Assessing the Willingness to Pay in the Pacific Northwest for Salmon Produced by Integrated Multi-Trophic Aquaculture

by

Winnie Wing Yan Yip

B.B.A. (Hons.), Simon Fraser University, 2008

RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF RESOURCE MANAGEMENT

in the
School of Resource and Environmental Management
Faculty of Environment

© Winnie Wing Yan Yip 2012

SIMON FRASER UNIVERSITY

Spring 2012

All rights reserved. However, in accordance with the *Copyright Act of Canada*, this work may be reproduced, without authorization, under the conditions for "Fair Dealing." Therefore, limited reproduction of this work for the purposes of private study, research, criticism, review and news reporting is likely to be in accordance with the law, particularly if cited appropriately.

Approval

Name: **Winnie Wing Yan Yip**

Degree: **Master of Resource Management (Planning)**

Report Number: **530**

Title of Research Project: ***Assessing the Willingness to Pay in the Pacific Northwest for Salmon Produced by Integrated Multi-Trophic Aquaculture***

Examining Committee:

Chair: **David Kyobe**

MRM Candidate, School of Resource and Environmental Management, Simon Fraser University

---

Duncan Knowler

Senior Supervisor
Associate Professor, School of Resource and Environmental Management
Associate Dean, Faculty of Environment

Wolfgang Haider

Supervisor
Professor, School of Resource and Environmental Management

Date Defended/Approved: March 12, 2012

Abstract

Integrated Mutli-Trophic Aquaculture (IMTA) combines the culturing of fish and extractive aquaculture species at one site to simulate a balanced natural system and reduce some environmental issues of monoculture systems. The study explores consumer preferences for IMTA and Closed Containment Aquaculture (CCA). Two questions are posed: (1) how do salmon consumers in the US Pacific Northwest perceive IMTA and its products compared to other salmon aquaculture methods and products; and, (2) what are salmon consumers in the US Pacific Northwest willing to pay for salmon produced by IMTA compared to its potential close substitutes? Results of a discrete choice experiment revealed a willingness to pay price premiums of 9.8% and 3.9% for IMTA and CCA, respectively, over conventionally produced Atlantic salmon. Results of the survey also revealed that 44.3% and 16.3% of the respondents preferred the adoption of IMTA and CCA to conventional salmon farming, respectively. Results using a decision support system further confirmed a stronger market for IMTA salmon than for CCA and conventionally produced salmon.

Keywords: Integrated Multi-Trophic Aquaculture; Close-Containment Aquaculture; salmon aquaculture; British Columbia aquaculture; discrete choice experiment; willingness to pay

Acknowledgements

I would like to thank my senior supervisor, Dr. Duncan Knowler, for providing his guidance and knowledge throughout the project. His dedication to the project helped make this project so successful. I would also like to thank Dr. Wolfgang Haider for providing his insight and expertise on surveying and discrete choice modelling. I would also like to express my gratitude to Dr. Thierry Chopin, Dr. Gregor Reid, Dr. Steve Cross, Dr. Roberto Martínez-Espiñeira, and other researchers in the Canadian Integrated-Multi-Trophic Aquaculture Network for their input, and The Natural Sciences and Engineering Research Council for providing the project's funding. I also thank Patrick Kitchen, who has been my mentor at REM and gave me countless input and advice, both about the project and the program, throughout the last three years. Special thanks to Nina Mostegl, who not only contributed significantly with her expertise in the analysis phase, but also encouraged me continuously with her kind words. Chapter 5.4 of this paper is based on the results of Nina's analysis of the discrete choice experiment.

I am blessed by many other friends and family throughout my time at REM. I would like to thank the professors and the administrative staff at REM. Special thanks to David K., Courtney, Jessica, and my peers at REM, who made my studies more enjoyable. To Sandra, Adam, and David A., thanks for your input and help in the choice model and website. I am also blessed by my family, who extended their support from overseas. I am more than simply grateful for Hugo, who was a true blessing in my life and supported me with prayers, patience, and help. Most of all, I would like to give thanks to the One who truly blesses. I would not be in this program without Him opening the way for me, and surely I would not be able to finish my race here without His faithfulness and blessings.

Table of Contents

Approval ii
Abstract iii
Acknowledgements iv
Table of Contents v
List of Tables viii
List of Figures x
Glossary xi

Chapter 1: Introduction 1
1.1 Introduction 1
1.2 Problem Statement 1
1.3 Research Questions 2
1.4 Research Methods and Approach 3
1.5 Scope of the Study 3
1.6 Report Organization 4

Chapter 2: Background 5
2.1 The Canadian and BC Salmon Farming Industry 5
2.2 Environmental Impacts of BC Salmon Aquacultures 8
2.3 Closed Containment Aquaculture (CCA) 10
2.4 Integrated Multi-Trophic Aquaculture (IMTA) 11

Chapter 3: Literature Review 12
3.1 The Economics of IMTA & CCA 12
3.2 Willingness-to-pay for Food and Sustainable Food 15
3.3 WTP Estimation Methods for Food Products 18
3.3.1 Contingent Valuation Method 20
3.3.2 Conjoint Analysis & Discrete Choice Experiments 21

Chapter 4: Research Methods 25
4.1 Identification of the Appropriate Study Method 25
4.2 Discrete Choice Experiment (DCE) 26
4.2.1 Theoretical Background 27
4.2.2 Design of the DCE 29
4.3 Survey Design 34

4.4 Recruitment of Survey Respondents 37
4.5 Sample Splitting Exercise 37
4.5.1 Sequence of the Descriptions of Production Technologies 38
4.5.2 Nature of the Descriptions of the Production Technologies 38
4.5.3 Common Set 39
4.6 Data Analysis 39
4.6.1 Principal Component & Cluster Analysis 40
4.6.2 The Multinomial Logit Model 41
4.6.3 Latent Class Analysis 42

Chapter 5: Results 45
5.1 Sample Characteristics 45
5.1.1 Socio-Demographics 46
5.1.2 Consumption Frequencies and Characteristics 48
5.1.3 Level of Environmental Participation 49
5.1.4 Perceived Consumer Effectiveness 51
5.2 Attitudes toward Salmon Aquaculture 53
5.2.1 Preference for Wild and Farmed Salmon 53
5.2.2 Awareness of Salmon Aquaculture Methods 55
5.2.3 Attitudes toward IMTA and CCA 55
5.2.4 Preference toward IMTA or CCA 58
5.2.5 Willingness to Increase Salmon Consumption 61
5.3 Principal Component Analysis 61
5.3.1 Hierarchical Cluster Analysis 63
5.3.2 Description of the Clusters derived from the Cluster Analysis 64
5.4 DCE Results 67
5.4.1 Part-Worth Utility Results 68
5.4.2 Information Effects on Part-Worth Utility 73
5.4.3 WTP Estimates and Price Premiums for IMTA and CCA salmon 73

Chapter 6: Discussion 77
6.1 WTP Premium for Sustainably Farmed Salmon 77
6.2 Market Implications of IMTA & CCA Adoptions in BC 80
6.3 Policy Implications for IMTA Salmon in BC 88
6.4 Limitations of Research 89
6.5 Recommendations for Future Research 90

Chapter 7: Conclusion 92

References 94

Appendices 105
Appendix A: Map of BC Salmon Farm Tenures 105
Appendix B: Conceptual Diagrams of CCA 106
Appendix C: Conceptual Diagram of IMTA 107
Appendix D: Sustainable Salmon Consumption Survey 108
Appendix E: Sample reference photographs of salmon products 128
Appendix F: Reasons for not eating salmon at home 129
Appendix G: Salmon Consumption Frequency & Patterns 130
Appendix H: Characteristics of Environmental Participation Clusters 132
Appendix I: Responses to Perceived Consumer Effectiveness Statements 133
Appendix J: Frequency Distribution of PCE Levels 134
Appendix K: Frequency Distributions of Estimated Farmed Salmon Consumption 135
Appendix L: Percentage per Response Distribution of Attitudes toward IMTA and CCA 136
Appendix M: Differences in Mean Attitudes toward IMTA and CCA by Descriptions 137
Appendix N: Percentage per Response Distribution of Preference toward IMTA or CCA 138
Appendix O: Frequency Distribution of Responses to Method Preferences 139
Appendix P: Reasons for Preference for IMTA or CCA 140
Appendix Q: Responses on Sustainable Method Adoption 141
Appendix R: Responses on Additional Farmed Salmon Purchases 142
Appendix S: Frequency Distributions of Salmon Purchase Factors 143
Appendix T: Demographic Distribution of PCA Clusters 145
Appendix U: Part-Worth Utility of the 1-Class Model 146
Appendix V. Graphical Illustration of the Part-Worth Utilities for Each Attribute by Class of the 3-Class Model 147
Appendix X: Analysis of Correlation between PCA and Environmental Participation Clusters 149
Appendix X: Demographics & Attitudes of Latent Classes 151
Appendix Y: Known Class Analysis Results by Information Treatments 153
Appendix Z: Market Shares of Latent Classes in DSS 156

List of Tables

Table 1. Evaluation of WTP Methods Based on Study Objective and Criteria 26
Table 2. DCE Attributes and Levels 31
Table 3. DCE Attributes and Levels by Species 32
Table 4. Summary of the Sample Splitting Exercise 38
Table 5. Demographic Characteristics of the Sample Compared to the General Population of Seattle, Portland and San Francisco (U.S. Census Bureau, 2010) 47
Table 6. Details of the Sample's Home and Restaurant Salmon Consumption in the Last 12 Months 49
Table 7. Percentage of Respondents who consumed Atlantic, Sockeye, and King Salmon in the Last 12 Months 49
Table 8. Percentage of Responses to Level of Environmental Activity Participation 50
Table 9. Perceived Consumer Effectiveness (PCE) based on the Level of Agreement with Statements. Rating scale: 1 (Strongly disagree) to 5 (Strongly agree) 52
Table 10. Comparison of the PCE Scores across the Environmental Participation Clusters 52
Table 11. Treatments in the Splitting of the Sample 55
Table 12. Attitudes towards IMTA and CCA using the Full Sample and the Segments (See Table 11) based on a Rating Scale of 1 (Very negative) to 5 (Very positive) 56
Table 13. Preference towards IMTA or CCA using the Full Sample and the Segments (See Table 11) based on a Rating Scale of -2 (Much more prefer CCA) to 2 (Much more prefer IMTA) 59
Table 14. Factors Influencing Salmon Purchase Decisions – Aggregated Survey Results; Ranked from Highest to Lowest by Mean Responses using a Rating Scale: 1 (Not at all important) to 5 (Extremely important) 62
Table 15. Eigenvalues from the Principle Component Analysis (PCA) based on Nine Purchase Factors 62
Table 16. Rotated Component Loading from the PCA 63
Table 17. Salmon Consumption Frequencies, Purchase Details, and PCE scores by clusters 65
Table 18. Results of the Goodness-of-Fit Tests for the Latent Class Analysis based on the 1 to 5 Class Models 68
Table 19. Part-Worth Utility Estimates based for the Latent Class Model (3-Class Solution) for the latent classes by Salmon Species 69
Table 20. Covariate Importance Estimates based on the Latent Class Model (3-Class Solution) for the Wild Salmon Lovers, Price-Sensitive Consumers and Sustainably Farmed

Salmon Supporters by Covariates: PCA Clusters, Environmental Participation Clusters, PCE Score 70
Table 21. WTP Price Premiums for IMTA and CCA Produced Atlantic Salmon versus Conventionally Produced Atlantic Salmon: 1-Class and 3-Class (LCA) Model Results 74
Table 22. WTP Premiums for Eco-certification of Atlantic, Sockeye, and King Salmon: 1-Class and 3-Class (LCA) Model Results 75
Table 23. Market Shares of Sustainably Farmed and Conventionally Farmed Salmon, and "Neither", across scenarios A1, B1, C1, and Baseline 1: for Sustainably Farmed Salmon Supporters (LC3) 86
Table 24. Market Shares of Farmed and Wild Salmon, and "Neither", across Scenarios A2, B2, C2, and Baseline 2: full sample (1-class model) 87

List of Figures

Figure 1. Actual & Predicted Canadian Salmon Production, 1990 - 2020 6
Figure 2. Percentage of BC salmon exports by destination, 2008 7
Figure 3. Percentage of BC salmon exports by major products, 2005 8
Figure 4. Sample Choice Set from the DCE Presented to Respondents 33
Figure 5. Respondents' Reasons for Preferring Wild or Farmed Salmon.....54
Figure 6. Mean Importance of Principal Components by Cluster based on Factor Scores from PCA 64
Figure 7. Market Scenario Analysis for IMTA and CCA Adoptions: Baselines 1 & 2 Compared to Scenarios A1, B1, and C1, and Scenarios A2, B2, and C2.....83

Glossary

ACS	American Community Survey
BC	British Columbia
CA	Conjoint Analysis
CAD	Canadian dollar
CCA	Closed Containment Aquaculture
CVM	Contingent Valuation Method
DCE	Discrete Choice Experiment
DSS	Decision Support System
GHG	Greenhouse Gas
IMTA	Integrated Multi-Trophic Aquaculture
LB	lb – one pound
LC	Latent Class
LCA	Latent Class Analysis
PCA	Principal Component Analysis
PCE	Perceived Consumer Effectiveness
RP	Revealed Preference
SP	Stated Preference
US/USA	United States of America
USD	United States Dollar
WTP	Willingness-to-pay

Chapter 1: Introduction

1.1 Introduction

Since the 1980s, aquaculture has become the dominant method of salmon production as global salmon demand rises and the supply of wild salmon stagnates. . British Columbia's salmon aquaculture industry plays a significant role as the fourth largest producer of farmed salmon in the world (Province of British Columbia, 2009). Controversies surrounding the environmental and social impacts of conventional salmon aquaculture have raised criticism and deterred farmed salmon consumption in Vancouver and some cities in the United States (US) (Wild Salmon Supporters, 2010; Coastal Alliance for Aquaculture Reform, 2010; Associated Press, 2010). Despite public concerns, the demand for farmed BC salmon has not declined and the aquaculture industry has continued to contribute substantially to BC's economy (Province of British Columbia, 2007). Nonetheless, addressing public and environmental concerns about salmon aquaculture is a priority for the industry and the government as they continue to identify sustainable and cost-effective options to produce salmon.

1.2 Problem Statement

Integrated Multi-Trophic Aquaculture (IMTA) represents one sustainable salmon farming method. It combines fed aquaculture (e.g. finfish) with extractive aquaculture (e.g. shellfish and kelp) at one site (Chopin & Robinson, 2006). Although the co-culturing of multiple species has proven feasible in other countries, the biological, technical and financial feasibility of IMTA in BC

must be analyzed before presenting it as a possible solution to the growing problems facing the salmon aquaculture industry (Neori, Troell, Chopin, Yarish, Critchley, & Bushmann, 2007). Even if IMTA proves to be technically and biologically successful, its adoption in BC will depend on its economic feasibility and this will rely on the market response to IMTA. Presently, a lack of such knowledge inhibits policy makers and stakeholders from understanding the potential for adoption of IMTA in BC. The purpose of this study is to understand the potential market response to IMTA by examining consumers' perceptions of IMTA and their willingness-to-pay (WTP) for salmon produced using IMTA.[1]

1.3 Research Questions

Currently, Closed Containment Aquaculture (CCA) is often the only option presented to BC salmon farmers, policy makers, environmental organizations and the public, but CCA has yet to be proven as a fully acceptable option for all stakeholders. A broader spectrum of reasonable options should be considered before one determines the future of the BC salmon aquaculture industry. Therefore, this research focuses on the perception of IMTA and the resulting WTP for IMTA salmon in the Pacific Northwest region of the US, the main market for BC farmed salmon.[2] Such knowledge will contribute significantly to the analysis of profitability and the potential for adoption of IMTA in BC and Canada.

Specifically, I will answer the following questions:

---

[1] In this paper, we will call salmon produced in an IMTA "IMTA salmon". Similarly, salmon produced in a CCA is called "CCA salmon".

[2] Willingness-to-pay (WTP) is the economic value of the product (Breidert, 2006).

Research Question 1: How do salmon consumers in the key US Pacific Northwest markets perceive IMTA and its products in comparison to other salmon aquaculture methods and products?

Research Question 2: What are salmon consumers' in the US Pacific Northwest willing to pay for salmon produced by IMTA compared to its potential close substitutes (e.g. conventionally farmed salmon, wild salmon, and CCA salmon)?

1.4 Research Methods and Approach

An Internet survey was designed and distributed to more than two thousand households in three major cities of the US Pacific Northwest, Seattle (Washington), Portland (Oregon) and San Francisco (California). The survey included questions concerning salmon consumption behavior, attitudes towards conventional salmon aquaculture and two new production technologies (IMTA and CCA), environmental attitudes, and a discrete choice experiment (DCE). The application of a DCE enabled me to estimate WTP and consumer choice behavior with respect to IMTA, CCA, conventionally farmed and wild salmon when all products are presented concurrently. Furthermore, it allowed me to explore heterogeneity within the sample with a subsequent latent class analysis (LCA). I also examined the effects of differing amounts of information provided to respondents on WTP and preferences.

1.5 Scope of the Study

The scope of this study is limited to salmon products and the US Pacific Northwest market. The results should not be generalized to other types of aquaculture products or to attitudes of consumers in other parts of the US and other countries. I targeted consumers who

purchased salmon for at-home consumption and designed the DCE to replicate a salmon purchase situation at a supermarket. Thus, purchase behaviour at restaurants, another important market for salmon products, was not considered. This study is also limited to the current understanding of the various aquaculture methods. Future research and further product development in aquaculture will likely provide additional options to consumers in the future.

1.6 Report Organization

This report is divided into seven chapters. Chapter 2 provides the background of my study, which includes an overview of salmon aquaculture in Canada and BC, the associated environmental concerns and an introduction to IMTA. Chapter 3 consists of a literature review of economic studies of IMTA and CCA, WTP studies related to food quality and the associated estimation methods typically used to study 'green' food alternatives. Chapter 4 presents the research methodology, including design details of the survey and DCE used. Chapter 5 presents the results. Chapter 6 discusses the WTP results, market simulation and policy implications of the findings, and the limitations and suggestions for future research. Chapter 7 concludes the paper with the key findings and final thoughts.

Chapter 2: Background

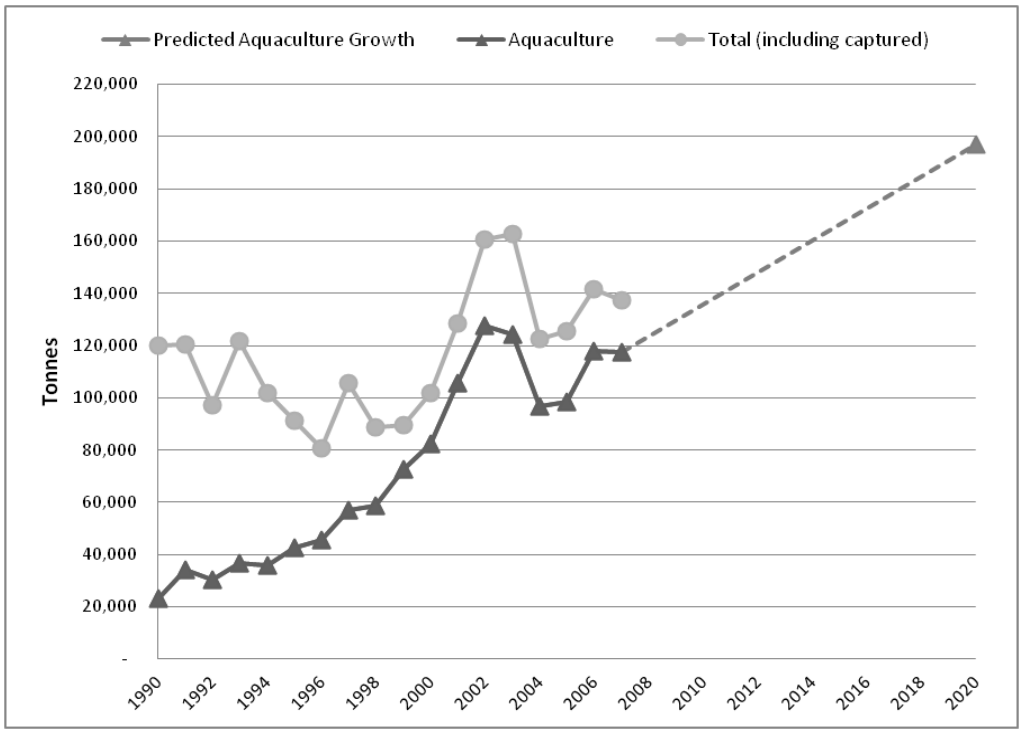
Chapter 2 provides the background to this study with an overview of the Canadian and BC salmon farming industries, the environmental impacts of conventional salmon aquaculture and the sustainable production options currently available to the BC salmon aquaculture industry. Focus is placed on the demand for and products of the BC salmon industry.

2.1 The Canadian and BC Salmon Farming Industry

An enormous expansion of the global salmon market was observed during the last two decades. The total volume of salmon sold more than doubled from 1.2 to 2.7 million tonnes between 1990 and 2007 (FAO, 2010). Salmon aquaculture has become the predominant production method since 1998 when the capture level of wild salmon plateaued. In 2007, 62% and 85% of global and Canadian salmon outputs were farmed, respectively (FAO, 2010). While Canada supplies various salmon species to the global market as the world's fourth largest salmon supplier, over 80% of Canadian salmon is Atlantic salmon produced by aquaculture (FAO, 2010).[3] As global demand rises, output from Canadian aquaculture is projected to grow from 117,000 tonnes in 2007 to 197,000 tonnes by 2020 (Figure 1) (DFO, 2009).

[3] Species supplied by Canada are Atlantic, Chinook, Chum, Coho, Pink, and Sockeye (FAO, 2010).

Figure 1. Actual & Predicted Canadian Salmon Production, 1990 - 2020



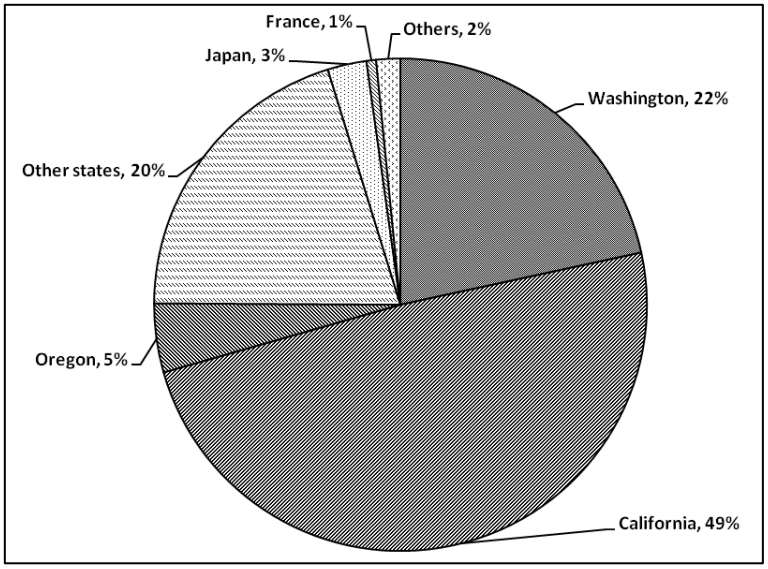
Data Source: DFO, 2009 and FAO, 2010

BC's salmon aquaculture industry is the dominant national contributor and supplies 70% of all Canadian farmed salmon (Statistics Canada, 2008). Salmon farming in BC began in the 1970's as a few local small farmers started producing Coho and Chinook salmon along the Sunshine Coast, northeast of Vancouver (Marshall, 2003). By the late 1980s, Atlantic salmon became the favoured farmed species due to its rapid growth and high survival rates, making it more suitable and profitable to produce commercially compared to other species (Marshall, 2003). During the same era, international corporations bought out some local farms and began consolidating the salmon aquaculture industry in BC. By 2006, four international corporations dominated the BC salmon aquaculture industry, together owning 118 farming licenses, with seven other smaller independent firms holding one license each, for to a total of 125 farming

licenses in BC (MMK Consulting Inc., 2007b).[4] Approximately 75% of the salmon farming licenses in BC are located along North Vancouver Island and the Georgia Strait, while the rest are dispersed between South and West Vancouver Island and in the South Coast of BC. A map of the BC salmon farm tenures is provided in Appendix A.

In 2008, the BC salmon aquaculture industry contributed CAD $180 million to the province's GDP and provided 2,800 jobs directly through aquaculture production, processing and other related activities (Price Water House Coopers, 2009). Exports represented the primary sales channel for most of BC's farmed salmon. In 2008, BC exported 70% of all its farmed salmon and 95% of all BC exports were destined for the US, 79% of which headed into the Pacific Northwest, namely Washington, California, and Oregon (Figure 2) (Price Water House Coopers, 2009; Industry Canada, 2010).

Figure 2. Percentage of BC salmon exports by destination, 2008

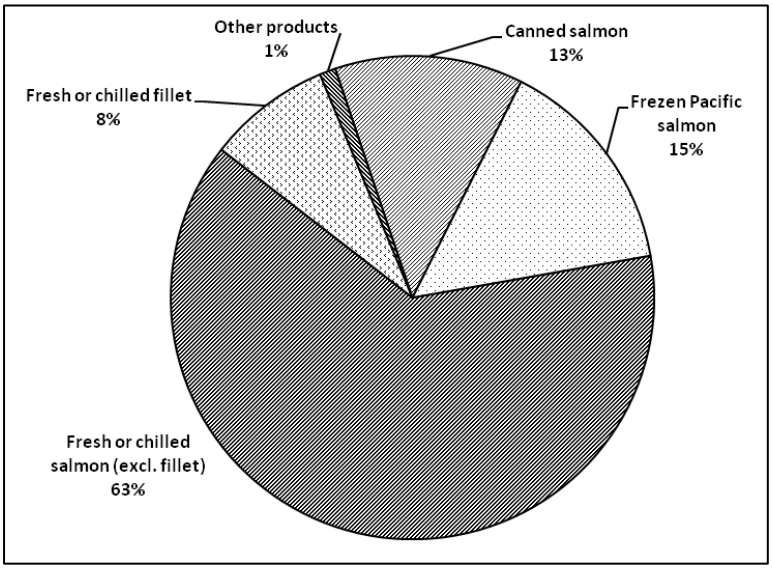


Data Source: Industry Canada, 2010

[4] The four dominant corporations include Panfish, Mainstream Canada, Greig Seafood BC Ltd and Creative Seafoods. Except Creative Seafoods, the other corporations are all Norwegian companies and farm Atlantic salmon exported to the US; while Creative Seafoods farm Chinook salmon exported to Japan (Price Water House Coopers, 2009).

In 2010, 94% of farmed salmon was Atlantic with an estimated farm gate value of CAD $470.3 million (Province of British Columbia, 2011). The remaining 6% was farmed Pacific salmon with an estimated farm gate value of CAD $29.3 million (Province of British Columbia, 2011).[5] While BC's salmon industry supplies variations of salmon products, its dominant output is a fresh or chilled product either sold in whole or as fillets, most of which are farmed Atlantic salmon destined for the Pacific Northwest (Figure 3) (MMK Consulting Inc., 2007b).

Figure 3. Percentage of BC salmon exports by major products, 2005



Source: MMK Consulting Ltd., 2007b

2.2 Environmental Impacts of BC Salmon Aquacultures

The monospecific, open-net cage salmon farming method currently used in BC has raised significant public concerns across Canada and the globe because of its associated

[5] Farm gate value is a "basic price with the "farm gate" as the pricing point, that is, the price of the product available at the farm, excluding any separately billed transport or delivery charge" (Organisation for Economic Co-operation and Development (OECD), 2001).
Pacific salmon includes Chinook, Coho, and Pink salmon.

environmental problems.[6] Common issues include threats to wild salmon stocks through potential sea lice and disease transfers, pollution from farm contaminants (such as feed waste and drugs), and escapes of non-native salmon species (Knapp, Roheim, & Anderson, 2007; David Suzuki Foundation, 2009; Allsopp, Johnston, & Santillo, 2008; Greenpeace USA, 2010). Other concerns include the influx of untreated organic and inorganic wastes into the marine environment. In aggregate, BC salmon farms discharge 1,435 to 2,100 mt of nitrogen annually, which is a nutrient responsible for ocean eutrophication, algal blooms, and severe ecosystem degradation along the coastline (Field, Hempel, & Summerhayes, 2002; Goldburg & Naylor, 2005).[7] Much of the marine life beneath farm sites can be destroyed and the surrounding marine area may become polluted, which cumulatively affects species in the vicinity of the fish farms and traditional harvests of First Nations groups (Leggatt, 2001).

Environmental organizations and researchers have been very successful in communicating these concerns to the public, resulting in actions such as voluntary boycotts by high-end and environmentally-conscious restaurants in various cities in the Pacific Northwest (Coastal Alliance for Aquaculture Reform, 2005; FOCB.org, 2009). On the other hand, other stakeholders recognize the necessity of using aquaculture to meet global salmon demand and advocate for wild salmon protection in BC and across the world. Some also advocate for the consumption of both wild and farmed salmon that are certified to be sustainably harvested and cultured (Morrow, 2009). With the expectation of continuing growth in salmon demand, environmental organizations, the restaurant industry, and other stakeholders are urging the

---

[6] In this paper, we will refer the traditional mono-specific, open-net cage aquaculture/farming method as the "conventional method" or "conventional aquaculture". Salmon produced with the conventional method will be called "conventionally farmed/produced salmon".

[7] The amount of nitrogen discharged by BC's salmon aquaculture is equivalent to the amount in untreated sewage from approximately 245,000 to 359,000 people for a year

salmon aquaculture industry to adopt a new farming method that is more sustainable than the conventional method employed along BC's coast (Suzuki & Moola, 2010).

2.3 Closed Containment Aquaculture (CCA)

Closed Containment Aquaculture (CCA) is the most debated method among the discussions of sustainable aquaculture options in BC. CCA can be developed either at sea or on land, with varying degrees of isolation and environmental interactions. While land-based systems typically use large containers to hold and culture salmon, ocean-based systems utilize soft-bags floating on the sea surface to enclose the salmon in the marine environment (Liu & Sumaila, 2007; DFO, 2010). In both systems, water is continuously pumped into the containment for oxygen replenishment, solid wastes are collected in waste traps for disposal, and wastewater is discharged away from the containments. Conceptual diagrams of CCA are presented in Appendix B.

Some researchers and environmental organizations have argued that the BC's salmon industry should adopt land-based CCA to eliminate the industry's impacts through nutrient loading, sea lice outbreaks, fish escapes and disease transfer to wild salmon stocks (MMK Consulting Inc., 2007; Living Oceans Society, 2011). However, the industry and some researchers have argued against land-based CCA due to its high cost and the creation of other environmental problems, such as excessive energy consumption and the requirement for additional waste treatment (MMK Consulting Inc., 2007). Land-based CCA may also lead to land-use conflicts if the salmon aquaculture industry continues to expand.

2.4 Integrated Multi-Trophic Aquaculture (IMTA)

Another option that has so far been ignored by most stakeholders in the Pacific Northwest is Integrated Multi-Trophic Aquaculture (IMTA). IMTA combines the cultivation of fed aquaculture species (e.g. salmon) with extractive aquaculture species (e.g. mussels/oysters and kelp) to recreate the conditions of a balanced ecosystem at a farm site. IMTA recreates natural biological filtration and reduces the nutrients entering the ocean by enabling both organic and inorganic wastes from the fed salmon to be efficiently absorbed by the extractive species. In addition to environmental benefits, IMTA also can generate economic and social benefits such as product diversification and local First Nations partnerships (Pacific Sea-Lab Research Society, 2007).

Asian countries have been practicing a version of IMTA for centuries, but the IMTA concept only emerged in the Western world during the late 1980s and early 1990s and has yet to be commercially adopted on a large-scale (Chopin & Robinson, 2006). If Canada and BC are to maintain their competitive positions in the global salmon industry, while simultaneously increasing supply and reducing environmental impacts, IMTA could be considered along with CCA or as a possible sustainable alternative to CCA. An IMTA pilot project growing seaweed, mussels, and Atlantic salmon is underway in the Bay of Fundy, and both technical feasibility and biological results look promising (Ridler, et al., 2007). Another pilot project is being implemented in the Kyuquot Sound on the West coast of Vancouver Island to test the feasibility of IMTA on the West Coast. Please refer to Appendix C for a conceptual diagram of IMTA.

Chapter 3: Literature Review

This chapter reviews economic studies of IMTA and CCA and the knowledge gaps in the literature related to my project. I also review the attributes used in WTP studies of food and sustainable foods. The chapter concludes with a discussion of WTP estimation methods, including their strengths and weaknesses.

3.1 The Economics of IMTA & CCA

IMTA benefits are promising, but commercial adoption depends on the economic feasibility of the system. The added costs of implementing and operating a multi-species farming system means that the industry needs significant economic incentives to adopt IMTA. A recent case study on abalone and seaweed production with an IMTA system in Africa found significant reductions in nitrogen and Greenhouse Gas (GHG) emissions with a 1.4 to 5% increase in profitability and an estimated profit gain of USD $1.1 to $3 million per annum (Nobre, Robertson-Andersson, Neori, & Sankar, 2010). Further, IMTA systems can increase profits and reduce economic risks associated with natural and market causes through product diversification. Results from capital-budgeting and scenario analysis showed that the net present value of IMTA is 24% greater than salmon monoculture due to the additional revenues from mussel and kelp sales (Ridler, et al., 2007).[8] Attitudinal studies in New Brunswick showed acceptance and positive attitudes toward IMTA and its products with a 10% premium for

[8] Net present value refers to the discounted future revenues minus the discounted future costs associated with a project (Ward, 2006).

labelled IMTA seafood (Ridler, Robinson, Chopin, Robinson, & Page, 2006; Barrington, Ridler, Chopin, Robinson, & Robinson, 2008). Furthermore, an attitudinal study in New York found that 88% of 649 respondents are supportive of IMTA, while 61% were willing to buy eco-labeled IMTA mussels and 38% were willing to pay 10% more than conventional mussels (Shuve, et al., 2009).

Recent IMTA studies reveal additional information about the potential market impacts of IMTA. An intercept survey of shellfish consumers in restaurants in San Francisco found that 82% of respondents were concerned about the environmental impacts of aquaculture and 68% believed that IMTA had the potential to improve the sustainability of aquaculture practices (Kitchen, 2011). Using a payment card approach, Kitchen found a mean WTP of USD $2.48 to $2.71 for oysters produced using IMTA, which represented a 24 to 36% premium on the stated reference price of conventionally produced oysters (Kitchen, 2011).[9] Results from two surveys using contingent behavior and contingent valuation methods suggested that East Coast Canadian salmon consumers would derive benefits of between CAD $480 to $600 million per year for the first five years after IMTA salmon were introducted to the market, while non-consumers would derive environmental benefits of between CAD $42.5 to $93.3 million per year over the same period (Martinez-Espineira, 2011). [10]

[9] Two mean WTP measures were calculated; $2.48 was the mean WTP calculated based on the entire sample's responses (N=174), while $2.71 was the mean WTP calculated based on the respondents who stated a premium for the IMTA oysters (N = 124) as some individuals were only willing to pay the same price for IMTA oyster and conventionally produced oysters, while others were willing to pay less because they believed that IMTA products should be cheaper (Kitchen, 2011).

[10] Contingent behaviour method, similar to the contingent valuation method, is a stated preference method which elicits information about potential behavioural changes as a function of hypothetical changes to the conventional market (current situation). In Martinez-Espineira's study (2011), respondents were informed of the current state of some environmental problems with aquaculture and presented with a hypothetical proposed policy aimed to mitigate the issues at a specified aggregate cost. Respondents were then asked about potential changes in their salmon consumption behaviours if the environmental quality is increased at increased cost.

Although preliminary economic analyses seem promising, all but one of the studies cited were based on consumer perceptions on the East Coast. Most of the East Coast studies indicate positive initial perceptions toward farmed seafood and conventional aquaculture, which is evidently quite different from the attitudes on the West Coast, where aquaculture and farmed seafood, specifically farmed salmon, are more controversial. Further, Kitchen's study on the West Coast was limited in size and scope and targeted shellfish consumers instead of salmon consumers. A lack of studies of the perceptions and WTP for IMTA salmon on the West Coast hinders the evaluation of the economic feasibility and the likelihood and rate of adoption of IMTA in BC.

On the other hand, various CCA studies have confirmed its technical feasibility and ability to mitigate environmental impacts of conventional aquaculture (Liu & Sumaila, 2007; Wright & Arianpoo, 2010). However, while the local marine environmental impacts may be reduced with CCA, the associated material and energy demands may result in other ecological impacts (Marshall, 2003; Ayer & Tyedmers, 2009). Moreover, economic studies on CCA provided mixed profit results ranging from zero to CAD $13 million per annum, and all profitable results required assumptions of positive attitudes and WTP premiums for CCA products (Liu & Sumaila, 2007; Wright & Arianpoo, 2010).[11] Results of a feasibility study of CCA for the BC aquaculture industry revealed that only one of the various CCA technologies evaluated is marginally viable from a financial perspective (DFO, 2010). Further, these evaluations are not supported by any studies of consumers' perception of and WTP for salmon farmed in BC using CCA.

[11] Wright and Airanpoo (2010) estimated an annual profit stream between CAD $5 to $13 million based on farm ($12 million investment) that yields 1,000 MT of full-size 5 kg fish and 750 MT of fillet and plate-size fish per annum.

A thorough study of the WTP for more sustainably produced farmed salmon should not restrict the number of sustainable alternatives, but should strive to examine the WTP for all of the potential sustainable aquaculture methods. All IMTA and CCA studies conducted so far examined the systems separately and did not educate the respondents about other sustainable options. The existence of other sustainable alternatives can change the attitudes and WTP for a particular sustainable system substantially. Current studies have failed to examine such substitution possibilities and cannot accurately reflect the attitudes and preferences of salmon consumers.

3.2 Willingness-to-pay for Food and Sustainable Food

Some of the methods used to measure willingness to pay (WTP) originated in market research with the primary purpose to determine the best pricing strategy to maximize profits (Breidert, 2006).[12] As sustainable products grow in popularity, businesses and researchers are increasingly motivated to estimate the WTP for environmentally-friendly products and services for the following reasons:[13]

- To locate market niches and unrealized profits for eco-friendly products and opportunities for product diversification.[14] For instance, a high price premium for non-

[12] The maximum price a consumer is willing to pay for a product is the summation of the perceived reference value (value/price of a reference product) and the price difference between the reference product and the product of interest (Breidert, 2006). The reservation price is the perceived maximum worth of the product (Whynes, Frew, & Wolstenholme, 2005). It is also defined as the price at which the consumer is indifferent to purchasing or not purchasing the product in question (Olesen, Alfnes, Rora, & Kolstad, 2010). In practice, marketers often use the reservation price as the WTP value that is to be determined.

[13] Environmentally-friendly, eco-friendly, and green are used interchangeably in this paper.

[14] Product diversification is the process of creating a different type of an existing product by changing certain attributes to better serve a different and/or specific customer segment (Breidert, 2006).

genetically-modified (non-GM) food encourages the development of non-GM labels (Chern, Rickertsen, Tsuboi, & Fu, 2002).

- To raise producer and seller confidence in green product development and assure economic viability despite added production costs (Aguilar & Vlosky, 2007; Liljenstolpe, 2008).
- To accurately price new eco-friendly products so they can successfully stimulate market expansion without cannibalizing existing sources of revenue (Kannan, Pope, & Chang, 2008).
- To provide the basis for environmental policy recommendations and to examine the market implications of related policy changes. For example, WTP estimates can help determine whether the costs of a mandatory certification program will be covered by the market (Roe, Teisl, Levy, & Russell, 2001; Onyango, Nayga, & Govindasamy, 2005; Goddard, Boxall, Emunu, Boyd, Asselin, & Neall, 2007).
- To understand society's monetary value for and attitudes toward environmental betterment and the corresponding changes to WTP and consumption behaviour.

Environmentally and socially beneficial attributes of a product are often not observable and need to be communicated through clear indicators (e.g. certification labels) in WTP studies (Lange, Martin, Chabanet, Combris, & Issanchou, 2002; Gracia, Loureiro, & Nayga Jr, 2009). Such attributes are called "credence attributes", which are not related to the experiential quality of the product and cannot be discerned by the consumer without explicit indicators at the time of purchase (Loureiro & Umberger, 2007).[15] Certification labels can be used to reflect production methods, health claims, nutrient content and geographical information (James, Rickard, &

[15] Credence attributes are opposite to experience attributes that are linked to the consumers' experience during or following consumption (such as flavour, taste, tenderness, etc.) (Loureiro & Umberger, 2007).

Rossman, 2009). Other attributes commonly used in WTP studies of food quality, particularly those of seafood products, are reviewed and described below.

- The *appearance* of the product (e.g. redness of the salmon) may influence the perception of flavor, taste, freshness, and tenderness of the meat (Hearne & Volcan, 2002; Alfnes, Guttormsen, Steine, & Kolstad, 2005; James, Rickard, & Rossman, 2009). These factors can be visually displayed if desired.
- The *source or origin* is linked to the perception of freshness, safety, quality, and eco-friendliness of the meat product (Jaffry, et al., 2004; Loureiro & Umberger, 2007; James, Rickard, & Rossman, 2009).
- The *production method* relates to the environmental and social impacts of production (e.g. employment of animal welfare standards). The production method of salmon (e.g. farmed or wild) is particularly influential in salmon purchase decisions (Jaffry, et al., 2004; Olesen, Alfnes, Rora, & Kolstad, 2010).
- *Unobservable quality claims* include food safety, health, and nutritional claims (e.g. low sugar) that potentially increase the overall utility of the product. WTP for such claims are usually communicated with existing or hypothetical certification (Nauman, Gempesaw, Richard Bacon, & Manalo, 1995; Loureiro & Umberger, 2007; James, Rickard, & Rossman, 2009).
- The *certifier*'s perceived credibility may affect the utility of the food labels presented. However, evidence from reviewed WTP studies indicates that the certifier effect on WTP is not strong (Wessells, Johnston, & Donath, 1999; Jaffry, et al., 2004).
- The *brand* of packaged processed foods may be important in supermarket purchases. Store brands are often cheaper and perceived as lower in quality than manufacturer branded products, leading to differences in WTP (Jaffry, et al., 2004).

- The *price* of the product is sometimes expressed as an absolute dollar figure or as a percentage increase or decrease from a base product (Hearne & Volcan, 2002; James, Rickard, & Rossman, 2009). Price can also be expressed as a rate (e.g. low to very high), but this leads to ambiguity and is not preferred (Jaffry, et al., 2004).
- The *size or weight* of a product (e.g. price per pound or kg) relate to the value per dollar received and are often included to reflect real purchases made in supermarkets (Hearne & Volcan, 2002; Alfnes, Guttormsen, Steine, & Kolstad, 2005).
- The availability of competitive *substitutes* may affect the choice behavior of the consumer and should be incorporated when possible (Wessells, Johnston, & Donath, 1999).

3.3 WTP Estimation Methods for Food Products

Methods to measure WTP for foods vary from revealed preference (RP) to stated preference (SP) methods. RP methods use data collected in existing markets or experiments to estimate consumers' WTP. While historical sales data can be used to estimate the demand for a product, it assumes that the future is identical to the past and cannot estimate demand at prices that never existed or never varied (Garrod & Willis, 1999; Breidert, 2006). Consumer attitudes and demographics are often not captured at times of purchase and further limit the analysis of factors influencing WTP (Batte, Hooker, Haab, & Beaverson, 2007). Moreover, market data cannot be used to estimate WTP for new products. Alternatively, experiments do not present such limitations and can be incentive compatible by incorporating real products and money

transfers.[16] Researchers can observe the level of product acceptance and provide contextual support to replicate reality. Consequently, experiments suffer less from hypothetical bias than SP methods (Gil & Soler, 2006).[17] However, experiments are often very costly, less representative, exposed to irrational behaviours, prone to uncontrollable context influences, and only applicable to real products (Nagle & Holden, 2006).[18]

SP methods, on the other hand, examine consumer preferences, attitudes, and WTP through surveys. They are much less costly than RP methods and can estimate demand for non-existing products (Whynes, Frew, & Wolstenholme, 2005; Saphores, Nixon, Oqunseitan, & Shapiro, 2007; Olesen, Alfnes, Rora, & Kolstad, 2010). Researchers can capture a broad range of prices and quality attributes, detailed demographic data, and other data on independent variables, and can thus analyze market segments and factors influencing WTP (Mtimet & Albisu, 2006; James, Rickard, & Rossman, 2009). However, surveys tend to suffer from self-selection bias, hypothetical bias and social-desirability bias (Wessells, Johnston, & Donath, 1999; Olesen, Alfnes, Rora, & Kolstad, 2010).[19] Recent innovations in sampling methods and online surveys enable researchers to sample large populations that are more representative and

---

[16] Examples of experiments include field experiments, laboratory experiments, and Vikrey Auctions. Field experiments often modify in-store settings to observe consumer behaviors directly. An example can be found in Sue et al. (2010), who analyzed the WTP for grass-fed beef. The Vickrey auction (AKA second-price sealed-bid auction method) is a type of laboratory experiment where participants submit sealed bids for the product and the winner pays the second-highest bidder's submitted price (Lange, Martin, Chabanet, Combris, & Issanchou, 2002; Alfnes, Guttormsen, Steine, & Kolstad, 2005). It is an incentive-compatible method for eliciting WTP and is used to estimate WTP for real goods, but it has been criticized because the respondents are forced to be price-setters (Lange, Martin, Chabanet, Combris, & Issanchou, 2002).

[17] Hypothetical bias refers to the possibility of inconsistencies between the respondents' responses and actual behaviour (Hensher D. , 2010).

[18] Irrational behaviours often arise in experiments that are not incentive-compatible; for instance, when respondents do not actually pay the money nor take possession of their purchases (Nagle & Holden, 2006).

[19] Social-desirability bias occurs when respondents indicate higher WTP because it is socially-desirable, yet they are not actually willing to pay the premium prices in reality (Paulos, 1998). It may occur when respondents attempt to project favourable images of themselves during their responses. The resulting data are systematically biased toward answers that are perceived to be more correct or socially desirable (Olesen, Alfnes, Rora, & Kolstad, 2010). It is a prominent issue in WTP studies concerning environmental products or products related to animal welfare practices.

reduce the effects from these biases. The most popular SP methods are the Contingent Valuation Method, Conjoint Analysis and Discrete Choice Experiments (Breidert, 2006).

3.3.1 Contingent Valuation Method

The Contingent Valuation Method (CVM) is commonly used in WTP studies due to the ease of design and analysis. When related to environmental change, CVM attempts to answer a generally straightforward question, "are you willing to pay $X more for a product given a Y change in environmental quality?" (Goddard, Boxall, Emunu, Boyd, Asselin, & Neall, 2007). Respondents may be asked to state their WTP for the product or attribute directly in open-ended questions, to select their WTP from a payment-scale, or to make dichotomous choices between buying or not buying the product at a given price (Whynes, Frew, & Wolstenholme, 2005; Breidert, 2006; Veisten, 2007). Although open-ended CVMs can reduce the arbitrariness of the price range presented, they are not reliable for unfamiliar products because respondents generally find it difficult to set their own prices (Whynes, Frew, & Wolstenholme, 2005; Breidert, 2006). CVM is also prone to strategic behaviour biases.[20] On the other hand, CVM is less costly, easy to design and analyze, and simple for assessing preferences, and thus remains a popular method for marketing applications (Sattler & Hensel-Borner, 2007; Veisten, 2007; Saphores, Nixon, Oqunseitan, & Shapiro, 2007).

CVM applications in food quality studies often ask the respondents to state their WTP for the specific environmental quality associated with the product. For instance, respondents may be asked to directly state the price or premium they are willing to pay for GM-free food and a separate price or premium for pesticide-free food (Batte, Hooker, Haab, & Beaverson, 2007).

[20] Strategic behaviour occurs when respondents state a lower WTP with the attempt to lower the future price of the product, or when they state a higher WTP to appear not as "stingy" before the interviewers.

CVM has been used to analyze credence attributes, such as electricity produced using green technologies that does not affect the consumer's experience during consumption (Yoo & Kwak, 2009).[21] CVM is effective in obtaining premiums for environmentally-friendly alternatives to existing foods. For example, a 5 to 10% premium for 'green' labelled milk was assessed in China, and significant WTP premiums for certified organic food were detected among Argentineans, using CVM (Xia & Zeng, n.d.; Rodriguez, Lacaze, & Lupin, 2008).

CVM is also a popular method for analyzing goods that do not exist in the market. Examples include hypothetical organic foods and hypothetical seafood safety assurance labels (Wessells & Anderson, 1995; Rodriguez, Lacaze, & Lupin, 2008). However, WTP studies for hypothetical products and environmental attributes are prone to hypothetical bias and social desirability bias, which skews WTP estimations upwards (Guagnano, 2001).[22] Consequently, CVM has been criticized as being only sufficient to indicate the population's interest in consuming green products (Guagnano, 2001). Furthermore, CVM unrealistically assumes an all-or-nothing situation, where respondents will either transfer all purchases from the reference product to the new product, or not to transfer their purchases at all (Corsi, 2007).

3.3.2 Conjoint Analysis & Discrete Choice Experiments

Conjoint Analysis (CA) elicits WTP for a good or service implicitly and has been used extensively to determine preferences for new and existing products, pricing strategies and market segments (Gustafsson, Herrmann, & Huber, 2007). CA offers several benefits compared to RP methods and CVM: a broader range of prices can be selected, making it cognitively

[21] Green technologies include wind, solar tidal, and biomass power (Yoo & Kwak, 2009).
[22] Simulated CVM that is designed to be incentive compatible and comparable to actual market settings may reduce hypothetical biases, as long as the hypothetical credence attribute of interest is well-defined and communicated (Wessells & Anderson, 1995).

easier for respondents as they are not obliged to be the price-setters, and there is a lower possibility of strategic behaviour as the WTP values are not stated directly. In a CA, different levels for each of several attributes (including price) are presented jointly to form a product profile, and respondents are asked to state their preferences by accepting, ranking or rating several profiles (Haaijer & Wedel, 2007).[23] The ranking or rating approach possesses greater predictive validity and is generally preferred (Kalish & Nelson, 1991). Analysts can then decompose the contributed utility (or part-worth utility) of each attribute and identify an individual's preference structure and WTP for a particular profile (MarketVision Research, 2002; Breidert, 2006; Gustafsson, Herrmann, & Huber, 2007; Haaijer & Wedel, 2007).

A major pitfall of CA is that it estimates preference structure but not actual choice behaviour, and thus market reactions may not be truly predicted (Gustafsson, Herrmann, & Huber, 2007; Haaijer & Wedel, 2007).[24] Attempts have been made to eliminate the issue with extended methods, such as using the first-choice rule or a status-quo product. However, such modifications are arguably inadequate in raising the predictive power of conjoint surveys (Haaijer & Wedel, 2007).[25] Additionally, CA is subject to simplifying effects and response scale

---

[23] Such design is based on the Lancastrian Consumer Theory (Lancaster, 1966), which states that purchase decisions on products are based on a comparison of the combination of various attributes of all competing goods.

[24] Estimating the preference structure means that researchers can predict the most attractive product among different competing products, but actual purchase behaviours (whether or not the most attractive product will be purchased) cannot be predicted (Breidert, 2006).

[25] A status-quo product is assumed to be the product that will always be chosen by all consumers, and researchers can compare the product of interest to the status quo. However, surveys can be subject to incompleteness if researchers select an inappropriate status quo product. In response, researchers have attempted to ask respondents to create their own status quo products in conjoint surveys (Steiner, Gao, & Unterschultz, 2010). The first-choice rule is a method of converting ranked or rated results into choice predictions. It assumes that respondents will choose the product with the highest utility (Haaijer & Wedel, 2007).

differences, which further reduce its ability to estimate WTP and generate a cross-individual utility comparison (Sattler & Hensel-Borner, 2007; Haaijer & Wedel, 2007).[26]

The Discrete Choice Experiment (DCE), also known as Choice-based Conjoint Analysis, is a derivative of the CA. DCE emphasizes the trade-offs between product profiles that are compatible with reality and consistent with the Lancastrian Consumer and Random Utility theories (Louviere, Hensher, & Swait, 2007; James, Rickard, & Rossman, 2009). In a DCE, several product profiles with different levels of attributes are presented simultaneously (referred to as a choice set), and respondents are asked to make a choice between the profiles (McFadden, 1974; Hensher, Rose, & Greene, 2005). The sample's choices are collectively analyzed to provide the part-worth utility of each attribute level. Because the number of product profiles increases exponentially as the number of attributes and levels increase, fractional factorial design is often employed.[27] Consequently, DCEs can only provide consumer preferences and WTP at an aggregate level, as opposed to the individual level provided by a CA (Breidert, 2006; Haaijer & Wedel, 2007). DCE reduces the complexity and cognitive burden for the respondents while enabling WTP estimation for multiple attributes, which is an important feature for food studies that examine the contributed utilities of food quality and certifications (Roosen, Lusk, & Fox, 2003). Furthermore, DCE can present products that are not easily

---

[26] Simplifying effects refer to situations where respondents focus on a subset of attributes and neglect others when presented with profiles with a number of attributes. This behaviour causes severe bias in part-worth utility estimations (Sattler & Hensel-Borner, 2007). Response scale differences refer to the differences between individuals in their perceived understanding of the scale responses.

[27] Fractional factorial design refers to the use of only a fraction of the total number of choice combinations in a DCE design (Hensher, Rose, & Greene, 2005). It enables researchers to analyze the DCE while only showing a subset of the profile combinations to each respondent, thus reducing the time and effort required per respondent while obtaining enough sample data to analyze the main effects of the research. It is a much more efficient design method as the number of choice sets can increase exponentially with each additional attribute/level in a profile (Jaeger & Rose, 2008).

comparable in reality.[28] DCEs often include a “no-choice” alternative to mimic reality and reduce hypothetic bias.[29]

Discrete Choice Experiment is particularly useful in estimating WTP for hypothetical attributes and credence attributes. Hypothetical attributes should be realistic and clearly explained before the respondents make their choices. The method of communication needs to be without bias and reflect reality, such as presenting brief information inserts that replicate the information available on new products in supermarkets, as opposed to giving detailed information videos (Hearne & Volcan, 2002). DCE’s effectiveness in studying consumer preference and WTP for food is proven in the literature. For instance, DCE was able to estimate premiums for differences in color of farmed salmon, certified organic salmon, certified animal welfare salmon, and food production methods that reduce harm to the environment and ecosystem (Moon, Florkowski, Bruckner, & Schonhof, 2002; Alfnes, Guttormsen, Steine, & Kolstad, 2005; Olesen, Alfnes, Rora, & Kolstad, 2010). Furthermore, DCE has the ability to reveal the market potential and existing policy gaps, such as differences between segments and the need for education and other policies to ensure healthy market growth for sustainable food alternatives (Moon, Florkowski, Bruckner, & Schonhof, 2002).

[28] For instance, organic products and conventional products are often placed in separate sections in retail settings, making price comparisons more difficult for the regular consumer (Batte, Hooker, Haab, & Beaverson, 2007).

[29] However, some argue that an opt-out option creates a disadvantage for DCE as such responses do not provide information on the alternatives (Haaijer & Wedel, 2007).

Chapter 4: Research Methods

This chapter begins with identifying DCE as the appropriate method for my project, followed by a detail discussion of the theoretical background, the WTP estimation formulas, and the design of the DCE. I then discuss the survey and the recruiting process, and conclude with a brief description of the analysis methods used.

4.1 Identification of the Appropriate Study Method

Not knowing how much consumers in the Pacific Northwest of the US are willing to pay for IMTA salmon compared to its potential close substitutes, including CCA salmon, hinders further economic and profitability analysis of IMTA in BC. An appropriate method for such analysis must meet the following criteria:

- Be able to estimate WTP for a non-existing product,
- Be able to predict actual choice behavior between multiple products,
- Offer flexibility in setting varying prices,
- Be able to consider multiple attributes simultaneously, and
- Not be overly costly to design and distribute to a large sample.

I considered the various methods mentioned in Chapter 3.3, including market data, experiments, CVM, CA, and DCE. Given the criteria and methods mentioned, DCE is arguably the most appropriate method for my study (Table 1).

Table 1. Evaluation of WTP Methods Based on Study Objective and Criteria

Can/is the method…	Market Data	Experiments	CVM	CA	DCE
Estimate WTP for non-existing products?	No	No	Yes	Yes	Yes
Observe choice behaviour?	Yes	Yes	No	No	Yes
Offer flexible pricing & product options?	No	Yes	Yes	Yes	Yes
Consider multiple attributes simultaneously?	Maybe	Yes	No	Yes	Yes
Reasonable in costs to design and distribute to large samples?	No	No	Yes	Yes	Yes

4.2 Discrete Choice Experiment (DCE)

DCE emphasizes the trade-offs between product profiles that are compatible with reality and also consistent with Lancastrian Consumer Theory and Random Utility Theory (Louviere et al., 2007; James et al., 2009). Respondents are presented with different hypothetical products (e.g. profiles) composed of various levels of decision-influencing factors (e.g. attributes) and they are asked to choose one profile that they are willing to purchase. Researchers can then quantify and assess the stated choices and estimate the part-worth utility for each attribute level presented (Louviere, Hensher, & Swait, 2000). The benefits of DCE over other survey methods are two-fold:

1. DCE forces respondents to make a choice based on their perceived utility and the trade-off between profiles (Hensher, Rose, & Greene, 2005), thus preventing any ambiguous or anchored responses that may be associated with scale-rating surveys.
2. Profiles of hypothetical products can be designed to enable comparisons between new and existing products by the respondents. This advantage is fundamentally important to this study as IMTA salmon is not an existing product in the current market.

4.2.1 Theoretical Background

DCE is based on two underlying theories of consumer behavior: Lancastrian Consumer Theory and Random Utility Theory. Lancaster (1966) proposed that consumers do not choose between different products but between the different attributes which the products provide; in other words, the utility of each good is the sum of the utilities of the attributes or characteristics it provides to the consumer. Random Utility Theory, on the other hand, states that a consumer's utility from consuming a good can be decomposed into a deterministic (V) and a stochastic (Ɛ) component (McFadden, 1974; Adamowicz *et al.*, 1998). The overall utility (U) of option j for consumer i is represented as

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (1)$$

where V_{ij} is the systematic and observable component of the utility function and $Ɛ_{ij}$ is the stochastic component that cannot be observed by the researchers. An individual will choose alternative j over alternative k if $U_{ij} > U_{ik}$ for all $j \neq k$. In a DCE where respondents are given different alternatives to choose from, the probability that a respondent will choose alternative *j* is given by:

$$Prob\{j\ is\ chosen\} = Prob\left\{V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik}\ ;\ for\ all\ k \epsilon C_i\right\} \quad (2)$$

where C_i is the choice set for respondent i. Assuming that the random errors (Ɛ) are independently and identically distributed across individuals (IID) with a Type I extreme value distribution and scale parameter equal to 1, the multinomial logit (MNL) model takes the form:

$$Prob\{j\ is\ chosen\} = e^{v_{ij}} / \sum_k e^{v_{ik}}\ ; for\ all\ k \epsilon C_i \quad (3)$$

If V_{ij} is assumed to be linear in parameters, its functional form may be expressed as:

$$V_{ij} = \beta_1 x_{ij1} + \beta_2 x_{ij2} + \cdots + \beta_n x_{ijn} \quad (4)$$

where x_{ijn} is the n^{th} attribute value for alternative j for consumer i, and β_n represents the coefficient of the n^{th} attribute value to be estimated. The probability of alternative j being chosen may be formulated using the attribute levels and the responses from the DCE.

One way to conceive of the WTP for changes in a product attribute is the price discrepancy in the consumers' WTP for the product with one level of the attribute and the product with a different level of the attribute in question.[30] If the production method is an attribute of salmon, where the levels of the attribute are IMTA and conventional aquaculture, then the WTP for IMTA salmon is the difference between the consumers' WTP estimates for conventionally produced salmon and IMTA produced salmon. The WTP can be calculated as the ratio of two parameter estimates where the numerator is the negative of the coefficient of the attribute of interest and the denominator is the coefficient of the price attribute (β_P), holding all else constant (Hensher, Rose, & Greene, 2005). [31] Thus, the mean WTP for attribute y can be represented as:

$$Mean\ WTP_y = \frac{-\beta_y}{\beta_P} \quad (5)$$

The mean WTP for the IMTA attribute of salmon in a single purchase decision may thus be represented as:

$$Mean\ WTP_{IMTA} = \frac{-\beta_{IMTA}}{\beta_P} \quad (6)$$

---

[30] Alternatively, we can say that the WTP for a product attribute is the price discrepancy in the consumers' WTP for a product with the attribute and a product without the attribute in question in a single purchase situation.

[31] Analysts can take advantage of the fact that DCEs models are linear in the utility function and calculate the WTP using the equation represented above. The WTP may not be calculated with the same method in non-linear models.

4.2.2 Design of the DCE

As the purpose of the DCE was to replicate a more realistic salmon purchase situation, it was important to observe the actual attributes presented to a regular shopper at supermarkets and wharves in the US. I travelled to Seattle, Portland and San Francisco in 2009 to observe and study the attributes presented in a typical salmon product at supermarkets (Appendix E). The following attributes were generally presented on the packaging of salmon products (i.e. on the price tag): species of salmon, production method (e.g. wild or farmed), origin, weight, certification (if any), nutritional facts (e.g. high on Omega-3), handling instructions, and price per pound (lb). Fewer details about the fish are presented when it is sold at a wharf; however, price per lb, species, and origin were always provided on a board or directly by the seller. The fish can be sold whole, in fillets, or any of a number of cuts made available by the seller. After some deliberation, the price tag was determined to be the most suitable and easily understandable presentation format for the profiles. The price tag presents the most important information (e.g. attributes) of a salmon product in a common purchase situation. Additionally, the information presented on each price tag is the same, making it easier for the respondent to understand the differences between each profile.

The selection of attributes and levels are critical in a DCE. DCE enables the use of many product attributes, even those that are not commonly noticed by a consumer in reality. However, the inclusion of a large number of attributes and levels may over-complicate choice situations (James, Rickard, & Rossman, 2009). On the other hand, the exclusion of important attributes may increase cognitive efforts as respondents are required to make inferences about the missing attributes (Jaeger & Rose, 2008). The omission of relevant attributes will also increase the random error unobserved by the researcher. Therefore, the attributes and levels selected were carefully tested before finalizing the design. The finalized attributes were (Table 2):

- **Salmon species**: I included Atlantic, Sockeye and King salmon in the study because Atlantic salmon is the primary product of the BC aquaculture industry and Sockeye is the primary wild product available to US salmon consumers. While King salmon is not as widely consumed as the other two species, it was included as it is the only species produced in BC that can be both farmed and wild.
- **Production method**: The conventional farming method, IMTA and CCA farming methods, and the wild production method were presented as levels of the production method attribute as the coefficients of the part-worth utilities for the production methods were used in the WTP estimation for salmon produced in IMTA and CCA.
- **Eco-certification** (represented with a generic label): eco-certification may affect the consumers' utilities for salmon. While eco-certification for wild salmon exists, eco-certification for farmed salmon may be developed in the future as sustainable technologies for salmon farming become available.
- **Country of origin**: the consumers' perception and utility for salmon may change depending on its source, as they may feel that certain countries produce salmon of greater quality than other countries (Chapter 3.2).
- **Price per lb**: the price of salmon was a necessary attribute in the DCE as the utility coefficients of the price attribute served as the denominator of the WTP estimation equations (equation 5 and 6). The average market price of each species was analyzed and used as the reference price of the DCE.

These attributes were selected because they were commonly shown on the price tags of fish products sold in the US and they were also deemed fundamental to answering my research

questions. Visual images of the salmon were considered and later discarded due to the added complexity and the possible biases it would introduce to the exercise.[32] Respondents were also asked to assume that the cut of the salmon "suit their preferences".

Table 2. DCE Attributes and Levels

Attribute	Levels
Species	Atlantic Salmon; Sockeye Salmon; King Salmon
Production Method	Conventionally Farmed; Farmed in IMTA; Farmed in CCA; Caught wild
Country of Origin	Canada; USA; Chile; Norway
Eco-Certification	Yes; No
Price	Reference price; Reference – 30%; Reference + 30%; Reference + 60%

Designing the DCE was complicated because of conflicts among levels of the different attributes. For instance, Sockeye salmon (SS) cannot be farmed; therefore these two levels across the species and production method attributes cannot be presented together. Additionally, the reference prices are different across each species (e.g. King salmon are much more expensive than Atlantic salmon). With such constraints, I considered using a labeled DCE where each profile is labeled based on salmon species and the attribute levels are constrained by the species. However, a labeled design would prevent choice sets where the same species with different attribute levels are compared against each other. This disadvantage critically reduces the level of realism in the DCE. Therefore, I decided to design attribute levels specific to the species, but use an unlabelled DCE so that the same species can be presented in the same choice set (Table 3). Furthermore, all wild salmon profiles were presented as "previously-frozen" salmon, while all farmed salmon profiles were presented as "fresh" salmon. "Fresh wild

[32] Design complexity may increase with the use of visuals as the researchers would have to decide on the "cut" (e.g. fillet, whole, steak, etc.), the color, and the various small appearance cues (e.g. fatness, etc.) of the fish presented. These visual information cues can affect utility and the selection of visual images can thus introduce bias to the exercise and lead to simplifying effects, where respondents choose options solely based on the image provided (Alfnes, Guttormsen, Steine, & Kolstad, 2005).

salmon" is not included as it is only available seasonally and is not a year-round substitute for farmed salmon.

Table 3. DCE Attributes and Levels by Species

	Atlantic Salmon	Sockeye Salmon	King Salmon
Production Method	• Conventionally Farmed • Farmed in IMTA • Farmed in CCA	• Wild	• Conventionally Farmed • Farmed in IMTA • Farmed in CCA • Wild
Country of Origin	• Canada • USA • Chile • Norway	• Canada • USA	• Canada • USA
Certification	• Yes • No	• Yes • No	• Yes • No
Price / lb[33]	• $7.99 • $10.99 • $14.99 • $17.99	• $8.99 • $11.99 • $15.99 • $19.99	• $11.99 • $15.99 • $20.99 • $25.99

I designed the price tag so that the species name appeared as the label of the profiles. Pre-test respondents confirmed that this design was the most logical presentation format and more appropriate than a generic label, which is common in unlabelled CEs (e.g. "option 1") (Figure 4). Various seafood certification programs were considered, but none of the existing programs were suitable for the DCE as they do not certify both farmed and wild salmon. To avoid adding complexity to the DCE, I created a generic sustainable seafood certification label

[33] The reference price was the average market price selected based on a review of the observed prices of salmon sold in supermarkets and available data of farm gate prices. The final price levels of our survey were tested rigorously to ensure that the DCE was realistic and that the respondents were responsive to the prices set in the DCE through pretests.

so that the respondents were not burdened with learning the differences among labelling programs.[34]

Figure 4. Sample Choice Set from the DCE Presented to Respondents

The finalized design had five attributes that varied on four levels, representing a 4^5 factorial design and yielding 1024 possible choice sets.[35] Following an orthogonal fractional factorial design, 48 choice sets were selected from the total and blocked into six versions, each containing eight choice sets.[36] Each respondent saw one block of eight choice sets of randomized sequences and one common set (discussed in *Section 4.5.3*). In each choice set,

---

[34] Several sustainable seafood labels were examined while designing the generic label (the "green fish" label). The resulting label was "green" as the color is associated with "sustainability" or "sustainably-managed" products by most, and the fish and check mark signified its focus on fish products (similar to the idea of the certified sustainable seafood label from the Marine Stewardship Council) (Marine Stewardship Council, 2011).

[35] Less than four levels existed in certain species-specific attributes (Table 3). In these cases, some levels were used twice to make up for the missing levels to achieve a factorial design. In this design, AS was duplicated (which was logical as it was the primary product of the study); IMTA was duplicated for AS and wild for SS under production methods; both yes and no were duplicated equally in certification; Canada and USA were both duplicated for SS and KS in country of origin.

[36] Blocking is a method to reduce the number of choice sets shown to any particular respondent. The analysts would add in an orthogonal column designed for blocking, which breaks the fractional factorial design into "blocks" (Hensher, Rose, & Greene, 2005). Each block is then presented to a different respondent, which means that six different respondents are required to complete the full fractional factorial design in this DCE.

the respondent was asked to choose one of the three profiles presented or "none" if none of the profiles was acceptable.

4.3 Survey Design

I designed an online survey to elicit salmon consumers' perceptions and their WTP for salmon produced using IMTA and other aquaculture methods.[37] Online surveying is an efficient and cost-effective vehicle to survey a large sample in a targeted region and allowed me to present my DCE creatively in the price tag format. This approach also enabled me to examine information effects on WTP by programming treatments randomly and systematically (see *Chapter 4.5*). Online surveying provides a high level of confidentiality, which significantly reduces social desirability bias (Brace, 2004). The survey was developed over a period of seven months with the final survey delivered to over 4000 respondents.[38]

The survey was divided into the following six sections with summary descriptions provided below (the final version of the full survey is provided in Appendix D):

A. Screening, salmon purchase and consumption behavior
B. Knowledge and perception on salmon production methods
C. IMTA and CCA descriptions and attitudes
D. DCE
E. Environmental participation and perceived consumer effectiveness (PCE)
F. Demographics

[37] The survey was called "salmon consumption survey" when presented to the respondents to avoid possible biases from respondents who are more inclined to respond to surveys related to "sustainable consumption".

[38] We employed Research Now, an online marketing research company that provides a broad range of services, including survey development, programming, delivery and reporting, to deliver our survey to the targeted respondents. The company provides access to a global network of more than 6 million quality online panellists.

Section A: Screening, salmon purchase and consumption behavior

I presented screening questions related to the respondents' place of residence, role in grocery shopping, and at-home salmon consumption experiences. Qualified respondents were asked questions about previous salmon purchases, such as the price and amount of salmon purchased, and asked to rate factors influencing salmon purchase decisions.[39]

Section B: Knowledge and perception on salmon production methods

The purpose of this section was to confirm the respondents' knowledge of salmon farming and the associated environmental concerns. I briefly described Atlantic, Sockeye, and King salmon to ensure general awareness of differences among the species presented in the DCE. I also asked the respondents to indicate their preference for either farmed or wild salmon and the reasons for their preferences. Environmental concerns related to conventional salmon aquaculture were then described to provide the background for the proposed sustainable aquaculture technologies. In order to reduce potential bias from overstating the benefits of the new technologies, I only listed three of the environmental issues associated with conventional salmon farming that are commonly illustrated in the media (see preamble before Question B8 of Section B in Appendix D).

Section C: IMTA and CCA descriptions and attitudes

IMTA and CCA were presented with an image and a favorable or balanced description (See *Section 4.3*). Respondents were asked to state their awareness and attitudes toward each technology. After both technologies were presented, respondents were asked to indicate their

[39] Some factors were adopted based on a literature review of factors influencing meat consumption while others were incorporated from Verbeke, Vermeir, & Brunso (2007).

preference for either IMTA or CCA (or none), if one was to be adopted for salmon farming, and to provide reasons for their preferences.

Section D: DCE

Directions for completing the choice exercise were provided. Respondents then proceeded to answering a series of nine mandatory choice questions. While the actual design of the DCE only involved 8 choice questions, an initial "common" choice set was first presented as an educational exercise and to explore possible initial choice bias (See *Chapter 4.5.3*). Following the DCE, respondents were asked to state their willingness to increase salmon consumption if IMTA and CCA salmon were available.

Section E: Environmental participation and perceived consumer effectiveness

Questions on environmental activism from Saphores et al. (2007) were adopted to determine the respondents' level of organized environmental activity participation; this was followed by four Likert-scale questions on sustainable salmon farming adoption and perceived consumer effectiveness (PCE).[40]

Section F: Demographics

Demographics data, including age, education, household size and income were gathered in the final section of the survey.

[40] Perceived consumer effectiveness (PCE) is a measure of the respondent's perceived individual consumer ability to affect environmental/resource problems. (Antil, 1978)

4.4 Recruitment of Survey Respondents

The target population consisted of all salmon consumers residing in Seattle, Portland and San Francisco.[41] These cities were chosen as they are the major cities located in the three US states that import most of BC's farmed salmon products. I employed the market research firm Research Now to recruit and deliver the survey's online link to the sample population. Respondents were screened out if they did not live in the targeted cities, if they were not the primary or secondary grocery shoppers in their household, or if they had not consumed salmon at home over the past year. Furthermore, respondents who completed the survey and were validated based on the screening criteria were rewarded points in Resource Now's system.

Equal representation was sought from each city and for each gender.[42] Moreover, data quality may be affected by individuals who sped through the survey to earn the reward for completing the survey. As such, I eliminated respondents who completed the survey in less than 6 minutes or who took more than one hour, and those who selected the same option during the DCE task more than four times consecutively.[43]

4.5 Sample Splitting Exercise

I incorporated three sample splitting or partitioning exercises to explore impacts on WTP and consumer perceptions from exposing respondents to different descriptions and presentation

---

[41] I recruited populations in the metropolitan areas of Seattle, Portland, and San Francisco.

[42] The sample initially consisted of around 80% of female respondents in the first two weeks of collection period. As recent trends showed that men are also becoming more influential in grocery shopping decisions of the household, the sampling strategy was slightly changed to target more males to ensure that the sample is representative of the overall population (DeNoon, 2005; Neff, 2011). The final sample consisted of around 33% males and 67% females.

[43] We also removed respondents who took longer than an hour because the survey had educational components related to IMTA and CCA. Individuals who took too long to complete the survey must have left in the middle of the survey period and may not have retained the IMTA and CCA information to the same extent as others.

sequences for IMTA and CCA. Each information treatment method is described in the following subsections. A summary table of the sample splitting methods is presented in Table 4.

Table 4. Summary of the Sample Splitting Exercise

Splitting Method	Split 1	Split 2
Sequence of technologies	IMTA first, CCA second	CCA first, IMTA second
Descriptions of the technologies	Favorable	Balanced
Common set presented to all respondents initially	High price common set	Low price common set

4.5.1 Sequence of the Descriptions of Production Technologies

The attitudes toward and WTP for each technology may depend upon which technology is introduced first. I explored such impacts by splitting the sample, where half of the respondents were presented IMTA first and the other half were presented CCA first.

4.5.2 Nature of the Descriptions of the Production Technologies

Two options were adopted for the descriptions of the IMTA and CCA technologies. The first option was to present the descriptions in a "balanced" way, where respondents were offered general descriptions and both the positive and negative environmental impacts of each technology.[44] Another option was to present the descriptions "favorably", where a general description and only positive environmental impacts were provided. Both types of descriptions were appropriate, as the first option provided a neutral view of the technologies, which complemented the academic nature of my study. However, the "favorable" option is more reflective of the present and future marketing efforts used in the sale of salmon or any other products.

[44] The "balanced" information is also sometimes referred to as the "two-sided" information in the literature (Depositario, Nayga, Wu, & Laude, 2009).

Presenting either the “balanced” or “favorable” descriptions can influence perceived utility and the final WTP estimate.[45] The fluctuations found in the literature and the lack of studies exploring appropriate information treatment methods motivated me to eventually split the sample, so that half of the respondents were presented the “balanced” description, while the other half saw the “favorable” description (see Appendix D). To avoid bias, I split the sample such that respondents always saw the same type of description for both technologies.

4.5.3 Common Set

A “common” choice set was presented to all respondents at the beginning of the DCE as a practice set. To understand any potential bias from arbitrarily setting a price range for the common set, I decided to split the sample into two segments, where one segment saw a “high price” choice set and the other saw a “low price” choice set. The “high price” choice set presented higher price products with an average price of ~$17, while the “low price” choice set had an average price of ~$10 (Appendix D). I also examined possible part-worth utility differences between the two segments.

4.6 Data Analysis

A number of statistical methods were used to analyze the data. IBM SPSS Statistics 19 was used to analyze most of the descriptive elements of the survey, including sample characteristics, salmon consumption behavior, and attitudes toward salmon aquaculture, IMTA,

[45] In a WTP study for golden rice, the mean WTP was higher with positive information > no information > negative information > two-sided information, while a study for biotech foods showed greater WTP bids with positive > two-sided > negative information (Tegene, Huffman, Rousu, & Shogren, 2003; Depositario, Nayga, Wu, & Laude, 2009).Golden rice is a type of GM food that contains greater amounts of Provatimin A, which is beneficial to consumers (Depositario, Nayga, Wu, & Laude, 2009). Both studies used experimental auctions to estimate WTP for the products of interest.

and CCA (SPSS Incorporated, 2010). The DCE was analyzed with major assistance from Nina Mostegl, who carried out the statistical analysis of the DCE data using the software package Latent Gold (Statistical Innovations Incorporated, 2010).

4.6.1 Principal Component & Cluster Analysis

Principal Component Analysis (PCA) seeks to "reduce the dimensionality of the data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set" (Jolliffe, 2002, p.1). The number of variables is reduced into a set of uncorrelated variables (principal components) so that correlations between the sample and the variables in question can be more clearly analyzed (StatSoft, Inc., 2011). I used PCA to derive principal components associated with influences on salmon purchase behavior. The Varimax method of orthogonal rotation was used to maximize the variance (variability) of the principal components, while minimizing the variance around these new component variables (StatSoft, Inc., 2011). Factors with an Eigenvalue of 1 or greater were retained according to the Kaiser criterion (Kaiser, 1960).[46]

Cluster analysis was used to identify homogenous groups based on the PCA results and the respondents' level of environmental participation. Many clustering methods exist, all of which seek to sort respondents into groups by maximizing the homogeneity within and minimizing the heterogeneity between the groups (StatSoft, Inc., 2011). I analyzed groups based on the PCA scores using the hierarchical tree method, which is a bottom-up approach where respondents are initially treated as separate classes, then slowly grouped together by identifying similarities across the individual respondents. Groups are then linked together to

[46] Eigenvalues are "the variances extracted by the factors" (StatSoft, Inc., 2011). The Kaiser criterion states that only factors that extract at least as much as the original variable should be used (StatSoft, Inc., 2011).

create larger and larger clusters, where eventually all respondents are linked together at the highest level (StatSoft, Inc., 2011). The resulting dendrogram needs to be visually interpreted to identify the appropriate number of clusters used for further analysis.

I employed a Two-Step Cluster Analysis to identify homogenous groups based on the respondents' stated environmental participation levels. The Two-Step Cluster Analysis does not require the use of a PCA and is appropriate for clustering the sample based on a small number of variables. It automatically detects the proper number of clusters by first pre-clustering the data into many small sub-clusters, and then in a second step clustering the sub-clusters into larger clusters of a predetermined number of clusters desired by the analyst, or a proper number determined by automation (SPSS Incorporated, 2001). The Two-Step Cluster Analysis allows the use of categorical variables and therefore was deemed more appropriate in analyzing the environmental participation responses in my survey. Both clustering methods were conducted with IBM SPSS Statistics 19. Differences in part-worth utilities among groups identified with the Cluster Analyses were explored with known class analysis in Latent Gold.

4.6.2 The Multinomial Logit Model

As mentioned previously, the MNL model assumes that the random errors (Ɛ) are independently and identically distributed across individuals (IID) with a Type I extreme value distribution and scale parameter equal to 1, allowing me to define the probability distribution of alternative j being chosen by individual i as:

$$Prob\{j\ is\ chosen\} = e^{v_{ij}} / \sum_k e^{v_{ik}}\ ; for\ all\ k \in C_i \qquad (7)$$

Latent Gold calculates the actual frequency that the individual i chooses alternative j, forming the dependent variable, and then estimates each researcher-specified parameter

through maximum likelihood procedures. The parameter estimates can then be used to predict the relative probability that an individual will choose a particular profile as described by various combinations of attributes, compared to other profiles with different attribute levels (Hensher, Rose, & Greene, 2005). Further, the parameters associated with the each level of an attribute can translate into the part-worth utility associated with the level in question (Hensher, Rose, & Greene, 2005). As mentioned, the coefficients of the part-worth utilities can then be used to estimate the WTP for the level in question.

4.6.3 Latent Class Analysis

The latent class analysis (LCA) is an expanded, mixed logit form of the MNL and can be used to measure preference heterogeneity among the sample (Train, 2009). The model assumes an overall heterogeneous sample that is made up of a number of relatively homogenous classes. These classes can first be identified based on differences in preference across the classes and then be described by socio-demographic information and other attitudinal data (Boxall & Adamowicz, 2002). Each class is characterized by homogeneous preferences within and heterogeneous preferences between classes (Birol, Karouskis, & Koundouri, 2006). As opposed to known class models, which analyze part-worth utilities based on pre-assigned clusters, LCA defines the number of classes endogenously using the data.

The latent class model is the product of two probability distributions, where the probability *P* of individual *i* choosing alternative *j* is:

$$P_{ij} = (P_{ix})(P_{ij|x}) \quad (8)$$

where P_{ix} is the probability that individual *i* will be part of class *x* and $P_{ij|x}$ is the probability that individual *i* will choose alternative *j* conditional on membership in class *x.* Assuming that the

probability distributions (equation 8) follow the random utility model and the error term in both of these distributions is independent and identically distributed among individuals with Type I, extreme value distributions, they can then be expressed as (Boxall & Adamowicz, 2002):

$$P_{ij} = \sum_{x=1}^{x} \left[\frac{e^{\alpha_x S_i}}{\sum_{x=1}^{x} e^{\alpha_x S_i}} \right] \left[\frac{e^{\beta_x Z_j}}{\sum_{h \in C} e^{\beta_x Z_h}} \right] \quad (9)$$

where α_x is the parameter associated with the socio-demographics, attitudinal, or psychometric effects *S* specific to group *x*. β_x is the class *x* specific parameter for alternative *j,* chosen from all alternatives *h* in choice set *C*. If there is only one class in the sample, then

$$\frac{e^{\alpha_x S_i}}{\sum_{x=1}^{x} e^{\alpha_x S_i}} = 1 \quad (10)$$

and equation 9 collapses to the MNL.

The analysts can determine the best-fit model based on results of the Bayesian Information Criterion (BIC) and the Akaike Information Criterion (AIC and AIC3) of each model, which assess the improvements in the log likelihood value for each model (Vermunt & Magidson, 2005).[47] LCA is advantageous as it avoids biases from *a priori* market-based segmentation methods (Bhat, 2002). Furthermore, it estimates different parameters for all specific classes and thus enables researchers to examine part-worth utility and WTP differences among the classes for a given product or attribute level. Covariate analyses using other variables from the survey can also be conducted in latent class analysis to further describe the traits of the classes identified (Boxall & Adamowicz, 2002).

[47] The BIC, AIC, and AIC3 penalizes the models as the log likelihood of the classes increase, therefore the lower the values, the better fit the model is (Vermunt & Magidson, 2005).

Finally, a Decision Support System (DSS) was developed using the results of the DCE, and this enabled me to assign attributes to three different product profiles and examine changes in market share for each product. The market share of each profile was derived from a calculation of the total utility of the profile for the entire sample, or each latent class (LC), based on the part-worth utility of each attribute level.

Chapter 5: Results

This chapter summarizes the results of the survey, starting with the characteristics of the sample, followed by the results of the PCA and cluster analyses. I then conclude the chapter with DCE results and the estimated WTP for salmon produced with IMTA and CCA.

5.1 Sample Characteristics

A total of 5329 respondents opened the survey during the three sampling Phases (Pre-test, Phase 1, and Phase 2).[48] My analysis focused on the 4653 respondents from Phase 2 only to avoid any potential impacts from minor changes to the survey made between the phases. The completion rate in Phase 2 was 44.4% (n=2067). Of the 130 respondents who started and did not complete, 46% dropped out within the first five pages, while others dropped out at relatively even rates throughout the rest of the survey. Four criteria were set to identify invalid responses: respondents who did not reside in the targeted cities, were not the primary or secondary shopper of the household, did not eat salmon or only ate salmon in restaurants, and took less than 6 minutes or more than 1 hour to complete the task.[49] These responses were detected and replaced immediately to reach a total sample size of 1712 respondents. The

[48] From July 21st to 26th, 2011, 164 individuals responded to the pre-test of the survey, 80 of which completed the survey. Upon making some changes to the survey, it was launched again (Phase 1) from September 19th to 23rd, and 512 individuals responded while 205 respondents completed the survey. After final changes, the last launch (Phase 2) occurred during October 28th to November 19th, 2011, which collected 2067 completed surveys.

[49] Pretest determined that the survey should take between 15 to 20 minutes to complete if the reader read very diligently. The average completion time for respondents was 12.3 minutes. Although not a focus of this study, 516 respondents who did not eat salmon at home during the last 12 months provided reasons for their lack of at-home consumption, results are shown in Appendix F.

results from the screening process indicated a large at-home salmon market in the targeted cities, as 82% of all surveyed respondents ate salmon at home in the past 12 months.[50] Finally, I detected some erratic choice behavior in the DCE and subsequently removed 81 respondents who selected the same option 6 or more times in the 8 DCE questions.[51] The final data used for the analysis were based on a sample of 1631 verified completed respondents.

5.1.1 Socio-Demographics

The socio-demographic data of the sample is compared to results of the 2005-2009 American Community Survey (ACS) for Seattle Washington, Portland Oregon, and San Francisco California (U.S. Census Bureau, 2010) (Table 5). Demographic differences between the sample and the general population in the three targeted cities were detected for gender, age, education, and household income. Additionally, 66.9% of the respondents were females, while the genders were equally distributed in the population. The age range of the sample was higher than in the Census Bureau data, with more people between the ages 45-54 (20.5% vs. 16.7%) and ages 55-64 (25.4% vs. 13.0%). The overall education level of the sample was also much higher, with 13.6% of respondents with an Associate degree (vs. 6.1% in the population), 37.6% with a Bachelor degree (vs. 30.3%), and 31.0% with a Graduate degree or higher (vs. 18.8%).[52] Subsequently, the sample earned a higher household income than the population; most respondents had a household income of over USD $50,000 and there were very few low

[50] 400 respondents indicated that they only ate salmon at home, while 1977 respondents indicated that they ate salmon at home and in restaurants. This shows that the restaurant market for salmon is also quite large (~78%), but the at-home salmon market is slightly larger based on our data. This is an interesting finding as there is currently no study comparing the sizes of the at-home and in-restaurants markets.

[51] Erratic choice behavior can be a result of the individuals' tendency to rush through a survey without thought or effort to obtain completion rewards and/or protect votes from individuals who refuse to give the correct answer for reasons unknown to the researcher.

[52] An Associate degree is the equivalent to a college diploma in Canada.

income households, defined as households with incomes less than USD $24,999 (5.7% in the sample vs. 22.3% in the population).

Table 5. Demographic Characteristics of the Sample Compared to the General Population of Seattle, Portland and San Francisco (U.S. Census Bureau, 2010)

	Total Sample			ACS (2005-09)
	Mean	Std. Dev	Freq %	%
Place of Residence				
Seattle, WA	N/A	N/A	35.4%	-
Portland, OR			30.0%	-
San Francisco, CA			34.6%	-
Gender				
Female	N/A	N/A	66.9%	50.0%
Male			33.1%	50.0%
Age				
19	N/A	N/A	0.6%	2.5%
20 – 24			4.1%	8.2%
25 – 34			21.3%	25.6%
35 – 44			14.9%	19.7%
45 – 54			20.5%	16.7%
55 – 64			25.4%	13.0%
65+			13.2%	14.5%
Education				
Elementary / Middle School Graduate (grades 1 – 8)	N/A	N/A	0.0%	11.4%
High School Graduate (grades 9 – 12)			17.8%	33.4%
Associate's Degree			13.6%	6.1%
Bachelor's Degree			37.6%	30.3%
Graduate, Post-doctoral, or Professional Degree			31.0%	18.8%
Household Income				
Less than $24,999	N/A	N/A	5.7%	22.3%
Between $25,000 to $34, 999			7.3%	8.7%
Between $35,000 to $49,999			10.8%	12.3%
Between $50,000 to $74,999			21.0%	16.8%
Between $75,000 to $99,999			18.9%	11.9%
Between $100,000 to $149,999			21.3%	14.0%
Between $150,000 to $199,999			8.8%	6.3%
$200,000 or more			6.0%	7.7%
Average Household Size	2.46	1.327	N/A	2.25
Average number of people under 18 years of age per household	0.38	0.812	N/A	N/A

The differences in socio-demographic characteristics between the sample and the population can be explained by the nature of the survey. I intentionally targeted primary and secondary grocery shoppers, which may explain some of the gender and age differences. Online surveys tend to attract respondents who are frequent Internet users, which may explain the higher education and income. Differences may also be a reflection of membership in the Research Now panel database. Research Now uses an "invitation-only recruitment methodology to invite pre-validated individuals to participate in [their] Consumer and Business Panels", invited members tend to represent a more affluent clientele (Research Now, 2010). Finally, I targeted salmon consumers, which may explain some of the differences in demographic characteristics between the sample and the population.

5.1.2 Consumption Frequencies and Characteristics

On average, respondents consumed salmon 12.26 times at home and 6.01 times in a restaurant during the last 12 months. Most respondents recalled the amount they purchased the last time they bought salmon for home consumption, which was, on average, 2.12 lbs per household. Fewer respondents were able to recall the purchase price, but those who responded indicated an average purchase price of USD $9.35/lb (Table 6).[53] The detailed frequency table, as well as the histograms of salmon purchase amount and price are included in Appendix G.

[53] Species was not taken into account in the average purchase price of salmon.

Table 6. Details of the Sample's Home and Restaurant Salmon Consumption in the Last 12 Months

	Unit	N[54]	Min	Max	Median	Mean	Std.Dev.
At home consumption frequency in the last 12 months	Average measure[55]	1599	1.5	52.0	9.0	12.26	13.109
In restaurant consumption frequency in the last 12 months	Average measure	1380	0.0	52.0	4.5	6.01	6.982
Last purchase amount (at home consumption)	Respondent Input	1488	0.2	33.0	2.0	2.12	2.264
Last purchase price (at home consumption)	Respondent Input	1112	0.0	30.0	8.0	9.35	4.360

Most respondents consumed at least one of the three salmon species used in the DCE, Atlantic, Sockeye or King salmon, in the last 12 months, which confirmed that they had basic knowledge about the differences among the three salmon species (Table 7).

Table 7. Percentage of Respondents who consumed Atlantic, Sockeye, and King Salmon in the Last 12 Months

	Yes		No		Don't know	
	Freq.	%	Freq.	%	Freq.	%
Atlantic salmon	1129	69.7%	383	23.7%	106	6.6%
Sockeye salmon	1157	71.3%	278	17.1%	187	11.5%
King salmon	1053	65.4%	311	19.3%	246	15.3%

5.1.3 Level of Environmental Participation

Most respondents did not actively participate in organized environmental activities (Table 8). Only 15.6% of the respondents were members of environmental organizations and only

[54] Total sample differs for each characteristic due to missing data or logic of survey (e.g. restaurant consumption frequencies are only asked to respondents who indicated that they consumed salmon in a restaurant at least once during the last 12 months).

[55] Home and restaurant consumption frequencies are coded to the average of the consumption frequencies (e.g. 3 to 6 times a year is recoded to 4.5 times).

24.9% of the respondents participated in at least one environmental activity (e.g. beach/river clean up, Earth Hour) in the last 12 months.

Table 8. Percentage of Responses to Level of Environmental Activity Participation

	Total Sample	
	Freq.	**Percent**
Attended a meeting or signed a petition aimed at protecting the environment in the last 12 months		
Yes	325	20.0%
No	1268	78.0%
Don't know	32	2.0%
Contributed to an environmental organization in the last 12 months		
Yes	366	22.5%
No	1233	75.7%
Don't know	29	1.8%
Participated in environmental activities in the last 12 months		
Yes	405	24.9%
No	1207	74.2%
Don't know	15	0.9%
Member of an environmental organization[56]		
Yes	255	15.6%
Active	*94*	*36.9%*
Inactive	*152*	*59.6%*
Not sure	*9*	*3.5%*
No	1365	83.7%
Don't know	10	0.6%

I analyzed respondents' level of participation in environmental activities further with a Two-Step Cluster Analysis (explained in Chapter 4.6.1). Three clusters were detected - the regular contributors, the limited participants, and the uninterested individuals. The regular contributors represented 15.6% of the sample and were members of and/or contributed to environmental organizations and attended a meeting or signed a petition aimed at protecting the

[56] The respondents' status of membership was asked if they indicated that they are a member of an environmental organization. The result to this question was not a significant factor in the cluster analysis.

environment in the last year. The limited participants represented 30.7% of the sample and were individuals who participated in environmental activities (e.g. Earth Hour, beach/river clean-ups) in the last 12 months, but were not members of nor contributed to environmental organizations. The uninterested individuals, who represented 53.7% of the sample, did not participate in any environmental activities whatsoever. Comparisons of the socio-demographic characteristics of the clusters revealed that there were significantly higher percentages of individuals between 45-64 years old among the regular contributors, higher percentages of individuals between 20-44 years old among the limited participants, and higher percentages of individuals between 25-34 and above 65 years old among the uninterested individuals compared to the other clusters. The regular contributors also tended to have higher education levels and belonged to smaller households compared to the other two clusters. The demographics distribution of the clusters is included in Appendix H.

5.1.4 Perceived Consumer Effectiveness

Perceived Consumer Effectiveness (PCE) measures the respondent's perceived ability to have an impact on environmental problems and solutions with their purchase behaviors (Antil, 1978). I asked three questions to understand the level of PCE of each respondent. Responses were based on a scale of 1 to 5, where 1 = "Strongly disagree", 2 = "Disagree", 3 = "Undecided", 4 = "Agree", and 5 = "Strongly agree". The average respondent agreed that he/she considers his/her impact on the environment when he/she buys products, disagreed that a person cannot have any effect upon pollution and natural resource problems, and agreed that each consumer's behaviour can have a positive effect on society by purchasing products sold by socially responsible companies (Table 9). Further information is presented in Appendix I.

Table 9. Perceived Consumer Effectiveness (PCE) based on the Level of Agreement with Statements. Rating scale: 1 (Strongly disagree) to 5 (Strongly agree)

Statement	Sample Mean
When I buy products, I usually try to consider how my use of them will affect the environment and other consumers.	3.74 N = 1631
Since one person cannot have any effect upon pollution and natural resource problems, it doesn't make any difference what I do.*	1.73 N = 1625
Each consumer's behaviour can have a positive effect on society by purchasing products sold by socially responsible companies.	4.20 N = 1631

*This statement was asked in a negative way - the more the person disagrees (the lower the score) meant that the person perceived higher consumer effectiveness.

The respondent's level of PCE was represented by the summation of the responses to the three statements.[57] The mean PCE level of the sample was 12.18 (*SD* = 1.913). The frequency distribution of the PCE levels is illustrated in Appendix J. Correlation between the PCE scores and the environmental participation clusters was detected and revealed that the regular contributors had a significantly higher average PCE score than the other two clusters; while the limited participants had a significantly higher mean PCE score than the uninterested individuals (Table 10).

Table 10. Comparison of the PCE Scores across the Environmental Participation Clusters

	Total	Regular Contributors n=255 (A)	Limited Participants n=500 (B)	Uninterested n=876 (C)	Sig. Level
PCE score	12.18	13.21 **B C**	12.71 **C**	11.59	<0.001

Note: Results of the comparison of column means were based on the one-way between subjects analysis of variance (ANOVA) test. The Brown-Forsythe test and Dunnett's T3 post hoc procedure were used for the remaining items, as the Levene's test indicated that the variable's variances were not equal. For each significant pair, the key of the smaller category (A, B, or C) appears under the category with the larger mean.

[57] Responses to statement 2 were re-coded so that the higher the number, the stronger the PCE. The range of the summation of the PCE scores is 3 to 15. Zeros were possible as some respondents may skip the questions; however, all 1712 respondents responded to the three PCE questions so the lowest score seen is 3.

5.2 Attitudes toward Salmon Aquaculture

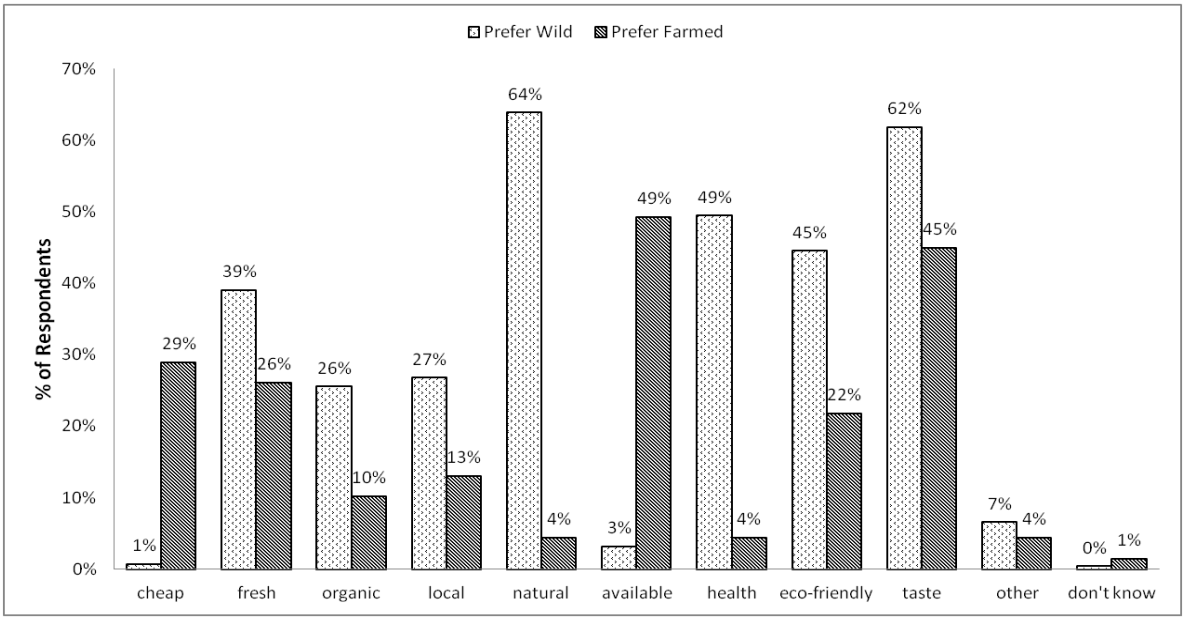
In order to understand the different products presented in the DCE, respondents needed to know the difference between farmed and wild salmon, the environmental concerns of conventional salmon aquaculture, and the two different sustainable technologies evaluated in this study. I presented definitions of farmed and wild salmon to the respondents and asked them if they were aware of the distinctions before the survey; 92.4% of the respondents said they were familiar, 5.4% said they were not familiar, and 2.2% said they were not sure. When asked to estimate the percentage of farmed salmon they consumed, 16.4% and 40.2% of respondents said they did not know how much of the salmon they consumed at home and in restaurants was farmed, respectively; while 25% and 18% of respondents indicated that none of the salmon they ate at home and in restaurants was farmed, respectively. Those who said they consumed farmed salmon at home indicated that, on average, 37% of the salmon they consumed at home was farmed and 32% of the salmon they consumed in restaurants were farmed. Previous findings for the 2000-04 period indicated that two-thirds of the salmon consumed in the US is farmed (Knapp, Roheim, & Anderson, 2007). The sample's underestimation may indicate a lack of true knowledge of farmed salmon products' penetration in the market. The frequency distributions of the respondents' estimation of farmed salmon consumption are presented in Appendix K. While I asked the respondents to estimate their level of farmed salmon consumption in restaurants, only the WTP for salmon purchased for home consumption was analyzed in the DCE.

5.2.1 Preference for Wild and Farmed Salmon

When asked about their preferences for either wild or farmed salmon, 64.6% of the respondents indicated that they prefer wild over farmed salmon, 4.2% preferred farmed over

wild salmon, 28.9% had no strong preference, and 2.3% indicated “don’t know”. Respondents who indicated a preference for either type of the salmon were asked to select reasons for their preferences. The respondents who preferred wild salmon believed that wild salmon were more natural, more healthy, more eco-friendly and tasted better than farmed salmon, while other respondents who preferred farmed salmon because they believed that farmed salmon is more available, tastes better, and is cheaper (Figure 5). Moreover, respondents could also specify their own reasons; those who specified reasons for preference toward wild salmon were concerned about salmon farming’s environmental problems, while those who specified reasons for preference toward farmed salmon believed that the consumption of wild salmon leads to wild stock depletion and overfishing.

Figure 5. Respondents’ Reasons for Preferring Wild or Farmed Salmon



5.2.2 Awareness of Salmon Aquaculture Methods

I asked respondents if they were aware of the environmental concerns of conventional salmon aquaculture presented in common media. While 45.2% of the respondents said they knew about the environmental concerns of salmon aquaculture, more than half of the respondents (51.9%) indicated that they were not aware, while the remainder (2.9%) were not sure if they knew about the environmental concerns. The awareness of IMTA and CCA were both low, but more respondents had heard of CCA (20.2%) than IMTA (7.0%). Additionally, 75.1% and 89.4% of the respondents had not heard of CCA or IMTA, respectively. Some respondents also said they were not sure if they had heard of the technologies (4.7% for CCA and 3.6% of IMTA).

5.2.3 Attitudes toward IMTA and CCA

The sample was split in two ways, first to allow for a differing sequence of technology descriptions (IMTA first or CCA first) and second to offer different descriptions of the technologies (favorable or balanced). As a result, I analyzed the sample aggregately and then compared the results across the four resulting segments (Table 11).[58]

Table 11. Treatments in the Splitting of the Sample

	Sequence Split	Description Split	# of Respondents
Segment 1	IMTA first	Favorable	397
Segment 2	IMTA first	Balanced	417
Segment 3	CCA first	Favorable	406
Segment 4	CCA first	Balanced	411

[58] Note that the common set split is not considered in this section because the two different common sets are not shown until the DCE, which is after this section of the survey.

Respondents were asked to express their attitudes toward IMTA and CCA immediately after each technology was presented. The responses were coded on a scale of 1 to 5, where 1 = “Very negative”, 2 = “Somewhat negative”, 3 = “Indifferent”, 4 = “Somewhat positive”, 5 = “Very positive”, and “Don’t know” is coded as a missing response. The percentage distribution by response is displayed in Appendix L. A paired sample t-test showed that the total sample felt significantly more positive towards IMTA (M = 3.68, SD = 0.965) than CCA (M = 3.15, SD = 1.109), $t(1350) = 16.753$, $p < 0.05$, $d = 0.46$. Results showed that the total sample felt more positively toward IMTA than CCA (Table 12).

Table 12. Attitudes towards IMTA and CCA using the Full Sample and the Segments (See Table 11) based on a Rating Scale of 1 (Very negative) to 5 (Very positive)

	Total Sample	Segment 1 (A)	Segment 2 (B)	Segment 3 (C)	Segment 4 (D)	Sig. Level
Attitudes toward IMTA	3.68 (3.63 - 3.73) n = 1421	3.86 (3.77 - 3.95) n = 344 **B D**	3.59 (3.50 - 3.69) n = 361	3.88 (3.78 - 3.98) n = 361 **B D**	3.40 (3.29 - 3.50) n = 355 **B**	<0.001
Attitudes toward CCA	3.15 (3.09 - 3.21) n = 1428	3.14 (3.02 - 3.25) n = 352 **B**	2.88 (2.77 - 3.00) n = 364	3.50 (3.39 - 3.60) n = 358 **A B D**	3.09 (2.97 - 3.21) n = 354	<0.001

*Sample sizes for each segment and total sample were different due to missing responses.
Results of the comparison of column means are based on the one-way between subjects analysis of variance (ANOVA) test. The Tukey's post hoc procedure assuming equal variances (0.05 significance level) was used for attitudes toward CCA. The Brown-Forsythe test and Dunnett's T3 post hoc procedure were used for attitudes toward IMTA, as the Levene's test indicated that the variable's variances were not equal. For each significant pair, the key of the smaller category (A, B, C or D) appears under the category with the larger mean.

The attitudes toward IMTA varied by segments, $F(3,1417) = 21.490$, $p < 0.05$, $\eta^2 = 0.04$. Brown-Forsythe's post hoc procedure indicated that those who saw the "favorable IMTA, favorable CCA" descriptions (Segment 1, M = 3.86, SD = 0.883) or the "favorable CCA, favorable IMTA" descriptions (Segment 3, M = 3.88, SD = 0.938) felt significantly more positive toward IMTA than those who saw the "balanced IMTA, balanced CCA" descriptions (Segment 2, M = 3.59, SD = 0.921) or the "balanced CCA, balanced IMTA" descriptions (Segment 4, M =

3.40, *SD* = 0.999). Segment 2 also felt significantly more positive toward IMTA than Segment 4. However, there were no significant differences between Segments 1 and 3.

The attitudes toward CCA also varied by segments, $F(3,1424) = 19.843$, $p < 0.05$, $\eta^2 = 0.04$. The Tukey's post hoc procedure indicated that those who saw the "favorable IMTA, favorable CCA" descriptions (Segment 1, *M* = 3.14, *SD* = 1.098) felt significantly more positive toward CCA than those who saw the "balanced IMTA, balanced CCA" descriptions (Segment 2, *M* = 2.88, *SD* = 1.105), while their attitudes toward CCA were not significantly different than the "balanced CCA, balanced IMTA" segment (Segment 4, *M* = 3.09, *SD* = 1.105). On the other hand, those who saw the "favorable CCA, favorable IMTA" descriptions (Segment 3, *M* = 3.50, *SD* = 1.031) felt significantly more positive toward CCA than all of the other three groups. Lastly, those in Segments 2 and 4, who saw the balanced descriptions, did not show any significant difference between their attitudes toward CCA.

Differences in attitudes can also be found when the sample splitting exercises are analyzed separately. An Independent Sample t-test was used to analyze correlation between the type of descriptions presented (e.g. favorable or balanced) and the attitudes. Those who saw the favorable description (*M* = 3.87, *SD* = 0.911) had significantly more favorable attitudes toward IMTA than those who saw the balanced description (*M* = 3.50, *SD* = 0.964), $t(1419) = 7.51$, $p < .05$, $d = 0.40$. Similarly, those who saw the favorable description (*M* = 3.32, *SD* = 1.079) also had significantly more favorable attitudes toward CCA than those who saw the balanced description (*M* = 2.99, *SD* = 1.109), $t(1426) = 5.737$, $p < .05$, $d = 0.30$. Appendix M shows a graphical representation of the differences in means between the two groups.

Differences in attitudes from the sequence split (e.g. IMTA first or CCA first) was also examined with an Independent Sample t-test. Attitudes towards IMTA was not affected by the

sequence split (two-tailed $p = 0.099$). However, those who saw the CCA descriptions first ($M = 3.29$, $SD = 1.087$) had significantly more favorable attitudes toward CCA than those who saw the IMTA descriptions first ($M = 3.01$, $SD = 1.108$), $t(1426) = -4.933$, $p < .05$, $d = 0.26$. Since each attitudinal question was asked immediately after each description was presented (i.e. before the respondents read about the other technology), the respondents who had basic knowledge of IMTA as presented in the survey were much less favorable toward CCA than those who did not know about IMTA. Attitudes toward IMTA, on the other hand, were not affected by knowledge about CCA.

In summary, the comparisons of the attitudes toward both technologies across the four segments revealed that the differing sequences of the technology presentation affected the sample's attitude toward CCA, while the different types of description for both technologies led to different attitudinal results. Specifically, individuals who saw the favorable descriptions had a more positive attitude toward both technologies than those who saw the balanced descriptions. Finally, all segments had more positive attitudes toward IMTA than CCA, which corresponded to the more positive attitude toward IMTA than CCA in the aggregate sample.

5.2.4 Preference toward IMTA or CCA

After being exposed to both the IMTA and CCA descriptions, I asked the respondents which technology they would prefer to see adopted if only one was to be adopted for salmon farming. Responses were coded from -2 to 2, where -2 = "Much more prefer CCA", -1 = "Somewhat prefer CCA", 0 = "Indifferent", 1 = "Somewhat prefer IMTA", and 2 = "Much more prefer IMTA". "I don't know" was coded as missing. For the aggregate sample, IMTA was preferred to CCA ($M = 0.45$) (Table 13). The percentage distribution by response is illustrated in Appendix N.

The preference toward IMTA or CCA varied by segments, $F(3,1422) = 3.467$, $p < 0.05$, $\eta^2 = 0.01$. Tukey's post hoc procedure indicated that those who saw the "favorable IMTA, favorable CCA" descriptions (Segment 1, $M = 0.57$, $SD = 1.037$) significantly preferred IMTA more than those who saw the "balanced CCA, balanced IMTA" descriptions (Segment 4, $M = 0.32$, $SD = 1.046$). There was no other significant difference found between segments 1 or 4 with those who saw the "balanced IMTA, balanced CCA" descriptions (Segment 2, $M = 0.43$, $SD = 1.055$) or the "favorable CCA, favorable IMTA" descriptions (Segment 3, $M = 0.47$, $SD = 1.014$). Although there were slight differences among the groups, all four segments preferred IMTA more than CCA. The frequency distribution of the responses is illustrated in Appendix O.

Table 13. Preference towards IMTA or CCA using the Full Sample and the Segments (See Table 11) based on a Rating Scale of -2 (Much more prefer CCA) to 2 (Much more prefer IMTA)

	Total Sample n = 1426	Segment 1 n = 353 (A)	Segment 2 n = 365 (B)	Segment 3 n = 358 (C)	Segment 4 n = 350 (D)	Sig. Level
Technology Preference	0.45 (0.39 - 0.50)	0.57 (0.46 - 0.68) **D**	0.43 (0.32 - 0.54)	0.47 (0.36 - 0.57)	0.32 (0.21 - 0.43)	0.016

*Responses based on scale of -2 to 2; -2 = Much more prefer CCA, -1 = Somewhat prefer CCA, 0 = Indifferent, 1 = Somewhat prefer IMTA, 2 = Much more prefer IMTA; Don't knows are coded as missing.
Figures in parentheses are the lower and upper bounds based on a 95% confidence interval for the mean.
Results of the comparison of column means were based on the one-way between subjects analysis of variance (ANOVA) test. The Tukey's post hoc procedure assuming equal variances (0.05 significance level) was used. For each significant pair, the key of the smaller category (A, B, C or D) appears under the category with the larger mean.

Independent Sample t-test results indicated that respondents who saw the favorable description ($M = 0.52$, $SD = 1.026$) are significantly more inclined to choose IMTA as their preferred salmon farming method than those who saw the balanced description ($M = 0.38$, $SD = 1.052$), $t(1424) = 2.594$, $p < .05$, $d = 0.14$. Similarly, respondents who saw the IMTA descriptions first ($M = 0.50$, $SD = 1.048$) were significantly more inclined to choose IMTA than those who saw CCA first ($M = 0.40$, $SD = 1.032$), $t(1424) = 1.872$, $p < .05$, $d = 0.10$. However, all groups were generally more inclined to choose IMTA.

Each respondent who expressed a preference for either IMTA or CCA indicated their reasoning in their responses to a follow-up question. Ten options were provided to the respondents based on the descriptions of the technologies and each reason was carefully scrutinized to ensure no new information was introduced.[59] Most respondents who preferred IMTA believed it was "more natural" (70% of respondents), "more environmentally friendly" (60%), "more sustainable" (49%), and "more effective in addressing conventional salmon aquaculture issues" (45%) than CCA. Out of the 23 respondents who specified another reason, eight stated that they believed IMTA is a more humane way to raise fish and five stated that they believed IMTA is more cost-effective compared to CCA. The most popular reasons for preference toward CCA were that it was "more effective in addressing conventional salmon aquaculture issues" (56%), "more environmentally friendly" (54%), and that "it separates farmed salmon from the marine environment" (48%). Four out of the ten respondents who specified other reasons stated that they preferred CCA because the farmed salmon is separated from natural habitats and thus marine pollution would not affect the salmon they eat. The percentage of respondents by reason for preference toward IMTA/CCA is provided in Appendix P.

Finally, all respondents were asked to indicate whether they agreed that "a more sustainable option for salmon farming should be adopted even if it may be more expensive" after they completed the DCE. Responses were based on a scale of 1 to 5, where 1 is "Strongly disagree" and 5 is "Strongly agree". The mean response was 3.74, which meant that the average respondent agreed to the adoption of a more sustainable salmon farming method even if it is more expensive. The percentage of respondents by response is presented in Appendix Q.

[59] Eight specific reasons, an "other, please specify" selection, and "I don't know". See Appendix D Questions C7 and C6 for details.

5.2.5 Willingness to Increase Salmon Consumption

After the DCE, respondents were asked if they would increase their home consumption of farmed salmon if IMTA and CCA salmon were widely available at the same price as conventionally farmed salmon. Results revealed that 38.4% of the respondents would buy more farmed salmon, 31.1% would not buy more, and 30.5% were unsure as to whether or not they will purchase more farmed salmon for home consumption. The respondents who said they would buy more farmed salmon indicated that they would, on average, purchase farmed salmon 5.87 times more often in a period of 12-months (median = 4.00). The frequency distribution and percentage of respondents by response are presented in Appendix R.

5.3 Principal Component Analysis

A Principal Component Analysis was performed based on the importance of nine factors that influence salmon purchase decisions. Each factor was rated from 1 to 5, where 1 is “Not at all important” and 5 is “Extremely important”. Qualities affecting consumption experience (e.g. freshness & smell, taste & texture) are the most important factors, while price was rated as the fifth most important purchase factor (Table 14).

Factors that reflect the environmental impacts of the salmon (e.g. certification, and salmon species) were rated as the least important. The frequency distributions by response for each factor are presented in Appendix S.

Table 14. Factors Influencing Salmon Purchase Decisions – Aggregated Survey Results; Ranked from Highest to Lowest by Mean Responses using a Rating Scale: 1 (Not at all important) to 5 (Extremely important)

	Rank	Mean	Median	Std. Dev.
Fresh & Smell	1	4.82	5	0.486
Taste & Texture	2	4.68	5	0.569
Color of meat	3	4.20	4	0.855
Health & Nutritional Content	4	4.02	4	0.910
Price	5	3.99	4	0.875
Origin & Source	6	3.97	4	1.032
Availability & Seasonality	7	3.89	4	0.904
Environmental Certification	8	3.56	4	1.126
Salmon species	9	3.45	3	1.062

The PCA identified three main components from the nine purchase factors which explained a cumulative variance of 62.005% (Table 15). Component 1 was the credence attribute category, which included five factors that did not affect the experiential quality of salmon. Component 2 was the experiential attribute category, which included three factors that affected the salmon consumption experience. The last component was the price variable of the salmon (Table 16).

Table 15. Eigenvalues from the Principle Component Analysis (PCA) based on Nine Purchase Factors

Component	Initial Eigenvalues Total	% of Variance	Cumulative %
1	3.15	34.96	34.96
2	1.34	14.84	49.80
3	1.10	12.21	62.01
4	.78	8.62	70.63

Table 16. Rotated Component Loading from the PCA

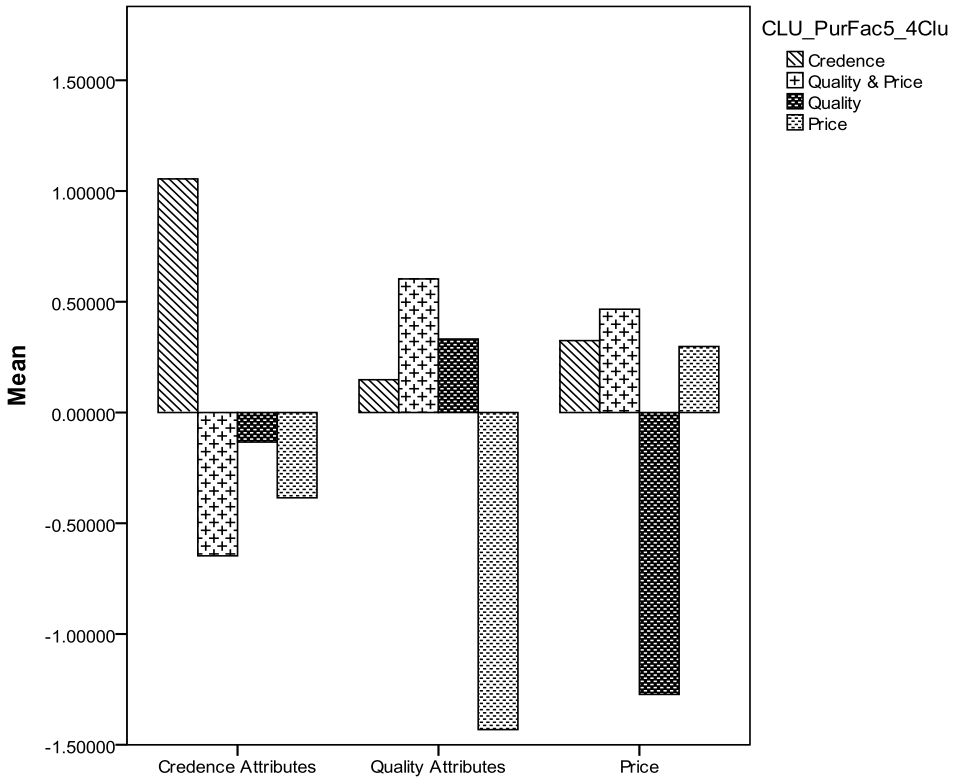
Attribute Category	Factor	Component		
		1	2	3
Credence	Origin & source	.847	.113	-.118
	Eco-certification	.790	.058	-.016
	Salmon species	.710	.136	.071
	Health & nutritional content	.592	.169	.209
	Availability & seasonality	.579	.208	.417
Experiential	Freshness & smell	.138	.850	-.068
	Taste & texture	.101	.829	.016
	Color of meat	.189	.523	.306
Price	Price	.009	.007	.928

5.3.1 Hierarchical Cluster Analysis

A Hierarchical Cluster Analysis was used to group each respondent based on the PCA results. The optimal solution of four clusters was identified by visually examining the dendrogram resulting from the analysis. Each cluster had one or two dominant principal components that they identified as most influential in their salmon purchase decisions and were thus named accordingly (Figure 6):

- Cluster 1: Credence group (n = 458, 28.1%)
- Cluster 2: Quality & Price group (n = 473, 29.0%)
- Cluster 3: Quality group (n = 368, 22.6%)
- Cluster 4: Price group (n = 332, 20.4%)

Figure 6. Mean Importance of Principal Components by Cluster based on Factor Scores from PCA



5.3.2 Description of the Clusters derived from the Cluster Analysis

The clusters were characterized by their demographic and salmon consumption characteristics and their Perceived Consumer Effectiveness (PCE) scores (Table 17). Significant differences among clusters were found for the price of salmon paid by the respondent in their last purchase and the level of the PCE for the respondent. The demographic distributions of the PCA clusters are illustrated in Appendix T.

Table 17. Salmon Consumption Frequencies, Purchase Details, and PCE scores by clusters

	Credence n=458 (A)	Quality & Price n=473 (B)	Quality n=368 (C)	Price n=332 (D)	Chi-Square
Home consumption frequency*	12.11	12.89	12.39	11.65	0.589
Restaurant consumption frequency	6.04	6.06	6.18	5.76	0.881
Salmon purchase amount (lb)*	2.19	2.07	1.99	2.22	0.490
Salmon purchase price ($/lb)	9.62 **D**	9.09	10.20 **B D**	8.39	<0.001
PCE score	12.87 **B C D**	11.78	12.23 **B D**	11.76	<0.001

Note: Results of the comparison of column means are based on the ANOVA test. The Tukey's post hoc procedure assuming equal variances (0.05 significance level) is used for * items. The Brown-Forsythe test and Dunnett's T3 post hoc procedure are used for the remaining items, as the Levene's test indicated that the variable's variances are not equal. For each significant pair, the key of the smaller category (A, B, C or D) appears under the group with the larger mean.

Cluster 1: Credence group

Since individuals in cluster 1 were much more concerned about the credence attributes than the experiential and price attributes of the fish, they were labelled the “Credence group”. They were more concerned about the origin, existence of eco-certification, and health & nutritional values of the salmon they purchased than the other three groups. Most individuals in this cluster were 55-64 years old (29.5%) and had a household income of $100,000 to $149,999 (22.7%). They consumed salmon approximately once a month at home (12.11 times) and approximately once every two months in restaurants (6.04 times) over the last year. They had the strongest belief that their consumption behavior can influence environment change in society, which was reflected in a significantly higher average PCE score than in the other clusters.

Cluster 2: Quality & Price group

Cluster 2, the “Quality & Price” group was almost equally concerned about the experiential quality and price attributes of the salmon they purchased. They indicated the lowest importance for eco-certification, origin, and salmon species as factors influencing their salmon purchase decisions. Most individuals in this cluster were either 25-34 years old (22.4%) or 55-64 years old (24.1%), and typically had a Bachelor’s degree (38.9%) and a household income of $50,000 to $74,999 (23.7%). They consumed salmon the most frequently at home among all four groups (12.89 times), and 6.06 times in restaurants over the last 12 months.

Cluster 3: Quality group

Individuals in the “Quality” group were more concerned with the experiential quality of the salmon and the least concerned about the price. Most individuals in this group were 55-64 years old (25.3%) with a household income of $100,000 to $149,999 (22.3%). They consumed salmon approximately 12.39 times at home and 6.18 times in restaurants in the past year (the most often among the four clusters). They purchased the least amount of salmon per meal (average 1.99 lbs) with a significantly higher purchase price (USD $10.20/lb), compared to the rest of the clusters. Finally, cluster 3 had a significantly higher PCE score than clusters 2 and 4, and a significantly lower PCE score than cluster 1.

Cluster 4: Price group

Cluster 4, the “Price” group, was the most concerned about the price and the least concerned about the experiential quality of the salmon they purchased. Individuals in the Price group were typically 25-34 years old (27.4%) with a household income of either $50,000 to $74,999 (20.2%) or $100,000 to $149,999 (21.1%). They consumed salmon least often during

the last 12 months, compared to the other clusters, at 11.65 times at home and 5.76 times in restaurants. On average, they purchased more salmon per meal (2.22 lbs) and paid a lower average price (USD $8.39/lb) compared to the other groups. Finally, cluster 4 had the lowest PCE score among all the clusters.

These clusters were used as *a priori* segments (known class analysis in Latent Gold) but were also used separately as covariates in the DCE analysis, which provided more insights into the characteristics of the latent classes identified in the next section.

5.4 DCE Results

The DCE was analyzed with Latent Gold by Nina Mostegl, who provided the results for the analysis. I explored the data using known class analysis based on the clusters, environmental participation clusters, segments from the sample splitting exercises, and other socio-demographic information. However, none of the known class analyses yielded encouraging results. Therefore, I continued using the LCA and I estimated the WTP for the aggregate sample and for each latent class. This section begins with the part-worth utility results of the LCA model, followed by the descriptions of the latent classes using the part-worth utilities for each attribute level. The section concludes with the WTP estimates for production technologies and eco-certification.

Results of the LCA for 1 to 5 classes confirmed the presence of heterogeneous preferences in the sample.[60] While the 4 and 5-class models had lower BIC, AIC, and AIC3 results, they generated unstable results and were discarded. Hence, the 3-class model was

[60] Interaction effects were explored in the LCA but minimal benefits to explanatory power was found. I concluded that the linear 3-class without interaction model was the best fit model in my analysis.

determined to be the best-fit model for the data as it had the lowest BIC, AIC, and AIC3 statistics amongst the stable models (Table 18). The $R^2(0)$ and R^2 confirmed the goodness-of-fit for the 3-class model, as estimates between 0.2 and 0.4 are indicative of a good model fit (Louviere, Hensher, & Swait, 2000).[61]

Table 18. Results of the Goodness-of-Fit Tests for the Latent Class Analysis based on the 1 to 5 Class Models

	LL	BIC(LL)	AIC(LL)	AIC3(LL)	$R^2(0)$	R^2
1-class	-15338.31	30817.1671	30714.6250	30733.6250	0.1467	0.1311
2-class	-13678.25	27689.3704	27446.5077	27491.5077	0.3118	0.2988
3-class	-13224.30	26973.7896	26590.6063	26661.6063	0.3631	0.3511
4-class	-12876.57	26470.6353	25947.1313	26044.1313	0.3940	0.3826
5-class	-12630.75	26171.3331	25507.5084	25630.5084	0.4256	0.4148

5.4.1 Part-Worth Utility Results

In the 3-class model, 45% (n=727) of the respondents belonged to the first class, 29% (n=472) to the second class, and 26% (n=432) to the third class.[62] The estimated coefficients of all attributes were significant at the 5% level, while significant differences among latent classes were found with the coefficients of the following attributes: salmon species, the production methods of Atlantic and King salmon, eco-certification for Sockeye salmon, the origin of Sockeye and King salmon, and the prices of all three species.

[61] R^2 and $R^2(0)$ are the rho-squared and pseudo-rho-squared, respectively.

[62] The part-worth utility results of the 3-class model are presented in Table 19 and graphically illustrated in Appendix V. The 1-class model results are presented in Appendix U to provide the option for comparison to the 3-class model. All attributes, except for the price, were coded as categorical variables, while the price attribute was coded as a numeric variable and the intercept was dummy-coded.

Table 19. Part-Worth Utility Estimates based for the Latent Class Model (3-Class Solution) for the latent classes by Salmon Species

	Wild salmon lovers n=727	Price-sensitive consumers n=472	Sustainably farmed salmon supporters n=432	Wald p-value	Wald(=) p-value
Atlantic Salmon	-1.8985 (0.0883)*	0.3364 (0.0829)*	0.6079 (0.0478)*	<0.001	<0.001
Production Method					
Conventional	-0.4502 (0.1556)*	-0.284 (0.0799)*	-0.0345 (0.0637)	<0.001	<0.001
IMTA	0.8572 (0.1272)*	0.3004 (0.0676)*	0.1138 (0.0538)**		
CCA	-0.407 (0.1672)**	-0.0163 (0.0868)	-0.0792 (0.0617)		
Eco-certification					
No	-0.342 (0.0864)*	-0.1106 (0.0545)**	-0.1987 (0.0409)*	<0.001	0.087
Yes	0.342 (0.0864)*	0.1106 (0.0545)**	0.1987 (0.0409)*		
Origin					
Canada	0.1705 (0.1323)	0.3706 (0.0847)*	0.1043 (0.0693)	<0.001	0.110
USA	0.8915 (0.1213)*	0.4688 (0.0927)*	0.7942 (0.0696)*		
Chile	-0.9074 (0.1717)*	-0.5297 (0.0851)*	-0.6401 (0.0768)*		
Norway	-0.1545 (0.1769)	-0.3097 (0.0964)*	-0.2585 (0.071)*		
Price	-0.2857 (0.0899)*	-1.1638 (0.0756)*	-0.3907 (0.0469)*	<0.001	<0.001
Sockeye Salmon	2.0518 (0.0602)*	0.8409 (0.0679)*	-0.9071 (0.063)*	<0.001	<0.001
Eco-certification					
No	-0.0297 (0.0311)	0.1677 (0.0485)*	-0.3016 (0.0721)*	<0.001	<0.001
Yes	0.0297 (0.0311)	-0.1677 (0.0485)*	0.3016 (0.0721)*		
Origin					
Canada	-0.245 (0.0307)*	0.1341 (0.0487)*	-0.2023 (0.0708)*	<0.001	<0.001
USA	0.245 (0.0307)*	-0.1341 (0.0487)*	0.2023 (0.0708)*		
Price	-0.5233 (0.0318)*	-1.0302 (0.058)*	-0.1987 (0.0674)*	<0.001	<0.001
King Salmon	-0.1534 (0.0519)*	-1.1773 (0.105)*	0.2992 (0.0467)*	<0.001	<0.001
Production Method					
Wild	1.9777 (0.0786)*	-0.0535 (0.1669)	-1.0207 (0.1004)*	<0.001	<0.001
Conventional	-0.9367 (0.1043)*	-0.0317 (0.1604)	0.3112 (0.0748)*		
IMTA	0.0844 (0.0745)	0.2172 (0.1442)	0.363 (0.0729)*		
CCA	-1.1254 (0.1002)*	-0.132 (0.1717)	0.3464 (0.0723)*		
Eco-certification					
No	-0.1027 (0.0424)**	-0.2345 (0.0741)*	-0.0978 (0.0431)**	<0.001	0.270
Yes	0.1027 (0.0424)**	0.2345 (0.0741)*	0.0978 (0.0431)**		
Origin					
Canada	-0.2789 (0.049)*	0.1256 (0.1163)	-0.2536 (0.0446)*	<0.001	<0.001
USA	0.2789 (0.049)*	-0.1256 (0.1163)	0.2536 (0.0446)*		
Price	-0.523 (0.0374)*	-1.3511 (0.0917)*	-0.5239 (0.0374)*	<0.001	<0.001
Intercept	-0.0664 (0.0734)	0.2223 (0.1689)	0.1524 (0.0819) ***	<0.001	<0.001

* Significantly different from a parameter estimate of 0 at the 1% level

** Significantly different from a parameter estimate of 0 at the 5% level

*** Significantly different from a parameter estimate of 0 at the 10% level

( ) represents standard error

Significance of coefficients are explained by the Wald p-value, while significance between classes are explained by the Wald(=) p-value; Note: the model has been estimated as an alternative specific model by salmon species: Atlantic, Sockeye and King Salmon, estimates are organized accordingly.

While demographic characteristics are often used to explain the willingness to pay estimates, personal environmental attitudes and values are often more important predictors of environmentally friendly behavior (Saphores, Nixon, Oqunseitan, & Shapiro, 2007). As such, I included the level of environmental participation, PCA and PCE results, as covariates in the model (Table 20). The correlation between the PCA and environmental participation clusters was analyzed and the result is presented in Appendix W. The demographic distributions and correlations with other salmon consumption and attitudinal variables of the three latent classes are presented in Appendix X.

Table 20. Covariate Importance Estimates based on the Latent Class Model (3-Class Solution) for the Wild Salmon Lovers, Price-Sensitive Consumers and Sustainably Farmed Salmon Supporters by Covariates: PCA Clusters, Environmental Participation Clusters, PCE Score

		Wild salmon lovers n=727	Price-sensitive consumers n=472	Sustainably farmed salmon supporters n=432	Wald p-value
PCA of Purchase Factor– 4 Clusters	Credence	0.4544 (0.0653)*	-0.4322 (0.0891)*	-0.0222 (0.0798)	<0.001
	Quality & Price	-0.2477 (0.0635)*	0.179 (0.0717)**	0.0687 (0.0692)	
	Quality	0.1001 (0.069)	-0.2844 (0.0888)*	0.1843 (0.077)**	
	Price	-0.3068 (0.0742)*	0.5376 (0.0786)*	-0.2308 (0.0865)*	
Environmental Participation Level Clusters – 3 Clusters	Uninterested	-0.1288 (0.0554)**	0.0957 (0.0681)	0.0331 (0.066)	<0.001
	Limited participants	-0.1276 (0.0583)**	-0.0937 (0.0741)	0.2213 (0.0689)*	
	Regular contributors	0.2564 (0.0719)*	-0.002 (0.0947)	-0.2544 (0.0948)*	
PCE – total score		0.0767 (0.0217)*	-0.0351 (0.025)	-0.0416 (0.0235)***	<0.001

* Significantly different from a parameter estimate of 0 at the 1% level
** Significantly different from a parameter estimate of 0 at the 5% level
*** Significantly different from a parameter estimate of 0 at the 10% level
( ) represents standard error

Next, I discuss the characteristics of each latent class based on the results of the LCA and the covariate analysis.

Class 1: Wild Salmon Lovers

Members of class 1 (45%) were labelled as the “wild salmon lovers” because of their strong preferences for Sockeye salmon and wild King salmon. In the case of farmed Atlantic salmon, the wild salmon lovers preferred IMTA over the other production methods. Their preference toward IMTA salmon can be explained by their more positive attitude toward IMTA (M=3.41) than CCA (M=2.84). The wild salmon lovers were most concerned about the credence attributes of their salmon, which was logical as the species of fish is a credence attribute. They were also most likely to be regular contributors to environmental organizations and had significantly higher PCE scores (M=12.48) than the other two classes.

Class 2: Price-Sensitive Consumers

Class 2 (29%) was the most price-sensitive class among the three classes and, therefore, was labelled the “price-sensitive consumers”. Members of this class do not prefer King salmon, likely because King salmon is always more expensive than the other two species. The price-sensitive consumers also preferred IMTA in both King and Atlantic salmon, which was explained by their more positive attitude toward IMTA (M=3.84) than CCA (M=3.29). Logically, the price-sensitive consumers were most concerned about the price of their salmon and identified with the “price” group and slightly with the “quality & price” group. They were mostly uninterested in participating in environmental activities and had the lowest PCE score (M=11.92) among the three classes.

Class 3: Sustainably Farmed Salmon Supporters

Class 3 (26%) found greater utility in farmed salmon than wild salmon, which was opposite to that of the wild salmon lovers, who preferred Sockeye and wild King salmon. Further, class 3 was the only class to prefer eco-certification for all three species. Therefore, I labelled them as the “sustainably farmed salmon supporters”. An examination of the reasons

for their preferences for farmed salmon revealed that some respondents believed that the consumption of wild salmon contributes to wild stock depletion, which is a possible reason for this class's preference for farmed salmon. In general, members of this group preferred IMTA, which confirmed their more positive attitude toward IMTA (M=3.93) than CCA (M=3.48). Additionally, they felt significantly more positive toward IMTA and CCA compared to the other classes. The sustainably farmed salmon supporters cared more about the quality of the salmon they purchased and were more likely "limited participants" in environmental activities. They also had a lower PCE score than the wild salmon lovers and a slightly higher score than the price-sensitive consumers.

General Observations

My results also revealed other trends in the data that were worthy of further discussion. I found that eco-certification increased the utility more significantly for species that were not originally preferred. For example, the wild salmon lovers who had the lowest part-worth utility for Atlantic salmon had the highest utility for eco-certification of Atlantic salmon. The price-sensitive consumers valued King salmon the least and had the greatest utility with eco-certification of King salmon. The sustainably farmed salmon supporters had the least utility with Sockeye salmon and valued eco-certification of Sockeye the most. All three classes valued eco-certification of Atlantic and King salmon, while only the sustainably farmed salmon supporters valued eco-certification of Sockeye salmon.

In addition, all three classes preferred IMTA over CCA and conventional methods in Atlantic salmon. These results mirror the more positive attitude toward IMTA than CCA seen in the attitudinal question responses, as well as the overwhelming preference for IMTA when

respondents were asked to choose between the two technologies.[63] The wild salmon lovers and sustainably farmed salmon supporters both experienced greater utility from salmon originating from the US, indicating that they preferred to buy local salmon. On the other hand, the origin was not as important for the price-sensitive consumers, as they did not have a strong preference for either Canada or US as the origin for their Sockeye and King salmon. Finally, the price attributes approximated negative, linear relationships between utilities and prices among all species and latent classes, meaning that the utility decreases as the price of the salmon increases. This finding was theoretically valid and confirmed that the sample was choosing logically in my DCE.

5.4.2 Information Effects on Part-Worth Utility

I explored the influences on part-worth utility from the sample splitting exercises using a known class analysis. No significant difference was found between the known classes in each of the treatments, which indicated that the information treatments did not influence the actual WTP and choices substantially. While the type of technology description (favorable or balanced) affected the initial perception of the technologies, the difference in attitudes did not translate to differences in choice and part-worth utilities of the product attributes between the classes. The statistical results of each of the known class analysis are presented in Appendix Y.

5.4.3 WTP Estimates and Price Premiums for IMTA and CCA salmon

I calculated the price premiums that the respondents were willing to pay for one pound of Atlantic salmon produced by IMTA or CCA, relative to the price they were willing to pay for one pound of conventionally produced Atlantic salmon based on the 1 and 3-class models (

[63] 722 respondents (44.3%) chose IMTA while only 265 respondents (16.2%) chose CCA when asked to choose one method to replace conventional aquaculture.

Table 21). I focused on the results for Atlantic salmon as it is the primary product of the BC aquaculture industry (refer to details of the outputs of the BC aquaculture industry in Section 2.1). I also calculated the premiums that the full sample and individual latent classes were willing to pay for eco-certification of each species (Table 22). While a positive estimate indicates a premium for the attribute level, a negative WTP estimate implies that the sample or latent class is only willing to pay a lower price than the price for conventional salmon (James, Rickard, & Rossman, 2009).

Table 21. WTP Price Premiums for IMTA and CCA Produced Atlantic Salmon versus Conventionally Produced Atlantic Salmon: 1-Class and 3-Class (LCA) Model Results

Production Methods	1-Class model	3-Class model		
		Wild salmon lovers	Price-sensitive consumers	Sustainably farmed salmon supporters
IMTA	$1.07	$4.58	$0.50	$0.38
CCA	$0.43	$0.15	$0.23	-$0.11

Note: All prices expressed in USD dollar per lb of salmon

The results of the 1-class analysis revealed that the sample, as a whole, was willing to pay a premium of USD $1.07/lb for IMTA salmon and a premium of USD $0.43/lb for CCA salmon in comparison to conventionally farmed salmon. These estimates can be expressed as a price premium of 9.8% and 3.9% for IMTA and CCA Atlantic salmon, respectively, compared to conventionally produced Atlantic salmon.[64]

The 3-class model results revealed price premium differences among the three latent classes. Most notably, the wild salmon lovers were willing to pay 41.7% more for IMTA salmon at USD $4.58/lb. CCA, on the other hand, did not enjoy the same premium over conventional salmon. The price premiums for CCA Atlantic salmon were not much higher than zero in the 3-

[64] These price premium percentages are calculated as a percentage increase from the reference price of conventionally produced Atlantic salmon in my DCE (USD $10.99/lb)

class latent class model. Moreover, the sustainably farmed salmon supporters were not willing to pay a positive price premium for CCA salmon. Such results indicated that while members in this class were concerned about the environmental problems of salmon production and desired eco-certification for all species, they did not think CCA was a lot more environmentally-friendly than conventional aquaculture. Overall, IMTA salmon enjoyed a higher premium than CCA salmon from all three latent classes, which paralleled their more positive attitude toward IMTA than CCA.

With the introduction of IMTA and CCA salmon, 38.4% of the respondents indicated they would buy farmed salmon more frequently. Those who would buy more often would do so, on average, 5.87 times more per year (median = 4). These results suggest that the presence of IMTA and CCA would not substantially increase existing consumer demand for salmon.

Table 22. WTP Premiums for Eco-certification of Atlantic, Sockeye, and King Salmon: 1-Class and 3-Class (LCA) Model Results

Eco-certification for Species	1-class model	3-class model		
		Wild salmon lovers	Price-sensitive consumers	Sustainably farmed salmon supporters
Atlantic	$0.51	$2.39	$0.19	$1.02
Sockeye	$0.12	$0.11	-$0.33	$3.04
King	$0.36	$0.39	$0.35	$0.37

Note: All prices are n USD/lb

The 1-class analysis revealed that the sample as a whole was willing to pay premiums for eco-certification of all three species. The premiums for eco-certification of Atlantic, Sockeye, and King salmon were USD $0.51/lb (4.6%), USD $0.12/lb (1.0%), and USD $0.36/lb (2.3%), respectively.[65] As discussed earlier, each class enjoyed greater utility when the least preferred

[65] The percentage premiums were calculated as the percentage increase from the reference prices for each species: Atlantic at $10.99/lb, Sockeye at $11.99/lb, and King at $15.99/lb.

salmon species was certified and, therefore, was more willing to pay a higher premium for eco-certification of the species they favored the least. Specifically, the wild salmon lovers were willing to pay a premium of USD $2.39/lb for eco-certification of Atlantic salmon, the price-sensitive consumers were willing to pay a premium of USD $0.35/lb for eco-certification of King salmon, and the sustainably farmed salmon supporters were willing to pay a premium of USD $3.04/lb for eco-certification of Sockeye salmon. The significant premiums estimated for the wild salmon lovers and the sustainably farmed salmon supporters indicated greater concerns about the environmental issues related to farmed Atlantic and wild Sockeye salmon, respectively.[66] The low premiums for the price-sensitive consumers, on the other hand, were reasonable as this group was much more price-sensitive than the other classes. Finally, the price-sensitive consumers were unwilling to pay a premium for eco-certification of Sockeye salmon, which indicated that they had very few concerns about the environmental impacts of wild salmon production.

[66] The sustainably farmed salmon supporters may believe that eating wild salmon contributes to the depletion of wild salmon stock, which is also a belief common to some individuals in the society (Grescoe, 2008).

Chapter 6: Discussion

The market potential for IMTA salmon produced in BC and the policy implications related to eco-certification of these sustainable methods are discussed in this chapter. I conclude the chapter with limitations of my study and future research recommendations.

6.1 WTP Premium for Sustainably Farmed Salmon

This study addressed the current literature gap relating to the consumer perception, consumer preference, and WTP for IMTA and CCA when both technologies are presented to respondents simultaneously. WTP estimates based on my DCE results revealed that salmon consumers in the US Pacific Northwest, as a whole, were willing to pay premiums of USD $1.07/lb (9.8%) and USD$0.43/lb (3.9%) for IMTA and CCA, respectively, compared to conventionally produced Atlantic salmon.[67]

Analysis of a 3-class latent class model revealed that there were significant differences in utility between classes for IMTA and CCA, which provided additional insights for the industry. Wild salmon lovers, who represented 45% of the sample and generally preferred to purchase wild salmon, were willing to pay a premium of USD $4.58/lb (41.7%) and $0.15/lb (1.4%) for IMTA and CCA Atlantic salmon, respectively. The price-sensitive consumers, who represented 29% of the sample, were willing to pay premiums of USD $0.50/lb (4.5%) and $0.23/lb (2.1%)

[67] Percentage premiums are based on the reference price of USD $10.99/lb for conventionally produced Atlantic salmon.

for IMTA and CCA Atlantic salmon, respectively. Finally, the sustainably farmed salmon supporters, who represented 26% of the sample and preferred to purchase farmed salmon instead of wild salmon, were willing to pay the lowest premium at USD $0.38/lb (3.5%) for IMTA Atlantic salmon and would need compensation of USD $0.11/lb (1.0%) to accept CCA Atlantic salmon. Such pronounced heterogeneity among salmon consumers indicates that the salmon aquaculture industry needs to target consumer segments when marketing their products. The analysis of the latent class analysis identified specific characteristics about each class that can be used by the industry to target individual segments. For example, if the industry adopted IMTA and targeted IMTA Atlantic salmon at wild salmon lovers, they would need to reach out to individuals who are regular contributors to environmental organizations and educate them about the new products and the associated environmental benefits of IMTA.

The results of the known class analyses revealed that information treatments did not alter stated WTP, but favorable descriptions led to slightly more positive attitudes toward both IMTA and CCA. I was very explicit when describing the limitations of each technology in the "balanced descriptions", stating that "IMTA does not address escapes by farmed salmon and may not significantly reduce the infestation of wild salmon by sea lice" and that "CCA requires a significant amount of energy and could face issues related to land use and waste disposal".[68] Yet, the minimal WTP impacts from the description treatment suggested that revealing the methods' environmental limitations will not affect the perceived utility of consumers as reflected by insignificant results in the *a priori* analysis with the information treatment variables. Given these results, marketers can expect a positive reaction and premiums for IMTA salmon even when the system's limitations are explained.

[68] Impacts to the attitudes of IMTA and CCA from the description nature treatment proved that the respondents read all of the descriptions.

A comparison of the WTP estimates also revealed a higher premium for IMTA compared to CCA. All three classes identified in the latent class model were willing to pay a higher price premium for Atlantic salmon produced in IMTA than for Atlantic salmon produced in CCA. The limited premium for CCA Atlantic salmon revealed a conservative consumer attitude toward CCA. Moreover, the lack of premium for CCA suggested that any added operating costs associated with this technology might not be recouped by charging a higher price to the consumer segments identified in this study. My results of a higher premium for IMTA compared to CCA were further supported by earlier results of more positive consumer attitudes toward IMTA (Chapter 5.2.3) and a stronger preference for IMTA adoption compared to CCA (Chapter 5.2.4).

Finally, I compared my results to other WTP studies on IMTA and CCA. Barrington et al. (2008) found that participants in focus groups were willing to pay a 10% premium for labelled IMTA seafood products.[69] An attitudinal study in New York revealed that 38% of the respondents were willing to pay 10% more for IMTA mussels compared to conventionally produced mussels (Shuve et al, 2009). Using a payment card method, Kitchen (2011) revealed a willingness to pay for a 24% to 36% premium for IMTA oysters compared to conventionally produced oysters from oyster consumers in San Francisco. While WTP studies for CCA salmon has not been found, a feasibility study of closed containment options for the BC salmon aquaculture industry suggested that salmon produced by a version of closed-containment system may generate a premium of CAD $0.33/kg (CAD $0.73/lb) compared to conventionally

[69] Participants of their focus group came from several segments of the population, including restaurateurs, residents of communities near aquaculture facilities, and the general population from New Brunswick, Canada (Barrington et al, 2008).

produced salmon (DFO, 2010).[70] These results were very similar to and provided strong support for the WTP premiums I found for IMTA and CCA salmon.

6.2 Market Implications of IMTA & CCA Adoptions in BC

A decision support system (DSS) was used to further illustrate the market implications of introducing IMTA and CCA salmon from BC to the US Pacific Northwest. The DSS calculates the utilities that the full sample and each latent class would receive from each profile based on a summation of the part-worth utilities for each attribute level of the profiles found in my LCA. The percentage of the class which would choose a certain profile (the market share of the profile) is revealed by comparing the utilities of all of the profiles against each other.[71] I first created the following base scenarios that represented the current market situation:

- Baseline 1: three uncertified conventionally farmed Atlantic salmon products from BC at the reference price of Atlantic salmon ($10.99/lb), with an option to choose none of these, and
- Baseline 2: two of the same uncertified conventionally farmed Atlantic salmon products and one wild frozen Sockeye salmon product, all from BC and sold at the species' reference prices ($10.99/lb and $11.99/lb for Atlantic and Sockeye), also with an option to choose none.

[70] The suggested premium for CCA salmon was based on suggestions of "subject matter experts" ranging from independent consultants and individuals from consulting firms, environmental advocacies, research groups, and salmon farming associations (DFO, 2010).

[71] Nina Mostegl created the DSS and I developed and examined the scenario analysis.

I then compared the two base scenarios to simulated markets where Atlantic salmon produced using IMTA and CCA technologies in BC were available. Specifically, the three markets I developed for comparisons were:

- Market A: IMTA and CCA were both adopted in BC and both were producing uncertified Atlantic salmon that were sold at the reference price of Atlantic salmon ($10.99/lb), in addition to the option for purchase of conventionally farmed Atlantic salmon. There was no price increase for the salmon produced by the sustainable technologies.
- Market B: IMTA and CCA were both adopted in BC and both were producing uncertified Atlantic salmon that were sold at the price premiums estimated from the WTP information for the respective technologies - $12.06/lb for IMTA ($10.99/lb + $1.07/lb) and $11.42/lb for CCA ($10.99/lb + $0.43/lb), as well as conventionally farmed Atlantic salmon price at $10.99/lb.
- Market C: IMTA and CCA were adopted in BC and their Atlantic salmon products were sold at a premium with a conventionally farmed Atlantic salmon option priced at its reference price ($10.99/lb). However, only IMTA salmon was certified eco-friendly and sold at a further premium based on the premium for eco-certification of Atlantic salmon. Therefore, the price for the eco-certified IMTA product was $12.57/lb ($10.99/lb + $1.07/lb + $0.51/lb) and the price for the uncertified CCA product was $11.42/lb.

Each of these three markets (A, B, and C) generated two subsequent scenarios for comparison to the two Baselines. The first scenario of each market (A1, B1, and C1) assumed IMTA and CCA adoptions did not fully replace conventional aquaculture and conventionally farmed Atlantic salmon continued to exist on the market (compared to Baseline 1). The second

scenario of each market (A2, B2, and C2) assumed that IMTA and CCA fully replaced conventional aquaculture and conventionally farmed Atlantic salmon no longer existed (compared to Baseline 2). The market shares for all three products and the “neither” option of the full sample and each latent class (LC1 = wild salmon lovers, LC2 = price-sensitive consumers, and LC3 = sustainably farmed salmon supporters) for each scenario are displayed in Figure 7, while the graphical illustrations of the market shares are presented in Appendix Z.

Figure 7. Market Scenario Analysis for IMTA and CCA Adoptions: Baselines 1 & 2 Compared to Scenarios A1, B1, and C1, and Scenarios A2, B2, and C2

Market A

Baseline 1

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Atlantic	
Production	Conventional	Conventional	Conventional	**I would not pick any of the options**
Eco-Cert	No	No	No	
Origin	Canada	Canada	Canada	
Prices	$10.99	$10.99	$10.99	

Market Shares

	Option A	Option B	Option C	Neither
All	23.1%	23.1%	23.1%	30.7%
LC 1	7.3%	7.3%	7.3%	78.0%
LC 2	29.5%	29.5%	29.5%	11.4%
LC 3	28.6%	28.6%	28.6%	14.2%

Baseline 2

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Sockeye	
Production	Conventional	Conventional	Wild	**I would not pick any of the options**
Eco-Cert	No	No	No	
Origin	Canada	Canada	Canada	
Prices	$10.99	$10.99	$11.99	

Market Shares

	Option A	Option B	Option C	Neither
All	15.3%	15.3%	49.2%	20.3%
LC 1	0.9%	0.9%	88.3%	9.9%
LC 2	16.6%	16.6%	60.5%	6.4%
LC 3	37.3%	37.3%	6.9%	18.6%

Scenario A1

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Atlantic	
Production	IMTA	CCA	Conventional	**I would not pick any of the options**
Eco-Cert	No	No	No	
Origin	Canada	Canada	Canada	
Prices	$10.99	$10.99	$10.99	

Market Shares

	Option A	Option B	Option C	Neither
All	32.1%	23.5%	19.1%	25.4%
LC 1	22.7%	6.4%	6.1%	64.8%
LC 2	40.0%	28.9%	22.4%	8.7%
LC 3	32.1%	26.4%	27.7%	13.8%

Scenario A2

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Sockeye	
Production	IMTA	CCA	Wild	**I would not pick any of the options**
Eco-Cert	No	No	No	
Origin	Canada	Canada	Canada	
Prices	$10.99	$10.99	$11.99	

Market Shares

	Option A	Option B	Option C	Neither
All	22.5%	16.5%	43.2%	17.8%
LC 1	3.4%	0.9%	86.1%	9.6%
LC 2	25.1%	18.2%	51.3%	5.4%
LC 3	41.5%	34.1%	6.6%	17.8%

Market B

Scenario B1

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Atlantic	I would not pick any of the options
Production	IMTA	CCA	Conventional	
Eco-Cert	No	No	No	
Origin	Canada	Canada	Canada	
Prices	$12.06	$11.42	$10.99	

Market Shares

	Option A	Option B	Option C	Neither
All	29.7%	23.5%	20.1%	26.7%
LC 1	21.4%	6.3%	6.2%	66.0%
LC 2	34.2%	29.7%	26.0%	10.1%
LC 3	30.2%	26.5%	28.9%	14.4%

Scenario B2

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Sockeye	I would not pick any of the options
Production	IMTA	CCA	Wild	
Eco-Cert	No	No	No	
Origin	Canada	Canada	Canada	
Prices	$12.06	$11.42	$11.99	

Market Shares

	Option A	Option B	Option C	Neither
All	20.5%	16.2%	44.8%	18.5%
LC 1	3.1%	0.9%	86.3%	9.6%
LC 2	20.2%	17.6%	56.2%	6.0%
LC 3	39.5%	34.6%	7.0%	18.8%

Market C

Scenario C1

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Atlantic	I would not pick any of the options
Production	IMTA	CCA	Conventional	
Eco-Cert	Yes	No	No	
Origin	Canada	Canada	Canada	
Prices	$12.57	$11.42	$10.99	

Market Shares

	Option A	Option B	Option C	Neither
All	33.6%	22.2%	19.0%	25.2%
LC 1	34.3%	5.3%	5.2%	55.2%
LC 2	35.9%	28.9%	25.3%	9.8%
LC 3	37.9%	23.6%	25.7%	12.8%

Scenario C2

	Option A	Option B	Option C	Neither
Species	Atlantic	Atlantic	Sockeye	I would not pick any of the options
Production	IMTA	CCA	Wild	
Eco-Cert	Yes	No	No	
Origin	Canada	Canada	Canada	
Prices	$12.57	$11.42	$11.99	

Market Shares

	Option A	Option B	Option C	Neither
All	23.7%	15.6%	43.0%	17.7%
LC 1	5.8%	0.9%	83.9%	9.4%
LC 2	21.5%	17.3%	55.3%	5.9%
LC 3	48.0%	29.8%	6.0%	16.2%

*The total size of the market shares across the sample and the three LC may be over 100% due to rounding

I focused my analysis of the impacts of IMTA and CCA adoption on 1) the overall size of the hypothetical salmon markets I simulated, and on 2) the market sizes for farmed and wild salmon. I also examined the order of preference for production methods by comparing the market sizes for salmon produced using various methods across the different scenarios and the effects on market share from eco-certification of IMTA salmon for the entire sample and the latent classes.

The overall size of the salmon markets was analyzed by examining the market shares of the "neither" option. Baseline 1 revealed that 30.7% of the respondents would not choose any of the products if only conventionally farmed Atlantic salmon was available on the market. On the other hand, 10.4% fewer individuals would not buy salmon in a market where wild Sockeye salmon was available (Baseline 2 – "neither" at 20.3%). When sustainably farmed products were available in Markets A, B, and C, more individuals were willing to enter the market compared to the two Baselines regardless of whether or not premiums were charged for the sustainably farmed products. Furthermore, the existence of an eco-certified IMTA product (Market C) led to the lowest number of individuals who chose "neither"; hence, Market C where eco-certified IMTA and uncertified CCA were adopted was the most optimistic market for the salmon industry compared to the Baselines and the other Markets. Overall, the adoption of IMTA and CCA and the availability of their products led to a larger salmon market.

The summation of the market shares for the sustainably farmed salmon, when compared to the market shares for conventionally produced salmon, revealed that the sustainably farmed salmon supporters indeed preferred the sustainable methods over conventional methods (Table 23). Moreover, 7.7% of the sustainably farmed salmon supporters switched their choice to IMTA salmon when it became certified in Scenario C1 (compared to Scenario B1).

Table 23. Market Shares of Sustainably Farmed and Conventionally Farmed Salmon, and "Neither", across scenarios A1, B1, C1, and Baseline 1: for Sustainably Farmed Salmon Supporters (LC3)

Scenarios	Scenario Conditions	Sustainable technologies	Conventional	Neither
Baseline 1:	Conventional	-	85.8%	14.2%
Scenario A1:	IMTA & CCA & Conventional Without premiums	58.5%	27.7%	13.8%
Scenario B1:	IMTA & CCA & Conventional With premiums	56.7%	28.9%	14.4%
Scenario C1:	Certified-IMTA & CCA & Conventional With premiums	61.5%	25.7%	12.8%

The size of the farmed salmon market was compared to the size of the wild market across scenarios A2, B2, C2 and Baseline 2 (Table 24). The total market share for farmed salmon in each scenario was the sum of the 1-class market shares for Options A and B, which were the two farmed products in scenarios A2, B2, and C2. The results revealed that the demand for farmed salmon increased with the adoption of IMTA and CCA compared to Baseline 2. Moreover, part of the increase in market shares for farmed salmon across each scenario were achieved because individuals were switching their wild salmon purchases to the sustainably farmed salmon. While charging premiums for IMTA and CCA reduced the market share of farmed salmon by 2.3% in scenario B2 compared to A2, certifying IMTA salmon led to the highest farmed salmon market at 39.3% even when the salmon was sold at a premium. However, the market shares of farmed salmon were always lower than the market shares of wild salmon in all of the scenarios. Overall, wild salmon was the most preferred option for the entire sample, but adopting sustainable technologies to farm salmon will cause some individuals to switch their choices from wild to farmed salmon.

Table 24. Market Shares of Farmed and Wild Salmon, and "Neither", across Scenarios A2, B2, C2, and Baseline 2: full sample (1-class model)

Scenarios	Scenario Conditions	Market share of farmed salmon	Market share of wild salmon	Neither
Baseline 2:	Conventional & Wild	30.6%	49.2%	20.3%
Scenario A2:	IMTA & CCA & Wild Without premiums	39.0%	43.2%	17.8%
Scenario B2:	IMTA & CCA & Wild With premiums	36.7%	44.8%	18.5%
Scenario C2:	Certified-IMTA & CCA & Wild With premiums	39.3%	43.0%	17.7%

An examination across all scenarios revealed the relative popularity of the four methods of salmon production. While IMTA was the most preferred when compared to CCA and conventionally farmed salmon, it was less preferred than wild Sockeye when it became available as an option on the market. Specifically, the order of preference for the sample was wild > IMTA > CCA > conventional farming method. A closer examination in the latent classes revealed that the preference order for the sample did not apply to the sustainably farmed salmon supporters, who preferred IMTA > conventional > CCA > wild. Although it seemed that the sustainably farmed salmon supporters did not prefer CCA salmon over conventionally farmed salmon at first glance, the lower percentages of market share for CCA was possibly due to the existence of IMTA products at the same time.

Finally, comparing Markets B and C revealed that the adoption of eco-certification for IMTA salmon increased the market shares of IMTA salmon by approximately three percent when eco-certification existed in Scenarios C1 & C2 compared to Scenarios B1 & B2, even though premiums for eco-certification were charged. While only approximately one percent of price-sensitive consumers switched their choices over to the eco-certified IMTA salmon, more than seven percent of individuals among the sustainably farmed salmon supporters switched

their purchases to the eco-certified product. Moreover, the wild salmon lovers were much more willing to switch their purchases over to the eco-certified product when wild frozen sockeye salmon was not available. Based on the DSS analysis, the order of preference should be more accurately shown as 'eco-certified sustainable methods' > 'uncertified sustainable methods' > conventional > wild for the overall sample. The price-sensitive consumers did not have substantially different preferences than the overall sample (wild > IMTA > CCA > conventional) because the premiums were not unacceptably high to them. If the industry sets a higher premium than those selected for this exercise, the price-sensitive consumers will probably choose the cheaper option among those presented.

6.3 Policy Implications for IMTA Salmon in BC

My study assumed that IMTA and CCA salmon will be labelled explicitly so that consumers can differentiate between the production methods, much like how wild and farmed salmon are distinguished currently at the time of sale (Appendix E). The potential demand and estimated premiums associated with IMTA salmon cannot be realized without appropriate labelling and marketing by the industry. Similar to the findings of Wessells, Johnston, & Donath (1999), education about the environmental issues of aquaculture and the need for sustainable seafood consumption was identified as a priority for the industry and policy makers if they want to realize the market potential for IMTA salmon.

Moreover, the use of eco-certification labels proved to be useful in increasing the utility of the less favored Atlantic salmon and the likelihood for the consumer to choose the product. My results confirmed other study findings of increases in utility from eco-labels in sustainable foods (Wessells, Johnston, & Donath, 1999; Onyango, Nayga, & Govindasamy, 2005; Olesen, Alfnes, Rora, & Kolstad, 2010). Canadian salmon exporters and policy makers should consider

the development of an eco-certification program to differentiate and increase the attractiveness of sustainable products. The price premiums identified can be used to analyze whether or not the costs of future eco-certification program will be covered by the consumers, and whether or not monetary subsidies are needed to encourage sustainable aquaculture development.

Finally, we should be mindful that charging a premium to the consumers does not gurantee additional funds to producers in Canada. Knapp, Roheim and Anderson (2007) found that the fisherman can be paid $0.59 per pound of salmon that the consumers paid $15.99 per pound for. Markups are charged by many participants in the U.S. salmon distribution system, including primary processors, importers, secondary distributors, brokers, traders, and many different kinds of retail and food service companies (Knapp, Roheim, & Anderson, 2007). Therefore, the premiums found in this study may not effectively encourage sustainable aquaculture technology adoption in the BC salmon industry.

6.4 Limitations of Research

The purpose of this research was not to examine which non-conventional aquaculture technology is a better option for salmon farmers from a biological and technical point of view, but to investigate the consumers' acceptance of IMTA and CCA, given our current understanding of the technologies. External factors, such as new research findings, can have a significant impact on consumer demand for fish (Egan & Gislason, 1989; Wellman, 1992).[72]

[72] On October 20, 2011, Rick Routledge (SFU statistician) and Alexandra Morton (biologist and anti-salmon farming advocate) published findings on the discovery of sockeye smolts infected by the Infectious Salmon Anaemia (ISA) virus on BC's central coast (Simon Fraser University, 2011). The finding was published during this study's sampling period and had a potential impact on the survey results. News and media outlets in the sampling regions were monitored immediately and only minimal coverage was found in the United States until November 29, 2011 (sampling closed on November 19, 2011). As a result, any threat of a significant impact of Routledge and Morton's study on the survey can be dismissed. Furthermore, studies are currently underway to examine other

Therefore, the WTP results from this study may not hold in the long run. However, the study results provide insights that may be instructive for future economic or financial feasibility analyses that compare IMTA and CCA directly.

Furthermore, I employed the survey research firm Research Now to deliver the online survey to the respondents who had signed up to its database. As such, the respondents were self-selected and participated, in part, for the reward points they received from Research Now. Salmon consumers who do not use the Internet or were not part of a Research Now panel are excluded from the sample. The results cannot be generalized to all markets for Canadian or IMTA salmon due to the regional scope of this project. Moreover, the results should not be generalized to restaurant consumption of salmon products. Finally, the DCE included some of the closest substitutes for farmed salmon, but strategically excluded others. Therefore, one should not generalize the WTP results to other types of protein substitutes, such as other fish products (e.g. tuna).

6.5 Recommendations for Future Research

While my study increased our understanding of the consumers' attitudes toward and WTP for IMTA and CCA, as well as their WTP for these production technologies, a gap in the literature relating to the profitability and financial feasibility of IMTA and CCA aquaculture remains. Only limited information is available concerning whether BC salmon farmers would support and adopt IMTA to reduce their environmental impacts and how this might take place. Furthermore, I did not examine the impacts of IMTA and CCA adoption on the quantity of

---

IMTA benefits, such as the potential role of blue mussels to mitigate *Loma salmonae* infections in marine-cultured salmon. If proven, such benefits may further increase the part-worth utility and the WTP for IMTA.

salmon demanded and supplied in the market, but my study may give insights if these questions are investigated more virgorously in the future. Future research can examine the potential for and the rate of IMTA adoption in BC from the industry's perspective.

Chapter 7: Conclusion

My study addressed a gap in the literature relating to the attitudes, preference and WTP for Integrated Multi-Trophic Aquaculture (IMTA) and Closed Containment Aquaculture (CCA), the two sustainable salmon farming methods under discussion by Canadian policy makers and the salmon farming industry. Two research questions were posed: (1) how do salmon consumers in the US Pacific Northwest perceive IMTA and its products in comparison to other salmon aquaculture methods and products? and (2) what are salmon consumers' in the key US Pacific Northwest markets willing to pay for salmon produced by IMTA compared to its potential close substitutes? I surveyed salmon consumers in the Pacific Northwest regions of the US and used a Discrete Choice Experiment (DCE) to elicit their stated preferences and estimate their WTP for the methods presented.

I found that consumers have a more positive perception towards IMTA compared to CCA. I tested attitudinal and WTP differences from information treatments and found that respondents who saw only favorable information felt more positive toward both technologies than those who saw both favorable and unfavorable information. However, information differences did not alter their relatively more positive preference for IMTA compared to CCA. Moreover, 44.3% of the respondents preferred the adoption of IMTA and only 16.3% of the respondents preferred the adoption of CCA. While the respondents perceived both methods as environmentally friendly, 70% of the respondents who chose IMTA felt that it was more natural than CCA.

The results revealed that consumers from the traditional markets for BC farmed salmon in the US Pacific Northwest were willing to pay a 9.8% premium for IMTA over conventionally produced Atlantic salmon. On the other hand, the sample was only willing to pay a 3.9% premium for CCA over conventionally produced Atlantic salmon. A closer look at the latent class results identified premiums of 41.6%, 4.6%, and 3.5% for IMTA over conventionally produced Atlantic salmon from the wild salmon lovers, price-sensitive consumers, and sustainably farmed salmon supporters, respectively. CCA only enjoyed modest price premiums at 1.4% and 2.1% from the wild salmon lovers and price-sensitive consumers, respectively, and 1.0% compensation (or price reduction) was needed for the sustainably farmed salmon supporters to accept Atlantic salmon produced with CCA.

Finally, my study revealed that the majority of salmon consumers were aware of the environmental concerns surrounding conventional salmon farming and 63.5% of them were supportive of adopting a more sustainable salmon farming method even if it is more expensive. While IMTA and CCA both have environmental advantages and limitations, IMTA was a much more preferred option over CCA when both were presented and evaluated by salmon consumers at the same time. Integrating the DCE results into a decision support system further confirmed that IMTA salmon will enjoy a relatively strong market when in competition with conventional, CCA, and wild salmon products. Such results provide assurance to the BC salmon farming industry and policy makers that consumers will receive IMTA salmon more positively than CCA. Lastly, IMTA and CCA products need to be labelled and the methods need to be communicated explicitly to the consumers for the industry to realize the premiums I found. My results will contribute to further financial feasibility analysis and the overall business case for adoption of more sustainable salmon farming methods in BC.

References

Aguilar, F., & Vlosky, R. P. (2007). Consumer willingness to pay price premiums for environmentally certified wood products in the U.S. *Forest Policy and Economics , 9*, 1100-1112.

Ajzen, I. (1991). The theory of planned behavior. *Organization behavior and Human Decision Processes , 50* (2), 179-211.

Alfnes, F., Guttormsen, A., Steine, G., & Kolstad, K. (2005). *Consumers' willingness to pay for the color of salmon: a choice experiment with real economic incentives.* Rhode Island: Presented at the American Agricultural Economics Association Annual Meeting.

Allsopp, M., Johnston, P., & Santillo, D. (2008). *Challenging the aquaculture industry on sustainability.* Greenpeace Research Laboratories. Greenpeace International.

Antil, J. H. (1978). *The Construction and Validation of an Instrument to Measure Socially Responsible Consumer Behavior: A Study of the Socially Responsible Consumer.* Department of Marketing. Pennsylvania: The Pennsylvania State University.

Associated Press. (2010, January 26). *Target pulls farmed salmon from its stores*. Retrieved from The Seattle Times: http://seattletimes.nwsource.com/html/businesstechnology/2010897130_apustargetfarmedsalmon.html

Ayer, N., & Tyedmers, P. (2009). Assessing alternative aquaculture technologies: life cycle assessment of salmonid culture systems in Canada. *Journal of Cleaner Production , 17*, 362-373.

Barrington, K., Ridler, N., Chopin, T., Robinson, S., & Robinson, B. (2008). Social aspects of the sustainability of integrated multi-trophic aquaculture. *Aquaculture International , 18* (2), 201-211.

Batte, M., Hooker, N., Haab, T., & Beaverson, J. (2007). Putting their money where their mouths are: Consumer willingness to pay for multi-ingredient, processed organic food products. *Food Policy , 32*, 145-159.

Bhat, C. (2002). Recent Methodological Advances Relevant to Activity and. In H. Mahmassani, *In Perpetual Motion: Travel Behaviour Research Opportunities and Application Challenges* (pp. 381-414). New York, NY, USA: Pergamon.

Birol, E., Karouskis, K., & Koundouri, P. (2006). Using a Choice Experiment to Account for Choice Heterogeneity in Wetland Attributes: The Case of the Cheimaditida Wetland in Greece. *Ecological Economics , 60*, 145-156.

Boxall, P., & Adamowicz, W. (2002). Understanding heterogeneous preferences in random utility models: a latent class approach. *Environmental and Resource Economics , 23* (4), 421-445.

Brace, I. (2004). *Questionnaire design: How to plan, structure and write survey material for effectvie market research.* London & Sterling, VA: Kogan Page.

Breidert, C. (2006). *Estimation of Willingness-to-Pay: Theory, Measurement, Application.* Frankfurt: Deutscher Universitats-Verlag.

Chern, W., Rickertsen, K., Tsuboi, N., & Fu, T.-T. (2002). Consumer acceptance and willingness to pay for genetically modified vegetable oil and salmon: a multiple-country assessment. *AgBioForum , 5* (3), 105-112.

Chopin, T., & Robinson, S. (2006, January/February). Rationale for developing integrated multi-trophic aquaculture (IMTA): an example from Canada. *Fish Farmer Magazine* , 20-21.

Chopin, T., Troell, M., Reid, G., Knowler, D., Robinson, S., Neori, A., et al. (2010). Integrated multi-trophic aquaculture: Part 1. Responsible practice provides diversified products, biomitigation. *Global Aquaculture Advocate* (September/October), 38-39.

Chopin, T., Yarish, C., & Sharp, G. (2007). Beyond the monospecific approach to animal aquaculture - the light of integrated multi-trophic aquaculture. In T. Bert, *Ecological and genetic implications of aquaculture activities* (pp. 447-458). Dordrecht, The Netherlands: Springer.

Coastal Alliance for Aquaculture Reform. (2010). Retrieved April 16, 2010, from Farmed and Dangerous: http://www.farmedanddangerous.org/

Coastal Alliance for Aquaculture Reform. (2005, June 15). *Media Relases - Renowned B.C. Chef Tojo Joins Farmed and Dangerous Campaign to Reform Salmon Farming Industry.* Retrieved March 14, 2011, from Farmed and Dangerous: http://www.farmedanddangerous.org/wp-content/uploads/2011/02/TojoPR2005.pdf

Corsi, A. (2007). Ambiguity of measured WTP for quality improvements when quantity is unconstrained: a note. *European Review of Agricultural Economics , 34* (4), 501-515.

David Suzuki Foundation. (2009). *Oceans*. Retrieved January 26, 2010, from Open-net-cage fish farming: http://www.davidsuzuki.org/Oceans/Aquaculture/Salmon

DeNoon, d. (2005, January 31). *Lost in the supermarket: Men without list*. Retrieved October 18, 2011, from MedicineNet: http://www.medicinenet.com/script/main/art.asp?articlekey=50293

Depositario, D., Nayga, R., Wu, X., & Laude, T. (2009). Effects of Information on Consumers' Willingness to Pay for Golden Rice. *Asian Economic Journal , 23* (4), 457 - 476.

DFO. (2010). *Economic study of closed-containment options for the Canadian aquaculture industry. Second draft.* Quebec: Fisheries and Oceans Canada.

Egan, D., & Gislason, G. (1989). *U.S. salmon consumer survey.* Ottawa, CAN: Department of Fisheries and Oceans.

FAO. (2010). *Global Statistical Collections (Online Query)*. Retrieved April 16, 2010, from Fisheries and Aqaculture Department: http://www.fao.org/fishery/topic/16140/en

Farm Foundation. (2008). *Program Focus*. Retrieved August 21, 2010, from Farm Foundation: http://www.farmfoundation.org/ourwork.aspx?m=Program&a=441

Field, J. G., Hempel, G., & Summerhayes, C. P. (2002). *Oceans 2020: Science, Trends, and the Challenges of Sustainability.* Washington: Island Press.

Fisheries and Oceans Canada (DFO). (2005, September 1). *Fact Sheet - Why Farm Fish and Seafood?* Retrieved January 26, 2010, from Aquaculture: http://www.dfo-mpo.gc.ca/aquaculture/sheet_feuillet/seafood-fruitdemer-eng.htm

Fisheries and Oceans Canada (DFO). (2009). *Federal BC aquaculture regulation & strategic action plan initiative - discussion document.*

FOCB.org. (2009, May 29). *The Farm Free Salmon Pledge.* Retrieved July 28, 2011, from Fish Or Cut Bait.Org: http://www.focb.org/Join%20The%20Cause.html

Friends of Clayoquot Sound. (2004). *BC Salmon Farm Tenures.* Retrieved June 27, 2011, from Fish Farming: Maps: http://www.focs.ca/fishfarming/map-bcfarms.asp

Garrod, G., & Willis, K. (1999). *Economic Valuation of the Environment: Methods and Case Studies.* Cheltenham: Edward Elgar Publishing.

Gil, J., & Soler, F. (2006). Knowledge and willingness to pay for organic food in Spain: Evidence from experimental auctions. *Food Economics* , 109-124.

Goddard, E., Boxall, P., Emunu, J., Boyd, C., Asselin, A., & Neall, A. (2007). *Consumer attitudes, willingness to pay and revealed preferences for different egg production attributes: analysis of Canadian egg consumers.* Edmonton: Department of Rural Economy, University of Alberta.

Goldburg, R., & Naylor, R. (2005). Future seascapes, fishing, and fish farming. *Frontiers in Ecology and the Environment , 3* (1), 21-28.

Gracia, A., Loureiro, M., & Nayga Jr, R. (2009). Consumers' valuation of nutritional information: A choice experiment study. *Food Quality and Preference , 20*, 463-471.

Greenpeace USA. (2010, January 26). *Target discontinues the sale of farmed salmon.* Retrieved January 27, 2010, from Greenpeace News Release: http://www.greenpeace.org/usa/news/target-discontinues-farmed-salmon

Grescoe, T. (2008, June 9). *Sardines with your bagel?* Retrieved February 14, 2012, from The New York Times: http://www.nytimes.com/2008/06/09/opinion/09grescoe.html?pagewanted=all

GSGislason & Associates Ltd. (2006). *The Canadian Farmed Salmon Industry Benchmark Analysis for the US Market.* Ottawa, Ontario: Agriculture & Agri-Food Canada.

Guagnano, G. A. (2001). Altruism and market-like behavior: an analysis of willingness to pay for recycled paper products. *Population and Environment , 22* (4), 425-438.

Gustafsson, A., Herrmann, A., & Huber, F. (2007). *Conjoint Measurement: Methods and Applications.* New York: Springer-Verlag Berlin Heidelberg.

Haaijer, R., & Wedel, M. (2007). Conjoint choice experiments: General characteristics and alternative model specifications. In A. Gustafsson, A. Herrmann, & F. Huber, *Conjoint Measurement: Methods and Applications* (pp. 199-230). New York: Springer-Verlag Berlin Heidelberg.

Hearne, R. R., & Volcan, M. M. (2002). *The use of choice experiments to analyze consumer preferences for organic product in Costa Rica.* Long Beach, CA: Presented at the 2002 Agricultural & Applied Economics Association Annual Meeting.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2005). *Applied Choice Analysis.* New York: Cambridge University Press.

Hensher, D. (2010). Hypothetical bias, choice experiments and willingness to pay. *Transportation Research Part B , 44*, 735-752.

Industry Canada. (2010). Trade Data Online (TDO) Online Database. Ottawa, Ontario, Canada.

Jaeger, S., & Rose, J. (2008). Stated choice experimentation, contextual influences and food choice: A case study. *Food Quality and Preference , 19*, 539-564.

Jaffry, S., Pickering, H., Wattage, P., Whitmarsh, D., Frere, J., Roth, E., et al. (2004). Consumer choice for quality and sustainbility in seafood products: empirical findings from United Kingdom. *Food Policy , 29* (3), 215-228.

James, J. S., Rickard, B. J., & Rossman, W. J. (2009). *Product differentiation and market segmentation in applesauce: using a choice experiment to assess the value of organic, local, and nutrition attributes.* Working Paper, Cornell University, Department of Applied Economics and Management, Ithaca, New York.

Jolliffe, I. (2002). *Principal component analysis* (Second Edition ed. ed.). New York: Springer.

Kaiser, H. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement* (20), 141-151.

Kalish, S., & Nelson, P. (1991). A comparison of ranking, rating and reservation price measurement in conjoint analysis. *Marketing Letters , 2* (4), 327-335.

Kannan, P., Pope, B., & Chang, A.-M. (2008). Pricing product lines of digital content: A model using online choice experiment. *The 41st Hawaii International Conference on System Sciences* (pp. 1-9). Hawaii: U.S. Government.

Kitchen, P. (2011). *An economic analysis of shellfish production associated with the adoption of Integrated Multi-Trophic Aquaculture in British Columbia.* Burnaby, BC: Simon Fraser University.

Knapp, G., Roheim, C., & Anderson, J. (2007). *The great salmon run: competition between wild and farmed salmon.* TRAFFIC North America. World Wildlife Fund.

Lancaster, K. (1966). A new approach to consumer theory. *The Journal of Political Economy , 74* (2), 132-157.

Lange, C., Martin, C., Chabanet, C., Combris, P., & Issanchou, S. (2002). Impact of the information provided to consumers on their willingness to pay for champagne. *Food Quality and Preference , 13*, 597-608.

Leggatt, S. (2001). Clear Choices, clean waters. *The Leggatt inquiry into salmon farming in British Columbia* .

Liljenstolpe, C. (2008). Evaluating animal welfare with choice experiments: An application to Swedish pig production. *Agribusiness , 24* (1), 67-84.

Liu, Y., & Sumaila, R. (2007). *Economic analysis of netcage versus sea-bag production systems for salmon aquaculture in British Columbia. Fisheries Centre Working Paper #2007-05.* Vancouver, BC: The University of British Columbia.

Living Oceans Society. (2011). *Assessing the viability of commercial-scale closed containment systems*. Retrieved February 16, 2012, from Living Oceans Society: http://www.livingoceans.org/initiatives/salmon-farming/what-were-doing/assessing-viability-commercial-scale-

Loureiro, M. L., & Umberger, W. J. (2007). A choice experiment model for beef: what US consumer responses tell us about relative preferences for food safety , country-of-origin labeling and traceability. *Food Policy , 32*, 496-514.

Louviere, J., Hensher, D., & Swait, J. (2007). Conjoint preference elicitation methods in the broder context of random utility theory preference elicitation methods. In A. Gustafsson, A. Herrmann, & F. Huber, *Conjoint Measurement: Methods & Applications* (pp. 167-198). New York: Springer-Verlag Berlin Heidelberg.

Louviere, J., Hensher, D., & Swait, J. (2000). *Stated Choice Methods: Analysis and Applications.* New York, NY: Cambridge University Press.

Marine Stewardship Council. (2011). *MSC standards and certification requirements*. Retrieved December 22, 2011, from Marine Stewardship Council Certified Sustainable Seafood : http://www.msc.org/about-us/standards

MarketVision Research. (2002). *Conjoint Analysis: An Introduction.* Retrieved June 17, 2010, from Market Vision Research: http://www.marketvisionresearch.com/pdf/Intro to Conjoint 2002.pdf

Marshall, D. (2003). *Fishy Business, The Economics of Salmon Farming in BC.* Vancouver, BC: Canadian Centre for Policy Alternatives - BC Office.

Martinez-Espineira, R. (2011). *Estimation of the biomitigation benefits of Integrated Multitrophic Aquaculture.* St. John's, NL: Memorial University of Newfoundland.

McFadden, D. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zarembka, *Frontiers in econometrics* (pp. 105-142). New York: Academic Press.

MMK Consulting Inc. (2007). *Special Committee on Sustainable Aquaculture Report: Volume 1.* Victoria, BC: The Legistlative Assembly of British Columbia.

MMK Consulting Inc. (2007b). *Special Committee on Sustainable Aquaculture Report: Volume 2.* Victoria, BC: The Legislative Assembly of British Columbia.

Moon, W., Florkowski, W., Bruckner, B., & Schonhof, I. (2002). Willingness to pay for environmental practices: implications for eco-labeling. *Land Economics , 78* (1), 88-102.

Moon, W., Rimal, A., & Balasubramanian, S. K. (2004). *Willingness-to-accept and willingness-to-pay for GM and non-GM food: UK consumers.* Denver, CO: Presented at the Amercian Agricultural Economics Association Annual Meeting.

Morrow, F. (2009, March 30). *C Restaurant swims against the current on salmon.* Retrieved July 29, 2011, from Globe and Mail: http://www.theglobeandmail.com/life/article682533.ece

Mtimet, N., & Albisu, L. (2006). Spanish wine consumer behavior: A choice experiment approach. *Agribusiness , 22* (3), 343-362.

Nagle, T., & Holden, R. (2006). *The Strategy and Tactics of Pricing.* Upper Saddle River, NJ: Prentice Hall.

Nauman, F. A., Gempesaw, C. M., Richard Bacon, J., & Manalo, A. (1995). Consumer choice for fresh fish: factors affecting purchase decisions. *Marine Resource Economics , 10*, 117-142.

Neff, J. (2011, January 17). *Time to rethink your message: Now the cart belongs to daddy*. Retrieved October 19, 2011, from AdvertisingAge: http://adage.com/article/news/men-main-grocery-shoppers-complain-ads/148252/

Neori, A., Troell, M., Chopin, T., Yarish, C., Critchley, A., & Bushmann, A. (2007). The need for a balanced ecosystem approach to blue revolution aquaculture. *Environment , 49* (3), 36-43.

Nobre, A., Robertson-Andersson, D., Neori, A., & Sankar, K. (2010). Ecological-economic assessment of aquaculture options: comparison between abalone monoculture and integrated multi-trophic aquaculture of abalone and seaweeds. *Aquaculture , 306*, 116-126.

Olesen, I., Alfnes, F., Rora, M. B., & Kolstad, K. (2010). Eliciting consumers' willingness to pay for organic and welfare-labelled salmon in a non-hypothetical choice experiment. *Livestock Science , 127*, 218-226.

Onyango, B., Nayga, R. M., & Govindasamy, R. (2005). *U.S. consumers' willingness to pay for labeling information on genetically modified food: an application of choice modeling.* Rhode Island: Presented at the American Agricultural Economics Association Annual Meeting.

Organisation for Economic Co-operation and Development (OECD). (2001, September 25). *Farm Gate Price*. Retrieved January 26, 2012, from Glossary of Statistical Terms: http://stats.oecd.org/glossary/detail.asp?ID=940

Pacific Sea-Lab Research Society. (2007, August 14). *Sea-System Proof of Concept R&D program*. Retrieved January 26, 2010, from Current Projects: http://pacificsea-lab.com/current.html

Paulos, B. (1998). Green power in perspective: Lessons from green marketing of consumer goods. *The Electricity Journal , January/February*, 46-55.

Pendleton, L., Whitney, J., Bonine, K., Schmelz, K., Ritchlin, J., Rothenbush, T., et al. (2005). *Closing in on environmentally sound salmon aquaculture: a fresh look at the economics of closed tank systems.* Coastal Alliance for Aquaculture Reform.

Price Water House Coopers. (2009). *Profile of the BC Farmed Salmon Industry in 2008.*

Province of British Columbia. (2009, October 6). *Aquaculture Statistics*. Retrieved April 16, 2010, from Ministry of Environment - Oceans and Marine Fisheries Branch: http://www.env.gov.bc.ca/omfd/fishstats/aqua/index.html

Province of British Columbia. (2007). *British Columbia's Fisheries and Aquaculture Sector.* Ministry of Environment.

Province of British Columbia. (2009). *Salmon Aquaculture in British Columbia.* Retrieved from Ministry of Environment: http://www.env.gov.bc.ca/omfd/fishstats/aqua/index.html

Province of British Columbia. (2011, November 28). *Salmon Aquaculture in British Columbia, 2010 Quick Facts*. Retrieved January 27, 2012, from Province of B.C.: http://www.env.gov.bc.ca/omfd/fishstats/aqua/salmon.html

Research Now. (2010). *Select Recruitment*. Retrieved February 20, 2012, from Research Now : http://www.researchnow.com/en-GB/Panels/PanelQuality/Recruitment.aspx

Ridler, N., Robinson, B., Chopin, T., Robinson, S., & Page, F. (2006). Development of integrated multi-trophic aquaculture in the Bay of Fundy, Canada: a socio-economic case study. *World Aquaculture , 37* (3), 43-48.

Ridler, N., Wowchuk, M., Robinson, B., Barrington, K., Chopin, T., Robinson, S., et al. (2007). Integrated multi-trophic aquaculture (IMTA): a potential strategic choice for farmers. *Aquaculture Economics & Management , 11* (1), 99-110.

Rodriguez, E., Lacaze, V., & Lupin, B. (2008). Contingent valuation of consumers' willingness-to-pay for organic food in Argentina. *12th Congress of the European Association of*

Agricultural Economists (pp. 1-10). Mar del Plata: European Association of Agricultural Economists.

Roe, B., Teisl, M., Levy, A., & Russell, M. (2001). US consumers' willingness to pay for green electricity. *Energy Policy , 29*, 917-925.

Roosen, J., Lusk, J., & Fox, J. (2003). Consumer demand for and attitudes toward alternative beef labeling strategies in France, Germany, and the UK. *Agribusiness: An International Journal , 19* (1), 77-90.

Saphores, J.-D. M., Nixon, H., Oqunseitan, O., & Shapiro, A. A. (2007). California households' willingness to pay for 'green' electronics. *Journal of Environmental Planning and Management , 50* (1), 113-133.

Sattler, H., & Hensel-Borner, S. (2007). A comparison of conjoint measurement with self-explicated approaches. In A. Gustafsson, A. Herrmann, & F. Huber, *Conjoint Measurement: Methods and Applications* (pp. 67-76). New York: Springer-Verlag Berlin Heidelberg.

Shuve, H., Caines, E., Ridler, N., Chopin, T., Reid, G., Sawhney, M., et al. (2009). *Survey finds consumers support integrated multitrophic aquaculture.* St. John: Ipsos Reid.

Simon Fraser University. (2011, October 20). *Discovery of lethal virus in Pacific salmon*. Retrieved October 22, 2011, from SFU News: http://www.sfu.ca/sfunews/stories/discovery-of-lethal-virus-in-pacific-salmon.html

SPSS Incorporated. (2010). IBM SPSS Statistics: Version 19. USA.

SPSS Incorporated. (2001). *The SPSS TwoStep Cluster Component.* USA: SPSS Inc.

Statistical Innovations Incorporated. (2010). Latent Gold: Version 4.5.0.10328. USA.

Statistics Canada. (2008). *Aquaculture Statistics.* Ottawa, Ontario: Statistics Canada.

StatSoft, Inc. (2011). *Electronic Statistics Textbook.* Tulsa, OK: StatSoft.

Steiner, B., Gao, F., & Unterschultz, J. (2010). Alberta consumers' valuation of extrinsic and intrinsic red meat attributes: a choice experimental approach. *Canadian Journal of Agricultural Economics , 58*, 171-189.

Suzuki, D., & Moola, F. (2010, April 27). *Salmon farming may be a good idea after all.* Retrieved July 28, 2011, from Straight.com: http://www.straight.com/article-319924/vancouver/david-suzuki-salmon-farming-may-be-good-idea-after-all

Tegene, A., Huffman, W., Rousu, M., & Shogren, J. (2003). The Effects of Information on Consumer Demand for Biotech Foods: Evidence from Experiemental Auctions. *Economic Research Service Research Briefs (Technical Bulletin number 1903)* (p. 32). United States Department of Agriculture.

Train, K. (2009). *Discrete Choice Methods with Simulation* (Second Edition ed.). New York, NY, USA: Cambridge University Press.

U.S. Census Bureau. (2010). *2005-2009 American Community Survey.* U.S. Census Bureau.

Veisten, K. (2007). Willingness to pay for eco-labelled wood furniture: Choice-based conjoint analysis versus open-ended contingent valuation. *Journal of Forest Economics , 13*, 29-48.

Verbeke, W., Vermeir, I., & Brunso, K. (2007). Consumer evaluation of fish quality as basis for fish market segmentation. *Food Quality and Preference , 18*, 651-661.

Vermunt, J., & Magidson, J. (2005). *Technical Guide for Latent Gold 4.0: Basic and Advanced.* Balmont Masschusetts: Statistical Innovations Inc.

Ward, F. (2006). *Environmental and Natural Resource Economics.* Upper Saddle River, NJ: Person Education.

Wellman, K. (1992). The US retail demand for fish products: an application of an almost ideal demand system. *Applied Economics , 24* (4), 445-457.

Wessells, C. R., Johnston, R. J., & Donath, H. (1999). Assessing consumer preferences for ecolabeled seafood: the influence of species, certifier, and household attributes. *American Journal of Agricultural Economics , 81* (5), 1084-1089.

Wessells, C., & Anderson, J. (1995). Consumer willingness to pay for seafood safety assurances. *Journal of Consumer Affairs , 29*, 85-107.

Whynes, D., Frew, E., & Wolstenholme, J. (2005). Willingness-to-pay and demand curves: a comparison of results obtained using different elicitation formats. *International Journal of Health Care Finance and Economics , 5*, 369-386.

Wild Salmon Supporters. (2010). *Official list of wild salmon supporters*. Retrieved April 16, 2010, from http://www.salmonsupporters.com/supporters.php

Wright, A., & Arianpoo, N. (2010). *Technologies for viable salmon aquaculture - an examination of land-based closed containment aquaculture.* Achieved from http://www.saveoursalmon.ca/solutions/closed_containment: SOS Solutions Advisory Committee.

Xia, W., & Zeng, Y. (n.d.). *Consumer's attitudes and willingness-to-pay for green food in Beijing.* Beijing, China: School of Agricultural Economics and Rural Development, Renmin University of China.

Yoo, S.-H., & Kwak, S.-Y. (2009). Willingness to pay for green electricity in Korea: A contingent valuation study. *Energy Policy , 37*, 5408-5416.

Appendices

Appendix A: Map of BC Salmon Farm Tenures

Source: The Province of British Columbia, 2011
Please see http://www.agf.gov.bc.ca/fisheries/ for enlarged version of the map.

Appendix B: Conceptual Diagrams of CCA

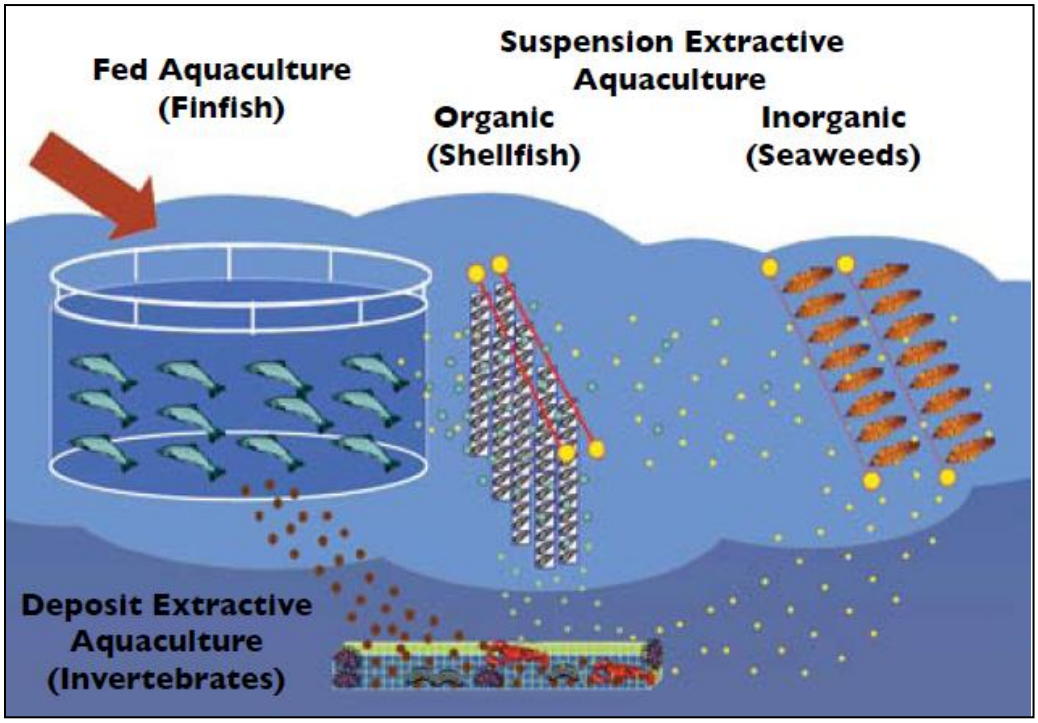
Ocean-based CCA

Source: DFO, 2010

Land-based CCA

Source: Living Oceans Society, 2011

Appendix C: Conceptual Diagram of IMTA



Source: Chopin, et al., 2010

Appendix D: Sustainable Salmon Consumption Survey

Sustainable Salmon Consumption Survey

Welcome to the Salmon Consumption Survey.

We are conducting this study to better understand salmon consumption and preferences in the Pacific Northwest.

This survey is not connected to any proposed initiative of any government program, or commercial enterprise. It is administered by the School of Resource and Environmental Management at Simon Fraser University (Burnaby, British Columbia, Canada) and is funded by the National Sciences and Engineering Research Council (NSERC) of Canada.

To view our privacy policy, please click here, a new tab/window will open.

If you choose to participate, please click the “Begin” button below.

Please answer the questions in sequence. The survey's intent is to capture your initial response in the order given. Please DO NOT press the "back button" on your browser to revisit or change your answer.

The survey will take about 15 minutes to complete.

To begin the survey, please click here →

Fine-prints:
By filling out this questionnaire, you are consenting to participate. Your participation in this survey is voluntary, and you may choose not to respond to any question or terminate the survey at any time. All information that you provide in this survey will be kept strictly confidential in accordance with Simon Fraser University’s research ethics guidelines. Your response will be stored offline in a secure password-controlled cache. Your responses are strictly anonymous and will not be recorded. Data will be used strictly for analysis related to academic studies. Your responses will be analyzed in aggregate and individual responses will not be identifiable in any publications.

Section A: Screening, salmon purchase and consumption behavior

A.1. Which city do you currently reside in? [*Please select one*]

- □ Eugene, Oregon **[Screen out after A.2.]**
- □ Los Angeles, California **[Screen out after A.2.]**
- □ Portland, Oregon **[Go to A.3. after A.2.]**
- □ Salem, Oregon **[Screen out after A.2.]**
- □ San Diego, California **[Screen out after A.2.]**
- □ San Francisco, California **[Go to A.3. after A.2.]**
- □ Seattle, Washington **[Go to A.3. after A.2.]**
- □ Spokane, Washington **[Screen out after A.2.]**
- □ Vancouver, Washington **[Screen out after A.2.]**
- □ None of the above **[Screen out after A.2.]**

A.2. What is your gender? [*Please select one*]

- □ Female
- □ Male

A.3. Do you, or any other member of your household eat salmon? [*Please select one*]

- □ Yes **[Go to A.5. after A.4.]**
- □ No **[Go to A.8. after A.4.]**

A.4. Which of the following best describes your involvement in the grocery shopping for your household? [Note: Your household includes you, your dependents and any other persons with whom you share living expenses.]

- □ You do all or most of the grocery shopping for your household **[Go to A.5. or A.8. depending on answer to A.3.]**
- □ You do at least half of the grocery shopping **[Go to A.5. or A.8. depending on answer to A.3.]**
- □ You do little or none of the grocery shopping for your household **[Go to A.5 or A.8 depending on answer to A.3.; screen out after Section A]**

A.5. Where do you, or members of your household, generally eat salmon? [*Please select one*]

- □ At home only **[Go to A.6.]**
- □ In restaurants only **[Go to A.7.]**
- □ Both at home and in restaurants **[Go to A.6. and A.7.]**
- □ I don't know **[Screen out]**

A.6. Approximately how often did you buy salmon for home consumption during the last 12 months? [*Please select one*]

- □ Never (I did not buy any salmon for home consumption during the last 12 months) **[Go to A.8.]**
- □ Once or twice in the last 12 months
- □ 3 to 6 times in the last 12 months
- □ 7 to 11 times in the last 12 months
- □ Once or twice a month
- □ 3 times a month
- □ Once a week or more
- □ I don't know (I bought salmon during the last 12 months but I cannot provide a reasonable estimate)

[All responses other than "Never", go to A.9. unless respondent don't grocery shop (A.4.)]

A.7. Approximately how often did you order salmon in restaurants during the last 12 months? [*Please select one*]

- □ Never (I did not order any salmon in restaurants for the last 12 months)
- □ Once or twice in the last 12 months
- □ 3 to 6 times in the last 12 months
- □ 7 to 11 times in the last 12 months
- □ Once or twice a month
- □ 3 times a month
- □ Once a week or more
- □ I don't know (I ordered salmon during the last 12 months but I cannot provide a reasonable estimate)

[Go to A.9. unless respondent only eats salmon in restaurants (A.3.) and/or don't grocery shop (A.4.); if respondent only eats salmon in restaurants, go to A.8.]

A.8. Why doesn't your household purchase salmon for home consumption?
[*Please select all that apply*]

- □ We don't eat salmon
- □ We don't eat any fish
- □ We are vegetarians
- □ We don't know how to cook salmon
- □ We or our friends catch salmon ourselves
- □ Salmon is too expensive
- □ Salmon is not available
- □ Salmon is unsafe
- □ Salmon is unhealthy
- □ Salmon is not environmentally-friendly
- □ Salmon smells bad in the house
- □ Other (please specify: _____)
- □ I don't know

[Screen out]

[From here on, every respondent sees each question consecutively unless otherwise stated]

A.9. Where do you usually buy salmon for your home consumption? [*Select all that apply*]

- □ Supermarket
- □ Big-box stores (e.g. Wal-Mart)
- □ Club stores (e.g. Costco, Sam's Club)
- □ Grocery or convenience store
- □ Fishers' market/wharf
- □ Organic food store
- □ Specialty seafood/fish stores or Deli
- □ Farmers' market
- □ Roadside stand
- □ We or our friends catch salmon for consumption
- □ Other (please specific: _____)
- □ I don't know

A.10. Approximately how many pounds of salmon do you usually purchase for one meal for your household? [*Please enter amount*]

_____ lbs

□ I don't know [please select only if you are unable to provide a reasonable estimate for this question]

A.11. How much did you pay the last time you bought salmon? [*Please enter amount*]

$ _____ / lbs

□ I don't know [please select only if you are unable to provide a reasonable estimate for this question]

A.12. Generally speaking, how important is each of the following factors when you decide to purchase salmon for your home consumption? [*1 = not at all important and 5 = extremely important*; *select one response for each line*]

	Not at all important				**Extremely important**
	1	**2**	**3**	**4**	**5**
Taste and texture					
Freshness and smell					
Color of the meat					
Salmon species					
Health and nutritional content					
Price					
Availability and seasonality					
Origin and source					
Environmental certification					

Section B: Knowledge and perception on salmon production methods

Some types of salmon available in stores and restaurants are grown in a controlled environment known as aquaculture or "salmon farming".
Other types of salmon are caught in the wild and are known as "wild salmon".
Some types of salmon are supplied from both farmed and wild sources.

B.1. Were you familiar with the distinction between farmed and wild salmon before starting this survey? [*Please select one*]

- ☐ Yes, I was familiar with the concept already
- ☐ No, I did not know about this distinction
- ☐ I'm not sure

Atlantic Salmon	Sockeye Salmon	King Salmon
Atlantic salmon are farmed and appear more pink or peach when compared to other salmon species. They are available all year round.	Sockeye salmon are wild and are only available seasonally, unless frozen. They have a strong red color, firmer flesh, and a more distinctive flavour than other salmon species.	King salmon can be wild or farmed. Wild King salmon is fairly rare and has a rich, creamy flavour compared to other salmon species.

B.2. Have you eaten any of the following salmon species in the past 12 months, regardless of whether it was wild or farmed? [*Please select one response for each species*]

	Yes	No	I don't know
Atlantic Salmon			
Sockeye Salmon			
King Salmon			

B.3. Do you prefer wild or farmed salmon? [*Please select one*]

- □ I prefer wild salmon **[Go to B.4.]**
- □ I prefer farmed salmon **[Go to B.5.]**
- □ No strong preference **[Go to B.6.]**
- □ I don't know **[Go to B.6.]**

B.4. Why do you prefer wild salmon over farmed salmon? [*Select all that apply*]

- □ It's cheaper
- □ It's fresher
- □ It's organic
- □ It's local
- □ It's more natural
- □ It's more readily available
- □ It's more nutritious/healthy
- □ It's more environmentally friendly
- □ It's not subject to food coloring
- □ It tastes better
- □ It has better texture
- □ Other (please specify: _____)
- □ I don't know

[Go to B.6.]

B.5. Why do you prefer farmed salmon over wild salmon? [*Select all that apply*]

- □ It's cheaper
- □ It's fresher
- □ It's organic
- □ It's local
- □ It's more natural
- □ It's more readily available
- □ It's more nutritious/healthy
- □ It's more environmentally friendly
- □ It tastes better
- □ It has better texture
- □ Other (please specify: _____)
- □ I don't know

[Go to B.6.]

B.6. Approximately what percentage of your salmon purchases for home consumption during the last 12 months was farmed salmon, regardless of species?

_____ %

□ I don't know

B.7. Approximately what percentage of your salmon purchases in restaurants during the last 12 months was farmed salmon, regardless of species?

_____ %

□ I did not eat salmon in restaurants during the last 12 months

□ I don't know

Conventional salmon aquaculture, using open-net cages in marine coastal areas, has been controversial for several reasons, such as

- Escape of salmon from the cages (Atlantic salmon is a non-native species),
- Discharge of waste and excess feed, and
- Possible infestation of nearby wild salmon by sea lice.

B.8. Prior to this survey, were you aware of any of these environmental concerns that might be associated with conventional salmon farming?

□ Yes, I was aware

□ No, I was not aware

□ I'm not sure

Section C: IMTA and CCA descriptions

****First Segment split****
Segment 1: Go to Preamble 1 → IMTA (Favorable) → CCA (Favorable) → Method Preference
Segment 2: Go to Preamble 1 → IMTA (Balanced) → CCA (Balanced) → Method Preference
Segment 3: Go to Preamble 2 → CCA (Favorable) → IMTA (Favorable) → Method Preference
Segment 4: Go to Preamble 2 → CCA (Balanced) → IMTA (Balanced) → Method Preference

[Preamble 1]

In order to reduce environmental impacts of conventional salmon aquaculture, researchers are looking into new ways to culture salmon more sustainably. Two alternatives to conventional salmon cage aquaculture are:

- Integrated Multi-Trophic Aquaculture (IMTA), and
- Closed Containment Aquaculture (CCA).

[Preamble 2]

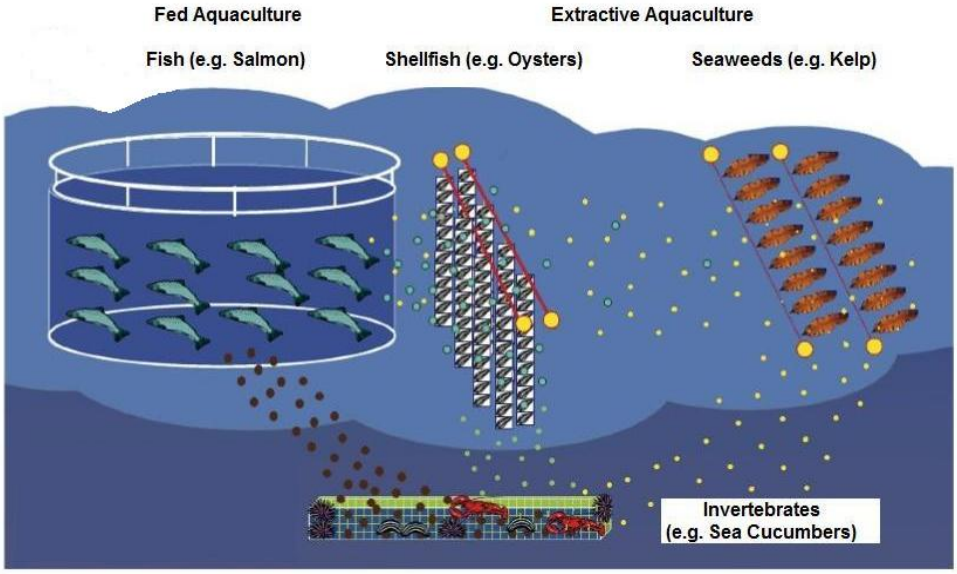
In order to reduce environmental impacts of salmon aquaculture, researchers are looking into new ways to culture salmon more sustainably. Two alternatives to conventional salmon cage aquaculture:

- Closed Containment Aquaculture (CCA), and
- Integrated Multi-Trophic Aquaculture (IMTA).

[IMTA (Favorable)]

Integrated Multi-Trophic Aquaculture (IMTA) seeks to replicate aspects of a natural ecosystem by combining the culture of fed species (i.e. salmon), with the culturing of other species that extract their food from seawater (i.e. shellfish, seaweeds, and invertebrates). Uneaten feed and waste from the fed species are recaptured and used by the extractive species, rather than remaining in the marine environment (as is the case with conventional aquaculture). Later, the extractive species can be harvested and marketed as well.

The diagram below illustrates the IMTA system:



C.1a. Have you heard of Integrated Multi-Trophic Aquaculture (IMTA) prior to this survey? [*Please select one*]

- ☐ Yes, I have heard of it
- ☐ No, I have not heard of it
- ☐ I'm not sure

C.2a. What is your opinion of IMTA? [*Please select one*]

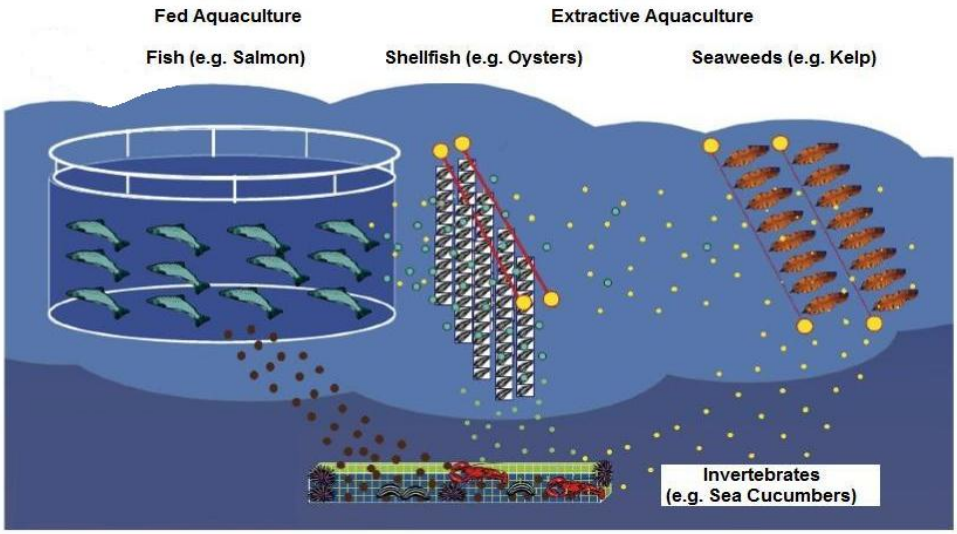
- ☐ Very positive
- ☐ Somewhat positive
- ☐ Indifferent
- ☐ Somewhat negative
- ☐ Very negative
- ☐ I don't know

[IMTA (Balanced)]

Integrated Multi-Trophic Aquaculture (IMTA) seeks to replicate aspects of a natural ecosystem by combining the culture of fed species (i.e. salmon), with the culturing of other species that extract their food from seawater (i.e. shellfish, seaweeds, and invertebrates). Uneaten feed and wastes from the fed species are recaptured and used by the extractive species, rather than remaining in the marine environment (as is the case with conventional aquaculture). Later, the extractive species can be harvested and marketed as well.

IMTA does not address escapes by farmed salmon and may not significantly reduce the infestation of wild salmon by sea lice.

The diagram below illustrates the IMTA system:



C.1b. Have you heard of Integrated Multi-Trophic Aquaculture (IMTA) prior to this survey? [*Please select one*]

- ☐ Yes, I have heard of it
- ☐ No, I have not heard of it
- ☐ I'm not sure

C.2b. What is your opinion of IMTA? [*Please select one*]

- ☐ Very positive
- ☐ Somewhat positive
- ☐ Indifferent
- ☐ Somewhat negative
- ☐ Very negative
- ☐ I don't know

[CCA (Favorable)]

Closed Containment Aquaculture (CCA) separates salmon farming operations from the natural environment by using closed water tanks on land or in water to raise salmon. Sea water is continuously cycled through the tanks and waste is disposed of on land, rather than being dispersed into the sea. CCA eliminates the impacts from conventional aquaculture on the marine environment, such as the release of any uneaten feed and waste and the interaction between farmed & wild salmon.

The following diagram is an example of a CCA system:

C.3a. Have you heard of Closed Containment Aquaculture (CCA) prior to this survey? [*Please select one*]

- □ Yes, I have heard of it
- □ No, I have not heard of it
- □ I'm not sure

C.4a. What is your opinion of CCA? [*Please select one*]

- □ Very positive
- □ Somewhat positive
- □ Indifferent
- □ Somewhat negative
- □ Very negative
- □ I don't know

[CCA (Balanced)]

Closed Containment Aquaculture (CCA) separates salmon farming operations from the natural environment by using closed water tanks on land or in water to raise salmon. Sea water is continuously cycled through the tanks and waste is disposed of on land, rather than being dispersed into the sea. CCA eliminates the impacts from conventional aquaculture on the marine environment, such as the release of any uneaten feed and waste and the interaction between farmed & wild salmon.

CCA requires a significant amount of energy and could face issues related to land use and waste disposal.

The following diagram is an example of a Closed Containment Aquaculture system:

C.3b. Have you heard of Closed Containment Aquaculture (CCA) prior to this survey? [*Please select one*]

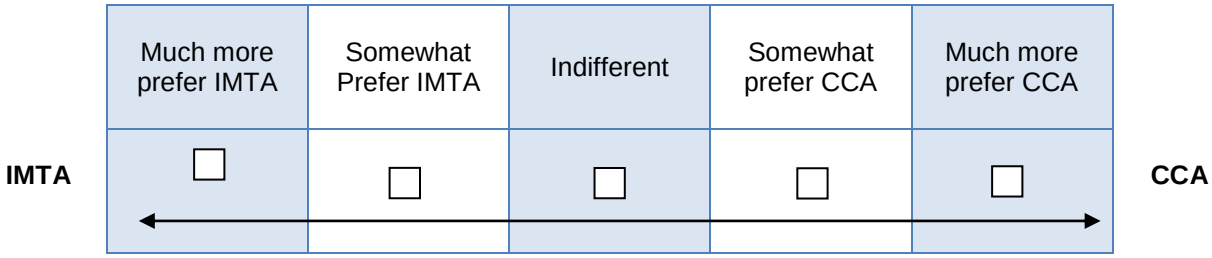
- □ Yes, I have heard of it
- □ No, I have not heard of it
- □ I'm not sure

C.4b. What is your opinion of CCA? [*Please select one*]

- □ Very positive
- □ Somewhat positive
- □ Indifferent
- □ Somewhat negative
- □ Very negative
- □ I don't know

[Method Preference]

C.5. If either IMTA or CCA was to be adopted for salmon farming, how strong is your preference for one method over the other? [*Please select one*]



- I don't know

[If respondents prefer IMTA (both "much more" and "somewhat") – go to C.6.]
[If respondents prefer CCA (both "much more" and "somewhat") – go to C.7.]
[If respondents chose "indifferent" or "I don't know" – go to Section D]

C.6. Why do you prefer IMTA over CCA? [*Select all that apply*]

- ☐ It seems more innovative
- ☐ It seems more efficient for producing seafood
- ☐ It seems more effective in addressing conventional salmon farming issues
- ☐ It seems to use less resources
- ☐ It seems more natural
- ☐ It seems more environmentally friendly
- ☐ It seems more sustainable
- ☐ It combines the culturing of multiple species
- ☐ Other (please specify: _____)
- ☐ I don't know

C.7. Why do you prefer CCA over IMTA? [*Select all that apply*]

- ☐ It seems more innovative
- ☐ It seems more efficient for producing seafood
- ☐ It seems more effective in addressing conventional salmon farming issues
- ☐ It seems to use less resources
- ☐ It seems more natural
- ☐ It seems more environmentally friendly
- ☐ It seems more sustainable
- ☐ It separates farmed salmon from the marine environment
- ☐ Other (please specify: _____)
- ☐ I don't know

Section D: DCE

Over the next few pages, we will show you some hypothetical salmon purchase situations. Each page will contain 3 different salmon products for you to choose from, or you may choose none. Each product description will contain the following information:

Species: The species of salmon

Production Method: Whether the salmon is

- wild,
- raised in a conventional salmon aquaculture system,
- raised in an Integrated Multi-Trophic Aquaculture (IMTA) system, or
- raised in a Closed Containment Aquaculture (CCA) system

Presentation: fresh or previously frozen

Origin: the country of origin

Price: The retail price (per lb)

Eco-certified: Whether or not the salmon is certified for using sustainable production practices, symbolized by a certification label shown on the right.

Below is an example of one such purchase situation:

Please **choose one product**. If none of the options are acceptable to you, you may select the option "**none**".

While deciding, please assume that you are doing your regular grocery shopping and that you are looking for salmon for your household. Please also assume that the salmon products presented have all **passed the FDA food safety examination** and note that we only present products that are **available year-round**. Although not explicitly specified, please assume that the cut (e.g. fillet, steak, etc.) of the salmon suits your preference.

****Second Segment split****
Segment 1: Go to Common Set High → DCE Choice Sets
Segment 2: Go to Common Set Low → DCE Choice Sets

[Common Set High]
D.1a.

- Which of these options will you choose? [*Please select one*]

[Common Set Low]
D.1b.

- Which of these options will you choose? [*Please select one*]

[DCE Choice sets] (Each respondent will see 8 sets, [6 blocks = 48 different combinations]):

D.2-9. Which of these salmon products will you purchase? [*please select one*]

D.10. Assuming IMTA and CCA salmon were widely available at the same price as conventionally farmed salmon, would you purchase farmed salmon for home consumption more often (regardless of the production method)? [*please select one*]

- ☐ Yes **[Go to D.11.]**
- ☐ No **[Go to Section E, E.1.]**
- ☐ I don't know **[Go to Section E, E.1.]**

D.11. How many more times within a 12-month period would you purchase farmed salmon for home consumption?

_____ times

- ☐ I don't know [*Please select only if you are unable to provide a reasonable estimate for this question*]

[Go to Section E, E.1.]

Section E: Environmental participation and perceived consumer-effectiveness

E.1. In the past 12 months, have you attended a meeting or signed a petition aimed at protecting the environment? [*Please select one*]

- □ Yes
- □ No
- □ I don't know

E.2. In the past 12 months, have you contributed to an environmental organization? [*Please select one*]

- □ Yes
- □ No
- □ I don't know

E.3. In the past 12 months, have you participated in environmental activities, such as Earth Hour or Beach/River Clean-Ups? [*Please select one*]

- □ Yes
- □ No
- □ I don't know

E.4. Are you a member of an environmental organization (e.g. Sierra Club, WWF)?

- □ Yes **[Go to E.5.]**
- □ No **[Go to E.6.]**
- □ I don't know **[Go to E.6.]**

E.5. Are you an active or inactive member of your environmental organization? [*Please select one*]

- □ Active
- □ Inactive
- □ Not sure

[Go to E.6.]

E.6. To what extent do you agree with each of the following statements?
[*Please select one for each statement*]

	Strongly Agree	**Agree**	**Undecided**	**Disagree**	**Strongly Disagree**
When I buy products, I usually try to consider how my use of them will affect the environment and other consumers.					
Since one person cannot have any effect upon pollution and natural resource problems, it doesn't make any difference what I do.					
Each consumer's behaviour can have a positive effect on society by purchasing products sold by socially responsible companies.					
A more sustainable option for salmon farming should be adopted even if it may be more expensive.					

Section F: Demographics

Just a few more questions about yourself.

F.1. Please indicate your age. [*Please select one*]

- □ 19
- □ 20-24
- □ 25-34
- □ 35-44
- □ 45-54
- □ 55-64
- □ 65+

F.2. Please indicate the highest level of education you have completed. [*Please select one*]

- □ Elementary / Middle School Graduate (grades 1 – 8)
- □ High School Graduate (grades 9 – 12)
- □ Bachelor's Degree
- □ Associate's Degree
- □ Graduate, Post-doctoral, or Professional Degree

F.3. How many people live in your household, including yourself? [*Please enter number*]

_____ persons

E.4. How many of the persons who currently live in your household are under 18 years of age, including babies and small children? [*Please enter number*]

_____ member(s) of my household is(are) under 18 years of age

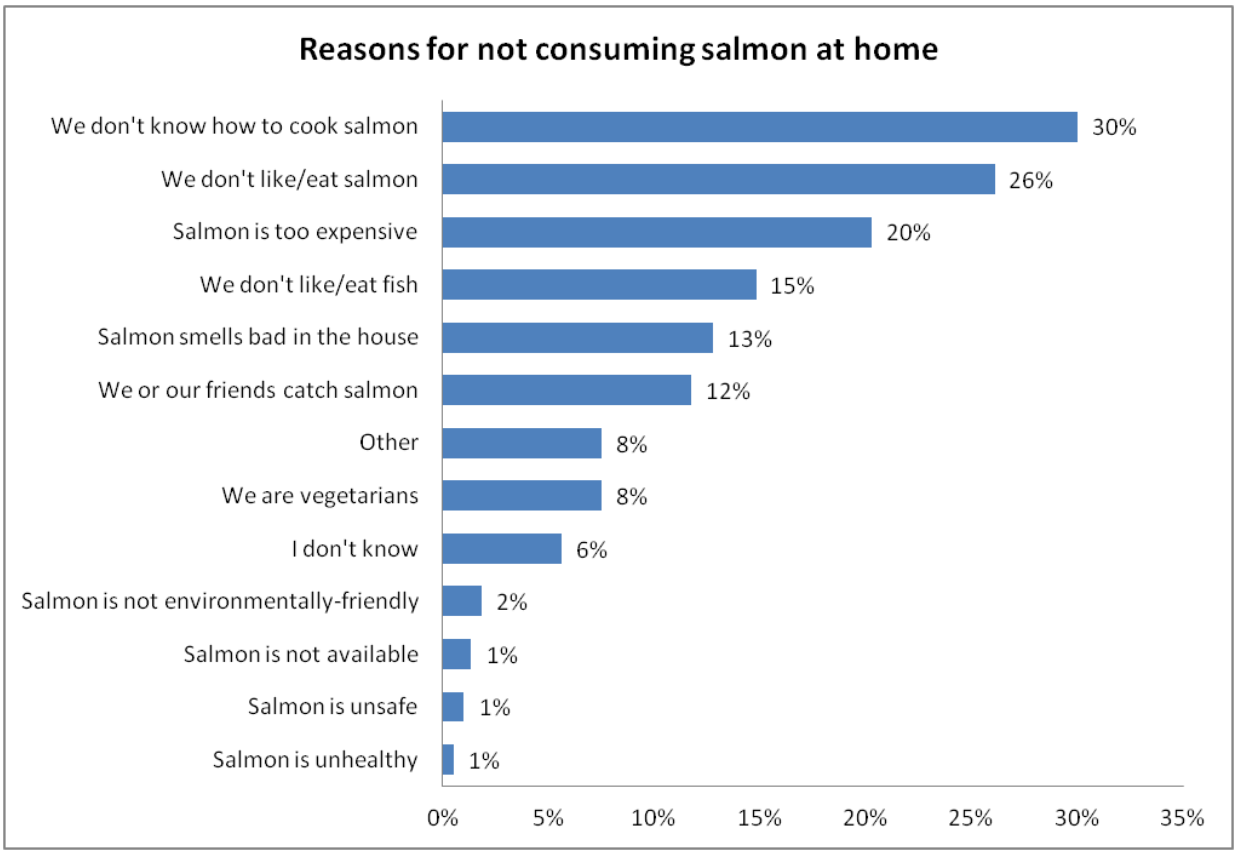
E.5. Which of the following categories best represents your annual household income before taxes? [*Please select one*]

- □ Less than $24,999
- □ Between $25,000 to $34, 999
- □ Between $35,000 to $49,999
- □ Between $50,000 to $74,999
- □ Between $75,000 to $99,999
- □ Between $100,000 to $149,999
- □ Between $150,000 to $199,999
- □ $200,000 or more

Appendix E: Sample reference photographs of salmon products

Appendix F: Reasons for not eating salmon at home

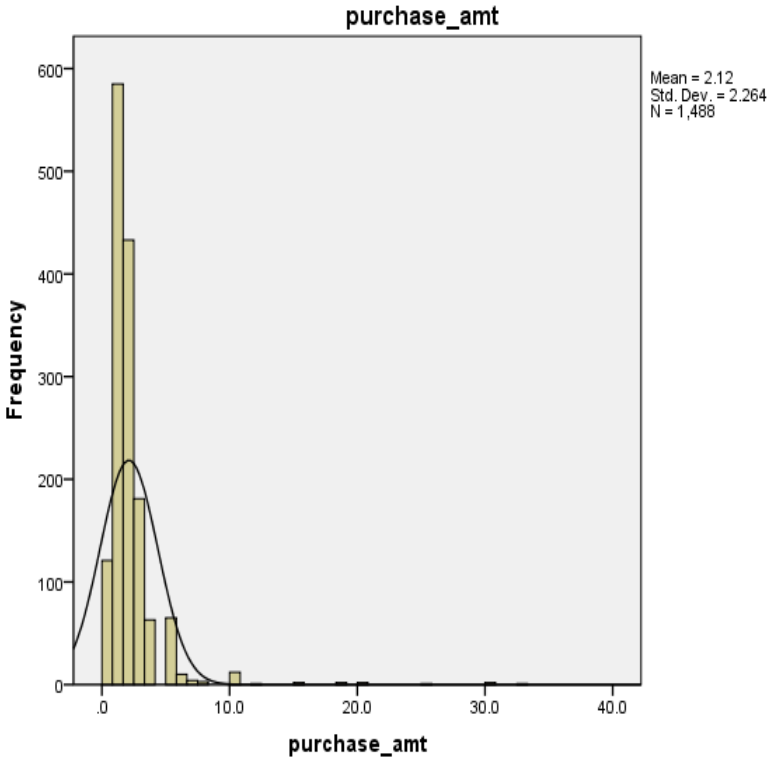
Respondents were given an opportunity to explain why they did not consume salmon at-home during the last 12 months in a follow-up question before they were screened out of the survey. A list of reasons were available and they were also allowed to specify their own reasons if they felt that the list was not comprehensive enough. The reasons and the percentage of respondents who selected that reason are provided below:

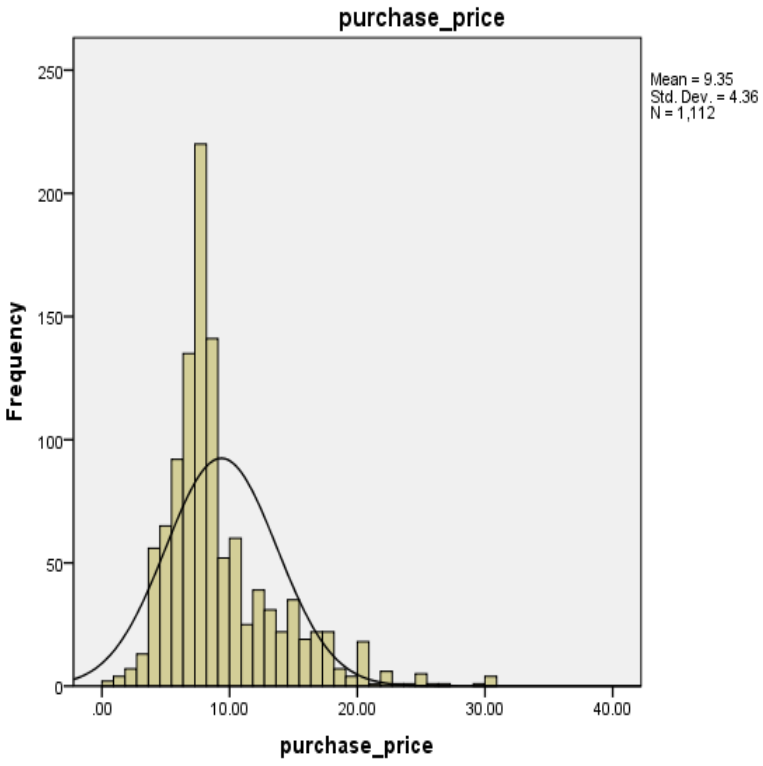


Other reasons which were frequently provided by respondents were allergies to fish/salmon products (1%), they don't eat salmon at home/they only eat it in restaurants (2%), and that they don't like the taste or texture of salmon (1%).

Appendix G: Salmon Consumption Frequency & Patterns

	Total Sample	
	Freq.	**Percent**
At home consumption frequency in the last 12 months		
Once or twice a year	255	15.8%
3 to 6 times a year	543	33.6%
7 to 11 times a year	297	18.4%
Once or twice a month	296	18.3%
3 times a month	127	7.9%
Once a week or more	81	5.0%
Don't know	18	1.1%
In restaurant consumption frequency in the last 12 months		
Never	22	1.6%
Once or twice a year	427	30.6%
3 to 6 times a year	607	43.5%
7 to 11 times a year	179	12.8%
Once or twice a month	113	8.1%
3 times a month	24	1.7%
Once a week or more	8	0.6%
Don't know	16	1.1%
Salmon purchase location (for at home consumption by % of case)		
Supermarket	1034	63.4%
Big-box stores (e.g. Wal-Mart)	43	2.6%
Club stores (e.g. Costco, Sam's Club)	677	41.5%
Grocery or convenience stores	349	21.4%
Fishers' market / wharf	261	16.0%
Organic food store	277	17.0%
Specialty seafood / fish stores / deli	292	17.9%
Farmers' market	161	9.9%
Roadside stand	26	1.6%
Self-catch	210	12.9%
Other	12	0.7%
Purchase amount & price		
Purchase amount (lb) - Mean		2.12
Purchase amount (lb) - Median		2.00
Don't know purchase amount	141	8.6%
Purchase price (USD $) - Mean		9.35
Purchase price (USD $) - Median		8.00
Don't know purchase price	515	31.6%


purchase_amt
Mean = 2.12
Std. Dev. = 2.264
N = 1,488
Frequency
600
500
400
300
200
100
0
.0
10.0
20.0
30.0
40.0
purchase_amt

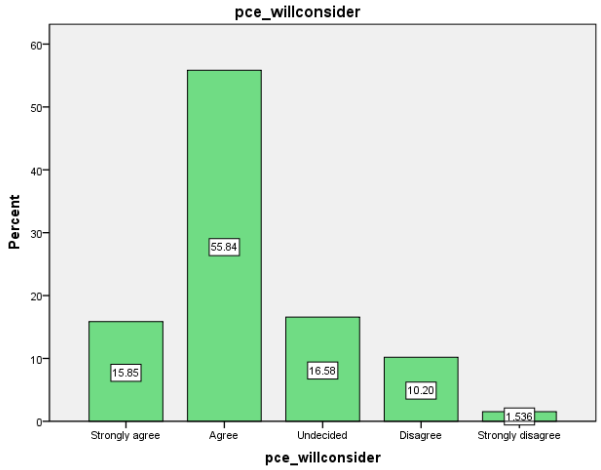

purchase_price
Mean = 9.35
Std. Dev. = 4.36
N = 1,112
Frequency
250
200
150
100
50
0
.00
10.00
20.00
30.00
40.00
purchase_price

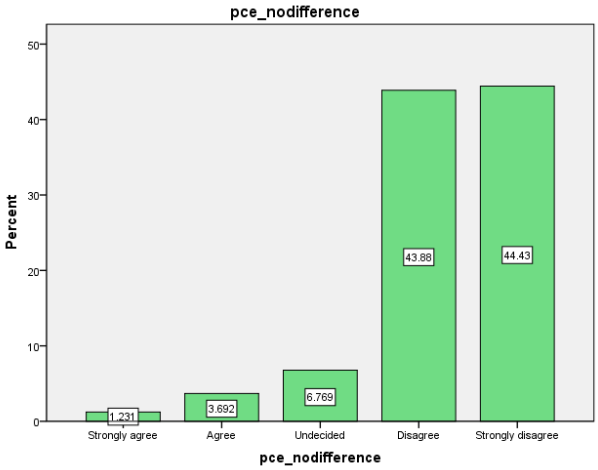
Appendix H: Characteristics of Environmental Participation Clusters

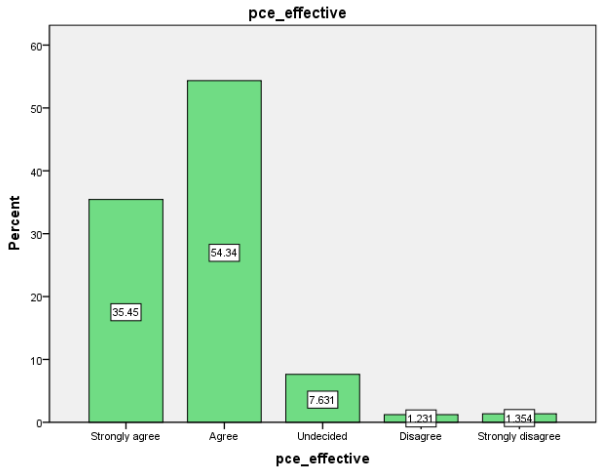
	Regular Contributors n=255 (A)	Limited Participants n=500 (B)	Uninterested n=876 (C)	Chi-Square
Place of Residence				
Seattle, WA	30.6%	33.4%	38.0%	0.075
Portland, OR	33.3%	29.8%	29.8%	
San Francisco, CA	36.1%	38.0%	32.2%	
Gender				
Male	25.9%	28.6%	37.8%	<0.001
Female	74.1%	71.4%	62.2%	
Age				
19	0.0%	1.0%	0.6%	<0.001
20 – 24	5.1%	4.8%	3.4%	
25 – 34	13.3%	24.4%	21.9%	
35 – 44	10.6%	17.2%	14.8%	
45 – 54	24.3%	20.2%	19.5%	
55 – 64	33.3%	22.2%	25.0%	
65+	13.3%	10.4%	14.7%	
Education				
High School Graduate	9.8%	15.7%	21.3%	<0.001
Associate's Degree	9.8%	13.9%	14.5%	
Bachelor's Degree	37.8%	38.6%	37.0%	
Graduate, Post-doctoral, or Professional Degree	42.5%	31.9%	27.2%	
Household income				
Less than $24,999	4.0%	6.4%	5.7%	0.764
Between $25,000 to $34, 999	7.6%	7.2%	7.7%	
Between $35,000 to $49,999	11.2%	10.3%	11.0%	
Between $50,000 to $74,999	18.5%	22.9%	20.6%	
Between $75,000 to $99,999	18.5%	18.0%	19.5%	
Between $100,000 to $149,999	20.9%	20.2%	22.1%	
Between $150,000 to $199,999	10.4%	8.9%	8.3%	
$200,000 or more	8.8%	6.0%	5.1%	
Household size*	2.22	2.52 **A**	2.51 **A**	.005
# of people under 18*	0.21	0.43 **A**	0.40 **A**	.001

*Results of the comparison of household size & # of people under 18 are based on the ANOVA test. The Brown-Forsythe test and Dunnett's T3 post hoc procedure are used. For each significant pair, the key of the smaller category (A, B, or C) appears under the group with the larger mean.

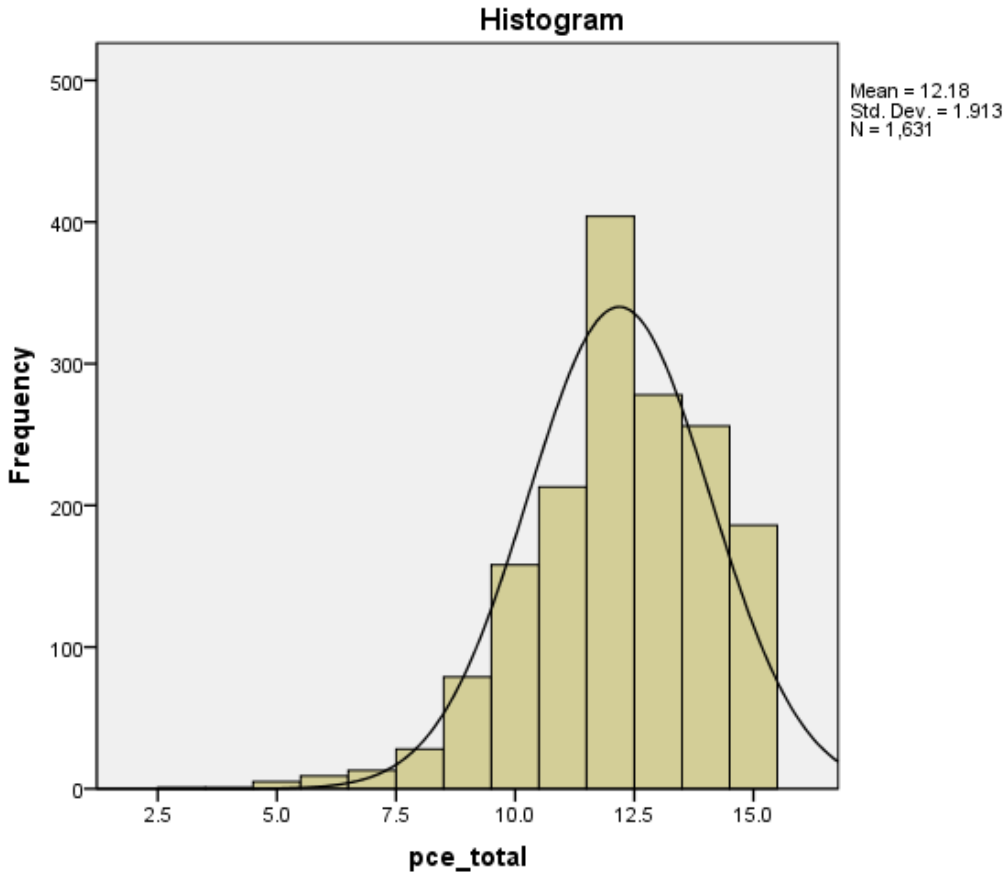
Appendix I: Responses to Perceived Consumer Effectiveness Statements



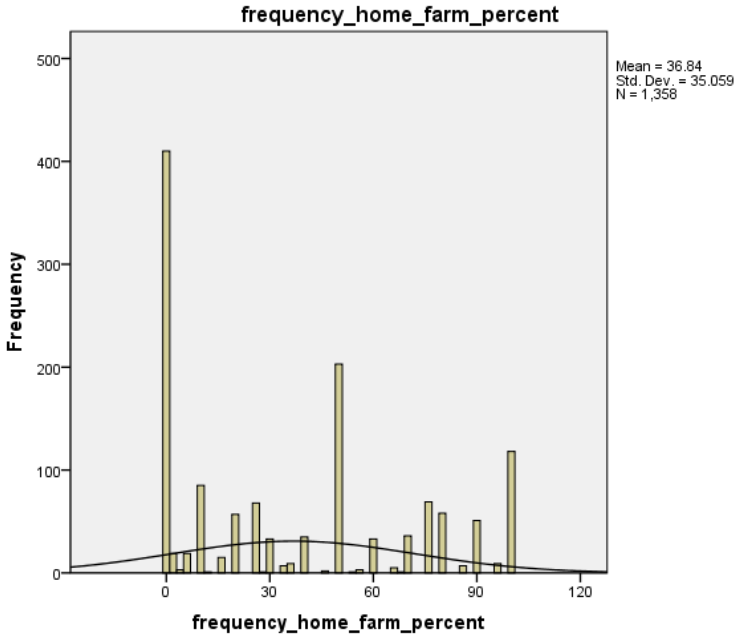


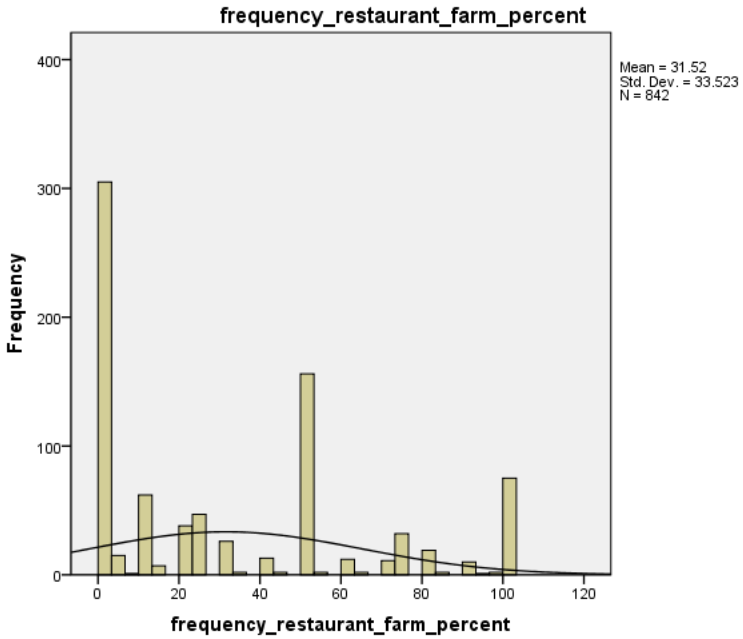


Appendix J: Frequency Distribution of PCE Levels

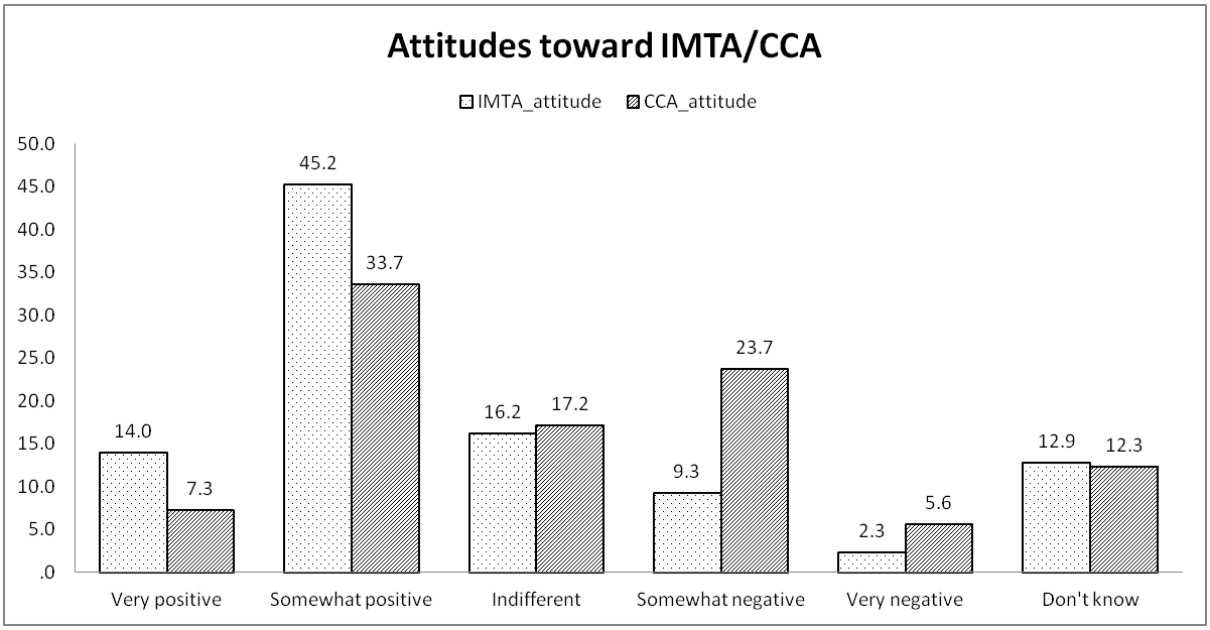


Appendix K: Frequency Distributions of Estimated Farmed Salmon Consumption

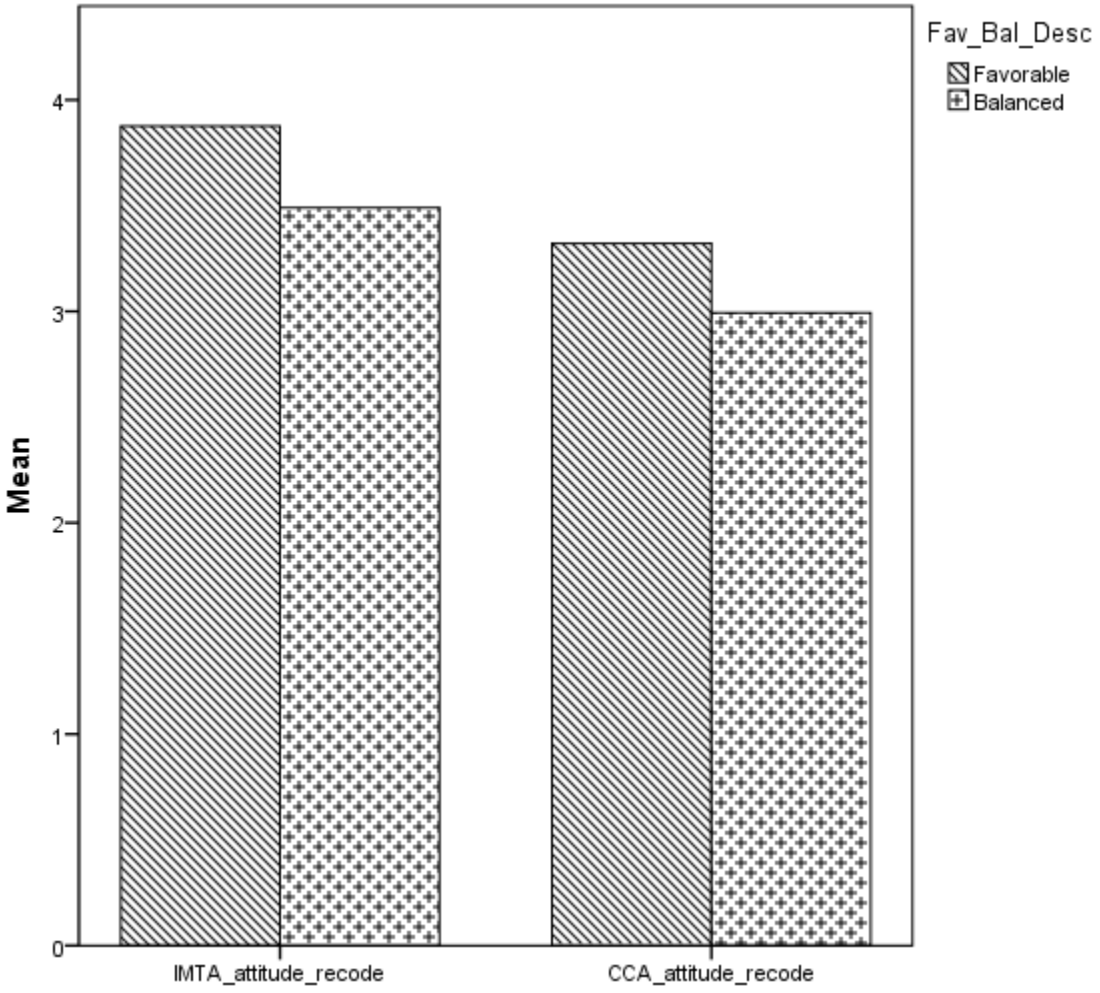




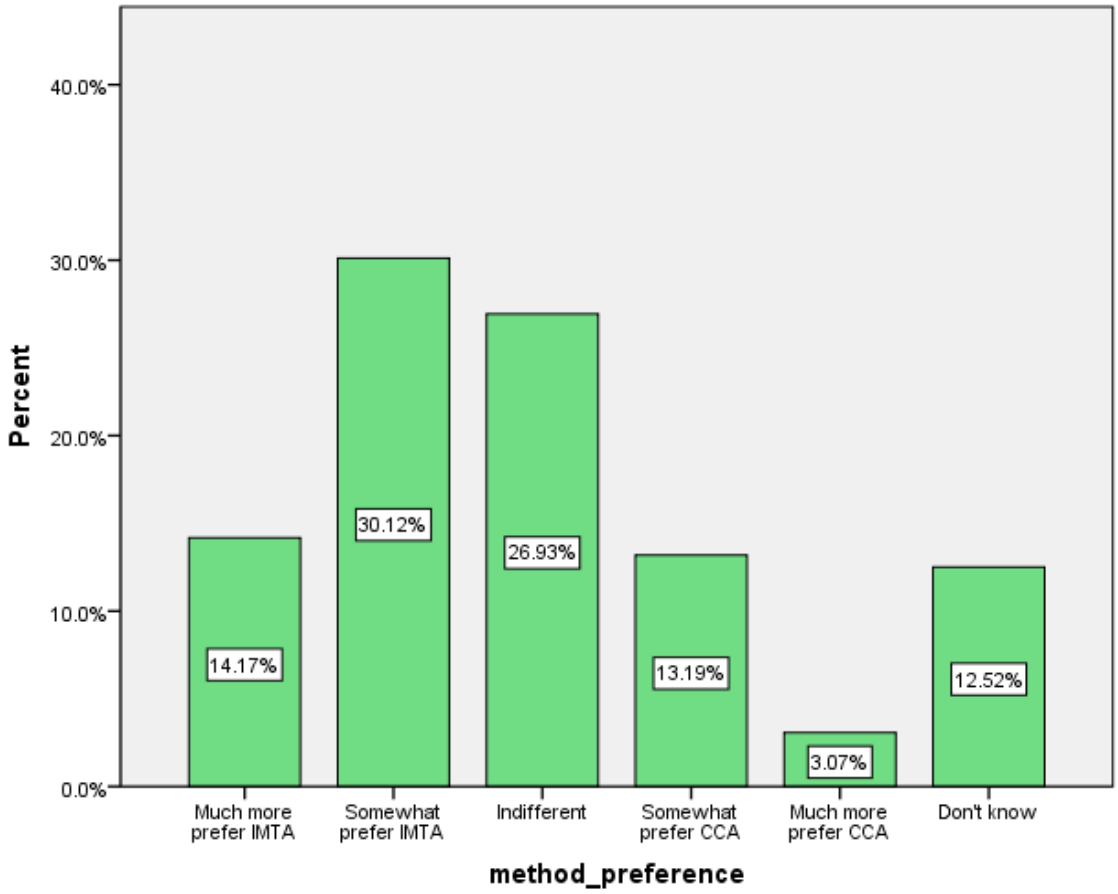
Appendix L: Percentage per Response Distribution of Attitudes toward IMTA and CCA



Appendix M: Differences in Mean Attitudes toward IMTA and CCA by Descriptions



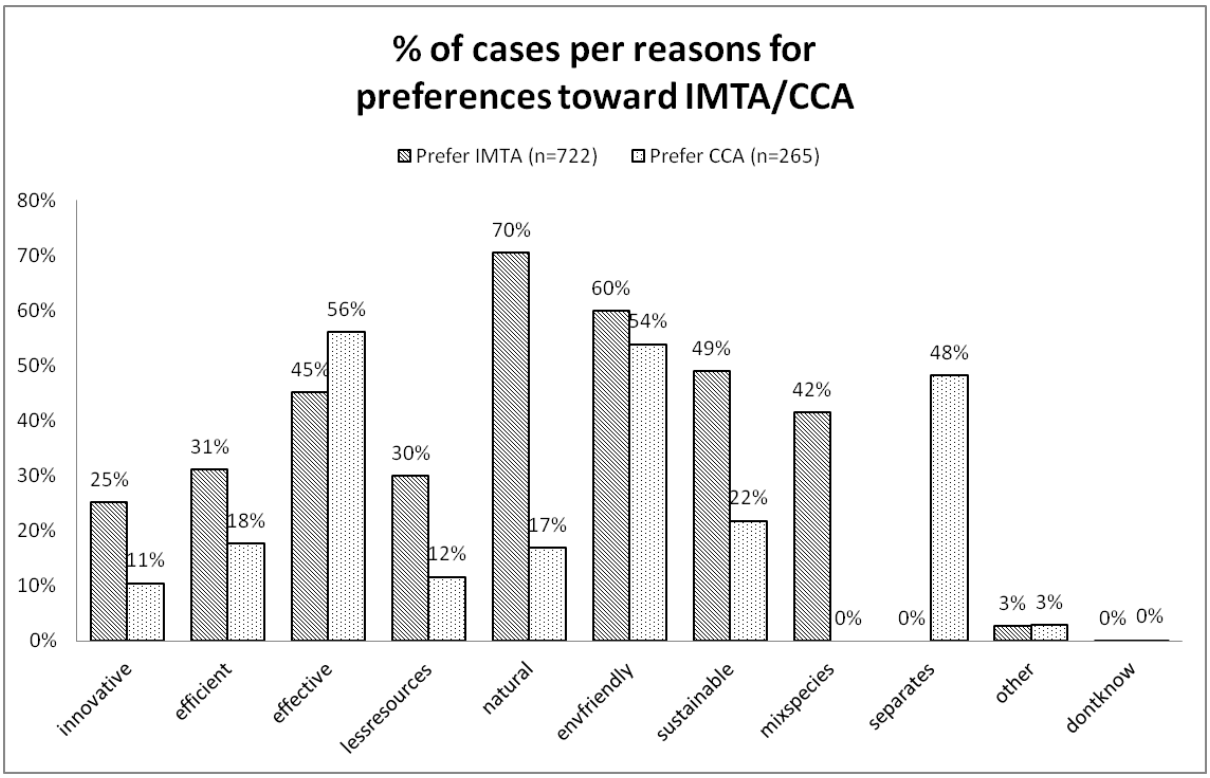
Appendix N: Percentage per Response Distribution of Preference toward IMTA or CCA



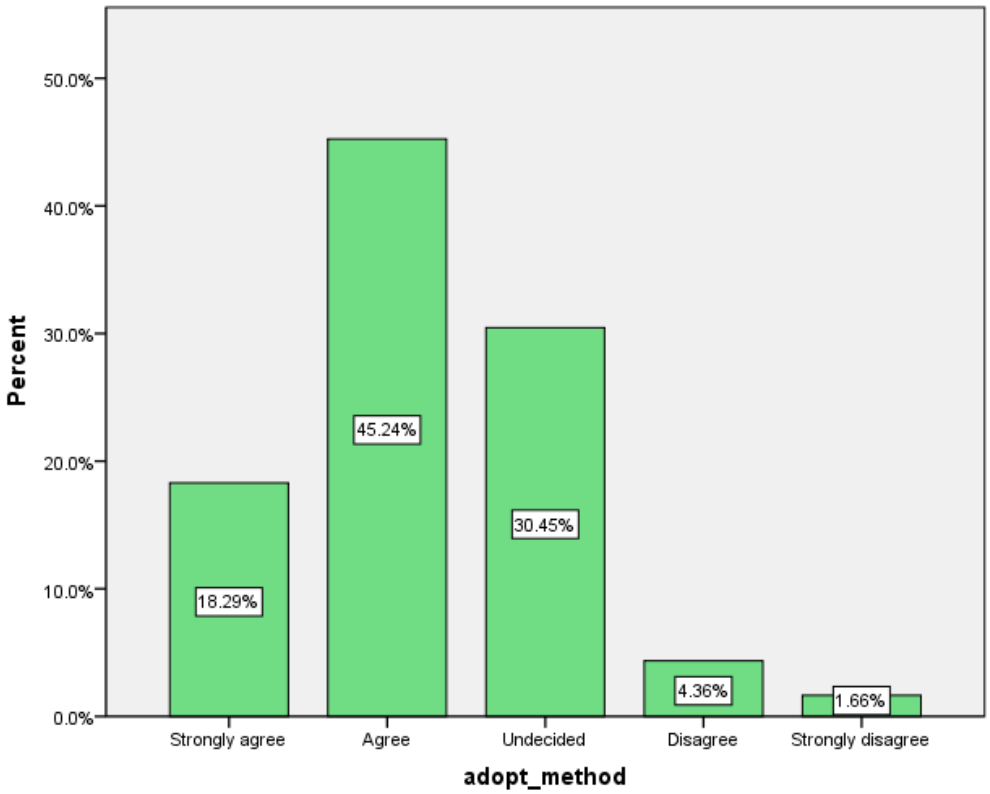
Appendix O: Frequency Distribution of Responses to Method Preferences

	Total Sample		Segments			
			Segment 1 Fav IMTA, CCA	Segment 2 Bal IMTA, CCA	Segment 3 Fav CCA, IMTA	Segment 4 Bal CCA, IMTA
	Freq.	Percent	Freq.	Freq.	Freq.	Freq.
Much more prefer IMTA	231	14.2%	70	59	52	50
Somewhat prefer IMTA	491	30.1%	125	127	137	102
Indifferent	439	26.9%	106	102	110	121
Somewhat prefer CCA	215	13.2%	40	66	45	64
Much more prefer CCA	50	3.1%	12	11	14	13
Don't know	204	12.5%	44	51	48	61
Total	1630	100.0%	397	416	406	411

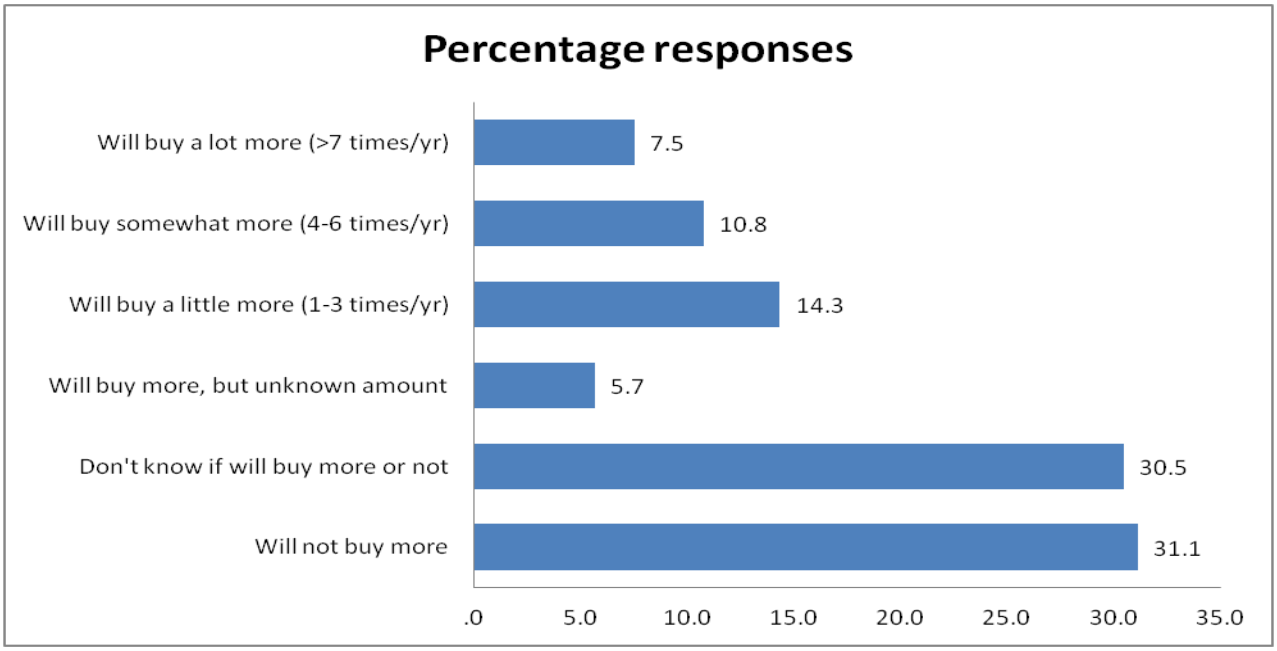
Appendix P: Reasons for Preference for IMTA or CCA

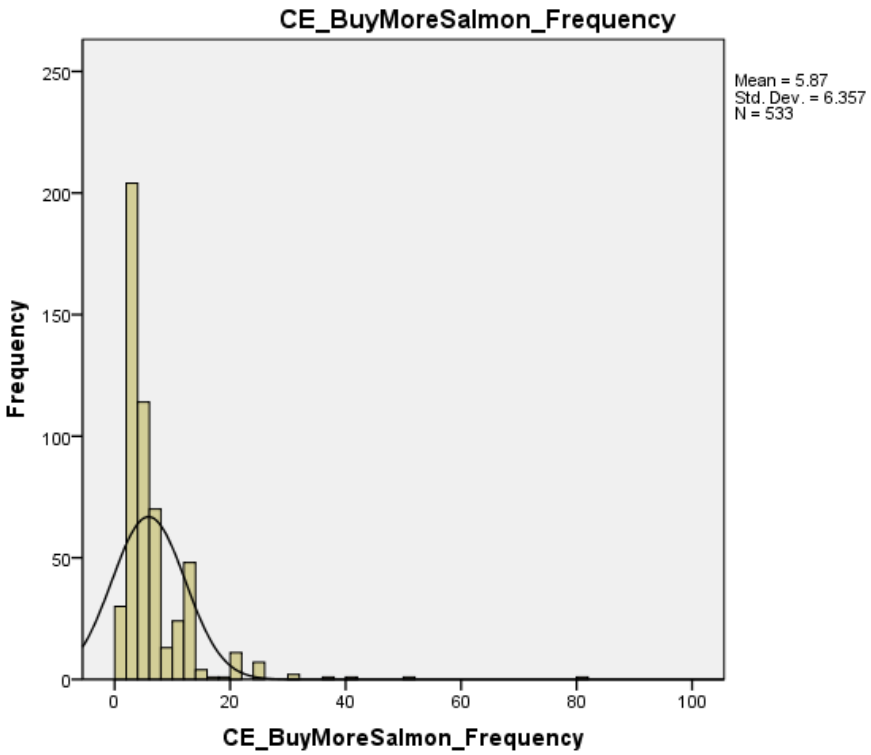


Appendix Q: Responses on Sustainable Method Adoption

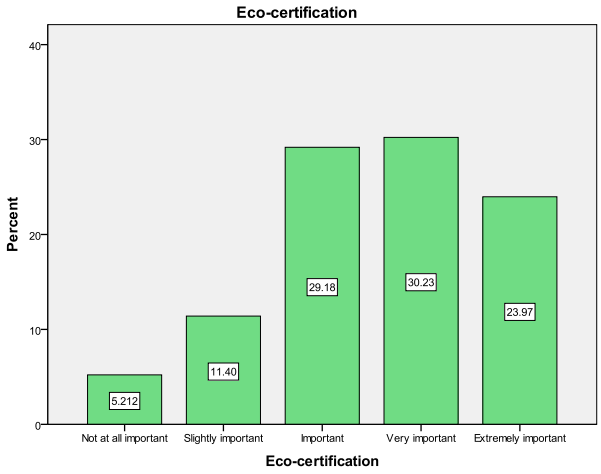


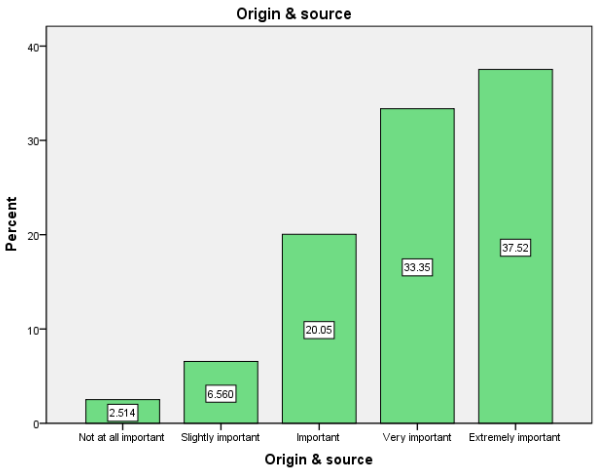
Appendix R: Responses on Additional Farmed Salmon Purchases

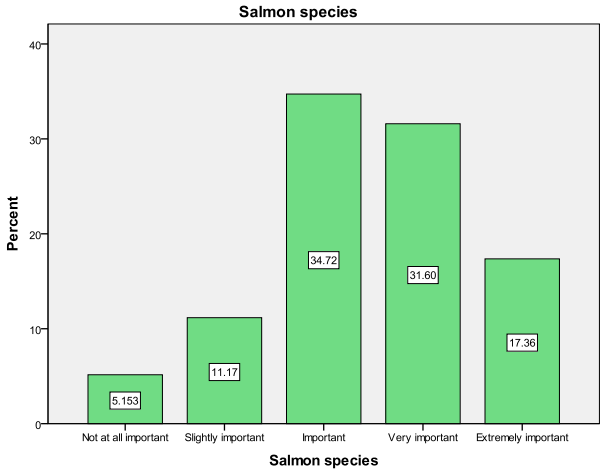


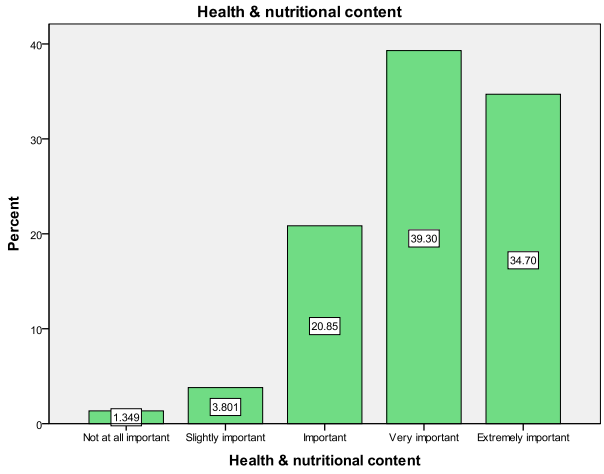


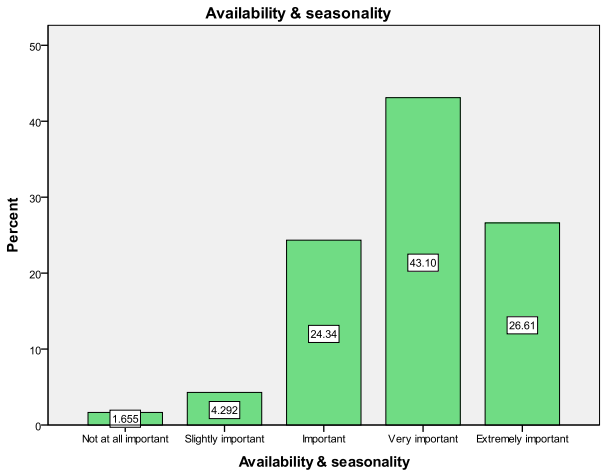
Appendix S: Frequency Distributions of Salmon Purchase Factors

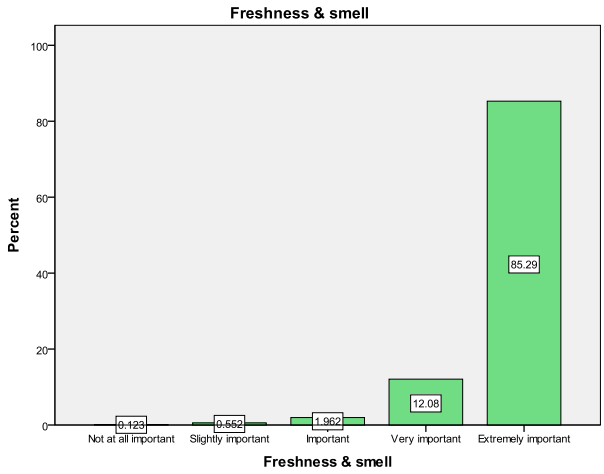


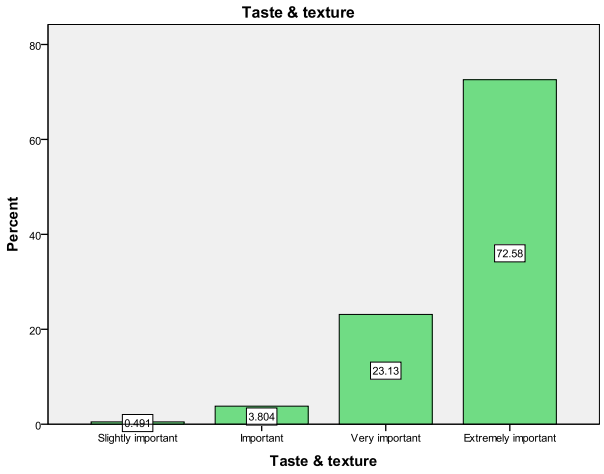


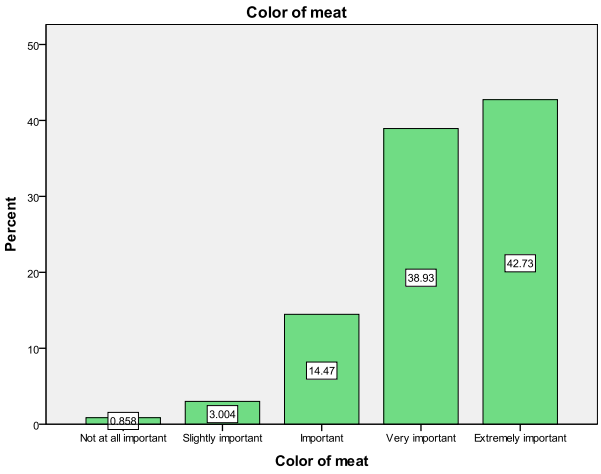


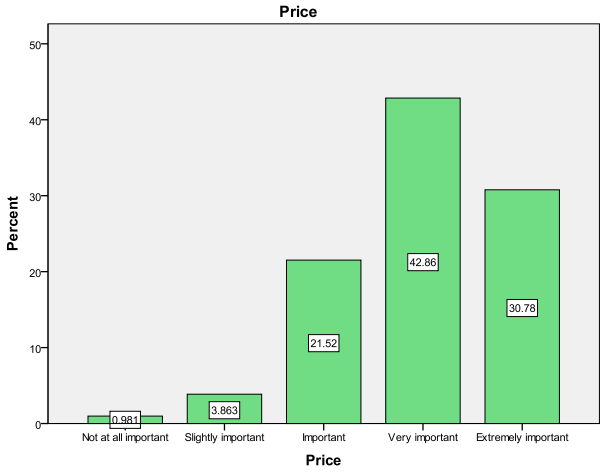







Taste & texture
Percent
80
60
40
20
0
0.491
3.804
23.13
72.58
Slightly important
Important
Very important
Extremely important
Taste & texture


Color of meat
Percent
50
40
30
20
10
0
0.858
3.004
14.47
38.93
42.73
Not at all important
Slightly important
Important
Very important
Extremely important
Color of meat


Price
Percent
50
40
30
20
10
0
0.981
3.863
21.52
42.86
30.78
Not at all important
Slightly important
Important
Very important
Extremely important
Price

Appendix T: Demographic Distribution of PCA Clusters

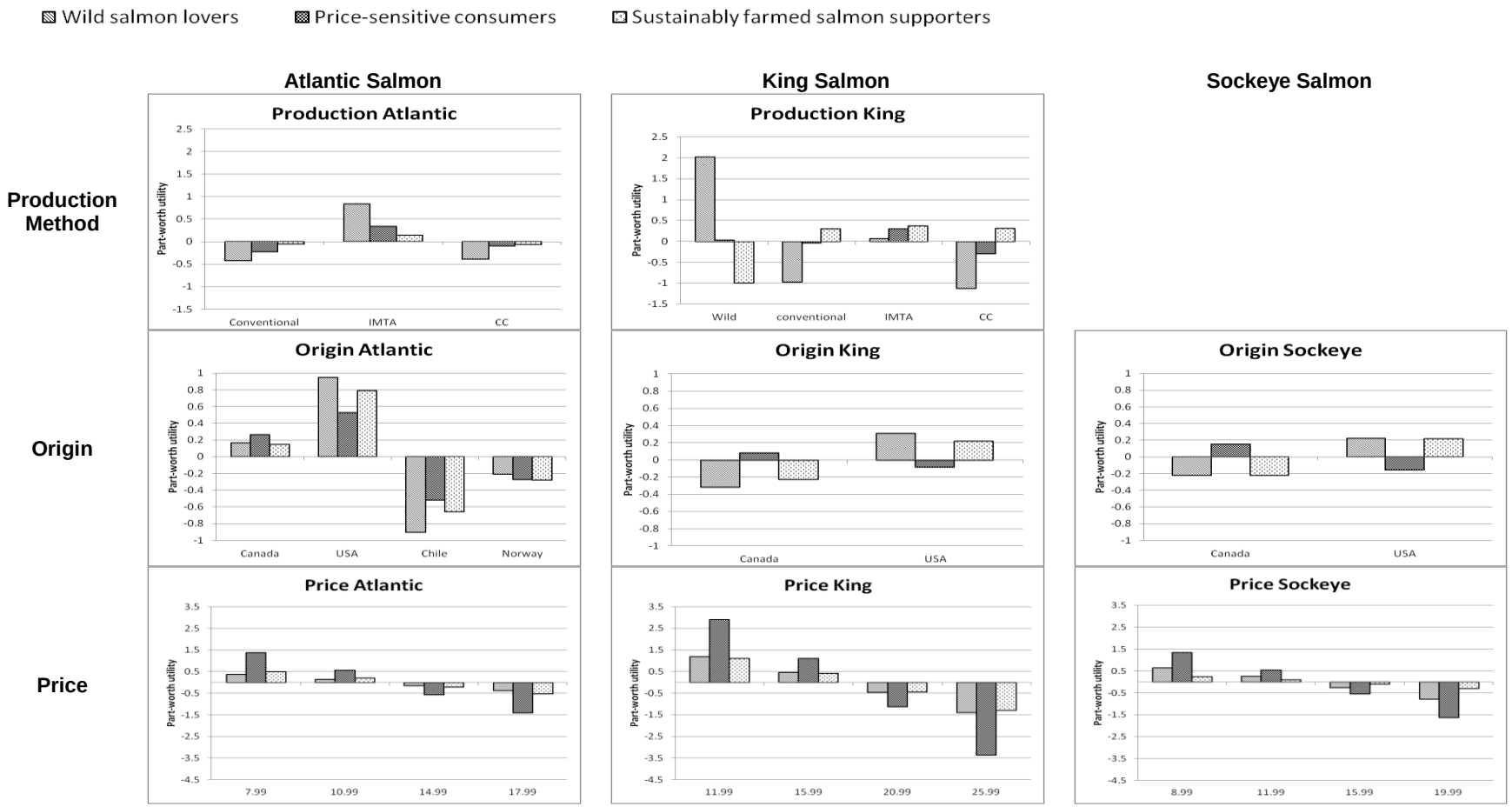
	Credence n=458 (A)	Quality & Price n=473 (B)	Quality n=368 (C)	Price n=332 (D)	Chi-Square
Place of Residence					
Seattle, WA	34.1%	37.4%	33.4%	36.7%	0.516
Portland, OR	28.8%	27.9%	32.3%	31.9%	
San Francisco, CA	37.1%	34.7%	34.2%	31.3%	
Gender					
Male	24.0%	33.8%	34.5%	43.1%	<0.001
Female	76.0%	66.2%	65.5%	56.9%	
Age					
19	0.2%	0.6%	0.5%	1.2%	0.005
20 – 24	2.4%	4.9%	3.0%	6.6%	
25 – 34	16.2%	22.4%	20.9%	27.4%	
35 – 44	15.7%	14.8%	14.9%	13.9%	
45 – 54	21.0%	21.8%	22.3%	16.0%	
55 – 64	29.5%	24.1%	25.3%	21.7%	
65+	15.1%	11.4%	13.0%	13.3%	
Degree					
High School Graduate	15.8%	20.8%	17.7%	16.3%	0.129
Associate's Degree	15.8%	12.3%	12.5%	13.6%	
Bachelor's Degree	34.6%	38.9%	36.0%	41.9%	
Graduate, Post-doctoral, or Professional Degree	33.9%	28.0%	33.8%	28.3%	
Household income					
Less than $24,999	5.6%	5.9%	3.9%	7.3%	0.002
Between $25,000 to $34, 999	9.2%	6.5%	4.5%	10.1%	
Between $35,000 to $49,999	11.5%	11.5%	7.5%	13.1%	
Between $50,000 to $74,999	18.5%	23.7%	21.2%	20.2%	
Between $75,000 to $99,999	20.3%	19.1%	18.7%	16.8%	
Between $100,000 to $149,999	22.7%	19.3%	22.3%	21.1%	
Between $150,000 to $199,999	8.3%	8.5%	11.5%	7.0%	
$200,000 or more	3.8%	5.9%	10.3%	4.3%	
Household size	2.39	2.47	2.41	2.62	0.096
# of people under 18	0.35	0.40	0.32	0.45	0.129

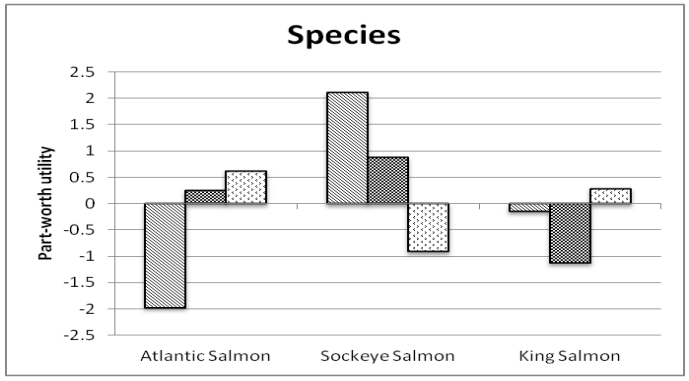
Appendix U: Part-Worth Utility of the 1-Class Model

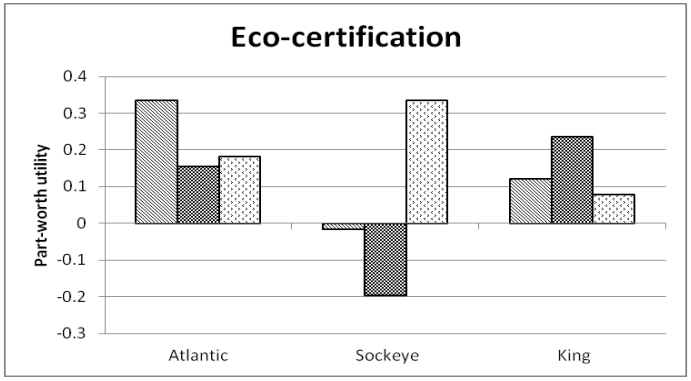
		Overall n = 1631	Wald (p-value)
Species	Atlantic Salmon	-0.3616 (0.0199)*	<0.001
	Sockeye Salmon	0.6255 (0.0174)*	
	King Salmon	-0.2639 (0.0193)*	
Production Atlantic	Conventional	-0.2427 (0.0375)*	<0.001
	IMTA	0.2759 (0.0304)*	
	CC	-0.0332 (0.0377)	
Production King	Wild	0.4478 (0.0373)*	<0.001
	Conventional	-0.2184 (0.0426)*	
	IMTA	0.084 (0.0384)**	
	CC	-0.3134 (0.0428)*	
Certification Atlantic	No	-0.1223 (0.0235)*	<0.001
	Yes	0.1223 (0.0235)*	
Certification Sockeye	No	-0.0328 (0.0186)***	0.077
	Yes	0.0328 (0.0186)***	
Certification King	No	-0.0988 (0.023)*	<0.001
	Yes	0.0988 (0.023)*	
Origin Atlantic	Canada	0.1754 (0.038)*	<0.001
	USA	0.5585 (0.0369)*	
	Chile	-0.6187 (0.0443)*	
	Norway	-0.1151 (0.0422)*	
Origin Sockeye	Canada	-0.1479 (0.0188)*	<0.001
	USA	0.1479 (0.0188)*	
Origin King	Canada	-0.1489 (0.0245)*	<0.001
	USA	0.1489 (0.0245)*	
Price Atlantic		-0.4833 (0.026)*	<0.001
Price Sockeye		-0.5259 (0.0195)*	<0.001
Price King		-0.5552 (0.0191)*	<0.001
Intercept		0.4133 (0.0257)*	<0.001

* Significantly different from a parameter estimate of 0 at the 1% level
** Significantly different from a parameter estimate of 0 at the 5% level
*** Significantly different from a parameter estimate of 0 at the 10% level
( ) represents standard error
Significance of coefficients are explained by the Wald p-value, while significance between classes are explained by the Wald(=) p-value

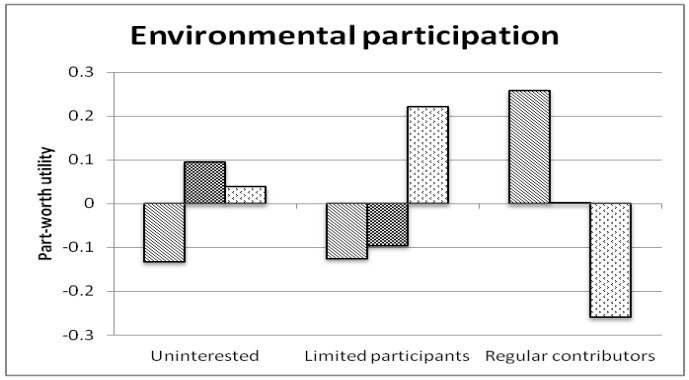
Appendix V. Graphical Illustration of the Part-Worth Utilities for Each Attribute by Class of the 3-Class Model







Coefficients of Covariate Analysis by Class:



Appendix X: Analysis of Correlation between PCA and Environmental Participation Clusters

CLU_Env_Part * CLU_PCA_4Clu Crosstabulation

			CLU_PCA_4Clu				
			Credence	Quality & Price	Quality	Price	Total
CLU_Env_Part	Uninterested	Count	221	291	184	180	876
		% within CLU_Env_Part	25.2%	33.2%	21.0%	20.5%	100.0%
		% within CLU_PCA_4Clu	48.3%	61.5%	50.0%	54.2%	53.7%
		% of Total	13.5%	17.8%	11.3%	11.0%	53.7%
	Limited participants	Count	149	132	122	97	500
		% within CLU_Env_Part	29.8%	26.4%	24.4%	19.4%	100.0%
		% within CLU_PCA_4Clu	32.5%	27.9%	33.2%	29.2%	30.7%
		% of Total	9.1%	8.1%	7.5%	5.9%	30.7%
	Regular contributors	Count	88	50	62	55	255
		% within CLU_Env_Part	34.5%	19.6%	24.3%	21.6%	100.0%
		% within CLU_PCA_4Clu	19.2%	10.6%	16.8%	16.6%	15.6%
		% of Total	5.4%	3.1%	3.8%	3.4%	15.6%
Total		Count	458	473	368	332	1631
		% within CLU_Env_Part	28.1%	29.0%	22.6%	20.4%	100.0%
		% within CLU_PCA_4Clu	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	28.1%	29.0%	22.6%	20.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.579[a]	6	.001
Likelihood Ratio	24.196	6	.000
Linear-by-Linear Association	.390	1	.532
N of Valid Cases	1631		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 51.91.

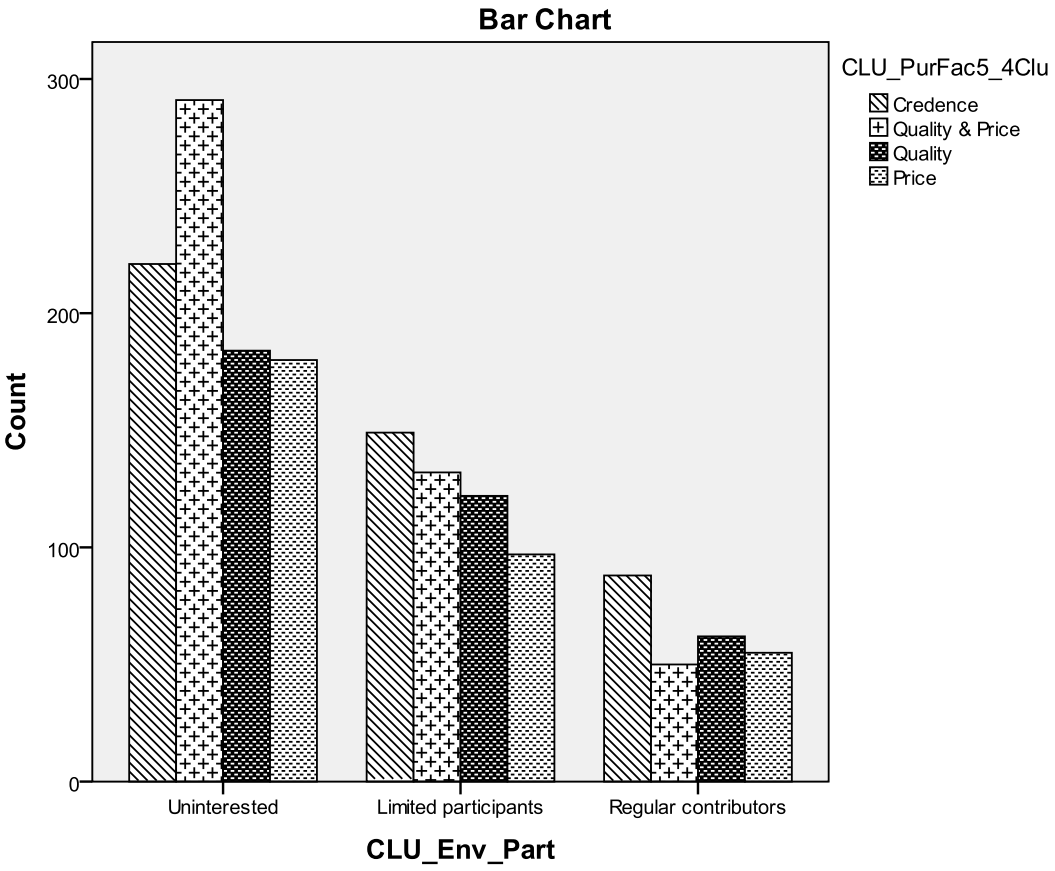
Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Interval by Interval	Pearson's R	-.015	.025	-.625	.532[c]
Ordinal by Ordinal	Spearman Correlation	-.020	.025	-.797	.425[c]
N of Valid Cases		1631			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.



Appendix X: Demographics & Attitudes of Latent Classes

Demographics

	Wild salmon lovers n=754 (A)	Price-sensitive consumers n=443 (B)	Sustainably farmed salmon supporters n=431 (C)	Chi-Square
Place of Residence				
Seattle, WA	42.2%	33.4%	26.0%	<0.001
Portland, OR	30.5%	33.9%	24.6%	
San Francisco, CA	27.3%	32.7%	49.4%	
Gender				
Male	32.5%	36.8%	29.9%	0.090
Female	67.5%	63.2%	70.1%	
Age				
19	0.3%	0.9%	0.9%	<0.001
20 – 24	1.7%	5.6%	6.7%	
25 – 34	18.6%	23.0%	24.6%	
35 – 44	13.9%	17.4%	14.2%	
45 – 54	22.0%	17.6%	20.6%	
55 – 64	29.6%	23.5%	20.0%	
65+	13.9%	12.0%	13.0%	
Education				
High School Graduate	13.9%	18.6%	23.5%	0.001
Associate's Degree	13.5%	13.2%	14.2%	
Bachelor's Degree	37.7%	39.0%	35.8%	
Graduate, Post-doctoral, or Professional Degree	34.8%	20.3%	26.5%	
Household income				
Less than $24,999	4.5%	6.7%	6.7%	0.057
Between $25,000 to $34, 999	6.3%	8.9%	8.1%	
Between $35,000 to $49,999	10.2%	11.9%	10.9%	
Between $50,000 to $74,999	18.9%	25.2%	20.2%	
Between $75,000 to $99,999	20.3%	18.1%	17.1%	
Between $100,000 to $149,999	22.9%	17.9%	22.1%	
Between $150,000 to $199,999	9.9%	7.1%	8.8%	
$200,000 or more	7.0%	4.1%	6.2%	
Household size	2.30	2.50 **A**	2.68 **A**	.000
# of people under 18	0.32	0.41	0.45 **A**	.032

*Results of the comparison of household size & # of people under 18 are based on the ANOVA test. The Brown-Forsythe test and Dunnett's T3 post hoc procedure are used. For each significant pair, the key of the smaller category (A, B, or C) appears under the group with the larger mean.

ANOVA Results

	Total	Wild salmon lovers n=754 (A)	Price-sensitive consumers n=443 (B)	Sustainably farmed salmon supporters n=431 (C)	Sig. Level
Home consumption frequency	12.28 (11.63 - 12.92)	14.27 (13.22 - 15.32) **B C**	10.67 (9.63 - 11.71)	10.46 (9.32 - 11.61)	<0.001
Restaurant consumption frequency	6.02 (5.65 - 6.39)	6.56 (5.96 - 7.20) **C**	5.66 (4.97 - 6.34)	5.46 (4.88 - 6.04)	0.027
Salmon purchase amount*	2.11 (2.00 - 2.23)	2.00 (1.82 - 2.17)	2.20 (2.00 - 2.39)	2.24 (2.00 - 2.48)	0.159
Salmon purchase price	9.36 (9.10 - 9.62)	9.74 (9.38 - 10.10) **B**	8.13 (7.73 - 8.53)	10.07 (9.45 - 10.69) **B**	<0.001
Attitude toward IMTA	3.68 (3.63 - 3.73)	3.41 (3.33 - 3.50)	3.84 (3.76 - 3.93) **A**	3.93 (3.85 - 4.00) **A**	<0.001
Attitude toward CCA	3.15 (3.09 - 3.21)	2.84 (2.75 - 2.93)	3.29 (3.19 - 3.39) **A**	3.48 (3.39 - 3.58) **A B**	<0.001
Method preference*	0.45 (0.39 - 0.50)	0.45 (0.37 - 0.54)	0.49 (0.39 - 0.59)	0.40 (0.29 - 0.50)	0.428
PCE score*	12.18 (12.09 - 12.28)	12.48 (12.35 - 12.61) **A B**	11.92 (11.74 - 12.10)	11.98 (11.80 - 12.16)	<0.001

Note: Results of the comparison of column means are based on the ANOVA test. The Tukey's post hoc procedure assuming equal variances (0.05 significance level) is used for * items. The Brown-Forsythe test and Dunnett's T3 post hoc procedure are used for the remaining items, as the Levene's test indicated that the variable's variances are not equal. For each significant pair, the key of the smaller category (A, B, C or D) appears under the group with the larger mean.

Appendix Y: Known Class Analysis Results by Information Treatments

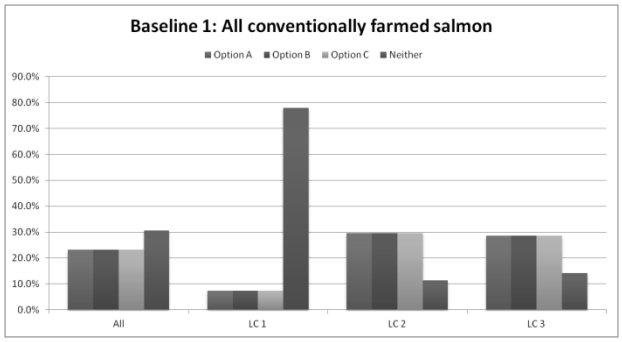
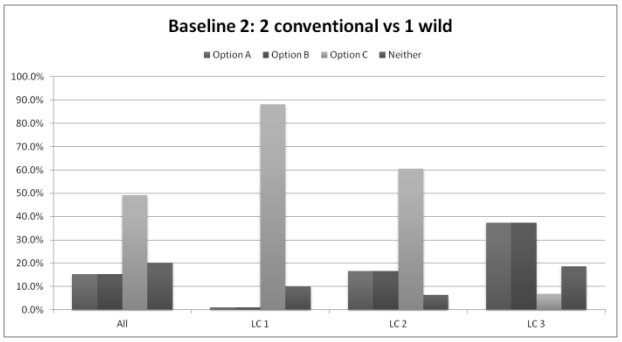
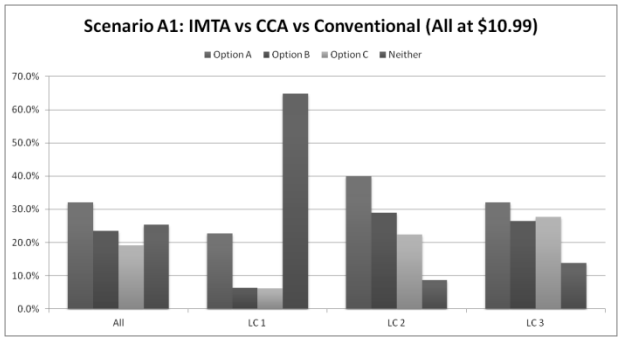
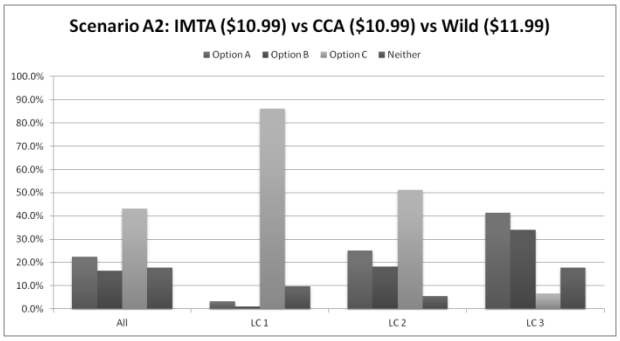
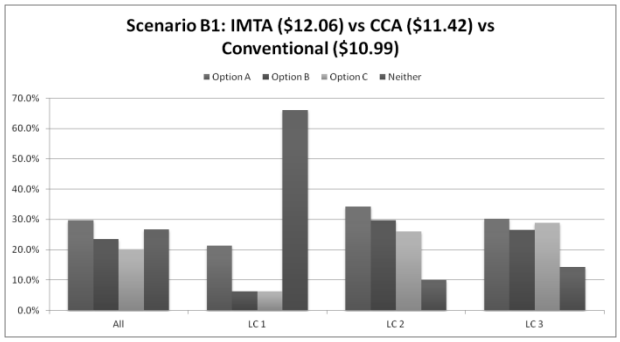
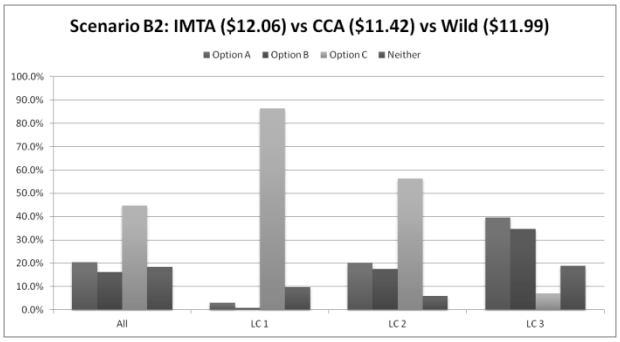
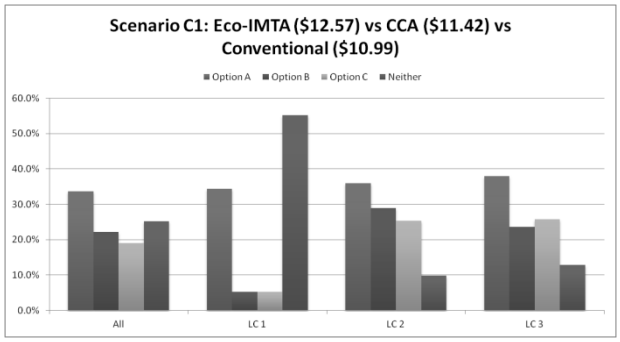
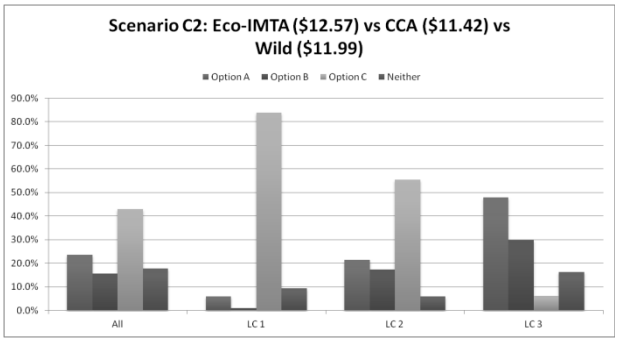
Treatment 1: The sequence of technology descriptions

Attributes		IMTA First	CCA First	Wald p-value	Wald(=) p-value
SPEC					
Atlantic Salmon		-0.3458	-0.5087	1.50E-30	0.38
Sockeye Salmon		0.6514	0.6751		
King Salmon		-0.3056	-0.1665		
PROD_A					
Conventional		-0.2283	-0.2739	5.20E-21	0.39
IMTA		0.3271	0.2711		
CC		-0.0987	0.0028		
PROD_K					
Wild		0.4851	0.436	7.60E-42	0.36
conventional		-0.3327	-0.1777		
IMTA		0.1869	0.1339		
CC		-0.3393	-0.3921		
Eco-certified Atlantic		0.1965	0.301	1.20E-06	0.28
Eco-certified Sockeye		0.1865	0.2375	9.40E-07	0.53
Eco-certified King		0.1935	0.1952	0.00023	0.98
ORIGIN_A					
Canada		0.1513	0.1311	1.70E-67	0.28
USA		0.4943	0.6417		
Chile		-0.6004	-0.6547		
Norway		-0.0452	-0.1181		
ORIGIN_S					
Canada		-0.242	-0.2051	8.60E-27	0.37
USA		0.242	0.2051		
ORIGIN_K					
Canada		-0.2072	-0.2281	9.10E-17	0.68
USA		0.2072	0.2281		
PRICE_A					
	$7.99	0.6333	0.6945	8.80E-81	0.79
	$10.99	0.2282	0.261		
	$14.99	-0.2881	-0.2962		
	$17.99	-0.5733	-0.6593		
PRICE_S					
	$8.99	0.8083	0.7741	1.50E-213	0.47
	$11.99	0.4664	0.4338		
	$15.99	-0.1364	-0.1884		
	$19.99	-1.1383	-1.0195		
PRICE_K					
	$11.99	1.1008	0.9599	2.30E-194	0.21
	$15.99	0.4645	0.4212		
	$20.99	-0.6029	-0.4625		
	$25.99	-0.9624	-0.9186		

Treatment 2: The type of technology descriptions

Attributes	Favorable	Balanced	Wald p-value	Wald(=) p-value
SPEC				
Atlantic Salmon	-0.3554	-0.4943	7.90E-31	0.33
Sockeye Salmon	0.6871	0.6454		
King Salmon	-0.3317	-0.1511		
PROD_A				
Conventional	-0.3343	-0.1672	1.00E-21	0.045
IMTA	0.3595	0.236		
CC	-0.0252	-0.0689		
PROD_K				
Wild	0.4744	0.4413	2.50E-41	0.5
conventional	-0.3155	-0.1913		
IMTA	0.1979	0.1241		
CC	-0.3568	-0.3741		
Eco-certified Atlantic	0.2519	0.2431	2.00E-06	0.93
Eco-certified Sockeye	0.1973	0.2238	1.30E-06	0.74
Eco-certified King	0.2576	0.1375	9.40E-05	0.21
ORIGIN_A				
Canada	0.1216	0.1668	3.60E-67	0.64
USA	0.5851	0.5508		
Chile	-0.5871	-0.6741		
Norway	-0.1195	-0.0434		
ORIGIN_S				
Canada	-0.2208	-0.227	9.00E-27	0.88
USA	0.2208	0.227		
ORIGIN_K				
Canada	-0.215	-0.2266	3.60E-17	0.82
USA	0.215	0.2266		
PRICE_A				
$7.99	0.6412	0.6902	8.60E-82	0.6
$10.99	0.2947	0.1968		
$14.99	-0.3092	-0.2796		
$17.99	-0.6267	-0.6073		
PRICE_S				
$8.99	0.7838	0.7989	1.70E-213	0.66
$11.99	0.4247	0.4713		
$15.99	-0.1776	-0.1465		
$19.99	-1.0309	-1.1237		
PRICE_K				
$11.99	1.1256	0.9351	5.90E-195	0.044
$15.99	0.4004	0.4831		
$20.99	-0.5006	-0.5564		
$25.99	-1.0254	-0.8619		

Treatment 3: High/Low Price Common Sets

Attributes	High Average Price	Low Average Price	Wald p-value	Wald(=) p-value
SPEC				
Atlantic Salmon	-0.2845	-0.5571	1.60E-31	0.066
Sockeye Salmon	0.6461	0.6821		
King Salmon	-0.3616	-0.125		
PROD_A				
Conventional	-0.2518	-0.2457	2.10E-20	0.71
IMTA	0.3241	0.2739		
CC	-0.0723	-0.0283		
PROD_K				
Wild	0.46	0.464	2.60E-42	0.24
conventional	-0.2133	-0.2888		
IMTA	0.2145	0.1159		
CC	-0.4611	-0.2911		
Eco-certified Atlantic	0.1229	0.3605	9.10E-08	0.014
Eco-certified Sockeye	0.2282	0.1946	1.40E-06	0.68
Eco-certified King	0.2683	0.1294	7.80E-05	0.14
ORIGIN_A				
Canada	0.0976	0.1786	1.40E-68	0.23
USA	0.6161	0.5409		
Chile	-0.5684	-0.6897		
Norway	-0.1453	-0.0297		
ORIGIN_S				
Canada	-0.2003	-0.245	5.40E-27	0.28
USA	0.2003	0.245		
ORIGIN_K				
Canada	-0.2094	-0.2294	4.70E-17	0.7
USA	0.2094	0.2294		
PRICE_A				
$7.99	0.7787	0.5671	2.10E-82	0.033
$10.99	0.2698	0.224		
$14.99	-0.3474	-0.2537		
$17.99	-0.701	-0.5374		
PRICE_S				
$8.99	0.8576	0.7275	5.80E-213	0.06
$11.99	0.4704	0.4342		
$15.99	-0.1426	-0.1774		
$19.99	-1.1854	-0.9843		
PRICE_K				
$11.99	1.0766	0.9845	1.30E-193	0.43
$15.99	0.4549	0.4364		
$20.99	-0.6063	-0.4676		
$25.99	-0.9252	-0.9533		

Appendix Z: Market Shares of Latent Classes in DSS