to pay more for blueberries, that's okay." "There's other ways to affect what they want to do - to scare the birds – with netting, etc." Definitely supports policy. "City government should work with farmers to find other ways of controlling the bird populations, but it shouldn't be a cost to the taxpayers."

20. Fine, if there are other alternatives elsewhere - hawks, netting.
21. Policy is great.
22. Policy is positive. Alternatives are available - nets, dogs, ribbons.
23. Support policy but not if coming out of my pocket.
24. Used to grow corn feed for cattle; [berries] chopped up fields. "We were here first." "Would love policy. About time they thought of it."
25. "Right direction to go because it's annoying and there are other ways to deter wildlife."
26. Definitely ban [cannons]. "They don't do anything if you watch them - birds leave momentarily only." "Doesn't do anything."
27. "Should be banned altogether. There are other alternatives that don't make noise."
28. "Farmers would need to be compensated [if cannons banned]." Support policy as long as compensated for crop loss.
29. Would vote for [policy]. Peaceful setting. Want to enjoy outdoors.
30. Don't think I should have to hear [cannons]. Policy is good.
31. Alternatives are netting.
32. "Probably support policy [to ban], but wouldn't go and picket…" I think there are other ways.
33. "[Blueberry farmers] should be offered a fine for the same amount as netting would cost."
34. Very noise-sensitive, but experience [cannon noise] at a low level currently. "If they have another alternative, I'd be for [policy]." "There are enough infringements on your quality of life as it is."
35. Should ban because other alternatives; too much noise pollution already.
36. Not too sure. Could they use nets? Would like to see cannons banned.
37. Support it.
38. Should ban. Alternatives.
39. Definitely thinks there should be a policy [to ban].
40. Cannons are like a warzone. Wears earmuffs for cannons. Would vote for banning cannons at all costs. Would be "thrilled" with policy. Moved to country for QUIET and solitude.
41. No reason to fire cannons. 100% for a policy [to ban]. "This is my home, I live here."
42. "No amount of money would make [noise] worthwhile. Policy is wonderful and I completely support it."
43. [Cannons are] noise pollution. In total agreement with policy.
44. "Should not have allowed the cannons in the first place." Supports policy. Wants them to find alternatives.
45. Supports policy.
46. "For policy [to ban]." "I like blueberries but why can't they use nets?" "All farmers have to take responsibility for their product."
47. "Cannons more damaging to hearing than a gunshot…. There need not be the noise from cannons. There are alternatives." Would favour government subsidizing nets. "Farmers get subsidizes to grow their crops, they should get grants to have netting…. Cannons create frustrated anger that I can't deal with."
48. Fine to ban.

Neutral/ambivalent (21)

1. "I can see where if you live next doors, it would drive you nuts"; firmly believe in the right to farm though.
2. Don't want to put farmers out of business - hope they find another way; have friend who has productive farm without use of cannons, so we should find out how much impact the birds actually have: do we really need cannons?
3. I usually have music on inside; not really bothered; don't hear them too often, only when outside in backyard.
4. Don't hear them, so no problem here.
5. "Depend on alternatives available. Cannons are better than sprays."
6. Neighbour has dog that's more annoying; dislike cannons, but not passionately "like some people."
7. Cannons "don't bother me." Farmers respect the hours/regulations. "I don't have an issue."
8. Neutral.
9. Neutral.
10. "Goes both ways. We don't hear [cannons] here, but you got to look at it from [the farmers'] side. [Cannons] are not crazy annoying."
11. "Doesn't really bother me." "Feel sorry for people that are closer."
12. Because of situation and where I live, I don't have an opinion on cannons.
13. I feel strongly: I don't like them. [Farmers] have to keep livelihood – so it's a balance.
14. Depends on alternatives.
15. Prefer other methods of controlling birds, it's [farmers'] livings though.
16. "Neutral"; "Doesn't affect me."
17. "Neutral." "Don't bother me. If they went all year long, maybe a different story, but I can't get too excited about it."
18. "If there is a better way, they should use it, but I'm not that bothered by it." "Not that big an issue for me."
19. Hardly hear cannons. "Sounds no worse than mowers, tractors, etc."
20. Not aware of issue and don't hear cannons.
21. No opinion.

Appendix C – Survey

1. I am going to list a number of sounds commonly heard in the area of your residence, and I would like you to tell me whether you hear them commonly or not. *(circle)*

   - Bird song and other morning wildlife sounds
   - Lawn mowers
   - Gun shots
   - Highway traffic
   - Bull frogs and other evening wildlife sounds

   - Agricultural sounds (such as tractors, harvesters or processors)
   - Air traffic
   - Barking dogs
   - Trains
   - (Other:_____)

2. a) Do you hear propane cannons at your residence? Yes No

   b) If so, during which months of the year do you hear propane cannons? *(circle)*
   - May/early June
   - Late June
   - July
   - August
   - Early Sept.
   - Late Sept./Oct.

   c) In general, do the sounds of propane cannons bother you? Yes No

3. I am going to list the noises you earlier stated you hear at your residence, and I would like you to tell me how you feel about propane cannon noise in comparison with these other noises. As I list each noise, please rate your feelings according to scale A.

	Cannon give much stronger negative feeling	Cannons give more negative feeling	Cannons give somewhat more negative feeling	Same feeling as cannons	Cannons give somewhat more positive feeling	Cannons give more positive feeling	Cannons give much stronger positive feeling
Morning wildlife	0	1	2	3	4	5	6
Lawn mowers	0	1	2	3	4	5	6
Gun shots	0	1	2	3	4	5	6
Highway traffic	0	1	2	3	4	5	6
Evening wildlife	0	1	2	3	4	5	6
Agricultural sounds	0	1	2	3	4	5	6
Air traffic	0	1	2	3	4	5	6
Barking dogs	0	1	2	3	4	5	6
Trains	0	1	2	3	4	5	6
(Other)	0	1	2	3	4	5	6

4. I am going to list a number of activities. In the months you hear propane cannons, during which of these activities do you hear propane cannons on an average day? *(circle)*

    - Sleeping
    - Working indoors (including work for income or chores)
    - Working or spending time outdoors (incl. farming, gardening or chores)

    - Relaxing indoors
    - Hosting social functions
    - (Other: _____ _____)

5. For each of the activities during which you hear propane cannons, please tell me your feeling on hearing them using scale B.

	Very strong negative feeling	Negative feeling	Somewhat negative feeling	No feeling	Somewhat positive feeling	Positive feeling	Very strong positive feeling
Sleeping	0	1	2	3	4	5	6
Working indoors	0	1	2	3	4	5	6
Working outdoors	0	1	2	3	4	5	6
Relaxing indoors	0	1	2	3	4	5	6
Hosting social functions	0	1	2	3	4	5	6
(Other)	0	1	2	3	4	5	6

Wildlife can disrupt and damage agricultural crops and livestock, reducing farmer's productivity. Under the current *Farm Practices Protection (Right to Farm) Act*, farm operators are permitted to use a number of repellant tactics including the use of propane cannons, provided certain regulations are followed. These regulations include that cannons only be in operation between 6:30 am and 8:30 pm, with a break from noon and 3:00 pm, and have a firing frequency of no more than 11 activations per hour. Farmers also need to maintain a minimum separation of 200 meters between the device and a neighbouring residence.

The next section of this survey will ask a series of hypothetical questions to determine the impact of farm practices on you. The purpose of asking these questions is to help people think in numerical or monetary ways about issues that are not commonly thought of numerically. These policies are not currently being proposed by either the Fraser Valley Regional District or the provincial government.

First, I'm going to ask you how much you'd be willing to pay to stop all cannon noise.

6. Suppose a policy that completely banned propane cannon use in your regional district was proposed, and to fund it citizens were required to <u>pay an annual fee</u>. I am going to list a number of dollar amounts ranging from $0 to $1,000, and I would like you to tell me how likely you would be to vote for this policy if you were required to pay that dollar amount annually. Please use scale C.

	Definitely would **not** vote for policy	Would **not** vote for policy	Probably would **not** vote for policy	Unsure	Probably would vote for policy	Would vote for policy	Definitely would vote for policy
$0	0	1	2	3	4	5	6
$5	0	1	2	3	4	5	6
$10	0	1	2	3	4	5	6
$25	0	1	2	3	4	5	6
$50	0	1	2	3	4	5	6
$100	0	1	2	3	4	5	6
$250	0	1	2	3	4	5	6
$500	0	1	2	3	4	5	6
$1,000	0	1	2	3	4	5	6

7. What is the highest dollar value you would be willing to pay annually to fund the policy?_____

Now we're going to ask the opposite situation. How much would you <u>require in compensation</u> for the noise to make you feel neutral about it?

8. Suppose your community proposed a policy that <u>taxed farm operators</u> using propane cannons and paid their neighbours an <u>annual sum in compensation</u> for the propane cannon noise. I am going to list a number of dollar amounts ranging from $0 to $5,000, and I would like you to tell me how likely you would be to vote for this policy if you were paid that dollar amount annually. Please use scale C.

	Definitely would not vote for policy	Would not vote for policy	Probably would not vote for policy	Unsure	Probably would not vote for policy	Would vote for policy	Definitely would vote for policy
$0	0	1	2	3	4	5	6
$10	0	1	2	3	4	5	6
$25	0	1	2	3	4	5	6
$50	0	1	2	3	4	5	6
$100	0	1	2	3	4	5	6
$250	0	1	2	3	4	5	6

$500	0	1	2	3	4	5	6
$1,000	0	1	2	3	4	5	6
$2,500	0	1	2	3	4	5	6
$5,000	0	1	2	3	4	5	6

9. What would your feelings be about enacting a policy that completely banned propane cannon use in the Fraser Valley Regional District? Or other comments on cannons: _____

_____

_____

_____

_____

10. a) Have you ever made a formal complaint to the Blueberry Council's liaison about cannon noise?   Yes   No

    b) If yes, was your complaint addressed to your satisfaction?   Yes   No

    Comments _____

    _____

Thank you for answering these questions about your experience with noise in your neighbourhood. We have just a few demographic questions to finish up the survey.

11. Gender of survey respondent: Male   Female

12. Age of survey respondent: _____

13. Do you own this home or do you rent it?   Own   Rent

14. For how long have you lived at this address? _____Years (_____Months)

15. a) How many members are there in your household, including yourself? _____

    b) In your household, how many members are aged
    ____less than 5   ____25-34   _____55-64
    _____ 5-14   _____35-44   _____65-74
    _____ 15-24   _____45-54   __75 and over

16. What is the highest level of formal education you have attained?
    ___ Some high school   ___ High school grad
    ___ Some college/university/trade school   ___ College/university/trade school grad
    ___ Some graduate level studies   ___ Master's/MD/BBA   ____ PhD

17. How would you describe your work situation and that of your partner/spouse (if applicable)?

    a) Themselves:____ working (for income) full-time____ working (for income) part-time
    ____ retired____ working in the home (homemaking/parenting) ____ unemployed

    b) Spouse: ____ working (for income) full-time ____ working (for income) part-time
    ____ retired ____ working in the home (homemaking/parenting) ____ unemployed

18. How many hours on a typical day do you spent at home (inside and outside)? _____

19. Does your household consume blueberries, either fresh or frozen?

                                                Yes   No

20. a) Do you know any individuals who either work on a berry farm or are directly impacted by the berry industry for their livelihood?

                                              Yes   No

    b) If so, what is their relationship to you? _____

21. a) When you moved to this residence, did you realize this residence was in close proximity to commercial agricultural operations?

                          Yes   Not sure/can't remember   No

    c) Did you realize that large agricultural operations could be established on the farmland in the future?

                          Yes   Not sure/can't remember   No

    d) Did you realize that commercial agriculture operations can produce noise, dust and odour as part of their ongoing operations?

                          Yes   Not sure/can't remember   No

    d) Comments on decision to choose this location: _____

_____

_____

_____

_____

22. I am going to ask you to state how much you value certain attributes associated with living in an agricultural community. Refer to scale D.

	Strongly dislike attribute	Dislike attribute	Somewhat dislike attribute	No value of attribute	Somewhat value attribute	Value attribute	Highly value attribute
Availability of local produce and farmer's markets	0	1	2	3	4	5	6
Presence of open space and agricultural views	0	1	2	3	4	5	6
Ecological services such as wildlife habitat and flood protection	0	1	2	3	4	5	6
Availability of educational opportunities like farm tours	0	1	2	3	4	5	6
Opportunities to participate in agritourism activities such as hay rides, corn mazes, pumpkin patches, U-pick	0	1	2	3	4	5	6
Tradition and heritage of area	0	1	2	3	4	5	6

23. In the last year, have you visited a farm?   No   This is a farm   Yes

That is the end of the survey. Thank you for your time and input. Here is an information sheet with some information about the project and also some contact names and numbers if you have questions about the project or about your rights as a research participant.

For surveyor only:

Survey date _____   Survey conducted by _____

Respondent's Address, Municipality: _____

Did you hear cannons firing while in this neighbourhood/vicinity?   Yes   No

Appendix D – Information sheet left with respondents

SCHOOL OF BUSINESS
TRINITY WESTERN UNIVERSITY

Project Information

Blueberries, Birds and Externalities of Control - Survey

Thank you for participating in this study. Your participation has provided valuable information to aid in examining externalities (or spillovers) that emanate from blueberry production and affect nearby residents.

This project is being conducted by Dr. Tracy Stobbe, an assistant professor of economics at the School of Business at Trinity Western University. It is being funded by the Provincial **Ministry of Agriculture and Lands (MAL)** and by the **Fraser Valley Regional District (FVRD).**

Purpose and Objectives
The purpose of this research is to quantify the external costs and effects of blueberry production near populated areas. Questions to be answered include: Do residents at large notice the firing of propane cannons to deter avian predation of blueberries (usually by starlings)? What effect do propane cannons have on residents' overall satisfaction with their neighbourhood? What is the distribution of opinions or feelings regarding cannons? What cost can be associated with the use of cannons near suburban residents?

Importance of this Research
This research project is important because local and provincial policy makers are interested in knowing how they might best support local agriculture while keeping nearby residents satisfied. We expect this research to assist policy makers in better decision-making and to help residents realize the tradeoffs inherent in the urban fringe between farmers' and residents' needs.

Participant Selection
You were asked to participate in this study because you were randomly selected from an identified group of local residents in an affected neighbourhood in the Fraser Valley Regional District. Households were identified with the use of GIS maps and were randomly selected within neighbourhoods. It is important that as many selected households as possible are included in the dataset to avoid selection bias. (This is a statistical term that means bias in the data can result when the characteristics of participants are not the same, on average, as the characteristics of households who do not choose to participate. In this case, if only households who feel strongly about the use of cannons choose to participate, the data that is collected will be biased and this will defeat one of the key purposes of this study which is to study the overall affects of the use of cannons on everyone, not just those who feel strongly about them.)

Anonymity and Confidentiality
In terms of protecting your anonymity, no identifying information of participants will be made available in any form when data is summarized and presented. Your confidentiality and the confidentiality of the data will be protected at all time. (Your survey will be shredded at the end of the project and the computer on which the data files are stored is password-protected.)

Contacts
If you have any questions with respect to this study, you may contact: Dr. Tracy Stobbe in the School of Business at TWU at (604) 513-2121 (ext. 3476), tracy.stobbe@twu.ca If you have any questions about your treatment or rights as a research participant you may contact Sue Funk in the office of Research and Faculty Development at TWU at (604) 513-2142, sue.funk@twu.ca If you have questions about noise regulations regarding cannons, please see the Ministry of Agriculture and Lands' website at www.al.gov.bc.ca/resmgmt/sf/farmpp/bird_devices.html
Thank you!