

# Risk-ranking of zoonotic diseases: a multi-factor framework

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# Objective

- To develop a framework that compares and ranks foodborne pathogens on the basis of public health impact as well as social and economic consequences

Why?

- Assist risk managers in allocating resources and establishing longer term policies
- Structured methods for assessing and integrating social and economic factors

# Multi-factor Risk Prioritization Framework

Four major factors (risk dimensions):

- Public Health
- Market-Level Impact
- Social Sensitivity
- Consumer Perception & Acceptance of Risk

# Factors

- **What:** Public Health
- **Why:** Quantify the impact and burden of disease
- **How:**
  - Disability-adjusted life years (DALY)
  - Cost-of-illness (COI)

# Factors

- **What:** Market-level impact
- **Why:** Capture the potential economic losses of foodborne pathogen-related disease and outbreaks
- **How:**
  - Total value at retail + value of exports minus value of imports

# Factors

- **What:** Social sensitivity
- **Why:** Account for society being more sensitive about risk to particular groups than to the ‘average’ risk for society
- **How:**
  - Delphi-based 0-1 rating for sensitivity based on vulnerable consumers (e.g. pregnant women and listeriosis, elderly, immune-compromised);
  - Delphi-based 0-1 rating for sensitivity based on vulnerable firms (e.g. small firms, firms in marginal economic areas)

# Factors

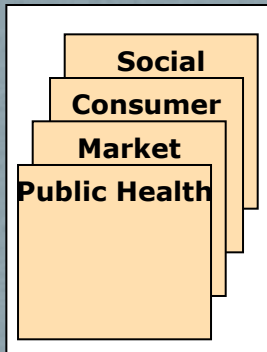
- **What:** Consumer perception and acceptance of risk
- **Why:** Capture that consumers may perceive and accept or reject foodborne risks differently based on characteristics of the risk as it affects themselves
- **How:**
  - Delphi-based rating of five criteria related to perception and acceptance of risk

# Criteria for Risk Perceptions

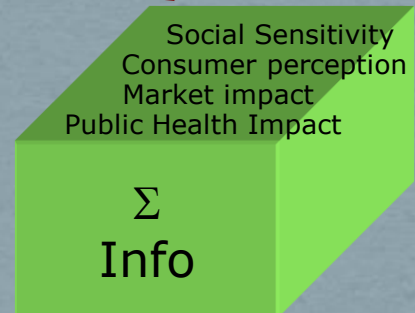
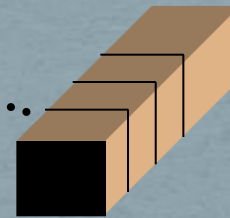
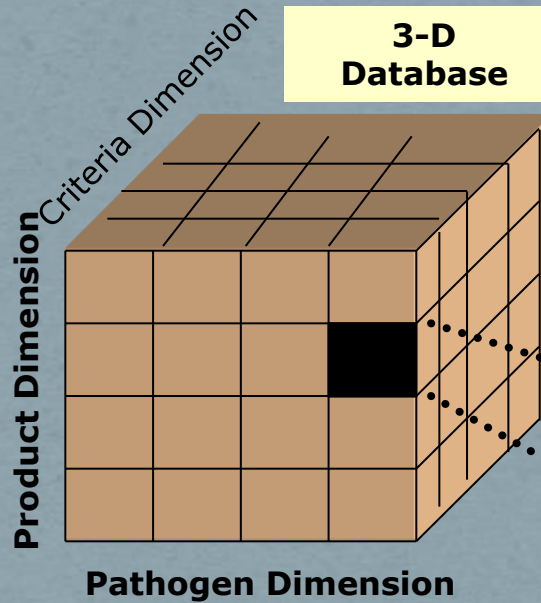
- Degree to which risk is perceived as uncontrollable by consumer
- Degree to which risk is perceived as unknown to the individual
- Degree to which risk is perceived as unknown to scientists
- Degree to which exposure to risk is perceived as involuntary
- Degree to which consumer perceive outcome as severe



## Information Cards



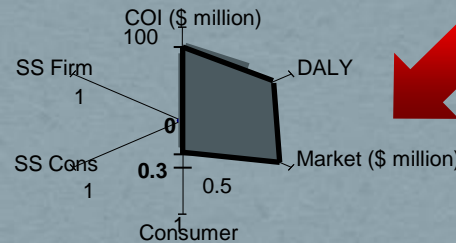
## 3-D Database



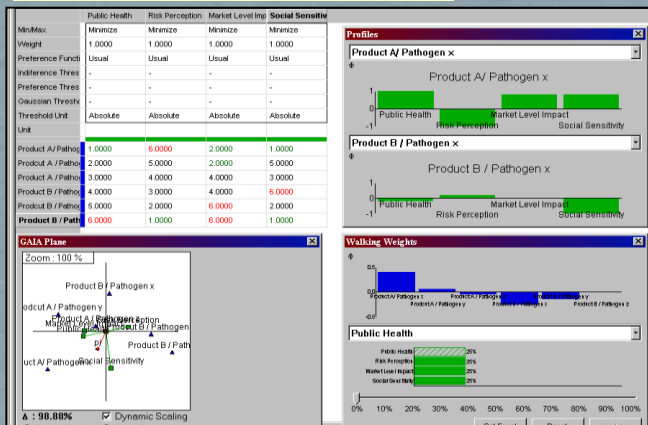
Food

Pathogen

## Visualisation Tool - Cobweb



## Formal MCDA Analysis



# Information Cards

## Campylobacteriosis associated with chicken consumption

### SOCIAL SENSITIVITY

Binary values (0 = no concern; 1=concern) are used for consumer groups and /or firm or market groups.

No human sub-populations are particularly susceptible to suffer lingering health effects, beyond vulnerability metrics. The chicken industry is not one of the most vulnerable in Canada.

Social Sensitivity Information

Consumer perspective

Industry/firm perspective

Information Card: CAMPYLOBACTERIOSIS ASSOCIATED WITH CHICKEN CONSUMPTION

### CONSUMER PERCEPTION AND ACCEPTANCE

#### Introduction

The following 5 criteria were selected to characterize consumer perception and acceptance of Campylobacteriosis in chicken.

Four members of the framework ranked the criteria according to the consumer's point of view. Then numerical scales (low=1, medium=2, and high=3), the average was calculated for each criteria. The expected total score for consumer perception and acceptance is 15. The expected score for each criterion is added to obtain the total score for consumer perception and acceptance in the summary table.

Consumer Perception and Acceptance
Degree to which risk is perceived as uncontrollable
Degree to which risk is perceived as unknown to the consumer
Degree to which risk is perceived as unknown to the consumer
Degree to which exposure to the risk is perceived to be high
Degree to which consumer perceive outcome as severe
<b>TOTAL (normalized, 0 to 1 scale)</b>

Information Card: CAMPYLOBACTERIOSIS ASSOCIATED WITH CHICKEN CONSUMPTION

### MARKET IMPACT

Canadian chicken consumption has been steadily increasing in last 3 decades. The demand for chicken rose by 136% from 1975 to 2005. Since 1979, the Canadian production of chicken is regulated under a supply management system. The intention of this supply management system is to match the demand with domestic supply and to guarantee a predetermined price to producers. Since Canadian producers mainly meet the domestic demand, Canada is ranked 15th in world export of chicken. Hence, Canada has a negative trade balance (imports outweigh exports). Chicken production is mainly concentrated in ON, QC and BC.

Data was obtained from Agriculture Economic Statistics (August 2009), CANSIM II and Agriculture and Agri-Food Canada. The average was calculated based on the last 3 years including the most recent year. The following market characteristics provide an overview of the commodity market and a point of comparison to the other cases.

- ⊖ The industry size is depicted by farm cash receipts, which is the total revenue to farms in an agricultural sub sector. It is comprised of agricultural commodity sales and program payments.
- ⊖ The importance of the commodity at the consumer level is represented by the total value at retail, which is the amount of the final consumer good purchased, multiplied by the price consumers paid.
- ⊖ The value of exports and imports is the quantity of the exported and imported commodity multiplied by the value, respectively.
- ⊖ To depict the economic significance of the commodity market in the domestic market, the following formula applies: Total value at retail + value of exports - value of imports . . .
- ⊖ The proportion of the domestic consumption of the commodity that is domestically produced is calculated by the domestic consumption divided by the domestic production.
- ⊖ The key import/export market values depict the importance of the imports and exports of the commodity. For the import market, the key import market number is calculated by the value of all imports of a specific commodity divided by the value of the total agri-food imports.

Market Information (\$1000)	Year 2008	3 year average 2006 ÷ 2008
Size of Industry (farm gate) farm cash receipts	\$1,987,928	\$1,760,597
Total value at retail	\$8,381,855	\$5,940,189
Value exports	\$328,475	\$285,732
Value imports	\$500,978	\$460,892
Economic importance of the domestic market	\$8,189,352	\$5,765,029
Domestic consumption / production	101.25%	102.24%
Key export market	0.84%	0.87%
Key import market	1.80%	1.84%

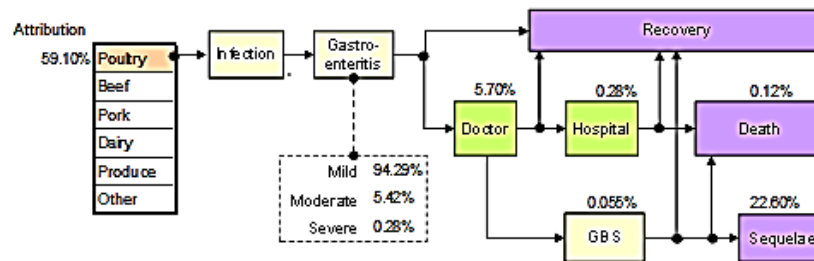
## PUBLIC HEALTH IMPACT

### Campylobacteriosis

It is an acute bacterial disease which attacks the digestive system. A person becomes infected by eating undercooked chicken or pork, or drinking contaminated water or raw milk. Infection may also be contracted from close contact with infected puppies and kittens, farm animals or infected infants. The illness is characterized by diarrhea, abdominal pain, malaise, fever, nausea and vomiting. Complications of Campylobacteriosis include Guillan-Barré syndrome (GBS) an illness which causes progressive weakness and paralysis; recovery is often slow and the condition may lead to death in some cases.

### The Data

Data was collected for a period of 10 years, 1994 to 2004. Disease incidence data was collected from Notifiable Disease on-line website and the estimates for the population were obtained from the CANSIM. The underreporting factor was considered to be 38.



### The Measures: DALYs and COI

Cost-of-illness (COI) was calculated based on the medical costs, loss of productivity and loss of life. OHIP costs were considered for doctor's visit, emergency services and hospitalization. The years of life loss and the years lived with disability were calculated to determine the Disability Adjusted Life Years (DALYs).

Public Health Information (associated with chicken consump.)	Year 2004		3 year average 2002 - 2004	
	Rate	# cases	Rate	# cases
Incidence of the disease*	483	154,252	529	167,142
Case-fatality of Campylobacteriosis	0.003%	5	0.003%	6
Cost-of-Illness (COI)	\$83,975,892		\$69,321,771	
Disability Adjusted Life Years (DALYs)	798		888	

\*. incidence rate per 100,000

*Campylobacteriosis associated with chicken consumption*

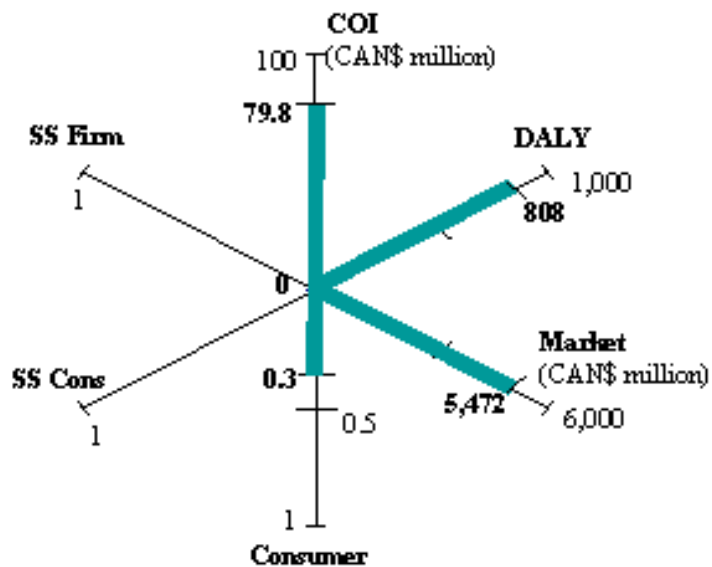
## SUMMARY

# CAMPYLOBACTERIOSIS AND CHICKEN CONSUMPTION

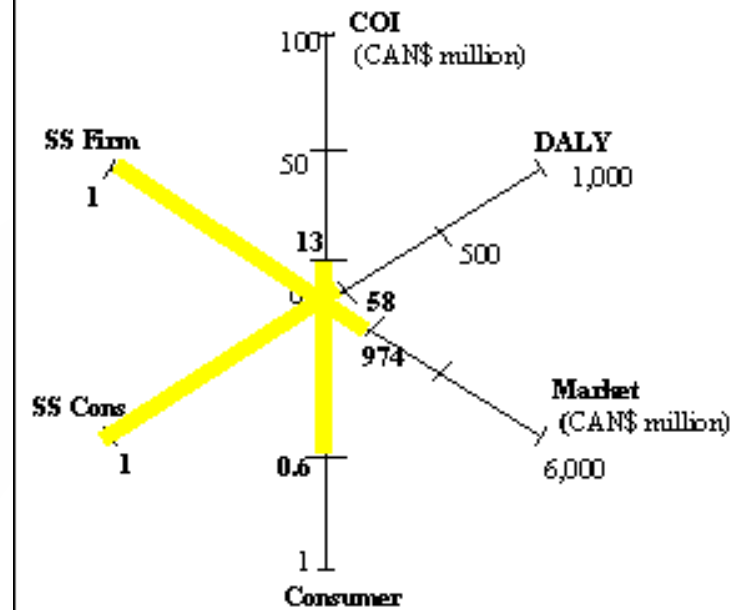
<i>Criterion</i>		3 yr avr	Score
Public Health Impact (2002– 2004)	Incidence (per 100,000)	495	n/a
	Case-fatality rate (%)	0.003%	n/a
	COI (\$)	79,807,811	n/a
	DALY	808	n/a
Market Impact (2003-2006)	Size of the industry		
	Farm gate (\$1,000)	1,580,045	n/a
	Total value at retail (\$1,000)	5,663,857	n/a
	Economic importance of the domestic market (\$1,000)	5,471,918	n/a
	Key export market	0.83%	n/a
	Key import market	1.94%	n/a
Consumer Perception and Acceptance (1 to 3 scale)	Degree to which risk is perceived as uncontrollable by consumer		1.25
	Degree to which risk is perceived as unknown to the individual		1.5
	Degree to which risk is perceived as unknown to the scientists		2
	Degree to which exposure to the risk is perceived to be involuntary		1.75
	Degree to which consumer perceive outcome as severe		1.5
	Total (normalized, 0 to 1 scale)		0.3
Social Sensitivity (0 to 1)	Consumer		0
	Industry/Firm		0

# Graphical Profiles

*Campylobacter* spp. / chicken (C-C)



*L. monocytogenes* / RTE meats (L-RTEM)

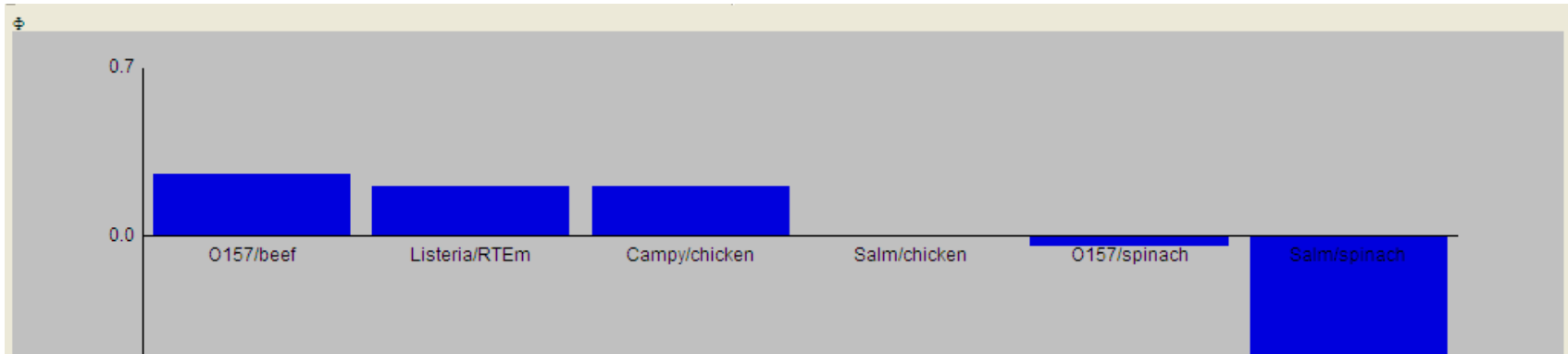


# Multi-criteria Decision Analysis

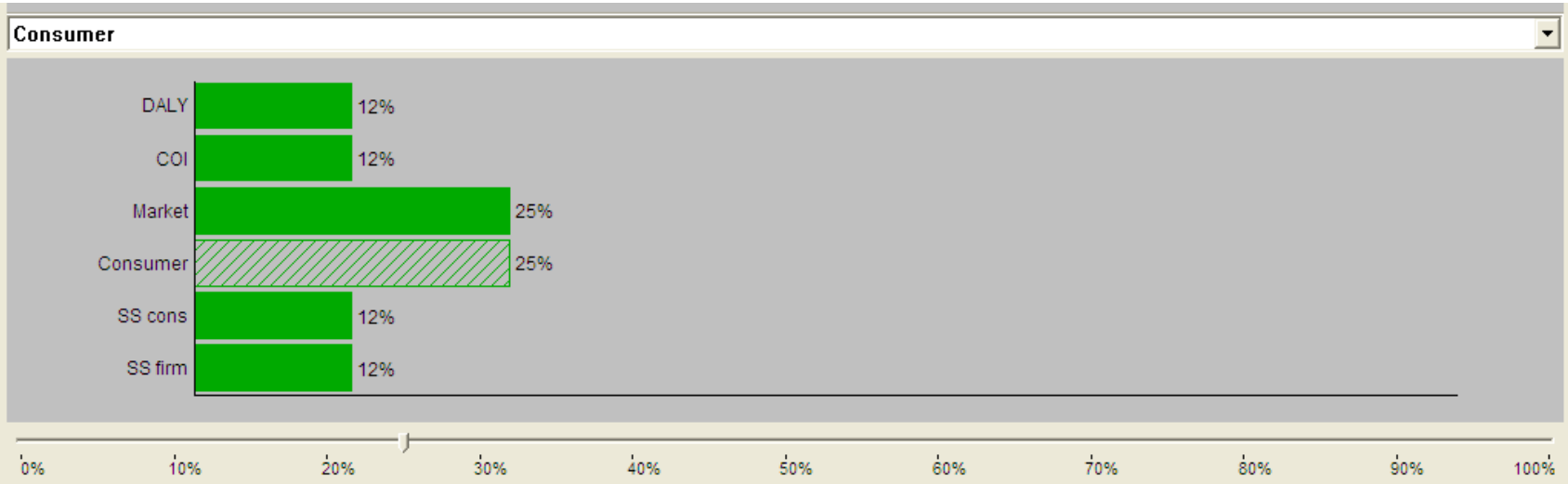
Decision matrix:

	Cost of Illness	DALYs	Market Impact	Consumer Perception	Sensitivity - Consumer	Sensitivity Supplier
<b>Max/Min</b>	Maximize	Maximize	Maximize	Maximize	Maximize	Maximize
<b>Weight</b>	1	1	1	1	0	0
<b>Pref. Func.</b>	Usual	Usual	Usual	Usual	Usual	Usual
<b>UNIT</b>	\$	DALY	\$ x1000	Index		
<b>E.coli 0157 Beef</b>	\$ 40,211,544	260	\$ 5,264,258	0.60	Yes	No
<b>E.coli 0157 Spinach</b>	\$ 499,255	3	\$ 118,075	0.80	Yes	No
<b>Campy Chicken</b>	\$ 79,807,811	808	\$ 5,471,918	0.30	No	No
<b>Salmonella Chicken</b>	\$ 79,351,944	449	\$ 5,471,918	0.25	No	No
<b>Salmonella Spinach</b>	\$ 212,740	1	\$ 118,075	0.50	No	No
<b>Listeria RTE</b>	\$ 12,740,374	58	\$ 974,419	0.60	Yes	Yes

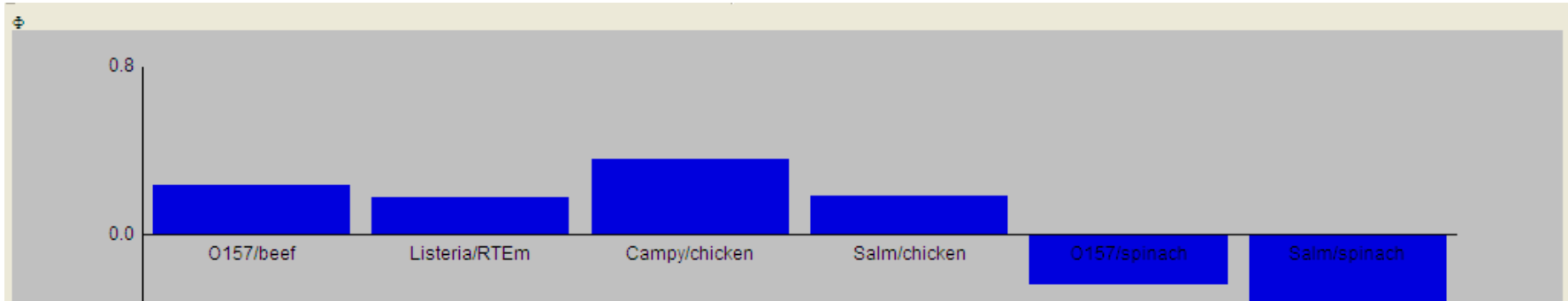
# Numerical results



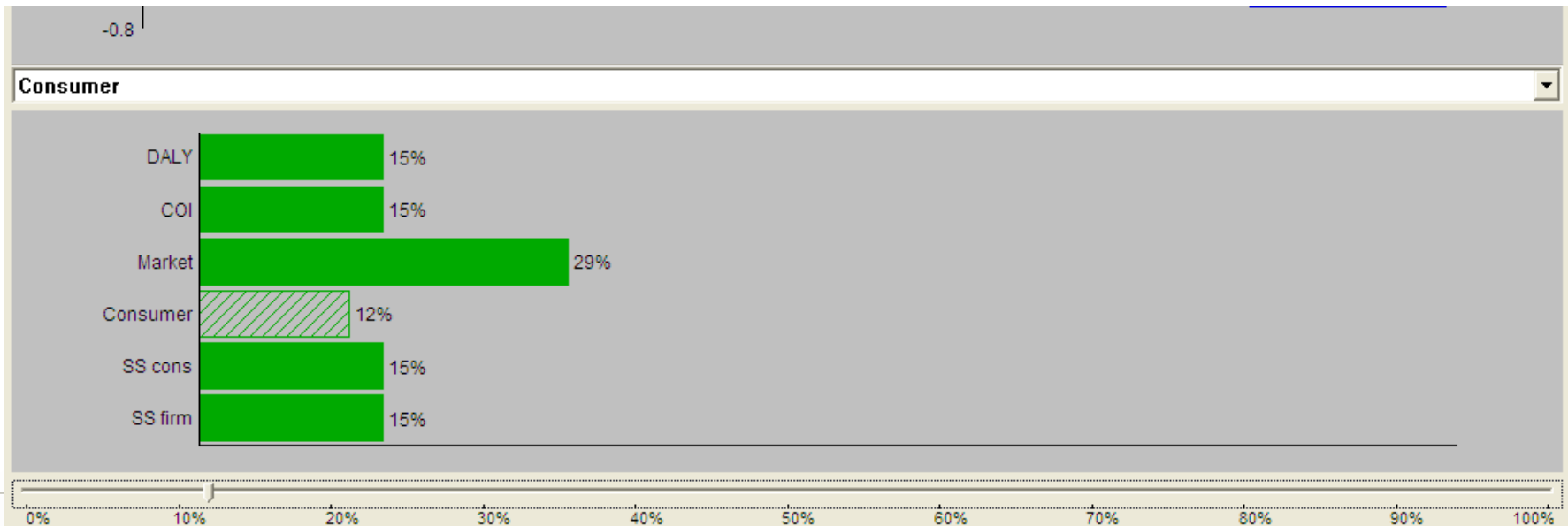
Equal weight on all 4 factors



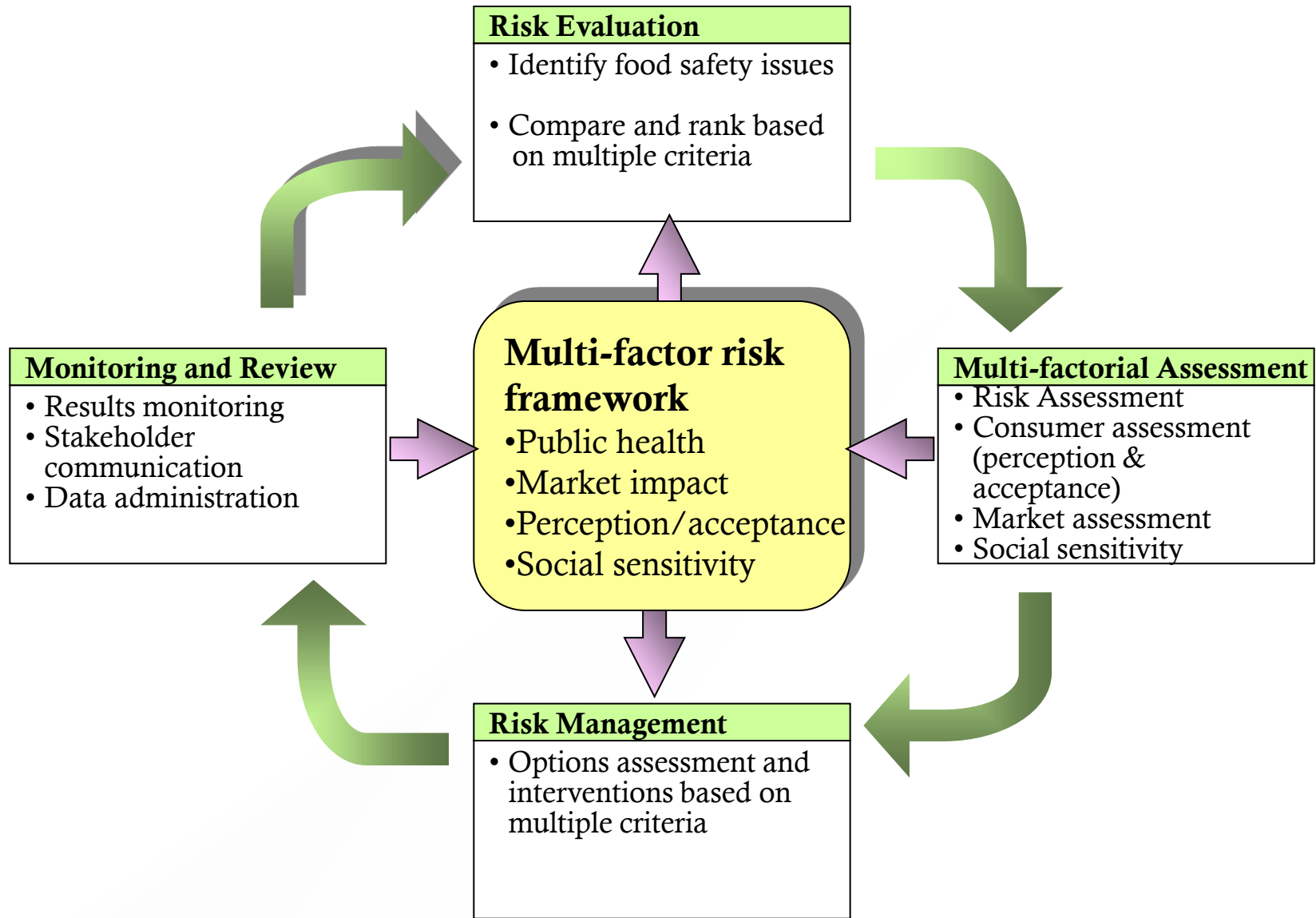
# Sensitivity to weight - Consumer perception



Consumer weight reduced; weights on other dimensions scale in proportion







# Progress to date

- Multi-factor framework & 6 case studies (Special Issue of Risk Analysis 2010)
- Presentations to risk analysts and managers:
  - Health Canada/Public Health Agency of Canada
  - Canadian Food Inspection Agency (CFIA)
  - United States - FDA & USDA

# Highlights of Feedback

- Public health is primary consideration (for some it is the only criterion for ranking)
- Some agreement that market-level impact should be considered
- Delphi-methods for consumer perception and awareness of risks are not seen as rigorous
- Social sensitivity flag is a crude metric
- Tools for comparing risks need to be refined (e.g. cobwebs)

# Further development of framework

- Collaboration with Canadian Food Inspection Agency (CFIA) and the Ontario Ministry of Agriculture and Food (provincial level)
- Expanded list of hazards (foodborne zoonotic pathogens & chemicals)
- Refining conceptualization and measurement of factors
  - Use FDA iRisk estimates of DALYs
  - Canadian National Consumer Monitor survey

# Wrap Up

- In practice, risk prioritization is done based on multiple factors—not only public health
- Formally incorporating all factors into prioritization tools will result in more rigorous and transparent decision making
- Similar approach can be used to compare risk management strategies

# Questions?

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