A RISK COMMUNICATION EXPERIMENT REGARDING CONSUMER DECISIONS ABOUT GENETICALLY –ENGINEERED INPUTS FOR SALMON AQUACULTURE

by

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ABSTRACT

Keywords:
Risk communication, mental models, genetic engineering, canola and salmon aquaculture

In the future, it may be possible to feed farmed carnivorous salmon on an essentially vegetarian diet by substituting genetically engineered canola for wild pelagic fish meal from South America as the main protein component in fish feed. By reducing the need for imported, high demand and sometimes unreliable wild fish, Canadian salmon farming productions may be able to lower their production costs and eventually be more competitive on the world market. However, in order for these technologies to be utilized by the aquaculture industry, the various risks and benefits associated with them must be acceptable to the citizens of Canada.

This research project analyzes and compares different methods of disseminating complex scientific information to Canadian consumers. The topic chosen is genetically engineered feeds that may be utilized by the Canadian salmon aquaculture industry in the future. To make more informed choices, the public needs access to trustworthy information that relates the known economic, social and environmental risks and benefits of using these new feeds. The motivation is to examine how different communication methods affect an individual's understanding of factual information, their confidence as a consumer, their acceptance of an issue, and their purchasing decisions.

The conceptual framework for this project involved four tasks. First, an extensive literature review was conducted in order to complete three flow charts that categorized the known economic, social, and environmental risks and benefits of using GE salmon feed. These charts were then distributed to a diverse set of experts who were asked to determine the validity of their content. Once these two stages were finalized, sixteen mental model interviews were conducted with volunteer members of the general public. During these interviews, I discovered that many people held common misconceptions regarding salmon aquaculture and genetic engineering technologies. These misconceptions would hinder the comprehension of new information and were addressed in the risk communication experiment. The experiment itself was an *in person* survey in three sections. In the first section, the respondent was asked a series of multiple choice questions concerning genetic engineering technologies and salmon aquaculture. In part two, the respondent was given three different methods of communicating the risks and benefits of using genetically engineered salmon feeds; a flowchart, a case study and frequently asked questions. Each format was based on the expert model flow charts. In the final section, the respondent was re-tested on the questions from section one and asked to rate the methods of communication in section two on several criteria.

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PREFACE

This thesis experiments with different methods of communicating complex scientific information to Canadian consumers. The motivation is to examine how different communication methods affect an individual's understanding of factual information, their confidence as a consumer, their acceptance of an issue, and their purchasing decisions. The subject that we chose for this experiment is genetically engineered feeds that may be used be the salmon aquaculture industry in the future. The methodology for the project is based on the mental models approach to risk communication created by Granger Morgan et al, (2002).[1]

We chose to address issues within the salmon aquaculture industry because of its controversial nature in Vancouver, British Columbia (BC). It is an industry that has disseminated very little meaningful information to the general public despite the fact it has been subject to a substantial amount of negative media attention. The pros and cons of salmon farming have been hotly debated in BC since this industry's inception in the mid 1980's. Many stakeholder groups have at times openly criticized salmon aquaculture in some locations along the Pacific coast. In 1995, debates over the environmental and social impacts of salmon aquaculture prompted a moratorium to be placed on this industry in BC. Despite lingering uncertainties, the moratorium was lifted in 2002, and the Canadian federal government has continued to support and promote the salmon aquaculture industry along both Canadian coasts.

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[1] Morgan, Granger M., Fischhoff, Baruch, Bostrom, Ann & Atman, Cynthis J.(2002).Risk Communication: A Mental Models Approach. Cambridge University Press.

Furthermore, the Canadian industry may soon adopt genetically engineered (GE) feeds as a means of decreasing overall costs and eliminating potential disease transfer from its current main protein component, wild South American fish. The canola plant could be engineered to make it easier for animals like salmon to digest.[2] However, it is possible that coupling GE technologies with salmon aquaculture may amplify the already controversial nature of this industry in BC. The Canadian public therefore needs to examine the wide array of risks and benefits associated with new transgenic salmon feeds before they can make informed purchasing decisions.

As mentioned, the methodology used in this thesis is based on the work of Granger Morgan, Baruch Fischhoff, Ann Bostrom, & Cynthis Atman, and their book *Risk Communication: A Mental Models Approach*. Together, this group has developed a systematic approach to risk communication. The mental models methodology acknowledges the fact that the minds of the general public are not a blank slate. Each individual will have a mental model of how their complex world operates. They will use this set of ideas, or pre-existing knowledge structures, to predict the world around them. They will also incorporate these preconceptions into their decision making processes. We use the mental models approach in a novel context rarely addressed in the past (GE animal feeds). As mentioned, this project also experiments with different methods of communication, a step rarely taken in the study of risk.

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2 Fisheries and oceans Canada, *Aquaculture –Biotechnology Topics*, January 2004, retrieved on February 2004 from http://www.pac.dfo-mpo.gc.ca/aquaculture/topics/salmonfeed_e.htm. This information was also confirmed through key informant interviews with employees of the Department of Fisheries and Oceans Canada.

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Financial support from AquaNet, the Center for the Integrated Study of Human Dimensions of Global Change at Carnegie Mellon University, and the University of British Columbia are highly appreciated. Special thanks also to my advisor Dr. Tim McDaniels, and to my committee members Dr. Les Lavkulich and Dr. Terre Satterfield. Lastly, I would like to acknowledge assistance from Joey Mikawoz, all of the experts who were consulted during this project, and the individuals who participated in our interviews and surveys.

A RISK COMMUNICATION EXPERIMENT REGARDING CONSUMER DECISIONS ABOUT GENETICALLY –ENGINEERED INPUTS FOR SALMON AQUACULTURE

1.0 INTRODUCTION

Members of the general public regularly make decisions about complicated issues in short periods of time with incomplete information. For example, while making food-purchasing decisions, individuals typically consider the nutritional content and price of the product, and how that product will affect the health and wellbeing of their family. A few may even reflect on the trade practices that allowed the product to reach the shelves of their local store. Many consumers now realise that what may appear to be a mundane purchasing decision can have significant impacts to people and ecosystems in other regions of the globe. As a result, many consumers want to be assured that children did not sew their clothes, and that the people who grew their coffee beans were paid a fair wage. When consumers decide to purchase products that contain genetically-engineered (GE) ingredients, they should be aware of the range of consequences that their decision will have on the farmers who grew the crop, the environment in which the crop was grown, and the company that owns the technology, among other things.

The price, nutritional content, ethical, and environmental impacts of a product amount to a great deal of information to consider while waiting in line at the grocery store. Many people do not have the requisite time and energy to research each of their purchasing decisions. As well, a significant portion of our interview respondents admitted that they did not know where to access information concerning certain food products, provided that it was in fact available to the general public. To make matters more complicated, Canadian consumers are often bombarded by messages from the media intended to manipulate them into watching a particular broadcast or reading a particular paper. If a product is given widespread attention by the popular media, that product may

be perceived as hazardous by the viewer despite scientific evidence to the contrary.[1] For this reason, risk communication literature often describes the media as an amplifier of risk because the social impacts of even minor events can be extreme if those events are covered extensively through the media.

> *Since the media tend to accord disproportionate coverage to rare or dramatic risks, or risk events, it is not surprising that people's estimates of the principal causes of death are related to the amount of media coverage they receive.*[2]

However, Roger Kasperson goes on to explain that the media is only one, among a myriad of factors that can influence an individual's purchasing decisions. Other significant factors include that individual's values, their comfort taking risks, and the trust they have in the body or individual disseminating the information. An animal rights activist may refrain from purchasing products that have been tested on animals as they place a great value on the welfare of non-human creatures. Because risk takers may be less concerned about the possible harms associated with certain products, they may make different purchasing decisions than those who are risk averse. And lastly, trust in the body providing the information will have a significant impact on a person's ultimate decision. Individuals who distrust major corporations will be less likely to believe such an organization when it states that a product is safe or healthy.

Thus it seems that even the most conventional purchasing decisions can be extremely complex. Various influences help to shape our decisions (i.e., the media, our values) and the impacts of our choices can affect people and ecosystems in many other regions of the globe. Risk communication is a tool that can be utilized to help consumers make informed decisions. This communication tool acknowledges the external and internal influences on our choices, while

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1 The Journal Science recently published the results of a study that found farmed salmon higher in PCBs than their wild counterparts. Since then, this study has been reported on extensively through the media. However, although levels of PCBs do seem to be higher in farmed salmon, these levels are still below Health Canada's current guidelines which are consistent with guidelines set by both the U.S. Food and Drug Administration (FDA) and the World Health Organization (WHO). Health Canada, *Food safety and PCBs found in fish*, January, 2004, retrieved on April 25, 2004 from http://www.google.ca/search?q=cache:-e-sHad4FXsJ:www.hc-sc.gc.ca/english/media/releases/2004/factsheet_food.htm+health+canada+farmed+salmon&hl=en&start=1

2 Kasperson, Roger E., Renn, Ortwin.,Slovic, Paul, Brown, Halina S., Emel, Jacque, Gobel, Robert, Kasperson, Jeanne X., & Ratick, Samuel. (1988). The Social Amplification of Risk: a Conceptual Framework. *Risk Analysis*. 8 (2), 177-187.

presenting complex information in a systematic way. Through risk communication, consumers are given the opportunity to think through many of the risks and benefits associated with their choices and make informed purchasing decisions that align with their values and beliefs.

1.1 OVERVIEW OF RISK COMMUNICATION

Two decades ago, risk analysis primary consisted of technical assessments performed by engineers and public health officers.[3] Over time, researchers within this field began to acknowledge the significance of perception, values, and public participation in the study of risk. As such, the discipline of risk analysis expanded to include risk communication, an interdisciplinary approach to public education that often involves psychologists, social scientists, and economists. Typically, risk communication is used to concentrate on the risks of specific risk events or hazards (i.e. nuclear power plant explosions, releasing of air emissions, disease transmission), or behaviours (i.e., smoking, radon testing). However, it was often performed in an ad hoc manner.[4][5] Researchers at Carnegie Mellon University believed that it was possible to improve the overall effectiveness of public risk communication by developing a more systematic approach that acknowledges the influence that an individual's pre-existing knowledge structures, or beliefs can have on how they learn.[6] They call this approach to risk communication the mental models methodology.[7]

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3 Engineering and Public Policy Carnegie Mellon University, *Risk Analysis and Risk Communication*, November 2002, retrieved on April 25th 2004 from http://www.epp.cmu.edu/research/risk.html

4 Morgan, Granger M.,Fischhoff, Baruch, Bostrom, Ann & Atman, Cynthis J.(2002).*Risk Communication: A Mental Models Approach*. Cambridge University Press

5 "...a U.S. consultant who monitored the communications strategies in SARS hot spots around the world offered a free assessment Wednesday: when it comes to risk communications, Health Canada officials are "zero beginners." "They were poor leaders,"...They just kept doing PR. Rah-rah Canada." The committee has ascertained that Health Canada does not have a sophisticated analytical framework for risk communication Branswell, Helen, Health Canada wants a grade on SARS risk communications; expert gives an F, *Canadian Press*, January 8 2004, retrieved on April 25, 2004 from http://mediresource.sympatico.ca/channel_health_news_detail.asp?channel_id=60&menu_item_id=4&news_id=3028.

6 Morgan, Granger M.,Fischhoff, Baruch, Bostrom, Ann & Atman, Cynthis J.(2002).*Risk Communication: A Mental Models Approach*. Cambridge University Press

7 Morgan, Granger M.,Fischhoff, Baruch, Bostrom, Ann & Atman, Cynthis J.(2002).*Risk Communication: A Mental Models Approach*. Cambridge University Press

The mental models methodology recognizes that the minds of laypeople are not a tabula rasa. Instead, this approach makes allowances for a person's individuality while disseminating information in a systematic and ethical way. As explained by Granger Morgan et al, each individual will have a mental model of how their complex world operates. They will use this set of ideas to predict the world around them and incorporate these ideas into their decision making processes. In the mental models risk communication process, the known risks and benefits of the product, behaviour, or event in question are determined by a diverse group of experts in order to minimize bias. The dissemination process thus allows the consumer to examine a wide range of risks and benefits of that product, behaviour, or event, thereby allowing that individual to determine which options align with their values and beliefs. Essentially, this process invites the risk communicator, expert, and layperson to work together to understand the acceptability of certain risks. This research project uses the mental models approach in a novel context rarely addressed in the past. The topic chosen is GE feeds that may be utilized by the Canadian salmon aquaculture industry in the future. We also experiment with different methods of communication, a step rarely taken in the study of risk.

1.2 CONCEPTUAL FRAMEWORK

The conceptual framework for this thesis involves four tasks and is based on the work of Granger Morgan et al and their book '*Risk Communication: A Mental Models Approach*'(see figure 1.1). First, an extensive literature review was conducted in order to complete three flow charts that categorized the known economic, social, and environmental risks and benefits of using GE salmon feed, which is the topic of interest in this paper.[8] These charts were then distributed to a diverse set of experts who were asked to determine the validity of their content. Once these two stages were complete, sixteen interviews were conducted with volunteer members of the general public. These interviews were intended to clarify and establish the mental models of our respondents and act as a basis for risk communication. During these interviews, it was determined that many people held

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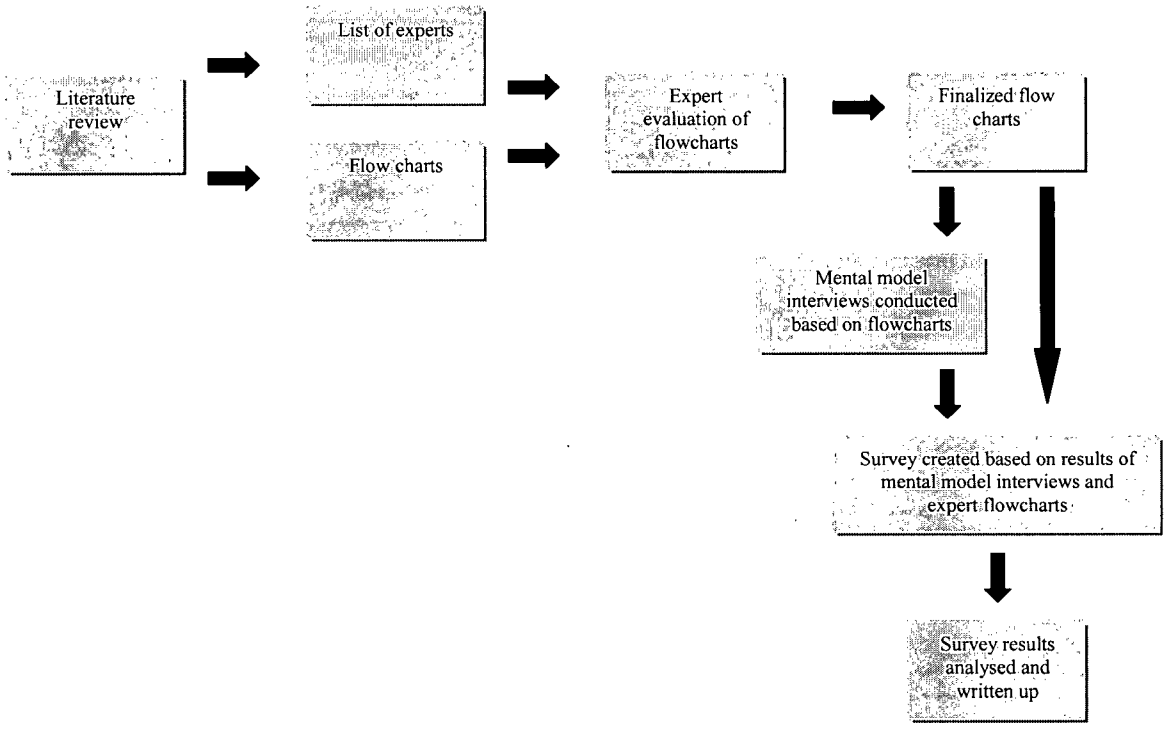
8 The decision context for this thesis is discussed in greater detail in chapter two

common misconceptions regarding salmon aquaculture and genetic engineering technologies. These misconceptions would hinder the comprehension of new information and were addressed in the risk communication experiment.

Figure 1.1 Overview of methodology



The experiment itself was an *in person* survey in three sections. In the first section, the respondent was asked a series of multiple choice type questions concerning genetic engineering technologies and salmon aquaculture. These questions were intended to test the prevalence of the common misconceptions discovered during the mental models interviews. In part two, the respondent was given three different methods of communicating the risks and benefits of using GE salmon feeds: a flowchart, a case study and frequently asked questions. Each format was based on

the expert model flow charts. In the final section, the respondent was re-tested on the questions from section one and asked to rate the methods of communication in section two on several criteria.

This thesis analyzes and compares different methods of disseminating complex scientific information to Canadian consumers. The motivation is to examine how different communication methods affect an individual's understanding of factual information, their confidence as a consumer, their acceptance of an issue, and their purchasing decisions. Each of these research questions is addressed in the in person survey. Understanding of factual information is determined by counting the number of correct and incorrect responses before and after the expert information is disseminated in part two of the survey. Influence on confidence levels is established by asking respondents to rate their confidence levels regarding certain purchasing decisions at the beginning and end of the survey. Overall acceptance is also determined by comparing responses from part one and three of the survey, and influence on purchasing decisions is ascertained by analysing responses at the end of the survey.

The following chapter will detail the problem at hand by providing an overview of salmon aquaculture in British Columbia and describing genetic engineering technologies that may be utilized in salmon aquaculture food production in the near future. Chapter three outlines why the practice of risk communication is important. Chapter four offers a more detailed description of the conceptual framework for this thesis including an explanation of the methodology used to inform the literature review, and the expert and layperson sample. Chapter five provides a description of the instruments that were created. Chapter six analyses the results of the interviews and surveys, and chapter seven relates some of the conclusions that can be drawn from these results with suggestions for further research.

2.0 OVERVIEW OF DECISION CONTEXT

To understand why public risk communication is important for consumer decisions regarding salmon aquaculture food products, it is helpful to explore a brief history of this industry in British Columbia (BC), Canada. This section details the topic at hand, and explains why the industry may choose to adopt GE technologies.

2.1 AN OVERVIEW OF SALMON AQUACULTURE IN BRITISH COLUMBIA

The pros and cons of salmon farming have been hotly debated in BC since this industry's inception in the mid 1980s. Stakeholder groups that have at times openly criticized salmon aquaculture in some locations include environmental non-governmental organizations (ENGOs), First Nations bands, local residents, commercial fishermen, and others who must share aquatic space with salmon farms. Although aquaculture has been practiced for thousands of years in other regions of the world, it is a relatively new industry to BC. As each ecosystem has unique characteristics and thresholds, the long term impacts of salmon farms along the Pacific coast of Canada cannot be predicted with confidence. The results of the literature review show that these unknown impacts are at the core of many arguments that oppose salmon farming.

Some ENGO's like the David Suzuki Foundation are convinced that salmon aquaculture will cause unacceptable harm to human beings. Such organizations often issue warnings to the pubic about the potential negative impacts associated with consuming farmed salmon.

> *Many people are turning to fish for a healthy contribution to their diet. This is generally a wise decision, but when it comes to salmon—choose wild over farmed for your and your family's well-being.*[9]

Other concerns focus on the harmful impacts that salmon farms may have on natural aquatic ecosystems. The most popular debates typically focus on the use of antibiotics, netpen containment technologies[10], medicated feeds, and the breeding of exotic salmon species.[11]

> *Greenpeace in British Columbia issued warnings throughout the 1990s, alerting citizens to the serious ecological dangers posed to wild salmon stocks and ocean ecosystems by the fish farm industry*

Much attention has also been directed at the social impacts of salmon aquaculture. The Environmental Assessment Office's 1997 Salmon Aquaculture Review (SAR) report recommended that the government adopt new siting criteria that allow for public participation in the siting process given the social impacts these farms may have on surrounding communities.[12][13] With their cultural ties to the natural environment, and their proximity to the farms, First Nations people likely experience the greatest direct impact from salmon aquaculture. Some bands have embraced the opportunity to bring a new industry into their community and have formed symbiotic relationships with multinational aquaculture companies. In 1998, the Kitasoo signed an agreement with Nutreco/Marine Harvest that successfully increased overall employment rates for the Kitasoo people and created a "*customized and accredited six-month aquaculture training program in the*

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9 David Suzuki Foundation, *Why you Shouldn't eat Framed Salmon*, retrieved on Feb 20, 2004 from http://www.davidsuzuki.org/files/PSF_Salmon_Brochure.pd

10 Netpens are often blamed for allowing Atlantic salmon to escape into Pacific waters. It is feared that this new species will out compete the native salmon, disturb their nests or negatively impact the larger ecosystem in ways we cannot anticipate

11 Atlantic salmon are bred on BC salmon farms because they are more docile. These salmon, unlike the Pacific variety, can withstand the stress of living with hundreds of other salmon in net pens.

12 Ministry of Agriculture Food and Fisheries, *Siting Fish Farms*, December 2003, retrieved on Feb 20 2004 from http://www.agf.gov.bc.ca/fisheries/siting_reloc/siting.htm

13 British Columbia Environmental Assessment Office, *Salmon Aquaculture Review -Consolidated List of Recommendations*, 1997, retrieved on April 2004 from http://www.intrafish.com/laws-and-regulations/report_bc/v1recs.htm

community".[14] However, many bands do not wish to participate in this industry. Local British Columbian First Nation bands like the Heiltsuk have stated that environmental damage caused by salmon farming could force them to change their traditional way of life. Some reportedly believe that salmon farming will destroy cultural food sources. Others fear that disagreements over the acceptability of this industry will cause pain between families living in the same or neighbouring villages thereby leading to dissention within their communities.[15]

In 1995, debates over the potential environmental and social impacts of salmon aquaculture prompted a moratorium to be placed on this industry in BC. This action prevented any new siting licenses from being granted while investigators studied the industry at its current level of production. Since that time, many hearings and reports have been conducted including the Salmon Aquaculture Review or SAR (1997), Ellis (1998), and Leggatt (1998) reports. As mentioned, the SAR report recommended that the government adopt new and improved siting criteria. According to the Ministry of Agriculture Food and Fisheries, the government has taken steps to comply with this request. [16] Recommendations from the Leggett report were more extreme. The latter document concluded that all netpen containment facilities should be removed from along the coast of BC by January 2005 due to the undesirable impacts of farms. [17] Despite lingering uncertainties, the moratorium was lifted in 2002, and the Canadian federal government has continued to support and promote the salmon aquaculture industry along both Canadian coasts.[18]

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14 Indian and Northern Affairs Canada, *Kitasoo Aquafarms Ltd. - Salmon Farm Now in the Pink*, December 2002, retrieved on March 25 from http://www.ainc-inac.gc.ca/nr/ecd/ssd/ma06_e.html

15 This passage was taken from McDaniels, Tim and Longstaff, Holly (2003) *Structuring Hierarchies of Objectives as a Framework for Salmon Aquaculture Risk Management Decisions.* This paper was one of the final products of a project funded by AquaNet. This section is describing the results of interviews conducted by student researcher Kira Gerwing.

16 Ministry of Agriculture Food and Fisheries, *Siting Fish farms*, Dec 2003, retrieved on Feb 20 2004 from http://www.agf.gov.bc.ca/fisheries/siting_reloc/siting.htm

17 Leggatt, Stuart M, *Clear Choices, Clean Waters, the Leggatt Inquiry into Salmon Farming in British Columbia*, 2002

18 "Securing our Future Together, the Liberal Party's 1994 election platform, stated that improved support for the aquaculture industry from the federal government and its agencies would foster more rapid growth of the industry." (Office of the Commissioner for Aquaculture Development, *The Role of the Federal Government in Aquaculture*, July 2000, retrieved on February 2004 from http://ocad-bcda.gc.ca/emandate.html.)

2.2 GENETIC ENGINEERING TECHNOLOGIES UTILIZED IN SALMON AQUACULTURE FOOD PRODUCTION

Over the last few decades the BC salmon aquaculture industry has grown to become the fourth largest producer of farmed salmon in the world, providing millions of dollars each year to the provincial economy. In 2002, the farmgate value of farmed salmon was approximately $290 million while the value of salmon aquaculture products shipped to market was nearly $359 million at the wholesale level .[19] Yet despite this scale of economic success, the industry must operate within an extremely competitive world aquaculture market. As there is no global regulator of world salmon aquaculture, nations could employ environmentally questionable farming techniques to increase their short term profits. Federal and provincial regulations have been installed to prevent these sorts of practices in BC. The Canadian industry must therefore choose different methods of increasing its efficiency. Adopting genetic engineering technologies is one such option.

Currently, the main protein component in farmed salmon feed includes wild fishmeal and fish oil from South America. However, the salmon aquaculture industry is not the only consumer of this resource. Wild fish from this area of the world are also harvested for poultry, swine, and other animal feeds. As well, there is an increasing demand for wild fish oil because of its reported benefits to human health. These pressures, coupled with the fact that wild fishmeal and oil are subject to over-harvesting, natural disasters, and climate change will likely increase the costs of importing this resource in the future.[20] Experts from Fisheries and Oceans Canada report that feed costs for British Columbian salmon aquaculturalists are already approximately 50-60% of their total production costs[21]. The protein component makes up approximately 50% of the feed costs and fishmeal makes up roughly 25 - 50% (by weight) of the protein component (See figure 2.1). Consequently, finding an

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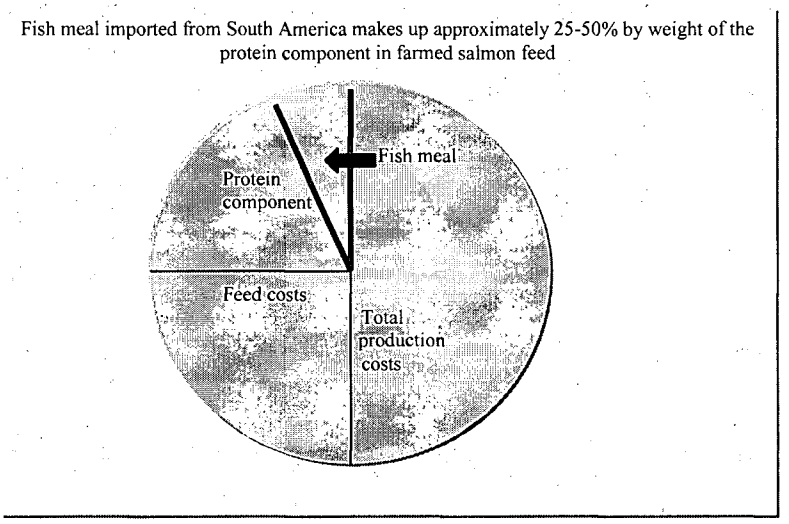
19 Ministry of Agriculture, Food and Fisheries, *BC Salmon Aquaculture Industry*, December 2003, retrieved on Feb 20 2004 from http://www.agf.gov.bc.ca/fisheries/bcsalmon_aqua.htm

20 This information was gained through key informant interviews with employees of the Department of Fisheries and Oceans Canada.

21 This information was gained through key informant interviews with employees of the Department of Fisheries and Oceans Canada.

alternative, stable source of local protein and oil would be economically advantageous to the Canadian aquaculture industry.

Figure 2.1 Break down of feed costs for the salmon aquaculture industry in BC according to experts at Fisheries and Oceans Canada.



Canadian grown canola could potentially be used as the main protein component in farmed salmon feed. The impediment to this option is that salmon, like many other carnivorous animals, cannot digest the phytic acid in canola because they lack the digestive enzyme phytase.[22] Although canola is already present in farmed salmon feed, using larger quantities of this oilseed plant would likely require the use of GE technologies.[23] The canola plant could be engineered to produce lower amounts of phytic acid thereby making it easier for animals (i.e., salmon) to digest.[24] It would also likely be engineered in ways that would make it more economically efficient to grow. Some of the latter modifications may include herbicide, frost, or pest resistance.

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22 According to Fisheries and Oceans Canada, Phytic Acid is a form of phosphorus that "*inhibits digestive absorption of some minerals and amino acids*". Fisheries and oceans Canada, *Aquaculture –Biotechnology Topics*, January 2004, retrieved on February 2004 from http://www.pac.dfo-mpo.gc.ca/aquaculture/topics/salmonfeed_e.htm.

23 It should also be noted that genetically engineering the canola plant is only one option available to the salmon aquaculture industry. In order to make larger quantities of canola digestible to animals, the industry could also choose to genetically engineer the salmon, or use food additives. These options were not discussed in detail in this project.

24 Fisheries and oceans Canada, *Aquaculture –Biotechnology Topics*, January 2004, retrieved on February 2004 from http://www.pac.dfo-mpo.gc.ca/aquaculture/topics/salmonfeed_e.htm. This information was also confirmed through key informant interviews with employees of the Department of Fisheries and Oceans Canada.

Animal feeds with GE ingredients could soon become a reality for the salmon aquaculture industry. Scientists at Fisheries and Oceans Canada have been investigating ways to use plants like canola in fish feeds for over two decades.[25] [26]On January 9th 2004, the journal 'Science' confirmed that farmed salmon is higher in industrial pollutants called polychlorinated biphenyls (PCBs) and other cancer causing contaminants than wild salmon. The fishmeal component of the farmed salmon feed was cited as the likely source of these contaminants.[27] The salmon aquaculture industry may therefore also choose to adopt transgenic feeds as a means of reducing the overall amount of fishmeal, and thereby, toxins in their fish.[28] Nevertheless, the decision to use transgenic feeds will undoubtedly require community consultation and public risk communication given the controversial nature of this issue.

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25 Betts, Kellyn S, Improving Fish Food, *Technology News*, February 12 2004, retrieved on Feb 20, 2004 from http://pubs.acs.org/subscribe/journals/esthag-w/2004/feb/tech/kb_fishfood.html.

26 Research studies conducted by Dr David Higgs at Fisheries and Oceans Canada have successfully substituted potions of fish meal with high protein plants. For more information on this subject please see Dosanjh, B.S., D.A. Higgs, D.J. McKenzie, D.J. Randall, J.G. Eales, N. Rowshandeli, M. Rowshandeli, & G. Deacon. (1998). Influence of dietary blends of menhaden oil and canola oil on growth, muscle lipid composition and thyroidal status of Atlantic salmon (Salmo salar) in sea water. *Biochem* 19, 123-134.

27 Hopki, Michale, Farmed Salmon Harbour Pollutants, *Nature News Service* January 2003, retrieved on February 20, 2004 from http://www.nature.com/nsu/040105/040105-10.html

28 In this thesis, a "transgenic" organism is defined as an organism that has a gene from another organism inserted into its genome. This definition is found in the Royal Society of Canada's, Expert Panel on the Future of Food Biotechnology, *Expert Panel Report*, 2001.

3.0 WHY RISK COMMUNICATION IS IMPORTANT

There are three reasons why it is important to have risk communication for GE inputs to salmon aquaculture food products. The first reason is so that consumers can decide whether they want to purchase this product, the second is to avoid confusion and possible manipulation, and the third is to reduce the potential for risk amplification. These issues will be explored in the following paragraphs.

The lack of consumer control concerning GE inputs for salmon aquaculture food products could become a contentious issue in BC. Currently, the Canadian public cannot choose whether to consume GE food products or animals that have consumed GE feeds because these items are not labelled in Canada and they cannot be identified by sight, taste or texture. Genetically-engineered foods are considered safe in Canada if they are '*substantially equivalent*' to their non-GE counterparts.[29] The Canadian public needs to examine the wide array of risks and benefits associated with new transgenic salmon feeds before they can make informed purchasing decisions. Upon receiving this information, they may decide that these feeds are actually the more environmentally, socially, or economically responsible choice for Canadian consumers. Yet, regardless of their ultimate decision, they should be given the opportunity to make that informed choice. To promote a trustworthy relationship with the public and reduce stigmatization, the aquaculture industry should encourage transparency in all of their activities. Disseminating meaningful information regarding the actual risks and benefits associated with transgenic salmon feeds would be a strong first step. Ideally, this process should take place before any new procedures are adopted by the Canadian aquaculture industry.

One of the objectives of this project is to experiment with different methods of communicating complex information in order to reduce the potential stigmatization of GE farmed

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29 GMO stands for genetically modified organism. Information on *substantial equivalence* can be found in the Royal Society of Canada, Expert Panel on the Future of Food Biotechnology, Expert Panel Report, 2001.

salmon feeds. We found that most of the people who participated in this research project had very little knowledge of GE food products and what's more, did not seem particularity concerned about them. However, those who disapprove of transgenic feeds could take advantage of this situation by supplying the general public with misleading or sensational information. Such practices would make it very difficult for consumers to make informed decisions that accurately reflect their values and beliefs. If the practice of using GE salmon feeds becomes exceedingly controversial, or stigmatized by consumers, any form of risk communication will be ineffective. Our goal is to initiate open communication about the known risks and benefits of these choices before the industry adopts any new technologies and before debates concerning these risks and benefits are played out in the popular media.

It is also possible that coupling GE technologies with salmon aquaculture may amplify the already controversial nature of this industry in BC. This would be particularly likely if the aquaculture industry were to utilize new transgenic feeds without informing the Canadian consumer. In our in person survey, we asked respondents to identify some of their concerns regarding farmed salmon being fed with GE canola. Before they examined expert information on the subject, almost half (22) said that using GE canola to feed farmed salmon would amplify or compound their pre-existing concerns about this industry (n=49). After examining our expert information, six fewer respondents reported this as a major concern.

Even if it is determined that there are very few environmental, economic, or social risks associated with GE farmed salmon feed, risk communication is still important. It will only be a matter of time before the uninformed Canadian public discovers that they have been consuming farmed salmon that were fed with transgenic feed without their knowledge or consent. This situation could promote even more resentment of the BC aquaculture industry, which in turn could irrevocably harm this industry's economic potential in Canada.

4.0 CONCEPTUAL FRAMEWORK: EXPERT AND LAYPERSON VIEWS

Experts in recombinant DNA technologies used in food production may believe that the risks of utilizing these technologies are relatively low and are justified by the potential benefits.[30][31] Yet, technical experts and laypeople can have contradictory perceptions of risk. As explained by Paul Slovic, laypeople tend to rate risk based on their intuitive risk judgements, which are informed primarily by the media instead of scientific knowledge. Underlying these intuitive judgements may be criteria such as the event's catastrophic potential, involuntariness, risk to future generations, how delayed its effects are, and whether it is controllable. In contrast, experts tend to rate riskiness based on "*technologically sophisticated*" risk assessment that may include criteria such as expected annual mortality.[32] These two approaches of categorizing risk can make it difficult for laypeople and technological experts to communicate with each other about the acceptability of certain risks.

In this project, we attempted to foster communication between experts and laypeople by bridging the gap between expert and layperson perceptions of risk. As asserted by Slovic, "*...risk communication and risk management efforts are destined to fail unless they are structured as a two-way process. Each side, expert and public, has something valid to contribute. Each side must respect the insights and intelligence of the other.*" [33] We captured the environmental, economic, and social risks and benefits of using GE canola to feed farmed salmon in three flow charts. These flow charts were based on an extensive literature review and were evaluated by our expert sample. After our experts finalized their evaluation, these charts reflected the collective perceptions of a diverse group of experts in the field of salmon aquaculture and GE technologies. In order to help laypeople become active participants in the risk communication process, the expert information in the flowcharts was presented in a decision context that would be meaningful to the citizens of BC. For

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30 Slovic, Paul. (1987). Perception of Risk. *Science*. 236, 280-285

31 Recombinant DNA is "DNA molecules created by splicing together two or more different pieces of DNA" Royal Society of Canada, Expert Panel on the Future of Food Biotechnology, Expert Panel Report, 2001.

32 Slovic, Paul. (1987). Perception of Risk. *Science*. 236, 280-285

33 Slovic, Paul. (1987). Perception of Risk. *Science*. 236, 280-285

this context, we chose everyday purchasing decisions. These revised flowcharts were then used to guide a series of interviews with volunteer members of the general public. Together, the results of the layperson interviews and the expert flow charts comprised the backbone of the final stage of this project, the in person survey conducted with forty-nine laypeople. The remaining subsections of this chapter will describe the methodology used for the literature review, as well as the conceptual framework that informed the expert and layperson samples.

4.1 LITERATURE REVIEW FOR CREATING THE EXPERT MODEL FLOW CHARTS

The first step in this project was to conduct an extensive literature review in order to create three expert model flow charts. These charts were intended to categorize the known environmental, economic, and social risks and benefits of using GE canola to feed farmed salmon. While many articles were referenced during the course of this literature review, one report was particularly important to the process. This document was the Royal Society of Canada's Expert Panel on the Future of Food Biotechnology.[34] This panel was commissioned by Health Canada, the Canadian Food Inspection Agency, and Environment Canada to provide advice on the health of novel food products. It is a thorough document that covers a wide variety of topics including salmon aquaculture and transgenic feeds. Other sources included documents produced by ENGO's, and provincial and federal government bodies. For a complete list of these documents, please see the bibliography found at the end of this thesis.

Although a traditional literature review was initially used for this project, the worldwide web was also an essential source of information. Searches on GE technologies resulted in an overwhelming amount of information. It was necessary to identify key interested parties in this controversy in order to narrow this search. Websites produced by special interest groups who oppose GE food technologies or salmon aquaculture, and industries that support these technologies or salmon

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34 Royal Society of Canada. (2001). *Expert Panel on the Future of Food Biotechnology,*. Expert Panel Report.

aquaculture were used frequently. We found that many of the arguments focussed on a few key issues. These issues were identified and incorporated into the expert model flow charts, which were created after the literature review was complete.

4.2 EXPERT SAMPLE

As stated previously, a variety of experts were consulted to review the original flow charts. An individual had to have expert knowledge in at least one of the subject areas relevant to this issue to be considered an expert for this study. The experts recruited for this project were drawn from many organizations including: Fisheries and Oceans Canada (DFO), the British Columbian Aboriginal Fisheries Commission, and the Prairie Feed Resource Centre at the University of Saskatchewan. Experts in food systems, the fish feed industry, nutrition, human health, and terrestrial canola farming were also consulted. The expert characterization process worked as follows. First, a list of experts was compiled based on popular references identified through the literature review. Care was taken to ensure that the sample would be as unbiased as possible, accurately representing the wide variety of expertise and opinions within the field of food biotechnology and salmon aquaculture. A list of experts who participated in this research study is shown in table 4.1 below. The names of individuals have been altered to maintain their anonymity.

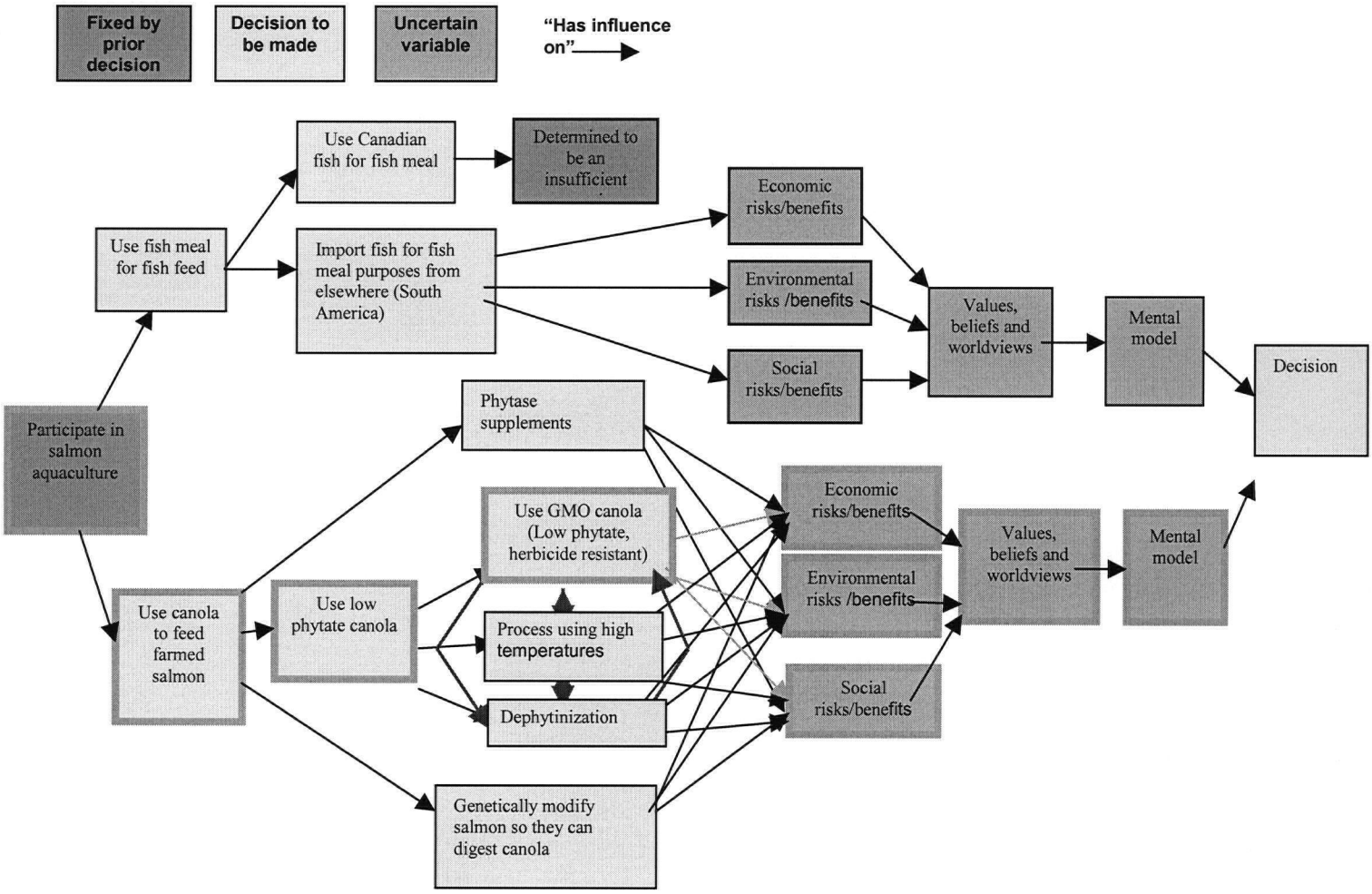
Table 4.1. Experts sample

Expert	Affiliation and area of expertise
Dr A	Representative of government body Expert in GE technologies and GE salmon
Dr. B	Representative of government body Expert in GE technologies, GE canola and utilizing GE canola for farmed salmon feeds
Ms C	Expert in issues concerning aboriginal fisheries
Mr. D	Employed in field of research and development for major fish feed company One of the first experts to identify the need for alternatives to fish meal and fish oil in the rapidly growing global aquaculture industry
Mr. E	Expert on the food system, author, researcher and writer on biotechnology. Expert environmentalist
Dr. F	Professor Expert in food, nutrition, health, and agricultural sciences
Dr G	Associate Professor Expert in food, nutrition, health, and agricultural sciences
Mr. H	Expert developer of noel fish feeds and grower of Roundup Ready canola.

After a short list of experts was assembled, each individual was contacted via e-mail or telephone. If the individual agreed to participate, they were sent a package that included the three expert model flow charts categorizing the environmental, economic, and social risks and benefits of using GE canola to feed farmed salmon.[35] They were also given the conceptual framework for the project, a list of tasks they would need to complete, and a decision tree that outlined the various choices that were available to members of the aquaculture feed industry (see figure 4.1). Once the expert reviewed their package, they were given (approximately) one month to evaluate the flow charts and make any necessary changes or suggestions. Of all the experts who were sent these packages, eight responded.

35 These flow charts will be discussed in greater detail in the Instruments chapter of this thesis.

Figure 4.1. Influence diagram for decision makers within industry



4.3 LAYPERSON SAMPLE

The following section gives a detailed description of the interview and survey respondents who participated in this research project.

4.3.1 MENTAL MODEL INTERVIEW RESPONDENTS

Representatives from the general public were needed for the final two sections of this project, the mental model open-ended interviews and the in person surveys. The individuals that we recruited represented a random sample of many diverse cultures, age categories, and occupations, but none were experts in any subjects relevant to this project. The only filter for participation was that the individual had to be involved in their household's purchasing decisions. The main goal of the recruitment process was to create a sample that had a fairly even gender split and that did not overly represent any particular section of the larger population of Vancouver, BC. Individuals were recruited at a downtown Vancouver office building, an aquatic center, The University of British Columbia, and a church.

A mental model is a collection of thoughts and beliefs that a person holds concerning the functioning of the world. They are informed by that person's life experiences or worldview, and help the individual to navigate through a very complex world.[36] However, these models are not always accurate. The purpose of our mental model interviews was to uncover what the public's perceptions, or a priori knowledge, of salmon aquaculture food products and GE technologies are. Once these mental models were examined, the expert information was organized into a format that would effectively speak to them by addressing major uncertainties or points of common interest.

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36 Morgan, Granger M.,Fischhoff, Baruch, Bostrom, Ann & Atman, Cynthis J.(2002).*Risk Communication: A Mental Models Approach*. Cambridge University Press

We initially set out to interview at least 30 individuals for the mental model interviews in accordance with advice given in the book "*Risk Communication: A Mental Models Approach*". [37] The researchers who wrote this book found that new information was not usually collected after 30 interviews, making additional interviews redundant. For this project, new information stopped being gathered after the 4th interview. A pattern of shared misconceptions emerged very early in the process and was continually referred to in subsequent interviews. Therefore, for the sake of efficiency, the mental model interviewing process was halted after 16 interviews. Misconceptions and the general concerns that were brought up during these open ended interviews would be used as a basis for section one of the in person survey. The individuals who were interviewed for the mental model interviews were recruited according to their gender, occupational background and age. They were not paid to participate in this project, and each signed a consent form approved by the University of British Columbia's Office of Research Services. Table 4.2 shows a statistical break down of the individuals who participated in the mental model interviews.

[37] Morgan et al, (2002)

Table 4.2 Statistical breakdown of mental model interview sample population

Mental model interview respondents		
Total number of participants	16	
Gender	Females	9
	Males	7
Range of occupations	– Students (5) – Journalist – Nanny/community support worker – Geographer – Musician – Mom – Graphic designer – Optometrist – Marketing financial products – Research scientist – Chartered accountant – unknown	
Age	21-30	9
	31-40	4
	41-50	2
	No response	1
Average running time	35 minutes	

4.3.2 SURVEY RESPONDENTS

Forty-nine respondents completed the in person survey portion of this project. They were recruited in the same locations as the mental model interview respondents, and were meant to represent a larger sample of those individuals. Each was paid ten dollars for their time, and signed a consent form approved by the University of British Columbia's Office of Research Services. The completion rate for this survey was 100%, and the completion time varied between 45 minutes to 1 hour per survey. In all cases, respondents were invited to write notes of criticism in the margins of their surveys or talk with me about the process after they had completed each section. In almost every case, the respondents offered very constructive suggestions and chose to discuss their comments at length.

Table 4.3 shows the statistical breakdown for the individuals who completed the in person survey. It is important to note that this sample cannot be used to represent the views of the general

population in Vancouver. This project should instead be viewed as a pilot project that experimented with different methods of communicating complex scientific information. As it was a novel approach to risk communication, we chose a methodology that allowed us to spend a great deal of time with each participant. Given time and monetary constraints, it was not practical to use a larger population with this methodology.

Table 4.3 Statistical breakdown survey sample population

Survey respondents		
	Statistical breakdown % (n=49)	
	n	%
Gender		
Female	29	59%
Male	20	41%
Occupation		
Student	10	20%
Non-student	39	80%
Age		
18-30	23	47%
31-60	14	29%
61 and over	12	24%
Note: Values may not sum to 100% due to rounding		

5.0 INSTRUMENTS

This project utilizes three different tools, the expert model flow charts, the mental model interview questions, and an in person survey. Each of these instruments is described in the following paragraphs.

5.1 EXPERT MODEL FLOW CHARTS

As mentioned previously, the expert model flow charts were based on an extensive literature review and were intended to categorize the known economic, environmental and social risks and benefits of using GE salmon feeds. The economic flow chart addressed the various economic risks and benefits that transgenic feeds posed to the Canadian salmon aquaculture industry, consumers of salmon aquaculture food products, users of aquatic resources in BC, BC coastal First Nations bands, and Canadian farmers (see figure 5.1). The environmental flow chart addressed the risks and benefits that transgenic feeds might pose to the aquatic environment along the coast of BC and South America, to farmed and wild salmon, and to ecosystems in the Canadian prairies (see figure 5.2). The social flow chart addressed a variety of concerns that ranged from consumer confidence issues to issues concerning animal welfare (see figure 5.3). To ensure their accuracy, each chart was examined by our sample of experts.

Figure 5.1 The **potential economic** risks and benefits of using GE canola as an alternative protein source for farmed salmon

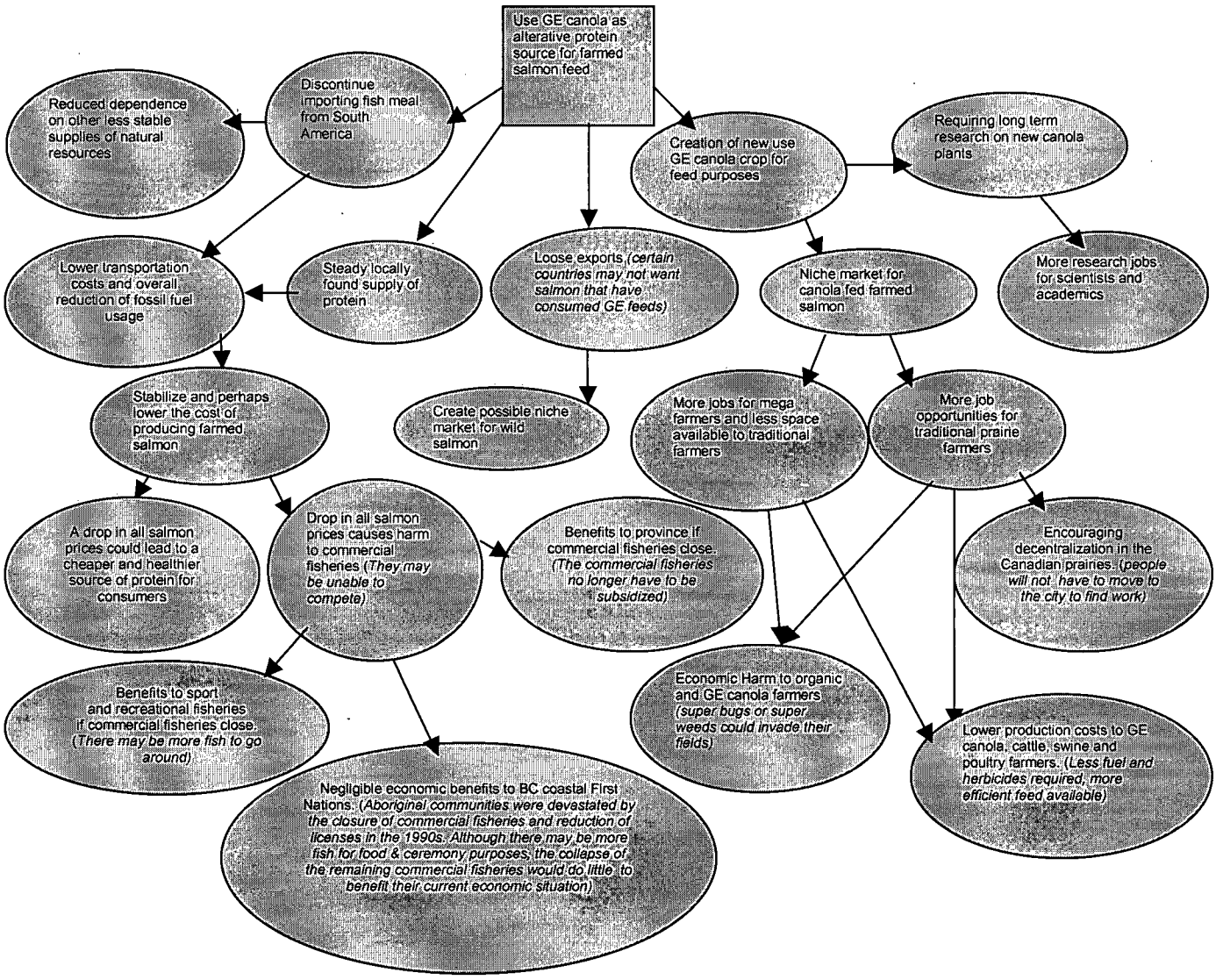


Figure 5.2 The **potential environmental** risks and benefits of using GE canola as an alternative protein source for farmed salmon

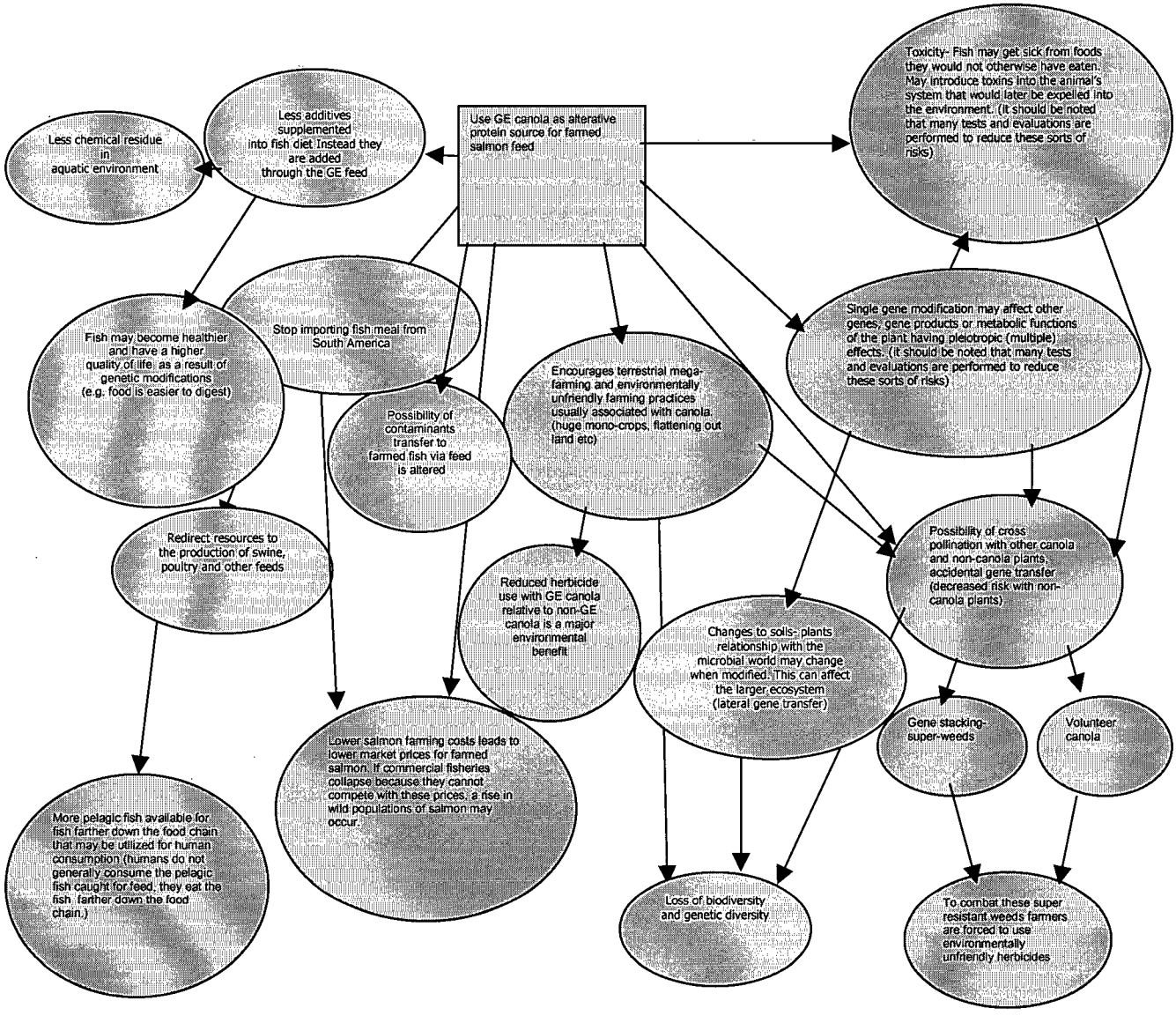
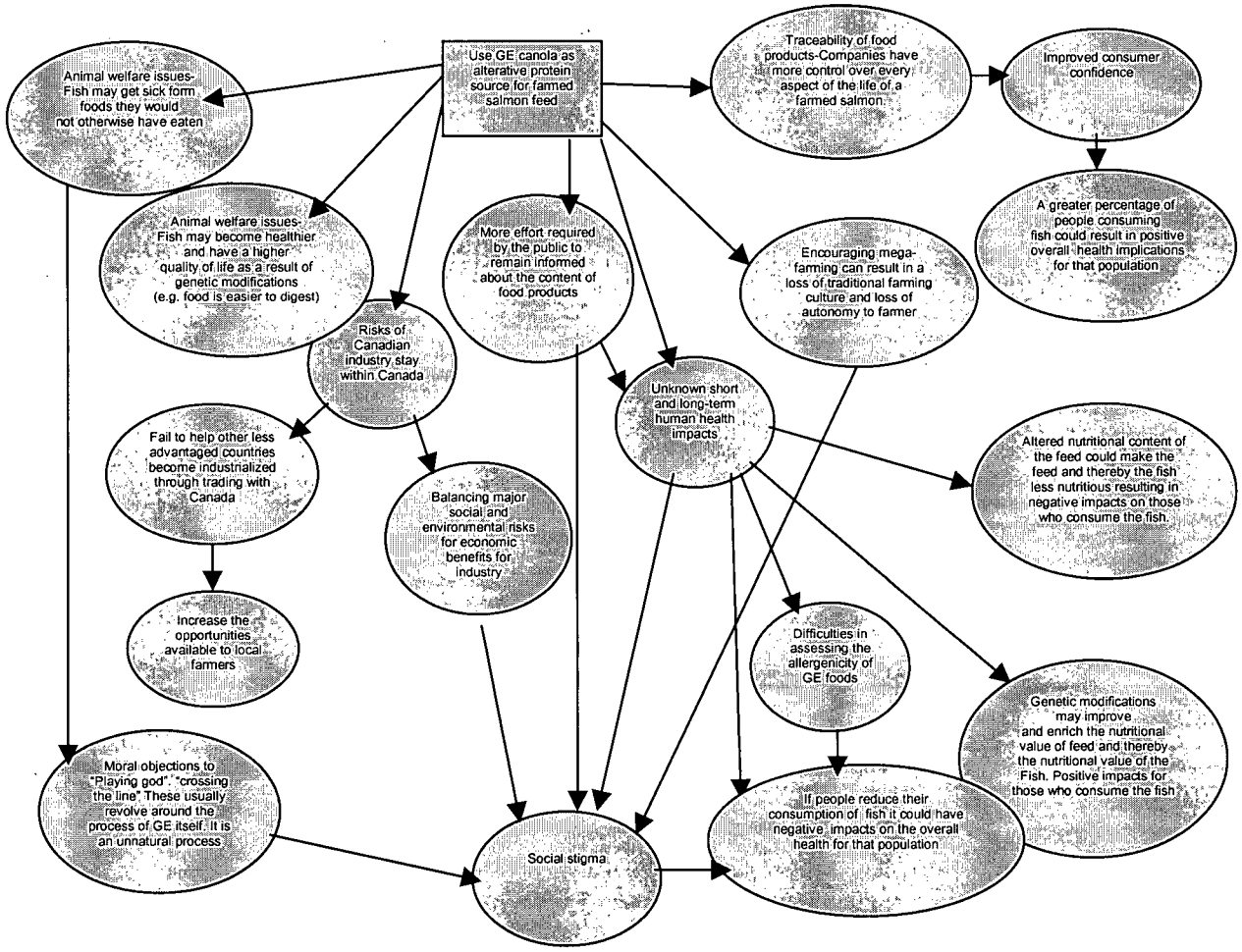


Figure 5.3 The **potential social** risks and benefits of using GE canola as an alternative protein source for farmed salmon



The flow charts consist of text bubbles that are connected by arrows indicating causal connection. Each chart flowed from the same source text box. This original text box described the decision that initiated the chain reaction in each chart, *"Use GE canola as alterative protein source for farmed salmon feed*". Each diagram explores its theme in relatively general terms, and should be read from the top down. Items that were overly complicated or unnecessary to the comprehension of the overall problem were omitted. For example, the specific actions that take place when a GE canola plant's genes are transfer to the soil around it are not given in detail. The respondent is only told in

general terms what this process is, and that it can occur. The charts were altered in accordance with each expert's advice. Entire bubbles were added, subtracted, and occasionally, the scripts inside the bubbles were modified. The process was halted after our team of experts generally agreed that further modifications of the flowcharts were unnecessary.

5.2 MENTAL MODEL INTERVIEW QUESTIONS

For the second stage of the project, sixteen mental model interviews were conducted. The format of the interview was analogous to a long open ended conversation that was lead by the interviewer. The three expert model flowcharts from phase two were used as a guide for the questions that were asked during the course of the discussion. Each individual was asked the same eleven questions and was encouraged to speak on each for as long as they felt comfortable.[38] Table 5.1 presents a complete list of questions that were included in each interview. Respondents would often spend more time on certain questions, and less on others. For this reason, the duration of these interviews varied from approximately twenty minutes to over ninety minutes. If the individual exhibited substantial knowledge in a particular area, they would be asked increasingly specific questions until they had exhausted their resources on the subject matter.

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38 Although the same questions were asked in each interview, many interviews included additional questions that reflected the respondent's knowledge in certain areas. The expert model flowcharts were used as a guide for these additional questions.

Table 5.1 A complete list of mental model interview questions

Mental model interview questions	Percentage of respondents that answered
1. Tell me about salmon aquaculture	100%
2. What do farmed salmon eat? (Ingredients)	100%
3. Where does farmed salmon feed come from (physical location/place)	100%
4. Do you purchase farmed salmon and why/why not?	100%
5. Do you have any concerns about purchasing farmed salmon? (if your answer is yes, please explain what these concerns are)	100%
6. Do you have any concerns about purchasing genetically-engineered food products?	100%
7. What foods that you eat are genetically-engineered? How do you know that they are genetically -engineered?	100%
8. What concerns do you have about purchasing farmed salmon that were fed with genetically-engineered canola?	100%
9. What concerns do you have about purchasing salmon that were fed with wild fish from South America?	100%
10. Suppose that you knew that a farmed salmon had been fed with genetically-engineered canola. Would this information influence your decision to purchase this fish? A. This would not influence my decision to purchase this fish B. This would influence my decision to purchase this fish. It would make me less likely to purchase this fish C. This would effect my decision to purchase this fish. It would make me more likely to purchase this fish Please explain your answer in more detail	100%
11. Is there anything else about farmed salmon or genetically-engineered food/feeds that I have not asked you that you would like to tell me?	100%

Each interview was recorded on an audio tape with the respondent's knowledge and permission. At no time during the interview was a subject told whether their responses were correct or how they should answer a question. When conducting the mental model interviews, we were looking for misconceptions and beliefs that would hinder the comprehension of new information. These misconceptions and beliefs were addressed in the final section of the project (the in person survey) while the respondent was being provided with new information concerning salmon aquaculture and GE technologies.

5.3 IN PERSON SURVEY

The final section of this project involved creating an in person survey consisting of three sections.[39] In the first section, the individual was asked a number of multiple-choice type questions that were based on the results of the mental model interviews. These questions tested the prevalence of certain misconceptions that were discovered during the earlier interviews, and probed the respondent's general knowledge of salmon aquaculture and GE technologies.

In the second section, the individual was given the expert information regarding the risks and benefits of transgenic farmed salmon feeds in three different formats. [40] The environmental risks and benefits were provided in a frequently asked question (FAQ's) format, the economic risks and benefits were outlined in a flowchart, and the social risks and benefits were described in a narrative case study. This middle section provided the respondent with the information she would require to answer the questions from section one.

The third and final section of the survey asked the respondent to perform three separate tasks. They were re-asked the multiple-choice questions from section one, asked to rate the methods of communication from section two, and asked to describe how the materials provided in this survey might affect their purchasing decisions, their confidence as a consumer and their overall acceptance of this issue.

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39 This survey is included at the end of this thesis in appendix B

40 Note that the methods of communication were continually rotated to avoid bias.

6.0 RESULTS

The first half of this section outlines the results that were gathered through consulting our expert sample. The latter half describes the results of our mental model interviews and surveys with laypeople.

6.1 EXPERT CHARACTERIZATION

One surprising result from this phase of the project involved the level of ultimate agreement between the experts. Most were happy to participate in this process and very few attempted to speak on issues outside their field. By the end of the three month period, our diverse group of experts had essentially come to agreement on the three flowcharts. That said, it should be noted that some of the experts that were consulted during this project were annoyed with the constraints that were placed on their choices.

Some of the experts consulted during this phase believe that a moratorium should be reintroduced on the BC salmon aquaculture industry or that the industry should be shut down permanently. For the purposes of this project, we asked them to assume that the salmon aquaculture industry was fully operational as we were only interested in receiving their opinions under what we felt were realistic conditions. The Canadian federal government is, and will likely continue to be, a strong proponent for netpen salmon aquaculture. Despite lingering objections, there does not seem to be any indication that this industry will be disbanded in BC. There is also considerable evidence to suggest that the BC salmon aquaculture industry may soon adopt new GE feeds in order to compete on the global market, and reduce the possibility of PCB contamination in their fish. This project was intended to communicate the risks and benefits of GE technologies used by the salmon aquaculture industry given certain facts that will inevitably constrain everyone's choices.

6.2 LAY CHARACTERIZATION RESULTS

In this section, the results of the mental model interviews and in person survey will be discussed in detail. A complete collection of all survey statistics and the instrument itself is provided at the end of this document in appendices A and B respectively.

6.2.1 MENTAL MODEL INTERVIEW RESULTS

We reviewed the audio taped discussions once the mental model interviews were complete. We soon discovered that many of the respondents held similar misconception regarding salmon aquaculture and other subjects relevant to this study. These misconceptions were later confirmed in a larger sample during the in person survey. For example, a large number of the individuals who participated in our study believed that salmon were omnivores or herbivores. This assumption is incorrect. Salmon are actually a carnivorous fish that require high protein diets. Other important misconceptions that were discovered during the mental model interviews concerned the canola plant.

Canola is a plant that was derived from rapeseed through traditional breeding methods.[41] In Canada, it is grown primarily in the Prairie Provinces (Alberta, Saskatchewan and Manitoba) although there are also some fields in southern Ontario and Quebec. It is a plant that can be genetically-engineered with ease to produce novel plants that are frost, herbicide, or pest resistant. In our mental model interviews, only two respondents were able to correctly tell us what canola was. Six individuals believed that it was some sort of grain, but were unfamiliar with any of the issues or controversies surrounding this particular crop. Our respondents were also confused about the origin of the ingredients for BC farmed salmon feed. During the interviews, the respondents were asked to tell us where the ingredients for farmed salmon feed came from. The majority of those interviewed

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[41] Canola Council of Canada, *Truths and Myths about Canola*, retrieved on April 1, 2003 from www.scdc.sk.ca/html/educ.html

believed that all of the ingredients came from Canada. In fact, none of the individuals gave the correct response or even suspected that some of the ingredients might come from South America.

Table 6.1 shows a list of the most significant misconceptions discovered during the mental model interviews. Notice that the number of times that a particular misconception was mentioned does not add up to the number of people interviewed. This is because the respondents were encouraged to speak at length on each issue and in most cases, give more than one response to each question. For example, when they were asked what they thought salmon would typically eat in nature, some individuals replied that these fish ate algae, aquatic plants, or nutrients floating in ocean water. Eight of our respondents believed that salmon likely consumed other fish as well, but few reported that the salmon were strictly carnivorous. In other words, a significant proportion of our respondents assumed that salmon were either omnivores or herbivores.

Table 6.1 Common misconceptions held by mental model interview respondents

Question	Correct response	Respondent answer	Number of times mentioned
What do wild salmon eat?	Salmon are carnivores	Aquatic vegetation	9
		Micro organisms in the water	2
		Other fish	8
What is canola?	An oilseed crop grown in the prairie provinces of Canada(Manitoba, Alberta and Saskatchewan)	Wheat	5
		Corn	2
		Oilseed, derived from rapeseed, mustard family	2
		Some kind of grain	6
		No idea	2
Where do the ingredients in farmed salmon feed come from?	South America (protein component) and North America for the rest	Canada	15
		USA	3
		Asia	2
Note: totals may not sum to 100% as individuals could offer multiple responses			

Misconceptions as filters for new information

Many of the misconceptions that were discovered during the mental model interviews would need to be corrected before any additional information was provided to the respondents. These misconceptions would likely hinder the comprehension of new information because of the underlying assumptions that informed them. Some of these mistaken beliefs and their underlying assumptions are presented in table 6.2. A misconception can act as a filter for new information. Many of the respondents who participated in our study believed that salmon were omnivores or herbivores. This is a noteworthy finding. If the public believes that salmon can digest plants naturally, they will not see the purpose, or the significance, of creating a vegetarian feed for them. The very reason that the canola requires genetic modification is because the carnivorous fish are unable to digest it. This information will be difficult for the public to learn if their previously existing assumptions are not also challenged.

Table 6.2 Common misconceptions and their underlying assumptions

Question	Correct response	Respondent answer	Number of times mentioned	Broad underlying assumption
What do wild salmon eat?	Salmon are carnivores	Aquatic vegetation	9	Many respondents believe that salmon are omnivores or herbivores
		Micro organisms in the water	2	
		Other fish	8	
What is canola?	An oilseed crop grown in the prairie provinces of Canada (Manitoba, Alberta and Saskatchewan)	Wheat	5	Most respondents did not differential between oilseeds and other grains and were unaware of any issues specific to canola.
		Corn	2	
		Oilseed, derived from rapeseed, mustard family	2	
		Some kind of grain	6	Most respondents were unaware that any of the ingredients in farmed salmon feed came from South America.
		No idea	2	
Where do the ingredients in farmed salmon feed come from?	South America (protein component) and North America for the rest	Canada	15	
		USA	3	
		Asia	2	
Note: totals may not sum to 100% as individuals could offer multiple responses				

Lack of knowledge coupled with common misconceptions can seriously impair an individual's judgment. To make an informed choice, a consumer must base their purchasing decisions on as much relevant information as possible. It is difficult to make informed purchasing decisions regarding GE salmon feeds if one does not know what canola is or where salmon feed currently comes from. To illustrate this point, let us examine some of the risks and benefits involved in growing GE canola. Genetically engineering the canola plant has resulted in many positive impacts for terrestrial growing operations.[42] This crop is often more reliable and robust than its non-GE counterparts thereby reducing the amount of financial risk involved for the grower. Additionally, GE canola growers can sometimes reduce their overall cost of production because crops like

[42] Government of Manitoba, *Agriculture and Food Agriculture Statistics*, retrieved on April 20, 2003 from http://www.gov.mb.ca/agriculture/statistics/

herbicide resistant canola require less herbicide and fossil fuels.[43] [44]However, opponents of GE canola, and of certain farming practices associated with producing these crops, believe that the risks of growing GE crops far outweigh any of the reported benefits.

GE canola is often grown on mega mono-cropping farms, which utilize environmentally unfriendly techniques that can lead to an overall loss of bio and genetic diversity.[45] Accidental gene transfer can also occur when growing GE canola. This transfer can cause gene stacking, which results in super resistant weeds that can be very difficult to remove.[46] As a result, GE canola farming, much like salmon aquaculture, has been subjected to a great deal of controversy in western Canada. It is important for an individual in our study to be aware of these issues. To make responsible purchasing decisions, consumers should know that their choices will impact cultures and environments in other regions of the world. They must be allowed to weigh these impacts into their food purchasing decisions. As consumers, our lack of knowledge and our misinformed beliefs can act as filters for new information while also impairing our decision-making ability.

6.2.2 SURVEY RESULTS

The survey that was created for this experiment consisted of three sections. In the first section, respondents were asked thirty questions concerning the risks and benefits of GE technologies and salmon aquaculture. These questions were intended to test the prevalence of the misconceptions that were discovered during the mental model interviews. In the second section, respondents were given expert information in three different formats (case study, FAQ's, and flowchart). Information from section two is required to answer the questions from section one. In the

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43 Canola Council of Canada, *Truths and Myths about Canola*, retrieved on April 1, 2003 from www.scdc.sk.ca/html/educ.html

44 Less fossil fuels are required because GE canola is "*...compatible with minimum tillage systems*" Monsanto, *Roundup Ready Canola*, retrieved on February 20, 2004 from http://www.monsanto.com.au/canola/roundupCanola.htm

45 Kneen, Brewster. (1999). *Farmageddon: Food and the Culture of Biotechnology*. New Society Publishers.

46 Gene stacking refers to the accumulation of genes in an organism, or the "*simultaneous presence of more than one transgene in an organism, usually a GM organism*" This phenomenon can lead to the creation of super weeds. Royal Society of Canada's, *Expert Panel on the Future of Food Biotechnology*, Expert Panel Report, 2001.

third and final section, individuals were re-asked the multiple-choice questions from section one, asked to rate the methods of communication from section two, and asked to describe how the materials provided to them in this survey might affect their purchasing decisions, their confidence as a consumer, and their acceptance of this issue. In total, section three contained sixty-seven questions.[47][48]

Statistical tests

In the following section, responses to the survey are presented, with the discussion cast in terms of the research questions guiding this work as outlined in chapter one. [49] To test for statistical significance, the McNemar Test and T-tests were used. Questions that could be tested for significance by one of the aforementioned tests are noted accordingly. The McNemar Test measures the significance of the difference between responses before and after expert information is disseminated. It is often referred to as "*the McNemar test for the significance of changes*", as it measures the number of individuals who respond differently after being exposed to new information or a new condition.[50] Hence it is a test of the effectiveness of this risk communication effort.

To perform the McNemar test, we add up all the incorrect and correct responses from a question in section one and three of the survey and insert them into the table shown below. For this table, V equals correct responses in part A and correct responses in part C, W equals incorrect responses in part A and correct responses in part C, X equals correct responses in part A and incorrect responses in part C, Y equals incorrect responses in part A and incorrect responses in part C (see figure 6.1). The statistical significance (z) is determined by subtracting W from X, divided by

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47 Please note that respondents were allowed to choose more than one answer for each question. As a result, most people made numerous incorrect choices in section one, and made fewer overall choices (including more correct responses) in section three. The decision to allow individuals to choose more than one response was made after the pre-tests were conducted. We found that when individuals were asked to choose only one response, they became very apprehensive to choose any answer. It is important to remember that most of our respondents were answering questions about subjects they knew very little about. Allowing them to choose more than one response made the whole process less daunting to the respondent. When allowed to choose multiple responses, individuals also completed surveys in less time.

48 Survey statistics can be found in appendix A

49 See Introduction –Chapter I for a list of research questions

50 Daniel, Wayne .W. (1990) *Applied Nonparametric Statistics, 2nd Edition*. PWS-Kent Publishing Company, Boston, Massachusetts

the square root of W plus X (see equation 6.1). If this absolute value of the result of the aforementioned equation is greater than 1.96, the null hypothesis is rejected and the result is considered statistically significant. [51] According to Mark Sirkin, in a normal distribution, 1.96 is equivalent to a 95% confidence interval.

Figure 6.1 McNemar test

Part A

Part C		Correct	Incorrect	Sum
	Correct	V	W	V+W
	Incorrect	X	Y	X+Y
	Sum	V+X	W+Y	n

Equation 6.1 McNemar test

$$z = (W-X) / SQRT (W+X)$$

To perform the T-test, a numerical value was given to each response ranging from 1 to 7 where 1 is "*not at all confident*" and 7 is "*extremely confident*" (see figure 6.2). The mean value (x_m) and the standard deviation (σ) of each part were then determined by the equation shown in equation 6.2.[52] As in the McNemar test, if the absolute value of the result of the aforementioned equation is greater than 1.96, the null hypothesis is rejected and the result is considered statistically significant. [53] According to Mark Sirkin, in a normal distribution, 1.96 is equivalent to a 95% confidence interval.

51 Sirkin, R Mark. (1995). *Statistics for Social Sciences*. Sage Publications Inc. Thousand Oaks, California

52 Holman, J.P. (2001). *Experimental Methods for Engineers, Seventh Edition*. McGraw Hill, Toronto, Ontario

53 Sirkin, R Mark. (1995). *Statistics for Social Sciences*, Sage Publications Inc. Thousand Oaks, California

Figure 6.2. Point Value

Not at all confident	A little confident	Somewhat confident	Neutral	Quite confident	Very confident	Extremely confident
1	2	3	4	5	6	7

Equation 6.2. T-test equation

$$x_m = (x_i) / n$$

$$\sigma = \text{SQRT}\left[\sum (x_i - x_m)^2 / (n-1)\right]$$

$$t = \frac{x_{m1} - x_{m2}}{\text{SQRT}[(\sigma_1^2 + \sigma_2^2) / n]}$$

Overview of survey results

The survey results confirm the presence of common misconceptions in the larger sample of respondents. The results also indicate that an individual's misconceptions can change when that person is offered accurate information that contradicts their mistaken beliefs. Of the forty nine people who participated in the survey, more had eaten wild salmon than had eaten farmed salmon. Most said that our research questions mattered to them, and that they cared what ingredients farmers used in their salmon feeds, and where farmers got their salmon feeds. The majority of individuals were unsure if the foods they ate were GE or contained GE ingredients. Yet after reading expert informtion on the subject, almost all realized that they probably had consumed transgenic food products at some time or another.

The expert information from section two taught respondents that GE foods are labelled if they cause allergies or have a different nutritional content. The majority of respondents did not believe they could tell if a food is transgenic or contains GE ingredients by the way it looks, tastes, or

smells. This is an interesting finding given that many individuals who participated in the mental model interviews held this misconception.

Most of our mental model interview subjects could tell us very little about GE canola, despite the fact that this transgenic plant is used in many popular household food products. By the end of the experiment, our survey respondents had increased their awareness of each canola product included in the experiment. When aided through multiple-choice type options, most individuals could correctly tell us what genetic engineering is. That said, at the beginning of the experiment, many thought that selective breeding was genetic engineering, and sixteen people thought that any scientific procedure performed by humans on a living organism that causes the organism to behave differently could potentially be called genetic engineering. A more detailed description of all survey results and their relation to our research questions will be given in the following paragraphs.

Research question #1: ***how will the materials in this experiment affect an individual's understanding of factual information?***

Confirmation of common misconceptions

As mentioned previously, individuals who participated in the mental model interview component of this project held a number of common misconceptions about the salmon aquaculture industry and GE technologies. In the last portion of this project, (the in-person survey), we asked respondents a number of questions designed to test the prevalence of these common misconceptions in a larger sample of people. Each of the questions was posed in a multiple-choice format, and each potential choice was an actual answer given by a mental model interview respondent. Figure 6.3 shows three of the multiple choice type questions included in the survey.

Figure 6.3 Survey questions representing commonly held misconceptions discovered during the mental model interviewing process.

1. What do wild salmon eat in nature? (please check off all that apply)
   - ☐ Aquatic plants
   - ☐ Fish that share their aquatic environment
   - ☐ Tiny nutrients found in ocean water

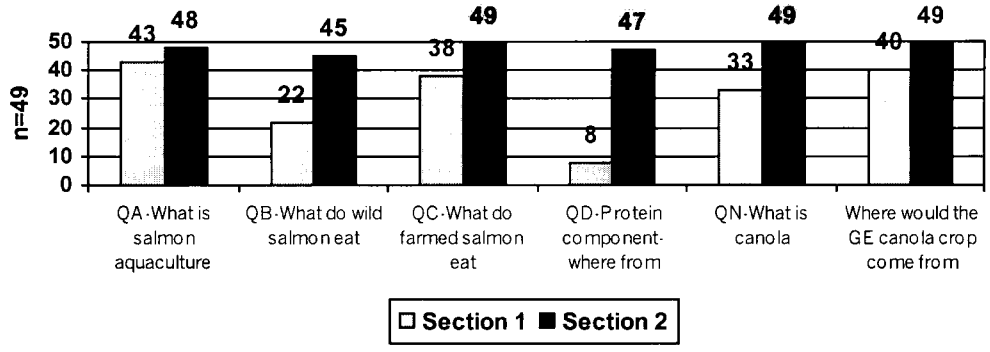
2. What is canola? (please check off all that apply)
   - ☐ An oilseed plant
   - ☐ A kind of wheat
   - ☐ A kind of sunflower
   - ☐ A kind of corn
   - ☐ A synthetic (man made) oil

3. Where does the protein component of farmed salmon feed currently come from? (please check off all that apply)
   - ☐ Canada
   - ☐ South America
   - ☐ United States
   - ☐ Japan
   - ☐ Europe

The survey results confirmed the presence of common misconceptions in the larger sample of respondents. According to the McNemar test, each of the results shown in figure 6.4 is statistically significant. Less than half (n=22) could correctly answer question regarding what wild salmon ate in nature, and only a mere eight could accurately tell us where the protein component for farmed salmon feed comes from. However, our results also indicate that an individual's misconceptions can change when that person is offered accurate information that contradicts their mistaken beliefs. Figure 6.4 shows the number of respondents who gave correct answers to our multiple choice questions both before and after they had received accurate information in section two of the survey.[54]

54 Please note that most of the charts in this report give only the number of respondents and not percentages. Due to the small sample size, percentages would be misleading. As well, individuals could offer multiple responses to each question. Therefore, the answers are mutually exclusive.

Figure 6.4. Learning : Correct Responses



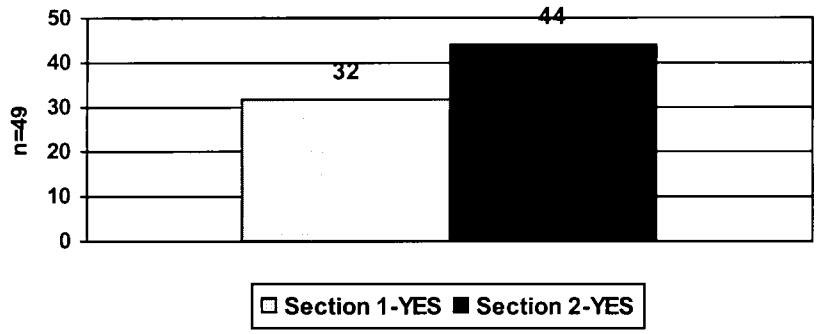
It is interesting to note that although most people from the mental model interviews did not know what salmon aquaculture was, what farmed salmon ate, what canola was, or where it came from, many of the respondents who answered the survey did. This could indicate that many individuals within the larger population do not hold misconceptions about the canola plant. However, it may demonstrate that it is simply easier for people to correctly answer these sorts of questions when aided through a multiple choice type question format. In the mental model interviews, the respondents were asked open ended questions and given no 'hints'. In the survey, the correct answer is always offered to the respondent as one of the potential choices.

Peceptions of GE technologies

Many respondents were unsure if the foods they ate were genetcailly engineered or contained GE ingredients. After reading expert informtion on the subject, almost all realized that they probably had injested transgenic food products at one time or another (n=44). According to the McNemar test, the results shown in figure 6.5 are statistically significant.

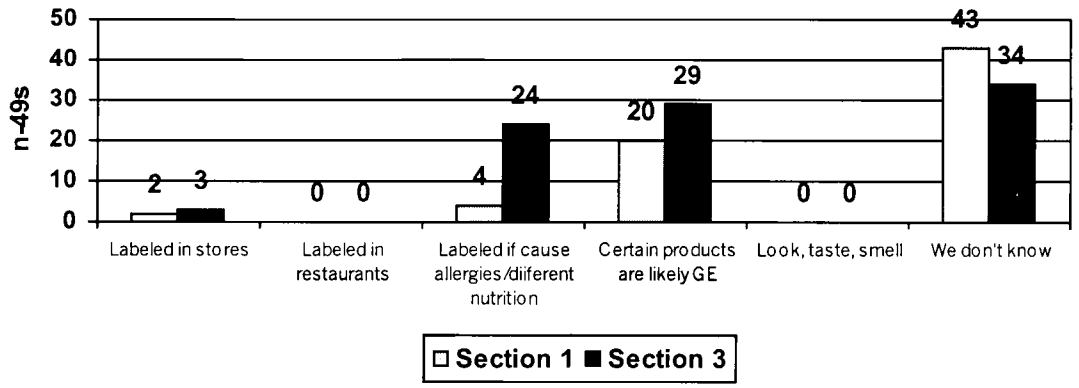
See Figure 6.5.

Figure 6.5 QJ. Do you eat any GE foods: positive response



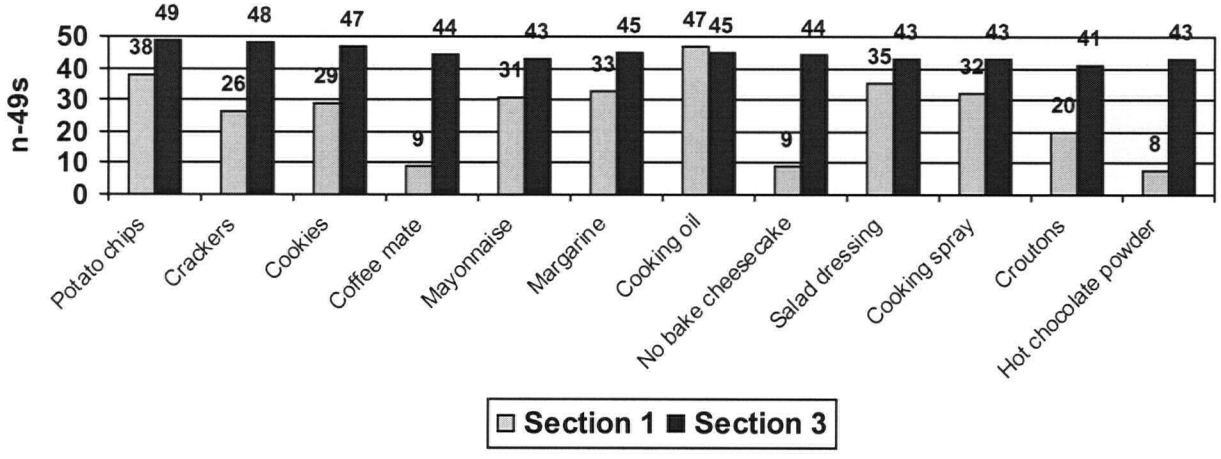
As well, most respondents admitted that they probably could not tell if the foods they ate were GE or contained GE ingredients (see figure 6.6). However, the expert information did teach twenty of them that GE foods are labelled in Canada if they cause allergies or have a different nutritional content. Nineteen respondents also learned that certain food products are more likely to be transgenic or contain GE ingredients. To our surprise, respondents did not believe that they could tell if a food is transgenic or contains GE ingredients by the way it looks, tastes, or smells. Many individuals who participated in the mental model interviews sited this common misconception.

Figure 6.6. QM-How do you know foods are GE



We believe that learning about the GE canola plant is vital to understanding the risks involved in using GE canola feeds. Most of our mental model interview subjects could tell us very little about GE canola, yet this transgenic plant is used in many popular household food products. During the course of our experiment, survey respondents learned that GE canola is present in many commonly used food items including hot chocolate powder, coffee mate, and no-bake cheesecake. By the end of the survey, our respondents had increased their awareness of each canola product discussed in the experiment (see figure 6.7).

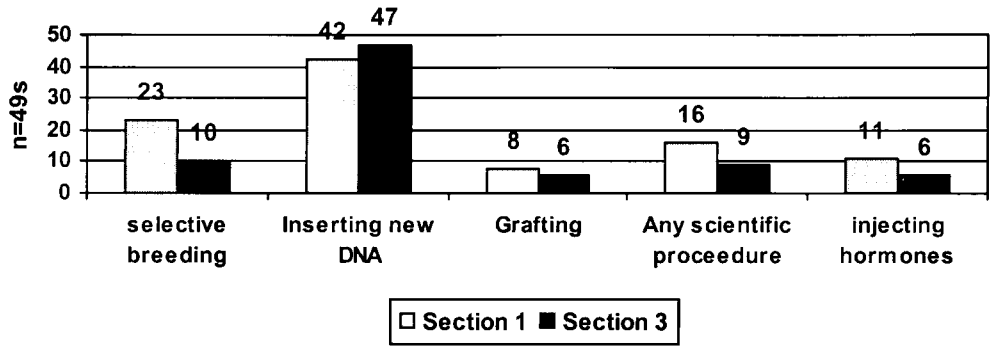
Figure 6.7. QO. Which of the following includes canola ingredients



When aided through multiple-choice type options, most respondents could correctly tell us what genetic engineering is (n=42). That said, at the beginning of the experiment, twenty three thought that selective breeding was genetic engineering, and sixteen people thought that any scientific procedure performed by humans on a living organism that caused that organism to behave differently could potentially be called genetic engineering. The number of people who chose incorrect responses had decreased by the conclusion of the experiment. In the re-test, almost 100% chose the correct response (n=47). However, according to the McNemar test, the results shown for responses concerning "*inserting new DNA*" in figure 6.8 are not statistically significant.

See figure 6.8.

Figure 6.8. QI-What is meant by the term genetic engineering



Rating the methods of communication

A surprising trend seems to be emerging between how respondents rated the methods of communication from section two of the survey, and how effective each one was in correctly conveying expert information. There seems to be an inverse correlation between the effectiveness of each method of communication and it's popularly. We had assumed that our respondents would like the communication methods that allowed them to answer the most correct answers in section three of the survey. However, the popularity of each communication method may not predict how effective that method was. Table 6.3 shows how all 49 respondents rated the methods of communication according to a pre-determined set of criteria.

Table 6.3. Rating the methods of communication on various criteria

How do you rate each method of communication in terms of...? (n=49)	**Overall favourite**	**Second favourite**	**Worst overall**
Trustworthiness	FAQ	Case study	Flow chart
Easiest to understand	FAQ	Case study	Flow chart
Enjoyable to read	Case study	FAQ	Flow chart
Contained the most useful information	FAQ	Case study	Flow chart
Liked the best overall	FAQ	Case study	Flow chart

Overall, the most trustworthy method of communication was the Frequently Asked Questions (FAQ) format. Respondents also rated the FAQ format as the easiest to understand, the one that contained the most useful information, and the one they liked best overall. The case study was rated as the most enjoyable to read. The flow chart did not lead in any of our categories; in fact, it was rated the worst overall in each category by the majority of respondents.

Section three of the survey also employed empirical testing methods to capture the effectiveness of each method of communication from section two. In order to ensure the reliability of the results, the answers to each set of questions could only be found in the method of communication being examined. For example, the answers to the flowchart questions could only be found in the flow chart, the case study questions could only be found in the case study, etc (see table 6.4).

Table 6.4. Effectiveness of communication methods

Question concerning environmental risks and benefits (FAQ format)	
Question	**Correct response (n=49)**
1)Farmed salmon would probably have an easier time digesting GE canola feed	28
2)GE canola could lead to a loss of genetic and biodiversity	39
3)if a animal eats GE feed, it then becomes GE	41
4)It is possible for different GE canola plans to become super weeds	46
5)Farmers use les herbicide with GE canola crops	43
6)GE feed leads to a cleaner aquatic environment	37
Average	**39**

Questions concerning economic risks and benefits (flow chart)	
Question	**Correct response (n=49)**
1) GE low phytase feed could be beneficial to poultry and pig farmers	48
2) If Canada stopped importing traditional feed it would devastate South American economy	46
3) GE feed would increase overall production costs of salmon farming	39
4) GE canola could cause organic farming operations	34
5) GE canola is grown mostly in Ontario	46
6) GE canola could reduce amounts of fossil fuels currently used in salmon aquaculture industry	34
Average	**41**

Questions concerning social risks and benefits (case study)	
	Correct response (n=49)
1) What tern is used to imply GE plant is very similar/as safe as to its non-GE counterpart	34
2) Human health risks of GE canola very well understood in Canada	26
3) GE canola could lead to loss of independence for traditional farmers	43
4)Many animal health problems linked to GE feeds	43
5)feed costs are a small proportion of total salmon farming production costs	41
6) Wild salmon in stores always fresher than farmed salmon	48
Average	**39**

Although the majority of respondents reported liking the *Frequently Asked Questions* method of communication the best on almost every criterion, this method was not the most effective in conveying information overall. On average, it produced correct responses for thirty-nine people. The case study also elicited correct responses for an average of thirty-nine people. The flow chart, rated the worst overall on every single criterion, averaged the most correct responses for forty-one people.

The differences between these averages are not statistically significant, but they may indicate the beginning of a trend. Given how each method was rated by respondents, and their personal comments and complaints regarding the flow charts, we expected it to produce significantly fewer correct answers. This was not the case. Although no conclusions can be reached at this time due to the slight variation between the results, it will be interesting to test this correlation between popularity and effectiveness in future research projects with larger samples of people.

Research question #2-- *how will the materials in this experiment affect an individual's confidence as a consumer?*

An additional objective of our experiment was to measure how the materials provided to the individual during the in person survey would influence their confidence levels as consumers. We asked each respondent how confident he or she was in two separate areas, *purchasing decisions regarding salmon aquaculture food products*, and *purchasing decisions regarding GE food products.* For these questions we used a seven point scale where one was '*not at all confident*', four was '*neutral*', and seven was '*extremely confident*' (see figure 6.9 below).

Figure 6.9. Sample confidence questions

1. **How confident are you in your level of knowledge when it comes to your purchasing decisions regarding salmon aquaculture food products?** (please circle the number that corresponds with your response)

1	2	3	4	5	6	7
Not at all confident	a little confident	somewhat confident	neutral	quite confident	very confident	extremely confident

2. **How confident are you in your level of knowledge when it comes to your purchasing decisions regarding genetically -engineered food products?** (please circle the number that corresponds with your response)

1	2	3	4	5	6	7
Not at all confident	a little confident	somewhat confident	neutral	quite confident	very confident	extremely confident

Overall, confidence levels were improved for most participants. Figure 6.10 shows the number of respondents that said they were not at all confident in their purchasing decisions regarding salmon aquaculture and GE food products both before and after they had reviewed expert information. Overall, fewer individuals said they were '*not at all confident*' by the end of the survey. While twenty four people said they were not at all confident in their salmon aquaculture food product purchasing decisions at the beginning of the experiment, only nine said they were sill not confident by the end. Twenty three people said they were not at all confident in their purchasing decisions regarding GE food products at the beginning of the survey. Although this number decreased by the end of the survey, fourteen remained not at all confident.

Figure 6.10. Confidence

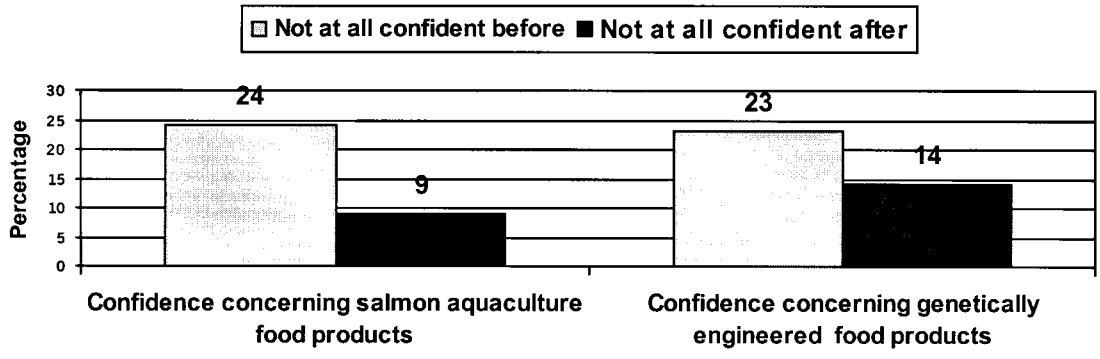
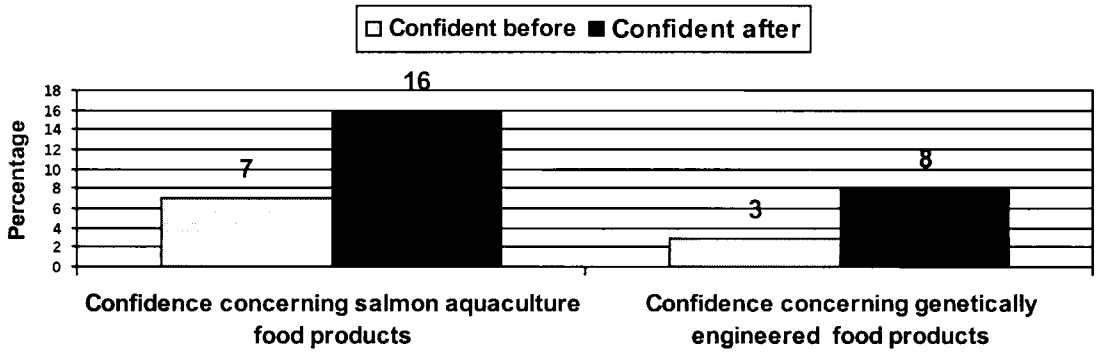


Figure 6.11 shows the amount of people who said they were quite, very, or extremely confident in their salmon aquaculture and GE food purchasing decisions at the beginning of the survey, and at the end. It seems that our expert information was more successful in raising consumer confidence levels regarding salmon aquaculture food purchasing decisions than GE food purchasing decisions. T-tests show that a statistically significant number of people had become more confident in their salmon aquaculture purchasing decisions. The same cannot be said of confidence levels

concerning GE food purchasing decisions. By the end of the survey, nine more people said they were confident in their salmon aquaculture foods purchasing decisions, while only five more were confident in their GE food purchasing decisions. Although confidence levels were raised overall, many people apparently need even more information or assurance before they can be completely confident in these types of purchasing decisions.

Figure 6.11. Confidence

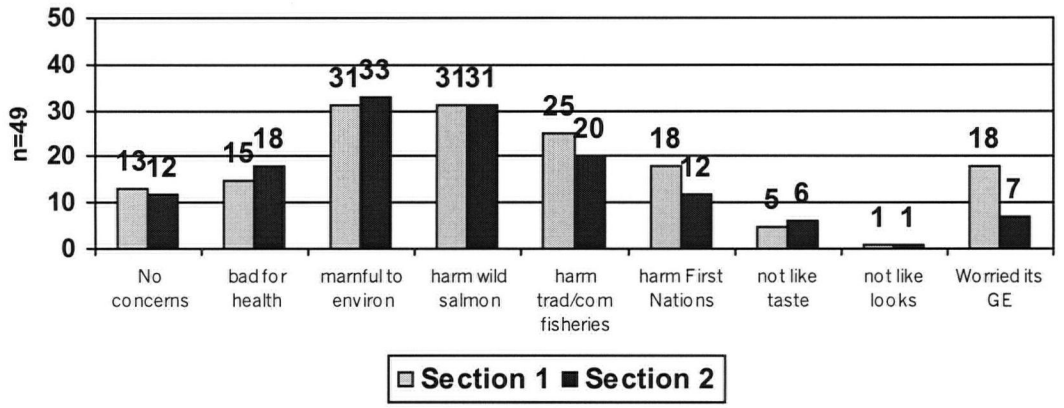


Research question #3- ***how will the materials in this experiment affect an individual's acceptance of an issue?***

Reported concerns

Respondents were asked to identify various concerns they may have about purchasing farmed salmon. Figure 6.12 shows that overall, most of our respondents concerns about farmed salmon concentrated on the impact it may have to other fish, and the natural environment. The most commonly reported concerns in section one were that farmed salmon may be harmful to the environment (n=31), harmful to wild salmon populations (n=31), and harmful to traditional or commercial fisheries (n=25).

Figure 6.12. QG-Concerns about farmed salmon

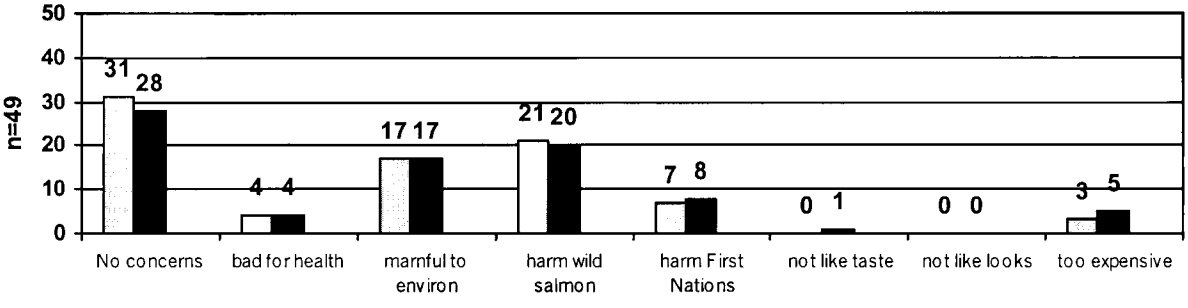


After receiving the expert information in section two, these three choices remained the most popular concerns. That said, the expert information reduced the number of people who were worried about salmon farming in three areas. Fewer were concerned that farmed salmon would harm traditional/commercial fisheries (-5), or First Nations fisheries (-6), and fewer people were worried that farmed salmon might be genetically-engineered (-11). In fact, expert information had the biggest impact on respondents' perceptions of GE technologies used in salmon aquaculture. In section one, eighteen were concerned that farmed salmon might be genetically-engineered. Reading expert information belayed the fears of eleven people in this area. However, expert information increased concern levels for some individuals. After reading section two, more people were worried about the impact that salmon farming may have on their own health (+3), and the environment (+2).

Figure 6.13 identifies the various concerns that our respondent had about purchasing wild salmon. The majority of individuals had no concerns about purchasing wild salmon (n=30). Only three people from this group changed their minds after reading the expert information in section two. Like concerns regarding farmed salmon food purchases, respondents were also concerned how

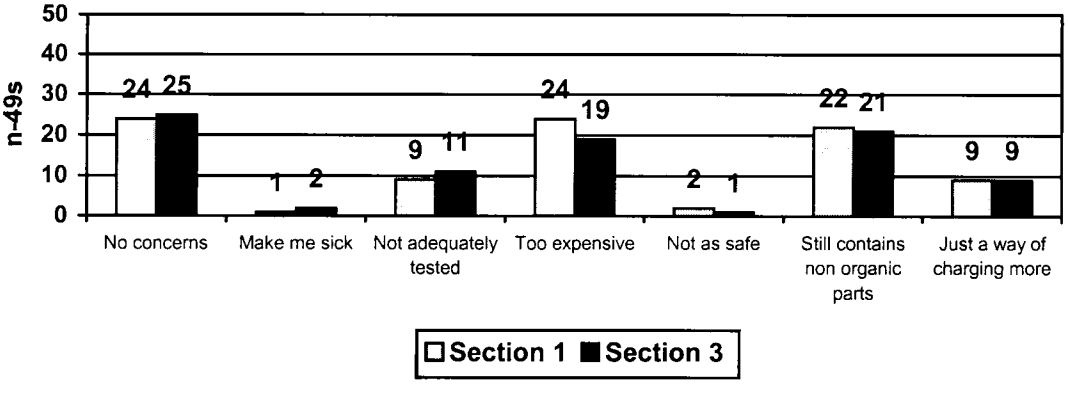
purchasing wild salmon would impact the natural environment and wild salmon stocks. Overall, the expert information had much less impact on questions concerning wild salmon than on those regarding farmed salmon, as would be expected.

Figure 6.13. QH-Concerns about wild salmon



We included certain questions on the survey that were not directly related to this research project to act as a sort of control group. The expert information from section two did not provide the respondents with information regarding organic food purchases. Therefore, an individual's responses to questions relating to organic foods should not vary significantly from section one to section three. As illustrated in figure 6.14, responses to our organic food questions were not significantly different from section one to section three overall.

Figure 6.14. QL-Concerns about organic foods

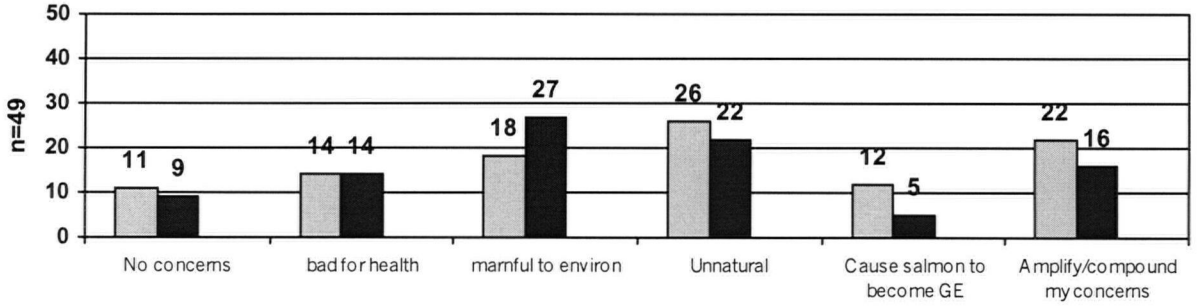


That said, reading information from section two did lead some individuals to reconsider some of their choices from section one. During the re-test, five were less concerned about the price of organic foods, and two were more concerned that organic foods may not be adequately tested. Perhaps our expert information concerning aquaculture and GE technologies introduced new issues that our respondents then transferred to other subjects (i.e., organic food purchasing decisions). Respondents may not have considered such concerns or impacts in the past.

We asked respondents to identify concerns they had about purchasing farmed salmon that had been fed with GE canola. Before reading expert information, the most commonly mentioned fears were that fish fed on transgenic feed amplified or compounded pre-existing concerns held by respondents (n=22). Many also believed that feeding fish GE canola feed was "unnatural" (n=26). After reading expert information on the subject, concerns in most areas decreased. The exception was fears regarding how these fish may impact the environment. In the re-test, nine more people expressed their concerns in this area.

The expert information had no impact on respondents who worried that GE canola fed fish might be bad for their health. Fourteen people stated this as a concern before they read the expert information and fourteen people stated it during the re-test. Although twelve people thought farmed salmon might become genetically-engineered after consuming a GE feed, only five still believed this after reading section two (See figure 6.15).

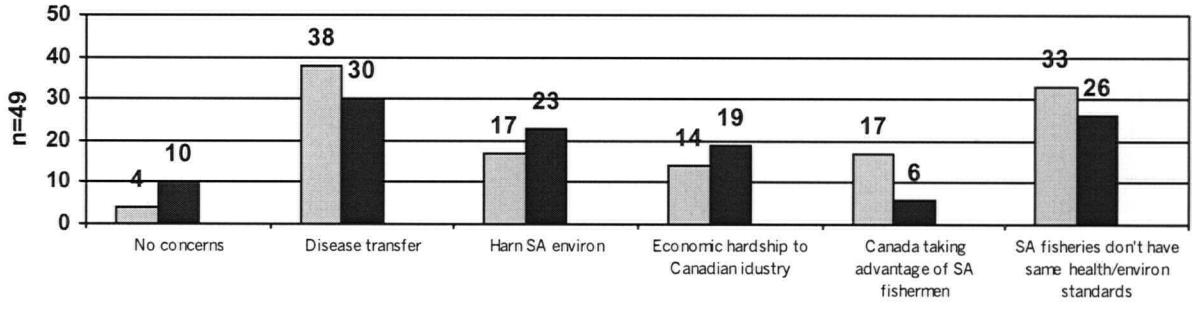
Figure 6.15. QP-Concerns about farmed salmon fed with GE canola



People who reported having no concerns about farmed salmon fed with South American fish increased from four to ten after reading our expert information. The expert information also influenced eight people's concerns regarding disease transfer (-8), South American health and environmental standards (-7), and fair trade between Canada and South American fishermen (-11). Fewer respondents maintained their concerns in these areas after reading section two of the survey. However, the expert information increased the fears of respondents in two areas including how this practice might impact the South American environment (+6), and the Canadian aquaculture industry (+5).

See figure 6.16

Figure 6.16. QP-Concerns about farmed salmon fed with South American fish



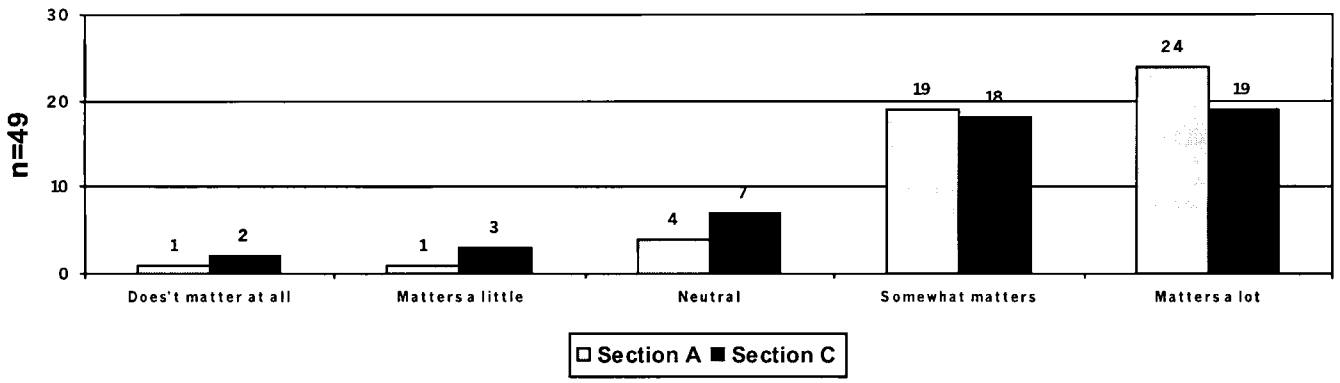
Research issues are important to respondents

We wanted to know how important our research questions were to our respondents, so we asked them to rate certain issues on a five point scale where one is '*doesn't matter at all*', three is '*neutral*', and five is '*matters a lot*'. We first asked if it mattered to them what ingredients farmers used in their salmon feeds. At the beginning of the survey, almost all said that it mattered (n=43),

including about half that said it mattered a lot (n=24). By the end of the survey five less people reported that it mattered a lot, but overall, most said that it still mattered (n=37).

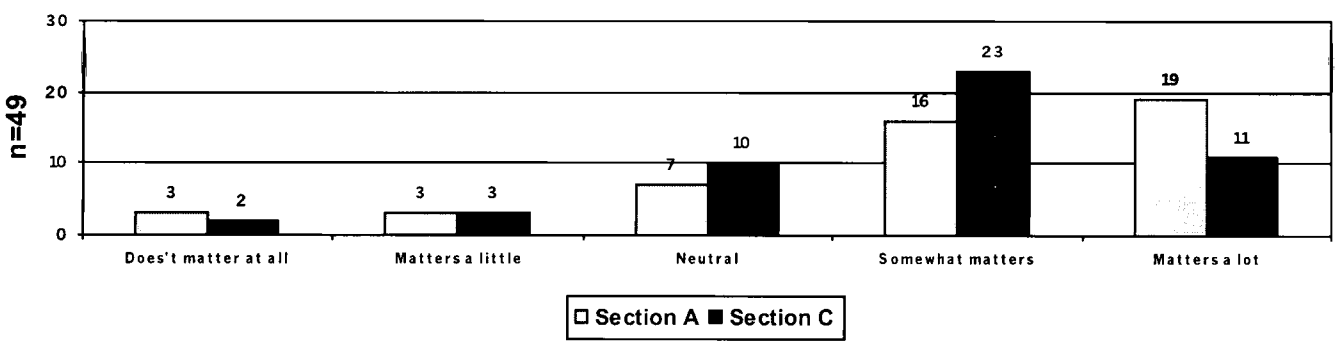
See figure 6.17.

Figure 6.17. QS-Ingredients used in farmed salmon feed-does it matter?



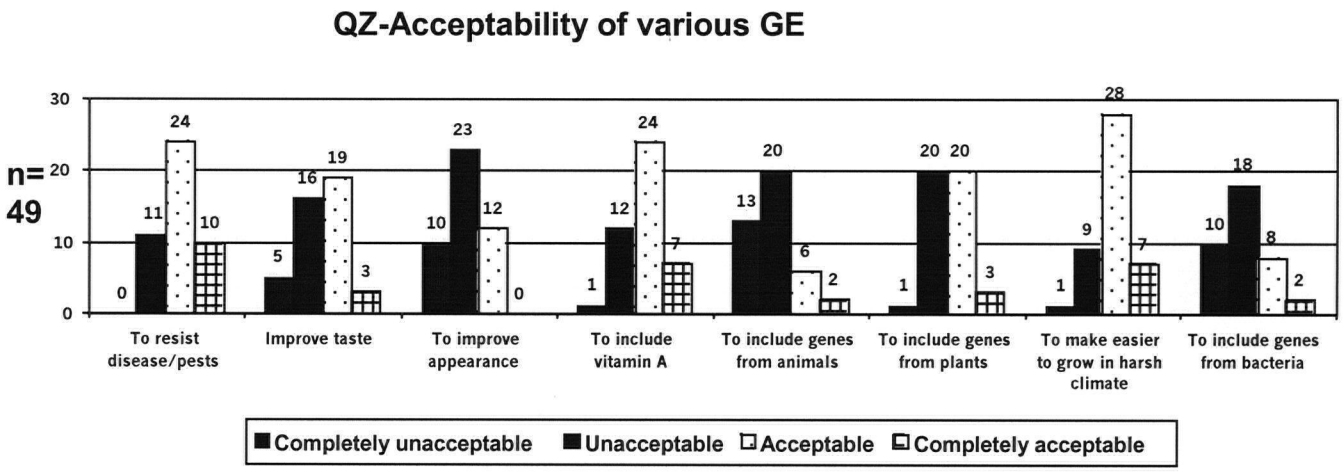
We also asked survey respondents if they cared where Canadian aquaculturalists got their salmon feed. Although more people were neutral on this issue than the previous one (*does it matter to you what ingredients farmers use in their salmon feeds?*), most still said that it mattered (n=35). After reading the expert information, eight less people said that it mattered a lot and seven more said it somewhat mattered (see figure 6.18).

Figure 6.18. QT-Where Canadian aquaculturalists get feed from-does it matter?



At the end of the survey, we asked respondents to tell us which GE technologies were acceptable to them. They rated eight reasons for using genetic engineering technologies on a four point scale where one was *'completely unacceptable'*, and four was *'complete acceptable'*. According to our survey respondents, certain GE technologies are more acceptable than others.[55] (See figure 6.19)

Figure 6.19.



Overall, the most acceptable reason to use GE technologies was to resist pests or disease. Thirty four people said this technology was acceptable or completely acceptable. If fact, more respondents rated this technology as *completely acceptable* than any other technology (n=10), and none said it was *completely unacceptable*. Thirty five people said it was acceptable to use GE technologies that allow plants to grow in a harsh climate, with only one stating it was *completely unacceptable*. Thirty one respondents said it was acceptable to use GE technologies to incorporate vitamin A into a plant, which helps to prevent blindness.

It appears that GE technologies intended to improve appearance or those that involve transferring genes from animals or bacteria are unacceptable to most survey respondents. Thirty three people found GE technologies that improve appearance unacceptable or completely unacceptable.

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55 Respondents could choose *don't know* for this particular question. Those who chose this response are not included in the chart.

Another thirty three found procedures that transferred genes from animals unacceptable, including thirteen who said it was *completely unacceptable*. This procedure was the least acceptance overall to our survey respondents. Twenty eight also found procedures that transfer genes from bacteria into other organisms unacceptable.

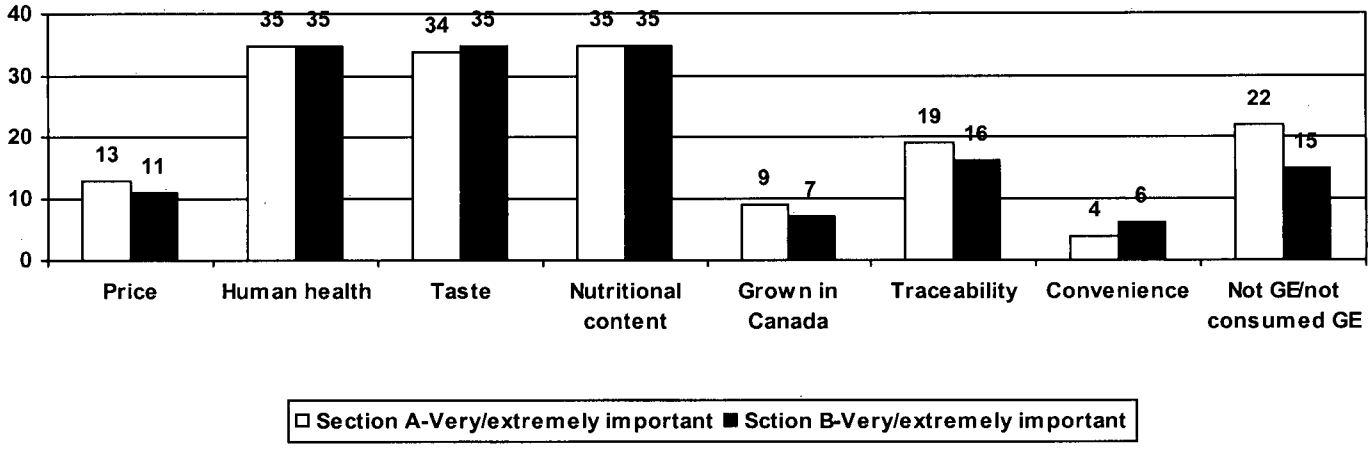
Survey respondents were split on two potential GE technologies. Twenty one believed that technologies used to improve taste are unacceptable, while twenty two thought they are not. Less than half believed that technologies that transfer genes from plants are unacceptable (n=21) and a similar amount thought they are (n=23).

Factors affecting food purchasing decisions

In sections one and three of the survey we asked respondents how important certain factors were in their decision to purchase food products. Among some of the factors were: the human health impacts of consuming that food, taste, traceability, convenience, and knowing that the food had not been genetically -engineered or had consumed feeds that had been genetically -engineered.

Twenty two respondents said that knowing their food had not been genetically -engineered or had eaten GE feeds was very or extremely important to them in section one of the survey, but only fifteen chose this response in the re-test. By the end of the experiment, seven respondents had decided that knowledge concerning the genetic modification of their food was less important to them after examining expert information on the subject. Yet their concerns in other areas relating to the foods they consumed remained about the same. As we learned in the previous section, our respondents were more inclined to believe that GE technologies that positively impacted industry or human health were acceptable and those that improved appearance or introduced genes from animals or bacteria were not. Perhaps we can infer that our respondents view GE technologies described in this experiment as useful to the salmon aquaculture industry without being unnecessarily harmful to human health, and therefore acceptable (see figure 6.20).

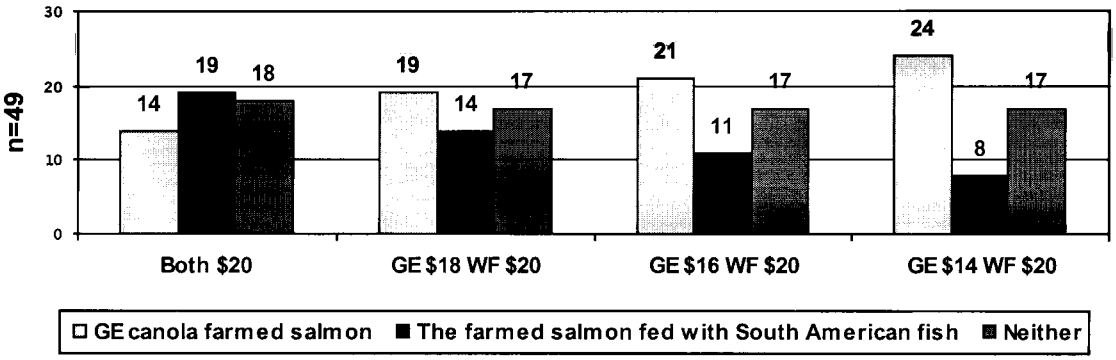
Figure 6.20. How important is each in food purchasing decisions



Research question #4: ***how will the materials in this experiment affect an individual's purchasing decisions?***

We were interested in how price would influence a respondent's decision to purchase salmon food products after they had examined our expert information. We gave individuals the choice between purchasing a farmed salmon fed with wild fish meal from South America and farmed salmon fed with GE canola. We started by making both farmed salmon worth twenty dollars. We then kept the price of the fish fed with wild fish from South America constant at twenty dollars, and decreased the price of the GE canola fed salmon by two dollar intervals (see figure 6.21).

Figure 6.21. Which fish would you choose if...



We found that price did have an influence on their purchasing decisions. When both fish were twenty dollars, five more respondents chose to purchase the farmed salmon fed with wild fish meal, rather than the GE canola fed farmed salmon. If the GE canola fed salmon was at least two dollars cheaper than the other fish, most people said they would be more likely to purchase it. When the GE canola fed farmed salmon was eighteen dollars, five more respondents chose this farmed salmon rather than the one fed with wild fish meal. When the price of the GE canola fed farmed salmon was another two dollars cheaper, ten more people chose to purchase it instead of the other fish. When the price dropped another two dollars, making the GE canola fed farmed salmon fourteen dollars, twenty four chose to purchase it and only eight still wanted to purchase the farmed salmon fed with wild fish meal.

We therefore concluded that purchase price may affect a consumer's decision to purchase GE canola fed farmed salmon. It should also be noted that the number of people who said they would purchase neither fish did not change as the price of the fish was altered. This led us to believe that those who do not purchase farmed salmon, for whatever reason, are less likely to be influenced by the price of the fish.

Impact of expert information on purchasing decisions

The last question in the survey asked respondents to rate how the experiment had impacted their purchasing decisions regarding salmon aquaculture food products. We asked them to choose between three statements (see figure 6.22 below).

Figure 6.22. Impact on purchasing decisions

- ☐ The information provided to me today **would not** influence my decision to purchase this fish
- ☐ The information provided to me today **would** influence my decision to purchase this fish. It would make me **less likely** to purchase this fish
- ☐ The information provided to me today **would** effect my decision to purchase this fish. It would make me **more likely** to purchase this fish

Of the 49 respondents who answered this question, eighteen said the information provided to them would not impact their decision (~37%). A similar amount said it would impact their decision, it would make them less likely to purchase this fish (n=19, 39%). The remaining thirteen said the information would make them more likely to purchase GE canola fed farmed salmon (~27%).[56] In other words, our experiment appeared to impact the purchasing decisions of thirty two survey respondents or almost two thirds of our sample.

See figure 6.23.

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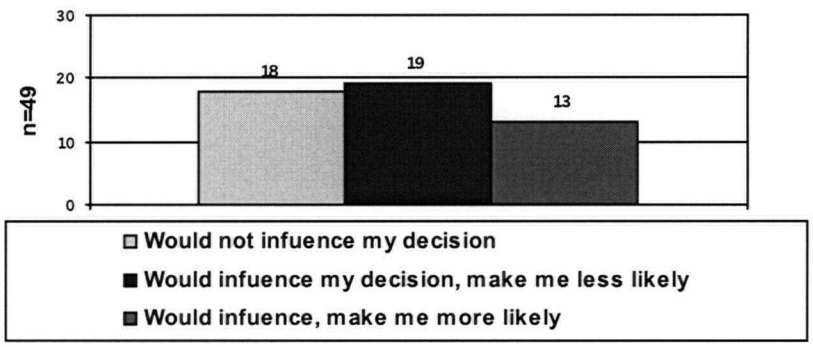
56 Although our n size for this question is forty nine, our results show that 50 people answered this question. One person gave two responses despite the fact they were asked to choose only one. For this reason, the percentages given in the section do not sum to 100%, and are not completely accurate.

Figure 6.23 Impact of expert information on decision to purchase GE canola fed farmed salmon



7.0 CONCLUSIONS

Canadian consumers have a right to make informed decisions regarding their food purchases. To make an informed decision, the public must have access to unbiased information concerning the known environmental, economic, and social risks and benefits of their choices. Communication between experts and the general public is therefore essential. However, this process often requires more effort than simply providing the public with scientifically accurate information. The mind of a consumer is not a tabula rasa. Each individual will have a mental model of how their highly complex world operates. These mental models are used to explain and predict the world around them and are informed by their life experiences and worldviews.[57] As demonstrated in this research project, these mental models may also contain mistaken beliefs that can hinder the comprehension of new information.

Given the influence of mental models, effective communication regarding the risks and benefits of new technologies used in food production requires a cooperative effort between Canadian consumers, risk communicators, and experts. Although experts can tell us what the actual risks and benefits of new technologies are, they often perceive and rate risk differently than laypeople. As a result, their recommendations do not always reflect the values of Canadian consumers. Risk communicators are needed to bridge the gap that occurs between the expert's and layperson's perceptions of risk. The layperson's mental models of the technology are captured by the risk communicator who then challenges commonly held misconceptions while offering the layperson scientifically accurate information in a context that is meaningful to them. We found that flow charts are an effective way to capture the expert view. The next step is to determine which method of communication most effectively communicates expert information to laypeople.

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[57] Morgan, Granger M.,Fischhoff, Baruch, Bostrom, Ann & Atman, Cynthis J.(2002).*Risk Communication: A Mental Models Approach*. Cambridge University Press

7.1 RESEARCH QUESTIONS

In this experiment, we were interested in how different communication methods would affect an individual's understanding of factual information, their purchasing decisions, their confidence as a consumer, and their acceptance of an issue. Table 7.1 evaluates the survey results against these four research questions.

Table 7.1. Exploring key research questions

How do the materials included in this risk communication experiment affect an individual's understanding of factual information?

Main findings:

The McNemar test indicates that a significantly greater number of people answered our multiple choice survey questions correctly after they were provided with expert information. In other words, this experiment increased out respondents' overall understanding of factual information.

Confirmation of common misconceptions

Individuals who participated in the mental model interview component of this project held a number of common misconceptions about the salmon aquaculture industry and GE technologies. The survey results confirmed the presence of common misconceptions in the larger sample of survey respondents. However, our results also indicate that an individual's misconceptions can change when that person is offered accurate information that contradicts their mistaken beliefs.

Perceptions of GE technologies

After reading expert information on the subject, almost all respondents realized that they probably had ingested transgenic food products (n=44). To our surprise, individuals did not believe that they could tell if a food is transgenic or contains GE ingredients by the way it looks, tastes, or smells. Many mental model interviews participants sited this common misconception.

When aided through multiple-choice type options, most respondents could correctly tell us what genetic engineering is (n=42). That said, at the beginning of the experiment, twenty three thought that selective breeding was genetic engineering, and sixteen people thought that any scientific procedure performed by humans on a living organism that caused that organism to behave differently could potentially be called genetic engineering. The number of people who chose incorrect responses had decreased by the conclusion of the experiment. In the re-test, almost 100% chose the correct response (n=47).

Lastly, by the end of the survey, our respondents had increased their awareness of each canola product discussed in the experiment.

Rating the methods of communication

The popularity of each communication method may not predict how effective that method was. Overall, the Frequently Asked Questions (FAQ) format was rated the highest on almost every criteria with one exception, the case study was rated as the most enjoyable to read. The flow chart did not lead in any of our categories; in fact, the majority of respondents rated it the worst overall in each category.

Although the majority of respondents reported liking the Frequently Asked Questions method of communication the best on almost every criterion, this method was not the most effective in conveying information overall. On average, it produced correct responses for thirty nine people. The case study also elicited correct responses for an average of thirty nine people. The flow chart, rated the worst overall on every single criterion, averaged the most correct responses for forty one people. The differences between these averages are not statistically significant, but they may indicate the beginning of a trend.

How do the materials included in this risk communication experiment affect an individual's confidence level as a consumer?

Main findings:

Overall, confidence levels were improved for most participants. Overall, fewer individuals said they were '*not at all confident*' in their salmon aquaculture and GE food purchasing decisions by the end of the experiment.

It seems that our expert information was more successful in raising consumer confidence levels regarding salmon aquaculture food purchasing decisions than GE food purchasing decisions. Although confidence levels were raised overall, many people apparently need even more information or assurance before they can be confident in these types of purchasing decisions.

How do the materials included in this risk communication experiment affect an individual's acceptance of an issue?

Main findings:

Most of our respondents concerns about farmed salmon concentrated on the impact it may have to other fish and the natural environment. After receiving the expert information in section two, these concerns were still apparent.

The expert information had the biggest impact on respondents' perceptions of GE technologies used in salmon aquaculture. Reading expert information belayed the fears of eleven people in this area. However, expert information increased concern levels for some individuals. After reading section two, more people were worried about the impact that salmon farming may have on their own health, and the environment.

Before reading expert information, the most commonly mentioned fears concerning GE canola fed farmed salmon were that this practice amplified or compounded pre-existing concerns held by respondents. Many also believed that feeding fish GE canola feed was "unnatural". After reading expert information on the subject, concerns in most areas decreased. The exception was fears regarding how these fish may impact the environment. The expert information had no impact on respondents who worried that GE canola fed fish might be bad for their health.

People who reported having no concerns about farmed salmon fed with South American fish increased after reading our expert information. The expert information also belayed people's concerns regarding disease transfer, South American health and environmental standards, and fair trade between Canada and

South American fishermen.

The expert information increased the fears of respondents in two areas including the impact that this practice may have on the South American environment, and the impact that this fish meal source may have on the Canadian aquaculture industry.

According to our respondents, the most acceptable reason to use GE technologies was to resist pests or disease. The majority also said it was acceptable to use GE technologies to make it easier to grow plants in a harsh climate, or artificially introduce vitamin A, which can prevent blindness. It appears that GE technologies intended to improve appearance, or ones that involve transferring genes from animals or bacteria are unacceptable to most survey respondents.

We wanted to know how this risk communication experiment had affected our respondents' overall acceptance of these issues. By the end of the experiment, seven respondents had decided that knowledge concerning the genetic modification of their food was less important to them after examining expert information on the subject. Perhaps we can infer that they view GE technologies described in this experiment as useful without causing intolerable harm, and therefore acceptable.

How do the materials included in this risk communication experiment affect an individual's purchasing decisions?

Main findings:

We found that price did have an influence on our respondents' purchasing decisions. When GE canola fed and South American wild fish fed farmed salmon were both priced at twenty dollars, five more respondents chose to purchase the farmed salmon fed with wild fish meal, rather than the GE canola fed farmed salmon. If the GE fed salmon was at least two dollars cheaper than the other fish, most people said they would be more likely to purchase it.

Eighteen respondents said the expert information would not impact their purchasing decisions. A similar amount said it would impact their decision; it would make them less likely to purchase this fish. The remaining thirteen said the information would make them more likely to purchase GE canola fed farmed salmon.[58] In other words, our experiment appeared to impact the purchasing decisions of thirty two survey respondents or almost two thirds of our sample.

58 Although our n size for this question is forty nine, our results show that 50 people answered this question. One person gave two responses despite the fact they were asked to choose only one. For this reason, the percentages given in the section do not sum to 100%, and are not completely accurate.

7.2 SUGGESTIONS FOR FUTURE RESEARCH

In this experiment we found that the popularity of a communication method did not seem to predict how effective that method would be in producing correct responses. Overall, the most trustworthy method of communication was the Frequently Asked Questions (FAQ) format. Respondents also rated the FAQ format as the easiest to understand, the one that contained the most useful information, and the one they liked best overall. The case study was rated as the most enjoyable to read. The flow chart did not lead in any of our categories; in fact, it was rated the worst overall in each category by the majority of survey respondents. Yet although most individuals reported liking the Frequently Asked Questions method of communication the best on almost every criterion, this method was not the most effective in conveying information overall. The flow chart, rated the worst overall on every single criterion, averaged the most correct responses for forty one people.

Of course these results are very close, but they may indicate a trend. Given how each method was rated by respondents, and our respondents' comments and complaints regarding the flow chart methodology, we expected it to produce significantly fewer correct answers. This was not the case. Although no conclusions can be reached at this time due to the insignificant variation between the results, it would be interesting to test this correlation between popularity and effectiveness in future research projects with larger samples of people.

It is important to remember that we are not acting as advocates of the salmon aquaculture industry or GE technologies. Our intention is simply to experiment with different methods of communicating complex scientific information to Canadian consumers. Spending a substantial amount of time with each mental model interviewee and survey respondent gave us the opportunity to gain a greater understanding of our respondents' perceptions of these issues. Most enjoyed participating in this risk communication experiment and were eager to learn about controversial

technologies. Almost one quarter wrote brief notes in the margins of their surveys thanking us for the opportunity to participate in an "*educational*" research study.

This project was successful in many respects. The materials in the experiment impacted most individuals purchasing decisions. The process increased our respondents overall acceptance of certain food products, and perhaps more importantly, their confidence levels regarding their salmon aquaculture and GE food purchasing decisions. Results also demonstrated that the risk communication methods included in the in person survey could successfully correct many commonly held misconceptions. That said, one quarter of survey respondents told us through hand written notes that they were still concerned about the amount of uncertainty surrounding these issues. They were also worried about the unknown long term impacts of salmon aquaculture and GE foods, and felt they needed even more information to make competent food purchasing decisions.

Of the 65 people we randomly spoke with, all were willing to consider new information about GE technologies and the salmon aquaculture industry. As mentioned in the first chapter of this thesis, a number of ENGO's have actively engaged in anti farmed salmon campaigns in BC. In the past, the salmon aquaculture industry has not made a significant effort to defend their industry. (See below)

> *Though (David) Rideout had a press release typed up soon after the 'Farmed and Dangerous' press conference and launch, he said he was reluctant to release it and get drawn into a protracted public relations war - as that's exactly what environmental groups want. "Are our fish safe? Of course they are," Rideout said. "But why should we go out saying that when we've got other issues to deal with?*[59][60]

This stance is unfortunate given that the results of our research seems to show that many people hold misconceptions about this industry and are eager to learn more about salmon aquaculture. It is our hope that the results presented here will encourage others to implement similar projects in the future to help foster an understanding of novel technologies and misunderstood industries.

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59 David Rideout is the Executive Director of the Canadian Aquaculture Industry Alliance

60 Canadian Aquaculture Industry Alliance, Media Corner, *CAIA Director Speaks Out On 'Farmed & Dangerous' Campaign*, retrieved on March 20 from http://www.aquaculture.ca/English/PressReleases/CAIA_PressReleases37.html

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Part A-Test		TOTAL (%)
Part A question A	TOTAL (n=49)	70
1	13	**19%**
2	3	**4%**
3	43	**61%**
4	11	**16%**
Part A question B		78
1	22	**28%**
2	22	**28%**
3	34	**44%**
Part A question C		91
1	12	**13%**
2	38	**42%**
3	17	**19%**
4	6	**7%**
5	2	**2%**
6	16	**18%**
Part A question D		55
1	28	**51%**
2	8	**15%**
3	11	**20%**
4	6	**11%**
5	2	**4%**
Part A question E		47
YES	37	**79%**
NO	10	**21%**
Part A question F		47
YES	25	**53%**
NO	22	**47%**
Part A question G		157
1	13	**8%**
2	15	**10%**
3	31	**20%**
4	31	**20%**
5	25	**16%**
6	18	**11%**
7	5	**3%**
8	1	**1%**
9	18	**11%**
Part A question H		83
1	31	**37%**
2	4	**5%**
3	17	**20%**
4	21	**25%**
5	7	**8%**
6	0	**0%**
7	0	**0%**
8	3	**4%**
Part A question I		100

1	23	**23%**
2	42	**42%**
3	8	**8%**
4	16	**16%**
5	11	**11%**
Part A question J		45
YES	32	**71%**
NO	13	**29%**
Part A question K		72
1	10	**14%**
2	5	**7%**
3	9	**13%**
4	30	**42%**
5	11	**15%**
6	2	**3%**
7	5	**7%**
Part A question L		91
1	24	**26%**
2	1	**1%**
3	9	**10%**
4	24	**26%**
5	2	**2%**
6	22	**24%**
7	9	**10%**
Part A question M		69
1	2	**3%**
2	0	**0%**
3	4	**6%**
4	20	**29%**
5	0	**0%**
6	43	**62%**
Part A question N		58
1	33	**57%**
2	4	**7%**
3	9	**16%**
4	5	**9%**
5	7	**12%**
Part A question O		317
1	38	**12%**
2	26	**8%**
3	29	**9%**
4	9	**3%**
5	31	**10%**
6	33	**10%**
7	47	**15%**
8	9	**3%**
9	35	**11%**
10	32	**10%**
11	20	**6%**
12	8	**3%**
Part A question P		103

1	11	**11%**
2	14	**14%**
3	18	**17%**
4	26	**25%**
5	12	**12%**
6	22	**21%**
Part A question Q		67
1	40	**60%**
2	21	**31%**
3	2	**3%**
4	4	**6%**
Part A question R		123
1	4	**3%**
2	38	**31%**
3	17	**14%**
4	14	**11%**
5	17	**14%**
6	33	**27%**
Part A question S		49
1	1	**2%**
2	1	**2%**
3	4	**8%**
4	19	**39%**
5	24	**49%**
Part A question T		48
1	3	**6%**
2	3	**6%**
3	7	**15%**
4	16	**33%**
5	19	**40%**
Part A question U-1		49
1	1	**2%**
2	2	**4%**
3	9	**18%**
4	4	**8%**
5	20	**41%**
6	8	**16%**
7	5	**10%**
Part A question U-2		49
1	0	**0%**
2	1	**2%**
3	1	**2%**
4	2	**4%**
5	10	**20%**
6	18	**37%**
7	17	**35%**
Part A question U-3		49
1	0	**0%**
2	0	**0%**
3	1	**2%**
4	3	**6%**

5	11	**22%**
6	23	**47%**
7	11	**22%**

Part A question U-4		49
1	0	**0%**
2	0	**0%**
3	1	**2%**
4	1	**2%**
5	12	**24%**
6	27	**55%**
7	8	**16%**

Part A question U-5		49
1	7	**14%**
2	2	**4%**
3	3	**6%**
4	13	**27%**
5	15	**31%**
6	8	**16%**
7	1	**2%**

Part A question U-6		49
1	1	**2%**
2	2	**4%**
3	8	**16%**
4	9	**18%**
5	10	**20%**
6	14	**29%**
7	5	**10%**

Part A question U-7		48
1	1	**2%**
2	3	**6%**
3	6	**13%**
4	10	**21%**
5	24	**50%**
6	4	**8%**
7	0	**0%**

Part A question U-8		49
1	3	**6%**
2	1	**2%**
3	7	**14%**
4	8	**16%**
5	8	**16%**
6	17	**35%**
7	5	**10%**

Part A question V		49
1	24	**49%**
2	4	**8%**
3	8	**16%**
4	6	**12%**
5	5	**10%**
6	2	**4%**
7	0	**0%**

Part A question W		49
1	23	**47%**
2	10	**20%**
3	9	**18%**
4	4	**8%**
5	3	**6%**
6	0	**0%**
7	0	**0%**

Part C -specifics environmental risks	#VALUE!	
Question1		49
TRUE	28	**57%**
FALSE	21	**43%**
Question2		49
TRUE	39	**80%**
FALSE	10	**20%**
Question3		49
TRUE	8	**16%**
FALSE	41	**84%**
Question1		49
YES	46	**94%**
NO	3	**6%**
Question2		49
YES	43	**88%**
NO	6	**12%**
Question3		49
YES	37	**76%**
NO	12	**24%**
Economic risks		
Question1		48
TRUE	48	**100%**
FALSE	0	**0%**
Question2		49
TRUE	3	**6%**
FALSE	46	**94%**
Question3		49
TRUE	10	**20%**
FALSE	39	**80%**
Question1		48
YES	34	**71%**
NO	14	**29%**
Question2		49
YES	3	**6%**

NO	46	**94%**
Question3		46
YES	34	**74%**
NO	12	**26%**
Social risks		
Question1-multiple		49
1	2	**4%**
2	34	**69%**
3	11	**22%**
4	0	**0%**
5	0	**0%**
6	2	**4%**
Question1Y/N		48
YES	22	**46%**
NO	26	**54%**
Question2		49
YES	43	**88%**
NO	6	**12%**
Question3		48
YES	5	**10%**
NO	43	**90%**
Question4		49
YES	8	**16%**
NO	41	**84%**
Question5		49
YES	1	**2%**
NO	48	**98%**
Part C-Retest		
Part C -Question A		56
1	5	**9%**
2	1	**2%**
3	48	**86%**
4	2	**4%**
Part C- Question B		58
1	5	**9%**
2	45	**78%**
3	8	**14%**
Part C- Question C		56
1	0	**0%**
2	49	**88%**
3	3	**5%**
4	1	**2%**
5	2	**4%**
6	1	**2%**
Part C- Question D		50
1	3	**6%**
2	47	**94%**

3	0	**0%**
4	0	**0%**
5	0	**0%**
Part C- Question E		48
YES	38	**79%**
NO	10	**21%**
Part C- Question F		47
YES	24	**51%**
NO	23	**49%**
Part C- Question G		140
1	12	**9%**
2	18	**13%**
3	33	**24%**
4	31	**22%**
5	20	**14%**
6	12	**9%**
7	6	**4%**
8	1	**1%**
9	7	**5%**
Part C- Question H		83
1	28	**34%**
2	4	**5%**
3	17	**20%**
4	20	**24%**
5	8	**10%**
6	1	**1%**
7	0	**0%**
8	5	**6%**
Part C- Question I		78
1	10	**13%**
2	47	**60%**
3	6	**8%**
4	9	**12%**
5	6	**8%**
Part C- Question J		51
1	49	**96%**
2	1	**2%**
3	1	**2%**
4	0	**0%**
Part C- Question K		535
1	49	**9%**
2	48	**9%**
3	47	**9%**
4	44	**8%**
5	43	**8%**
6	45	**8%**
7	45	**8%**
8	44	**8%**
9	43	**8%**
10	43	**8%**
11	41	**8%**

12	43	**8%**
Part C- Question L		47
YES	44	**94%**
NO	3	**6%**
Part C- Question M		86
1	10	**12%**
2	6	**7%**
3	9	**10%**
4	29	**34%**
5	22	**26%**
6	4	**5%**
7	6	**7%**
Part C- Question N		88
1	25	**28%**
2	2	**2%**
3	11	**13%**
4	19	**22%**
5	1	**1%**
6	21	**24%**
7	9	**10%**
Part C- Question O		90
1	3	**3%**
2	0	**0%**
3	24	**27%**
4	29	**32%**
5	0	**0%**
6	34	**38%**
Part C- Question P		93
1	9	**10%**
2	14	**15%**
3	27	**29%**
4	22	**24%**
5	5	**5%**
6	16	**17%**
Part C- Question Q		51
1	49	**96%**
2	2	**4%**
3	0	**0%**
4	0	**0%**
Part C- Question R		114
1	10	**9%**
2	30	**26%**
3	23	**20%**
4	19	**17%**
5	6	**5%**
6	26	**23%**
Part C- Question S1		51
1	14	**27%**
2	19	**37%**
3	18	**35%**

Part C- Question S2		50
1	19	**38%**
2	14	**28%**
3	17	**34%**
Part C- Question S3		49
1	21	**43%**
2	11	**22%**
3	17	**35%**
Part C- Question S4		49
1	24	**49%**
2	8	**16%**
3	17	**35%**
Part C-Question T1		49
1	1	**2%**
2	6	**12%**
3	10	**20%**
4	3	**6%**
5	18	**37%**
6	7	**14%**
7	4	**8%**
Part C-Question T2		49
1	0	**0%**
2	0	**0%**
3	1	**2%**
4	1	**2%**
5	12	**24%**
6	19	**39%**
7	16	**33%**
Part C-Question T3		49
1	1	**2%**
2	0	**0%**
3	0	**0%**
4	3	**6%**
5	10	**20%**
6	26	**53%**
7	9	**18%**
Part C-Question T4		49
1	0	**0%**
2	0	**0%**
3	2	**4%**
4	1	**2%**
5	11	**22%**
6	25	**51%**
7	10	**20%**
Part C-Question T5		49
1	3	**6%**
2	3	**6%**
3	7	**14%**
4	12	**24%**
5	17	**35%**

6	7	**14%**
7	0	**0%**
Part C-Question T6		49
1	0	**0%**
2	3	**6%**
3	7	**14%**
4	9	**18%**
5	14	**29%**
6	12	**24%**
7	4	**8%**
Part C-Question T7		49
1	0	**0%**
2	5	**10%**
3	12	**24%**
4	9	**18%**
5	17	**35%**
6	5	**10%**
7	1	**2%**
Part C-Question T8		49
1	2	**4%**
2	3	**6%**
3	5	**10%**
4	12	**24%**
5	12	**24%**
6	9	**18%**
7	6	**12%**
Part C-Question U		48
1	9	**19%**
2	11	**23%**
3	7	**15%**
4	5	**10%**
5	10	**21%**
6	6	**13%**
7	0	**0%**
Part C-Question V	0	49
1	14	**29%**
2	15	**31%**
3	11	**22%**
4	1	**2%**
5	7	**14%**
6	1	**2%**
7	0	**0%**
Part C-Question W1		
Question/answer	70	
Flow chart	116.5	
Case study	104.5	
Part C-Question W2		
Question/answer	76.5	
Flow chart	122	
Case study	94.5	

Part C-Question W3		
Question/answer	82.5	
Flow chart	129	
Case study	80.5	
Part C-Question W4		
Question/answer	72.5	
Flow chart	111.5	
Case study	105	
Part C-Question W5		
Question/answer	80	
Flow chart	123	
Case study	89	
Part C-Question X		49
1	2	**4%**
2	3	**6%**
3	7	**14%**
4	18	**37%**
5	19	**39%**
Part C-Question Y		49
1	2	**4%**
2	3	**6%**
3	10	**20%**
4	23	**47%**
5	11	**22%**
Part C-Question Z1		50
1	0	**0%**
2	11	**22%**
3	24	**48%**
4	10	**20%**
5	5	**10%**
Part C-Question Z2		49
1	5	**10%**
2	16	**33%**
3	19	**39%**
4	3	**6%**
5	6	**12%**
Part C-Question Z3		48
1	10	**21%**
2	23	**48%**
3	12	**25%**
4	0	**0%**
5	3	**6%**
Part C-Question Z4		47
1	1	**2%**
2	12	**26%**
3	24	**51%**
4	7	**15%**
5	3	**6%**
Part C-Question Z5		48

1	13	**27%**
2	20	**42%**
3	6	**13%**
4	2	**4%**
5	7	**15%**

Part C-Question Z6		48
1	1	**2%**
2	20	**42%**
3	20	**42%**
4	3	**6%**
5	4	**8%**

Part C-Question Z7		48
1	1	**2%**
2	9	**19%**
3	28	**58%**
4	7	**15%**
5	3	**6%**

Part C-Question Z8		48
1	10	**21%**
2	18	**38%**
3	8	**17%**
4	2	**4%**
5	10	**21%**

Part C-Question AA		50
1	18	**36%**
2	19	**38%**
3	13	**26%**

April 12, 2003

Group#
Version# 1
Participant #

Risk Communication Survey

Co-Investigator: Holly Ann Longstaff
MA Candidate
Resource Management and Environmental Studies Department
University of British Columbia

Purpose: This workshop is a communication experiment. The purpose of this experiment is to explore different methods of disseminating complex scientific information. We are interested in how receiving this information will affect your purchasing decisions and your acceptability of an issue.

Specific topic: The topics that will be discussed during this experiment will be salmon aquaculture (salmon farming) and the food that farmed salmon eat.

Procedure: This workshop will consist of 3 written sections followed by a short group discussion. I will hand the entire survey to you at the beginning of our workshop and collect each section after you have completed the tasks involved. If you have any questions please feel free to ask me. You will need to sign the bottom of this paper in order to receive your payment for participating in this workshop.

Thank you!

Holly

I have received $10 for my participation in this workshop on the date of _____/_____/03

Signature: _____

Risk Communication Survey
(Part one)

Before you begin I would appreciate it if you filled out some basic personal information for statistical purposes only.

a) Gender _____

b) Age (Please circle one)
Under 20 21 -30 31-40 41-50 51-60 61-70 71-80 over 80

c) Cultural/ethnic background _____

d) Highest level of education completed _____

e) Profession _____

SECTION #1

Instructions:

The first section of this survey is intended to clarify what you already know about salmon farming. Please answer each question to the best of your abilities and feel free to write as much or as little as you believe is appropriate. If you do not know the answer to a question, then simply put down the answer you think is most likely to be right. I know that you may have no direct knowledge in this area and that is fine. It is important for you to remember that the number of correct answers you give will have absolutely no effect on how well you answer this survey. This is not a test.

Questions:

a) What is salmon aquaculture (salmon farming)? (please check off all that apply)
- ☐ Growing salmon in rivers. They are kept separate from wild salmon by a net.
- ☐ Growing salmon in self contained lakes.
- ☐ Growing salmon in large net pens in sheltered bays along the coast
- ☐ Growing salmon in large tanks on land

b) What do wild salmon eat in nature? (please check off all that apply)
- ☐ Aquatic plants
- ☐ Fish that share their aquatic environment
- ☐ Tiny nutrients found in ocean water

c) What do farmed salmon eat? (please check off all that apply)
- ☐ Aquatic plants
- ☐ Processed fish food pellets
- ☐ Fish food flakes
- ☐ A sloppy loose wet feed
- ☐ Fish that share their aquatic environment
- ☐ Nutrients found in ocean water

d) Where does the protein component of farmed salmon feed currently come from? (please check off all that apply)
- ☐ Canada
- ☐ South America
- ☐ United States
- ☐ Japan
- ☐ Europe

e) Do you purchase or eat wild salmon? (please circle the appropriate answer)

YES NO

f) Do you purchase or eat farmed salmon? (please circle the appropriate answer)

YES NO

g) Do you have any concerns about purchasing farmed salmon? (please check off all that apply)
- ☐ I have no concerns about purchasing farmed salmon
- ☐ I believe that farmed salmon could be bad for my health
- ☐ I believe that salmon farming could be harmful to the environment
- ☐ I believe that salmon farming could harm wild salmon populations
- ☐ I believe that salmon farming could harm traditional and/or commercial fisheries in BC

- ☐ I believe that salmon farming could harm First Nations people
- ☐ I do not like the taste of farmed salmon
- ☐ I do not like the way farmed salmon looks
- ☐ I am worried that farmed salmon may be genetically engineered

Please list any additional concerns that you may have in the space provided

_____
_____
_____
_____
_____
_____

h) Do you have any concerns about purchasing wild salmon? (please check off all that apply)

- ☐ I have no concerns about purchasing wild salmon
- ☐ I believe that wild salmon could be bad for my health
- ☐ I believe that commercial salmon fishing could be harmful to the environment
- ☐ I believe that commercial salmon fishing could harm wild salmon populations
- ☐ I believe that commercial salmon fishing could harm First Nations people
- ☐ I do not like the taste of wild salmon
- ☐ I do not like the way wild salmon looks
- ☐ Wild salmon is too expensive

Please list any additional concerns that you may have in the space provided

_____
_____
_____
_____
_____
_____

i) What is meant by the term "genetic engineering"? (please check off all that apply)

- ☐ Selectively breeding two plants together in order to create a new plant with more desirable traits
- ☐ Alteration of the structure of genetic material in a living organism. It involves inserting one or more pieces of new DNA into the organism
- ☐ Grafting two living plants together by splicing off a section of one plant and binding to another.

- ☐ Any scientific procedure that is performed by humans on a living organism that will cause that living organism to behave differently than it would have if it had been left undisturbed in nature
- ☐ Injecting beef or dairy cows with hormones that will increase their growth rates or the rates at which they produce milk.

j) Do you eat any foods that have been genetically engineered? These foods are also sometimes called GMO's or GM food products. (please circle the appropriate answer)

YES NO

Please list some of the GE foods that you eat in the space provided

_____
_____
_____
_____
_____

k) Do you have any concerns about purchasing genetically engineered (GE) food products? (please check off all that apply)

- ☐ I have no concerns about purchasing GE food products
- ☐ I believe that GE food products may cause cancer
- ☐ I believe that GE food products are not as nutritious as non-GE food products
- ☐ I believe that GE food products are not adequately tested or regulated in Canada
- ☐ I believe that growing GE food products is harmful to the environment
- ☐ I believe that eating GE food products can cause deformities and/or strange illnesses in humans
- ☐ GE food products "cross the line". I do not feel comfortable eating any foods that were genetically engineered because I believe the technology is morally unacceptable

Please list any additional concerns that you may have in the space provided

_____
_____
_____
_____
_____

l) Do you have any concerns about purchasing organic food products? (please check off all that apply)

- ☐ I have no concerns about purchasing organic food products.
- ☐ I believe that organic food products could make me sick
- ☐ I believe that organic food products are not adequately tested or regulated in Canada
- ☐ Organic food products are too expensive
- ☐ I believe organic food products are not as safe an non-organic food products
- ☐ Even when a food is labeled "organic" there can still be non-organic ingredients in it
- ☐ Calling a food organic is just one way of charging more money for it

Please list any additional concerns that you may have in the space provided

_____

_____

_____

_____

_____

m) How do you know if the foods you eat have been genetically engineered? (please check off all that apply)

- ☐ All GE foods are labeled in Canadian stores
- ☐ All GE foods are labeled in Canadian restaurants
- ☐ GE food products are only labeled in Canada if they can cause allergies or if they have a different nutritional content than their non-GE counterparts
- ☐ Certain food products in Canada are very likely to be genetically engineered or contain GE ingredients.
- ☐ You can tell if they have been genetically engineered because of the way they look, taste or smell.
- ☐ I do not know if the foods I eat have been genetically engineered.

n) What is canola? (please check off all that apply)

- ☐ An oilseed plant
- ☐ A kind of wheat
- ☐ A kind of sunflower
- ☐ A kind of corn
- ☐ A synthetic (man made) oil

o) Which of the following processed food product include ingredients that often come from canola? (please check off all that apply)

- ☐ Potato chips
- ☐ Crackers

- ☐ Cookies
- ☐ Coffee mate
- ☐ Mayonnaise
- ☐ Margarine
- ☐ Cooking oil
- ☐ No bake cheesecake mixes
- ☐ Salad dressings
- ☐ Cooking spray
- ☐ Croutons
- ☐ Dry hot chocolate powder

p) What concerns do you have about purchasing farmed salmon that were fed with genetically engineered canola? (please check off all that apply)

- ☐ I have no concerns about purchasing farmed salmon that were fed with GE canola
- ☐ Eating farmed fish that were fed with GE canola may be harmful to my health
- ☐ Using GE canola to feed farmed salmon may be harmful to the environment
- ☐ It is unnatural to feed salmon GE canola
- ☐ Eating GE canola will cause the salmon to become genetically modified
- ☐ The concerns I already have about eating farmed salmon or GE foods would become compounded and amplified if they were combined in one food product.

Please list any additional concerns that you may have in the space provided

_____
_____
_____
_____
_____
_____
_____

q) If Canadian salmon farmers used genetically engineered canola in their feeds, where would this crop most likely come from?

- ☐ The Canadian prairies
- ☐ The United States
- ☐ Japan
- ☐ Europe

r) What concerns do you have about purchasing farmed salmon that were fed with wild fish from South America? (please check off all that apply)

- ☐ I am not concerned about purchasing farmed salmon that were fed with wild fish from South America
- ☐ Disease might be transferred from wild South American fish to farmed salmon
- ☐ Importing fish from South America may contribute to environmental damage in South America
- ☐ I am concerned that importing fish from South America may be economically hard on the Canadian salmon aquaculture industry.
- ☐ I am concerned that South American fishermen may not be getting a fair deal and that the Canadian salmon aquaculture industry might take advantage of them.
- ☐ I am concerned that the South American commercial fisheries may not be held up to the same environmental and human health standards that they are in Canada

Please list any additional concerns that you may have in the space provided

_____
_____
_____
_____
_____
_____
_____

s) Does it matter to you **<u>what ingredients</u>** Canadian salmon farmers use in their fish feed? (Please circle the appropriate response)

1	2	3	4	5
It doesn't matter at all	It matters a little	neutral	It somewhat matters	It matters a lot

t) Does it matter to you **<u>where</u>** (physical location) Canadian salmon farmers get their fish feed from? (Please circle the appropriate response)

1	2	3	4	5
It doesn't matter at all	It matters a little	neutral	It somewhat matters	It matters a lot

u) **How important is each of the following in your decision to purchase food products?** (please circle the number that corresponds with your response to each of the following questions)

How important is ...

Price

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Human health impacts of consuming that food

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Taste

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Nutritional content

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Knowing that the food was grown in Canada

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Traceability *(the entire life cycle of this food product is known and controlled by those who produce it)*

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Convenience

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Knowing that the food product has <u>not</u> been genetically engineered or has not eaten genetically engineered food products in its lifetime

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

v) **How confident are you in your level of knowledge when it comes to your purchasing decisions regarding salmon aquaculture food products?** (please circle the number that corresponds with your response)

1	2	3	4	5	6	7
Not at all confident	a little confident	somewhat confident	neutral	quite confident	very confident	extremely confident

w) **How confident are you in your level of knowledge when it comes to your purchasing decisions regarding genetically engineered food products?** (please circle the number that corresponds with your response)

1	2	3	4	5	6	7
Not at all confident	a little confident	somewhat confident	neutral	quite confident	very confident	extremely confident

**************************END OF PART ONE**************************

Instructions:

When you have completed this section please turn your booklet over and I will collect them. At this time I will also provide you with the second portion of this survey.

Risk Communication Survey
(Part two)

SECTION #2

Background information:

In British Columbia farmed salmon are usually grown in large netpens (large nets that do not touch the ocean floor) in sheltered bays along the coast. Salmon are carnivores (flesh eating) and therefore require a high protein feed. Currently, farmed salmon in BC are fed with processed fish food pellets. The main protein component in these pellets comes from wild fish meal and oil that is imported from South America. In the future, this supply of wild fish could become more costly because of the growing demand on this natural resource for fish feed, other animal feeds and now for human consumption. It could also become an unstable resource if South American wild fish stocks were to be impacted by natural disasters, climate change or over harvesting by humans. Feed costs are already a significant proportion of the total salmon farming production costs. Therefore, some salmon aquaculturalists in BC would like to find a more stable and possibly less expensive alternate source of protein and oil for their feeds. One such alternative is genetically engineered canola. However there are challenges involved with using large amounts of canola in farmed salmon feed.

Salmon cannot digest parts of canola because they lack a specific digestive enzyme. One of the substances that cannot be digested by salmon is phytic acid, a form of phosphorus. Salmon need phosphorous so farmers must add additional amounts of it to their fish feeds. The undigested excess phosphorous eventually ends up in the aquatic environment where it can lead to algae blooms that can oxygen starve the fish. There are numerous ways to try to overcome this problem. One option is to genetically engineer (GE) the canola plant to produce lower amounts of the phytic acid phosphorus. However this is not the only way in which the canola used in salmon feeds is likely to be genetically engineered. There are many ways to engineer a canola plant that make it cheaper to grow. These genetic modifications could eventually reduce or stabilize the feed costs to the salmon farmer, make the feed easier for the fish to digest and perhaps result in a cleaner aquatic environment. However using GE feed has many environmental, economic and social risks and benefits that must be considered by the citizens of BC.

The purpose of this section of the survey is to relate the various risks and benefits associated with using GE salmon feed on BC salmon farms to you.

Instructions: ***In this section you will be provided with three different ways of dispensing information about the risks and benefits of using GE canola to feed farmed salmon in BC. Please examine each carefully. Feel free to take notes.***

Frequently Asked Questions (FAQ's)

ENVIRONMENTAL RISKS AND BENEFITS OF USING GE CANOLA TO FEED FARMED SALMON

1. **Question:** What do salmon eat?

   Response: Salmon are carnivores. This means they eat the flesh of other fish. A farmed salmon therefore requires a high protein feed that can mimic the nutritional content of the food it would have eaten in nature. Currently farmed salmon are fed with processed feeds that look like dry pellets. These pellets contain wild fish from South America. For a variety of reasons, some salmon aquaculturalists would like to use GE canola (a high protein plant) instead of wild South American fish in their feeds.

2. **Question:** What is canola?

   Response: Canola is an oilseed plant that was developed using traditional plant breeding methods to remove undesirable qualities in the rapeseed plant. The rapeseed plant is not fit for human consumption but canola has been thoroughly tested and is guaranteed safe for humans. Many processed food products are made with canola including potato chips, crackers, cookies, coffee mate, mayonnaise, margarine, cooking oil, no bake cheesecake mixes, salad dressings, cooking spray, croutons and dry hot chocolate powder. It is also interesting to note that canola is named after the country it was created in. Canola stands for Canada oil.

3. **Question:** If a salmon eats GE canola will it then become genetically modified too?

   Response: No. Eating GE canola will not change the genetic structure of the salmon.

4. **Question:** Are farmed salmon genetically engineered?

   Response: No. Farmed Canadian salmon are not genetically engineered. The BC salmon aquaculture industry uses Atlantic salmon from the east coast of Canada in their growing operations because they are more docile and can live in the very cramped conditions of a netpen without dying of stress related illnesses. This species of salmon is not naturally found BC waters but they are not genetically engineered.

5. **Question:** I have heard that when an animal eats a GE feed there is a possibility that this GE feed can introduce toxins into the animal's system that would later be

expelled into their environment or stored in their meat. Is there a chance that farmed salmon will become toxic if they are fed with GE canola?

Response: It is true that novel toxins can theoretically be created when GE feeds are consumed. However it is vital to note that to date, no animal health problems have been reported from using GE oilseeds (like canola) and grains in animal feeds. Additionally, many tests and evaluations are performed to reduce these sorts of risks and the health impacts of GE canola in particular are researched extensively and are very well understood in Canada.

6. **Question:** If genetically engineered canola is used for fish food, will it end up polluting the aquatic environment?

   Response: Limited amounts of canola are already used in farmed salmon feed. However salmon cannot digest canola. The canola plant contains phytic acid (a form of phosphorus) that salmon cannot digest because they lack the enzyme phytase. Resultantly, salmon aquaculturalists must currently add phosphorus supplements to the feed. The nutrients in the traditional feeds that the fish are unable to digest eventually end up in the aquatic environment where excess phosphorous can cause algae blooms that can oxygen starve the fish. GE canola feed may actually result in a cleaner aquatic environment because it will be easier for the fish to digest and less food will be wasted.

7. **Question:** If we use GE canola for salmon feed then we won't need to use as much fish from South America to feed our salmon. Will this keep South American fisheries from over harvesting their oceans and in turn, be beneficial to the environment in South America?

   Response: There is tremendous demand on South American wild fisheries from many different industries. If Canadian salmon aquaculturalists were to discontinue using wild South American fish, this demand would continue and this natural resource would be quickly redirected into the production of swine, poultry and other feeds. Fish oil is also being utilized for human consumption due to its reported benefits to human health.
   However the South American fish that are caught for feed purposes are pelagic (deep ocean) fish. These small bony fish are generally not used for human consumption but they are food for fish farther down the food chain. These other fish are utilized for human consumption and there is always a possibility that less pressure on the pelagic fish may increase the amount of food and therefore amount of larger fish available for human consumption.

8. **Question:** Are salmon the only farmed animal/fish that cannot digest canola?

Response: No. Other animals like pigs and chickens also lack the enzyme phytase and therefore cannot properly digest their canola feeds. Creating a GE low phytate canola feed could therefore be beneficial to pig and poultry farming operations as well as salmon farms. Although it is sometimes believed that a fish may get sick from eating foods it would never have eaten in nature, using this GE feed could actually result in a healthier animal that has a higher quality of life because their food is now easier for them to digest.

9. **Question:** Does growing genetically engineered canola encourage environmentally harmful farming practices?

   Response: Farms that grow genetically engineered canola are generally terrestrial mega farms that sometimes utilize environmentally unfriendly farming practices like the growing of huge mono-crops, flattening out of land and the overall reduction of genetic diversity and biodiversity of the land. However it is also important to note that less herbicides are required to grow GE canola relative to non-GE canola and this has major environmental benefits.

10. **Question:** Can genetically engineered plants affect other plants around them?

    Response: GE plants can cause changes in the soils around them. The genetically engineered plant's relationship with the very complicated microbial world in the soil may change through a process called lateral gene transfer. This can affect the larger ecosystem. There is also a possibility of cross pollination with other canola and non-canola plants that could result in accidental gene transfer although there is decreased risk of this occurring with non-canola plants.
    Lastly we also have the risk of gene stacking and volunteer canola. Super-weeds are sometimes created when different varieties of resistant GE canola blend into one super and multiple resistant canola plant that is very difficult to remove. Volunteer canola is another kind of weed. Sometimes canola continues to grow in a field even after the farmer has stopped planting it. It shows up as a weed while other crops are being grown. This robust canola plant can be very difficult to remove. In order to combat these super resistant weeds, farmers are sometimes forced to use very strong environmentally unfriendly herbicides. Terminator technology, or seeds that are genetically engineered to die after one growing season, are one partial solution to this problem. Additionally, all of the previously mentioned concerns can lead to a loss of biodiversity and genetic diversity.

11. **Question:** Is it true that with single gene modification, there is almost no risk of creating unknown responses in the plant? The plant will probably not be affected if you only add one gene right?

Response: Single gene modification can affect other genes, gene products or metabolic functions of the plant having pleiotropic (multiple) unknown effects. It should be noted however that many tests and evaluations are performed to reduce these sorts of risks.

12. **Question:** Will using GE canola to feed salmon virtually eliminate the possibility of contaminants transfer to fish via their feed?

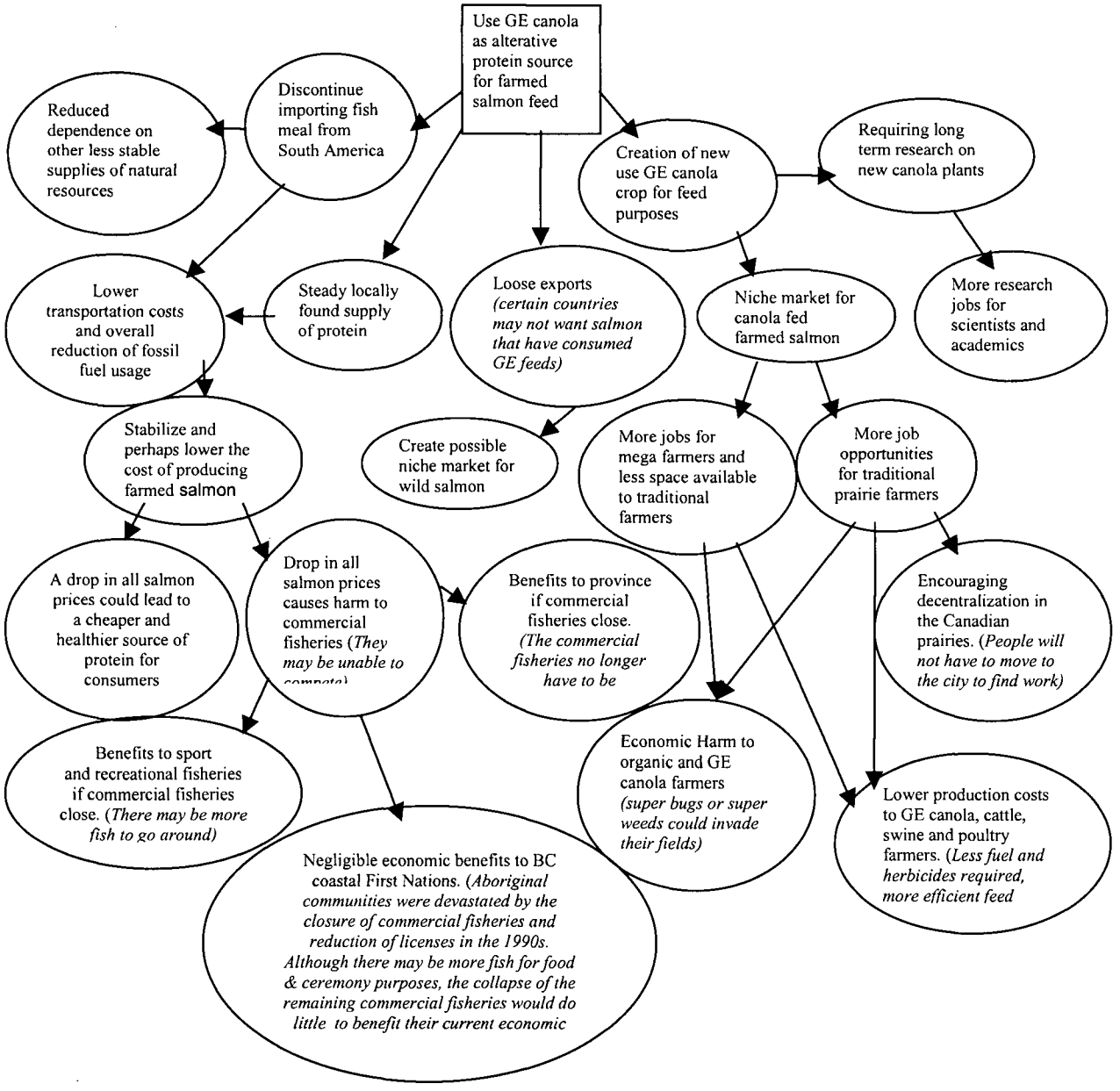
    Response: By switching from wild fish to GE canola as the main component in salmon feed the possibility of contaminants transfer to farmed fish via feed is merely altered not eliminated.

13. **Question:** Do we grow GE canola in Canada?

    Response: Yes we do. It is primarily grown in Saskatchewan, Alberta and Manitoba although there are also a few fields in Southern Ontario and Quebec. In fact, Canada is the third largest producer of genetically modified organisms (GMOs) in the world. Fifty-one novel foods (*a novel food is a food that is derived from a plant, animal or microorganism that has been genetically modified*) have been approved by Health Canada, most of which are derived from biotechnology-derived crop plants. Canadian GE crops so far approved include: corn, canola, tomato squash, soybean, sugarbeet, flax, and cottonseed oil. Additionally, about 60 % of all processed foods contain some genetic modifications. Some of these processed foods include crackers, taco shells, cereals, waffles, cookies, tomato sauce, cereal bars, chocolate bars, popcorn and ketchup.

Flow chart (1)

ECONOMIC RISKS AND BENEFITS OF USING GE CANOLA TO FEED FARMED SALMON



Case study

SOCIAL RISKS AND BENEFITS OF USING GE CANOLA TO FEED FARMED SALMON

My name is Sam. My partner and I have been farming salmon along the coast of British Columbia for about five years. We have always tried to adopt new technologies and incorporate the latest scientific developments into our methods of production. Recently we have been presented with the opportunity to use a new genetically engineered (GE) salmon feed on our farm.

We feed our fish with pellets that include a variety of ingredients. The main difference in this new GE feed is that it uses GE canola instead of wild fish for the main protein component of the feed. Salmon are carnivores (flesh eating) so it is important that they are fed with a feed that is high in protein. The wild fish that are used in my old feed are imported from South America. Scientists believe that this source of feed may become increasingly expensive as demand rises for the South American wild fish stocks. It seems that salmon aquaculturalists are not the only ones who want this supply of fish. Other farmers, like pig and poultry farmers, also use this resource in their feeds. Additionally, new markets are being created for fish oil because of its reported nutritional benefits to human health. Scientists also say that South American fish may become an unstable natural resource because of climate changes, natural disasters and over harvesting by humans. This instability could increase the cost of these fish to the aquaculture industry. Feed costs are already a substantial proportion of our total production costs and we cannot afford to pay much more for our feed. If this GE feed is cheaper or more reliable, it would definitely be beneficial to our farm. However, we are very concerned about the social risks and benefits of using this feed and cannot decide whether or not we should start buying it.

There are already small amounts of canola in the feed we use now and the fish sometimes have difficulties digesting it. There is always the possibility that they may get sick from eating large amounts of food, like canola, that they would never have eaten in nature. What if this new feed harms our fish?

The canola plant contains substances, like phytic acid, that salmon cannot digest. Phytic acid is a form of phosphorous. In order for a salmon to digest this phytic acid and access the phosphorus in the feed, they must produce the enzyme phytase, but they do not. Resultantly, phosphorus has to be added to the fish feed. Excess phosphorous eventually ends up in the aquatic environment where it can cause algae blooms that can oxygen starve the fish. Genetically engineering the canola plant to reduce its levels of phytic acid could make it easier for the salmon to digest, reduce or stabilize our feed costs and perhaps result in a cleaner aquatic environment. It is also possible that our fish may have a higher quality of life if they were better able to digest their food. However we have heard that this new feed may alter the nutritional content of the feed and the fish.

It is very possible that GE feed may create a healthier, happier fish and resultantly people who eat these salmon will become healthier by consuming a cheaper and nutritionally superior fish. However, my partner points out that the altered nutritional content of the feed could also result in a less nutritious fish. Although there are no negative human health impacts currently associated with GE feeds, the long term impacts on human health are unknown. One of the reasons I enjoy farming salmon is because I know we are supplying a source of inexpensive healthy protein to the public and I want to continue feeling proud of the work we do. I know that we can provide the public with fresh farmed salmon continuously while wild salmon can only be eaten fresh at certain times of the year. When a consumer buys a farmed salmon they know they are buying a fresh food product. However, even if we can determine that the fish that eat GE feed are just as nutritious as the fish that eat the traditional feed, the public might just **assume** that GE feed fed fish are not nutritious and stop eating our fish. Sometimes even the **perception** that a food is unhealthy is enough to stop people from buying it. This would have an overall negative impact on the public's health and on our business.

My business partner is also concerned that it is becoming increasingly difficult for the public to remain informed about the content of the food products that they consume. Genetically modified foods are not labeled in Canada and you cannot tell if a food has been modified just by the way it looks or smells. In Canada a GE food is considered fit for human consumption if it the GE plant is just as safe, just as nutritious and overall very similar to its non-GE counterpart. The term that is used to describe this similarity is Substantial equivalence. The GE food is said to be **Substantially Equivalent** to its non-GE counterpart and is therefore fit for human consumption. However, although the foods may look the same, the GE food product has nonetheless been modified in a significant way.

When an organism is genetically engineered it means that an alteration has been performed to the structure of that organism's genetic material. It involves inserting one or more pieces of new DNA into the organism's genome. The fact that this may not change the way it looks to you or me can be problematic. If a person is allergic to a certain plant, it becomes more difficult for them to avoid the triggers that make them sick because they do not always know what is in GE foods. A gene from the plant that makes them sick may be introduced into the food product they are eating without their knowledge. When plants are genetically modified, they may also produce novel toxins in the animal that consumes them because the animal would not otherwise have eaten that food or eaten that food in that quantity. These toxins can then be passed on down the food chain. These sorts of risks worried me very much so I performed some research on my own. I found out that new GE feeds must be tested for toxicity and to date, no animal health problems have been reported from using GE oilseeds (like canola) and grains in animal feeds. I also learned that the health impacts of GE canola are very well understood in Canada and have been studied for some time. It would be very unlikely for GE canola feed to cause unpredictable allergic reactions in humans. I also found out that despite the fact that GE food products,

or foods that contain GE ingredients are not required to be labeled in Canada, the government does require labeling of GE foods if the nutritional content has been changed or if it poses health and safety issues such as allergens to the public. The Canadian Food Inspection Agency performs allergenicity assessments on GE foods.

I believe that one positive aspect of using GE feed for our fish is that the risks of engaging in salmon aquaculture stay within Canada. I would hate to think that our demand for wild fish in our traditional feeds is contributing to environmental damage in South American waters. I would also like to support terrestrial Canadian prairie farmers in Manitoba, Saskatchewan and Alberta who grow canola. However my partner argues that growing GE canola is not "traditional farming" by any means and that it does not encourage that continuation of the family farm. My partner tells me that farmers who grow this crop must sign agreements with major corporations and follow rules that some of them believe disrespect their long standing farming traditions and destroy their **autonomy.** (*Autonomy: the condition or quality of being independent. It also means the right of self-government or self-determination*) My partner is also quick to point out that we as Canadians have a responsibility to encourage the industrialization of less advantaged regions of the world (like South America) through trading with them.

One thing my partner and I do agree on is the importance of consumer confidence to our business. I believe that using GE feeds could enhance the public's confidence in our business but my partner disagrees. My partner argues that some people may believe that GE technologies involve "playing God" and engaging in unnatural processes that "cross the line" and are morally wrong. They may also believe that utilizing GE technologies involves trading major social and environmental risks for benefits that go mostly to industry. Neither my partner nor I want to be perceived as monsters by the public. However I argue that although there is a possibility that using GE feeds may cause the social stigmatization of our fish, it will also enhance the traceability of the food products we produce. Through using GE feeds, the Canadian aquaculture industry will acquire more control over every aspect of the life of a farmed salmon. We will know that every area of production was held up to strict Canadian environmental regulations, health and safety standards and this could drastically improve consumer confidence.

**************************END OF PART TWO****************************

Instructions:

When you have completed this section please turn your booklet over and I will collect them. At this time I will also provide you with the third portion of this survey.

Risk Communication Survey
(Part three)

SECTION # 3

Instructions:

This is the final section of the survey. Please take your time and answer each question to the best of your abilities. Upon the completion of this section, we will all come together for a short group discussion.

QUESTION SET #1: Specifics

Environmental risks and benefits

Are the following statements true or false? (Please circle the correct answer)

1. Farmed salmon would probably have an easier time digesting GE canola feed compared to the feed they eat today **TRUE** **FALSE**

2. It is possible that growing genetically engineered canola could lead to a loss of genetic diversity and biodiversity **TRUE** **FALSE**

3. If a fish or animal eats a GE feed, then the fish/animal becomes genetically modified too.
TRUE **FALSE**

Please answer YES or NO to each of the following questions (Please circle the correct answer)

1. It is possible for different genetically engineered canola plants to combine through gene stacking into a super weed that is very difficult to kill.
YES **NO**

2. Farmers use less herbicides with GE canola relative to non-GE canola crops
YES **NO**

3. One of the benefits of using GE feed is the possibility of having a cleaner aquatic environment.
YES **NO**

Economic risks and benefits

Are the following statements true or false? (Please circle the correct answer)

1. Creating GE low phytate canola feed could be beneficial to poultry and pig farmers as well as salmon farmers.

   TRUE **FALSE**

2. If Canada stopped importing wild fish from South America it would devastate the South American economy.

   TRUE **FALSE**

3. Substituting GE salmon feed for traditional feed would likely increase the overall production costs of salmon farming in the future.

   TRUE **FALSE**

Please answer YES or NO to each of the following questions (Please circle the correct answer)

1. Growing GE canola could cause harm to organic farming operations.

   YES **NO**

2. In Canada, GE canola is mostly grown in Ontario.

   YES **NO**

3. Using GE canola could reduce the overall amounts of fossil fuels currently used by the salmon aquaculture industry.

   YES **NO**

Social risks and benefits

Multiple choice (Please check off one of the following responses)

1. What term do we use in Canada to imply that the GE plant is very similar to its non-GE counterpart? This term is also meant to imply that the GE food is as safe as its non-GE counterpart
   - ☐ CFIA (Canadian Food Inspection Agency) approved
   - ☐ Substantial equivalence
   - ☐ There is no such term
   - ☐ Gold seal
   - ☐ No known divergence
   - ☐ Scientifically determined similarity

Please answer YES or NO to each of the following questions (Please circle the correct answer)

1. The human health risks of GE canola are not very well understood in Canada.
   YES **NO**
2. Growing GE canola could lead to a loss of independence for a traditional independent prairie farmer.
   YES **NO**
3. Many animal health problems have been reported from using GE oilseeds and grains in animal feeds.
   YES **NO**
4. Feed costs are a small proportion of the total production costs of farming salmon.
   YES **NO**
5. The wild salmon that you buy in the store will always be fresher than farmed salmon.
   YES **NO**

QUESTION SET #2: Retest

Multiple Choice

a) What is salmon aquaculture (salmon farming)? (please check off all that apply)
- ☐ Growing salmon in rivers. They are kept separate from wild salmon by a net.
- ☐ Growing salmon in self contained lakes.
- ☐ Growing salmon in large net pens in sheltered bays along the coast
- ☐ Growing salmon in large tanks on land

b) What do wild salmon eat in nature? (please check off all that apply)
- ☐ Aquatic plants
- ☐ Fish that share their aquatic environment
- ☐ Tiny nutrients found in ocean water

c) What do farmed salmon eat? (please check off all that apply)
- ☐ Aquatic plants
- ☐ Processed fish food pellets
- ☐ Fish food flakes
- ☐ A sloppy loose wet feed
- ☐ Fish that share their aquatic environment
- ☐ Nutrients found in ocean water

d) Where does the main protein component of farmed salmon feed currently come from? (please check off all that apply)
- ☐ Canada
- ☐ South America
- ☐ United States
- ☐ Japan
- ☐ Europe

e) Do you purchase or eat wild salmon? (please circle the appropriate answer)

YES NO

f) Do you purchase or eat farmed salmon? (please circle the appropriate answer)

YES NO

g) Do you have any concerns about purchasing farmed salmon? (please check off all that apply)
- ☐ I have no concerns about purchasing farmed salmon
- ☐ I believe that farmed salmon could be bad for my health
- ☐ I believe that salmon farming could be harmful to the environment
- ☐ I believe that salmon farming could harm wild salmon populations
- ☐ I believe that salmon farming could harm traditional and/or commercial fisheries in BC
- ☐ I believe that salmon farming could harm First Nations people
- ☐ I do not like the taste of farmed salmon
- ☐ I do not like the way farmed salmon looks
- ☐ I am worried that farmed salmon may be genetically engineered

Please list any additional concerns that you may have in the space provided

_____

_____

_____

_____

_____

_____

_____

h) Do you have any concerns about purchasing wild salmon? (please check off all that apply)

- ☐ I have no concerns about purchasing wild salmon
- ☐ I believe that wild salmon could be bad for my health
- ☐ I believe that commercial salmon fishing could be harmful to the environment
- ☐ I believe that commercial salmon fishing could harm wild salmon populations
- ☐ I believe that commercial salmon fishing could harm First Nations people
- ☐ I do not like the taste of wild salmon
- ☐ I do not like the way wild salmon looks
- ☐ Wild salmon is too expensive

Please list any additional concerns that you may have in the space provided

_____
_____
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_____
_____
_____
_____

i) What is meant by the term "genetic engineering"? (please check off all that apply)

- ☐ Selectively breeding two plants together in order to create a new plant with more desirable traits
- ☐ Alteration of the structure of genetic material in a living organism. It involves inserting one or more pieces of new DNA into the organism's genome
- ☐ Grafting two living plants together by splicing off a section of one plant and binding to another.
- ☐ Any scientific procedure that is performed by humans on a living organism that will cause that living organism to behave differently than it would have if it had been left undisturbed in nature
- ☐ Injecting beef or dairy cows with hormones that will increase their growth rates or the rates at which they produce milk.

j) What is canola? (please check off all that apply)

- ☐ An oilseed plant
- ☐ A kind of wheat
- ☐ A kind of sunflower
- ☐ A kind of corn

k) Which of the following processed food product include ingredients that often come from canola? (please check off all that apply)

- ☐ Potato chips
- ☐ Crackers
- ☐ Cookies
- ☐ Coffee mate
- ☐ Mayonnaise
- ☐ Margarine
- ☐ Cooking oil
- ☐ No bake cheesecake mixes
- ☐ Salad dressings
- ☐ Cooking spray
- ☐ Croutons
- ☐ Dry hot chocolate powder

l) Do you eat any foods that have been genetically engineered? (please circle the appropriate answer)

YES NO

Please list some of the GE foods that you eat in the space provided

_____

_____

_____

_____

_____

m) Do you have any concerns about purchasing genetically engineered (GE) food products? (please check off all that apply)

- ☐ I have no concerns about purchasing GE food products
- ☐ I believe that GE food products may cause cancer
- ☐ I believe that GE food products are not as nutritious as non-GE food products
- ☐ I believe that GE food products are not adequately tested or regulated in Canada
- ☐ I believe that growing GE food products is harmful to the environment
- ☐ I believe that eating GE food products can cause deformities and/or strange illnesses in humans
- ☐ GE food products "cross the line". I do not feel comfortable eating any foods that were genetically engineered because I believe the technology is morally unacceptable

Please list any additional concerns that you may have in the space provided

n) Do you have any concerns about purchasing organic food products? (please check off all that apply)
- ☐ I have no concerns about purchasing organic food products.
- ☐ I believe that organic food products could make me sick
- ☐ I believe that organic food products are not adequately tested or regulated in Canada
- ☐ Organic food products are too expensive
- ☐ I believe organic food products are not as safe an non-organic food products
- ☐ Even when a food is labeled "organic" there can still be non-organic ingredients in it
- ☐ Calling a food organic is just one way of charging more money for it

Please list any additional concerns that you may have in the space provided

o) How do you know if the foods you eat have been genetically engineered? (please check off all that apply)
- ☐ All GE foods are labeled in Canadian stores
- ☐ All GE foods are labeled in Canadian restaurants
- ☐ GE food products are only labeled in Canada if they can cause allergies or have a different nutritional content than their non-GE counterparts
- ☐ Certain food products in Canada are very likely to be genetically engineered or contain GE ingredients.
- ☐ You can tell if they have been genetically engineered because of the way they look, taste or smell.
- ☐ I do not know if the foods I eat have been genetically engineered.

p) What concerns do you have about purchasing farmed salmon that were fed with genetically engineered canola?

- ☐ I have no concerns about purchasing farmed salmon that were fed with GE canola
- ☐ Eating farmed fish that were fed with GE canola may be harmful to my health
- ☐ Using GE canola to feed farmed salmon may be harmful to the environment
- ☐ It is unnatural to feed salmon GE canola
- ☐ Eating GE canola will cause the salmon to become genetically modified
- ☐ The concerns I already have about eating farmed salmon or GE foods would become compounded and amplified if they were combined in one food product.

Please list any additional concerns that you may have in the space provided

_____
_____
_____
_____
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_____
_____

q) If Canadian salmon farmers used genetically engineered canola in their feeds, where would this crop most likely come from?

- ☐ The Canadian prairies
- ☐ The United States
- ☐ Japan
- ☐ Europe

r) What concerns do you have about purchasing farmed salmon that were fed with wild fish from South America?

- ☐ I am not concerned about purchasing farmed salmon that were fed with wild fish from South America
- ☐ Disease might be transferred from wild South American fish to farmed salmon
- ☐ Importing fish from South America may contribute to environmental damage in South America
- ☐ I am concerned that importing fish from South America may be economically hard on the Canadian salmon aquaculture industry.

- ☐ I am concerned that South American fishermen may not be getting a fair deal and that the Canadian salmon aquaculture industry might take advantage of them.
- ☐ I am concerned that the South American commercial fisheries may not be held up to the same environmental and human health standards that they are in Canada

Please list any additional concerns that you may have in the space provided

_____
_____
_____
_____
_____
_____
_____

s) Suppose that you were going to purchase a salmon at the store for dinner. Suppose further that you had 2 fish to choose from that were identical in size, shape, taste and freshness.

Your 2 choices are…

1. A farmed salmon that had been fed with feed that included wild fish from South America. We will call this a **WF farmed salmon**
2. A GE canola fed farmed salmon. We will call this a **GE canola farmed salmon**.

Which one would you purchase if…

The GE canola farmed salmon and the WF farmed salmon <u>were both $20</u>? (Please circle the appropriate response)

The GE canola farmed salmon The WF farmed salmon Neither

The GE canola farmed salmon was <u>$18</u> and the WF farmed salmon was <u>$20?</u>
(Please circle the appropriate response)

The GE canola farmed salmon The WF farmed salmon Neither

The GE canola farmed salmon was <u>$16</u> and the WF farmed salmon was <u>$20</u>?
(Please circle the appropriate response)

The GE canola farmed salmon The WF farmed salmon Neither

The GE canola farmed salmon was $14 and the WF farmed salmon was $20? (Please circle the appropriate response)

The GE canola farmed salmon The WF farmed salmon Neither

t) **How important is each of the following in your decision to purchase food products?** (please circle the number that corresponds with your response to each of the following questions)

How important is ...

Price

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Human health impacts of consuming that food

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Taste

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Nutritional content

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Knowing that the food was grown in Canada

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Traceability *(the entire life cycle of this food product is known and controlled by the people who produce it)*

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Convenience

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

Knowing that the food product has <u>not</u> been genetically engineered or has not eaten genetically engineered food products in its lifetime

1	2	3	4	5	6	7
Not at all important	a little important	somewhat important	neutral	quite important	very important	extremely important

u) **How confident are you in your level of knowledge when it comes to your purchasing decisions regarding salmon aquaculture food products?** (please circle the number that corresponds with your response)

1	2	3	4	5	6	7
Not at all confident	a little confident	somewhat confident	neutral	quite confident	very confident	extremely confident

v) **How confident are you in your level of knowledge when it comes to your purchasing decisions regarding genetically engineered food products?** (please circle the number that corresponds with your response)

1	2	3	4	5	6	7
Not at all confident	a little confident	somewhat confident	neutral	quite confident	very confident	extremely confident

And finally.....

w) Consider each of the 3 methods of communicating the risks and benefits of using GE canola to feed farmed salmon that were shown to you in the 2nd section of this survey. Please rate each of them on the following criteria.

Please rate each means of communication on a scale of 1-3 were **1 is the best** of the three and **3 is the worst** of the three.

Which means of communication did you find the most <u>trustworthy</u>*?*

- ☐ Question and answer
- ☐ Flow chart
- ☐ Case study

Which means of communication was the <u>easiest to understand</u>*?*

- ☐ Question and answer
- ☐ Flow chart
- ☐ Case study

Which means of communication was the <u>most enjoyable to read</u>?

- ☐ Question and answer
- ☐ Flow chart
- ☐ Case study

Which means of communication contained the most useful information?

- ☐ Question and answer
- ☐ Flow chart
- ☐ Case study

Overall, which means of communication did you <u>like the best</u>?

- ☐ Question and answer
- ☐ Flow chart
- ☐ Case study

x) Considering everything you now know, does it matter to you **<u>what ingredients</u>** Canadian salmon farmers use in their fish feed? (Please circle the appropriate response)

1	2	3	4	5
It doesn't matter at all	It matters a little	neutral	It somewhat matters	It matters a lot

y) Considering everything you now know, does it matter to you **<u>where</u>** (physical location) Canadian salmon farmers get their fish feed from? (Please circle the appropriate response)

1	2	3	4	5
It doesn't matter at all	It matters a little	neutral	It somewhat matters	It matters a lot

z) Listed below are a number of ways in which genetic engineering can be used. How acceptable is each modification to you personally? (Please circle the appropriate response)

Crops modified to resist disease or pests

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

Crops modified to improve their taste

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

Crops modified to improve their appearance

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

Crops modified to be high in vitamin A, which helps to prevent blindness

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

Plants modified to include genes from animals

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

Plants modified to include genes from other plants

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

Modifying plants to make them easier to grow in harsh climates

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

Plants modified to include genes from bacteria

1	2	3	4	5
Completely unacceptable	unacceptable	acceptable	completely acceptable	don't know

aa) Suppose that you knew that a farmed salmon had been fed with genetically engineered canola. Does the information you have learned today regarding the environmental, economic and social risks and benefits of using GE canola to feed farmed salmon influence your decision to purchase this fish?

(Please check off one of the following three statements)

☐ The information provided to me today **would not** influence my decision to purchase this fish

☐ The information provided to me today **would** influence my decision to purchase this fish. It would make me **less likely** to purchase this fish

☐ The information provided to me today **would** effect my decision to purchase this fish. It would make me **more likely** to purchase this fish

Please explain your answer in more detail in the space provided

**********END OF PART THREE**********

Instructions:

When you have completed this section please turn your booklet over and I will collect them. This is the last section of the survey. Once everyone has completed this section we will come together for a short discussion in order to evaluate this entire process.