LDK, Inc

Economics, Modeling, Survey Research

the FHPM

FDA's Food Handling Practices Model

- Designed & developed in a collaborative project sponsored by FDA/CFSAN
- Project documentation available from Angie Ritzert

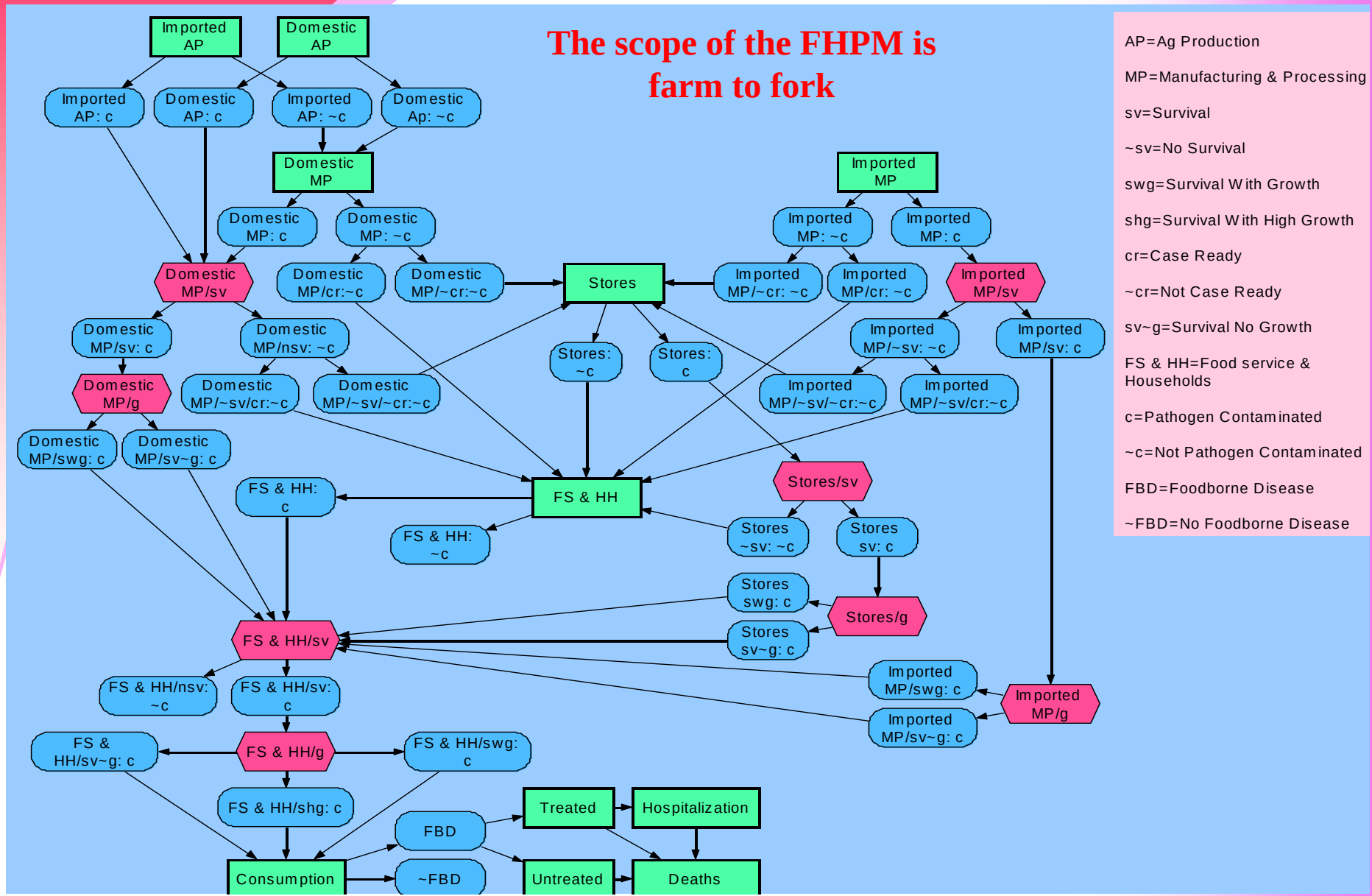
Purpose of the FHPM

- **Quantitatively Estimate Probable Effects of Food Handling Practices on the Incidence of Foodborne Illness**
- **Provide an Operational Tool for Analyzing the Incidence of Foodborne Illness by**
  - **Food Source**
  - **Food Delivery Channel**
  - **Food-Pathogen Pairs**
  - **Food Handling Risk Factors**
  - **Consumer Demographics**
  - **Disease End Points**

Key Features of the FHPM

- **Aggregate Level of Modeling Abstraction**
- **Scope of the Model is Farm-to-Fork**
- **Incorporates Random Variation and Uncertainty Via Monte Carlo Simulation**
- **Transparent Modeling Architecture with Built-in Documentation**
- **Analytica™ Platform with a User Interface**

How Is the Model Structured?



How Is the Model Structured?

Ag & Fisheries Production Module

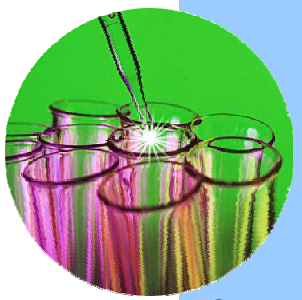
Manufacturing & Processing Module

Handling Practices Module

Consumption & Foodborne Disease Module

Auxillaries

The FHPM comprises four primary modules based on similarities of risk factors and types of food that are found at different stages of the food chain.



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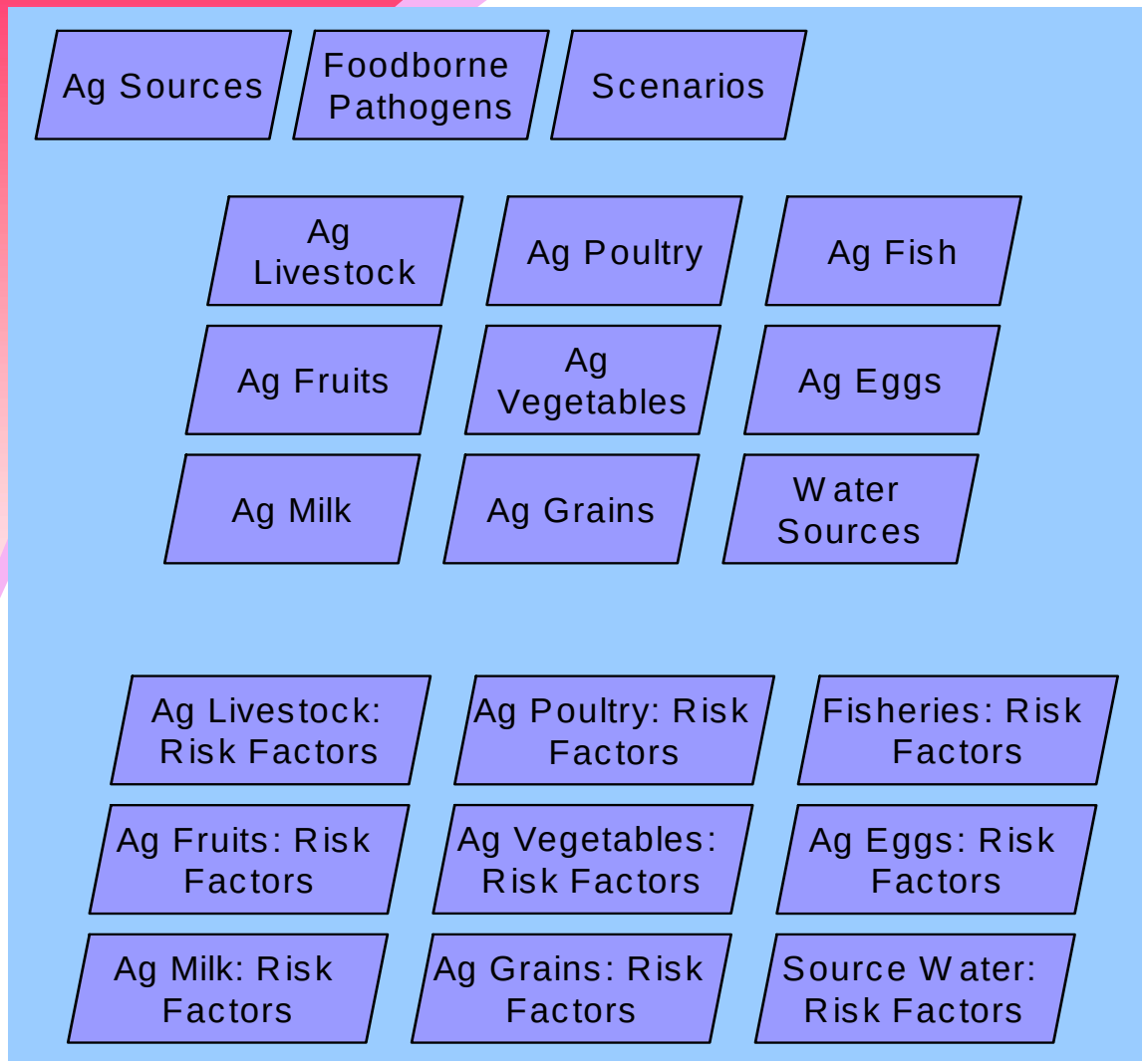

The Ag and Fisheries

Production module features eight primary commodity groups plus water

This modeling structure conveniently allows risk factors to be appropriately different for each commodity group

Quantities of food at this stage are measured in units commonly used within the ag and fisheries industry

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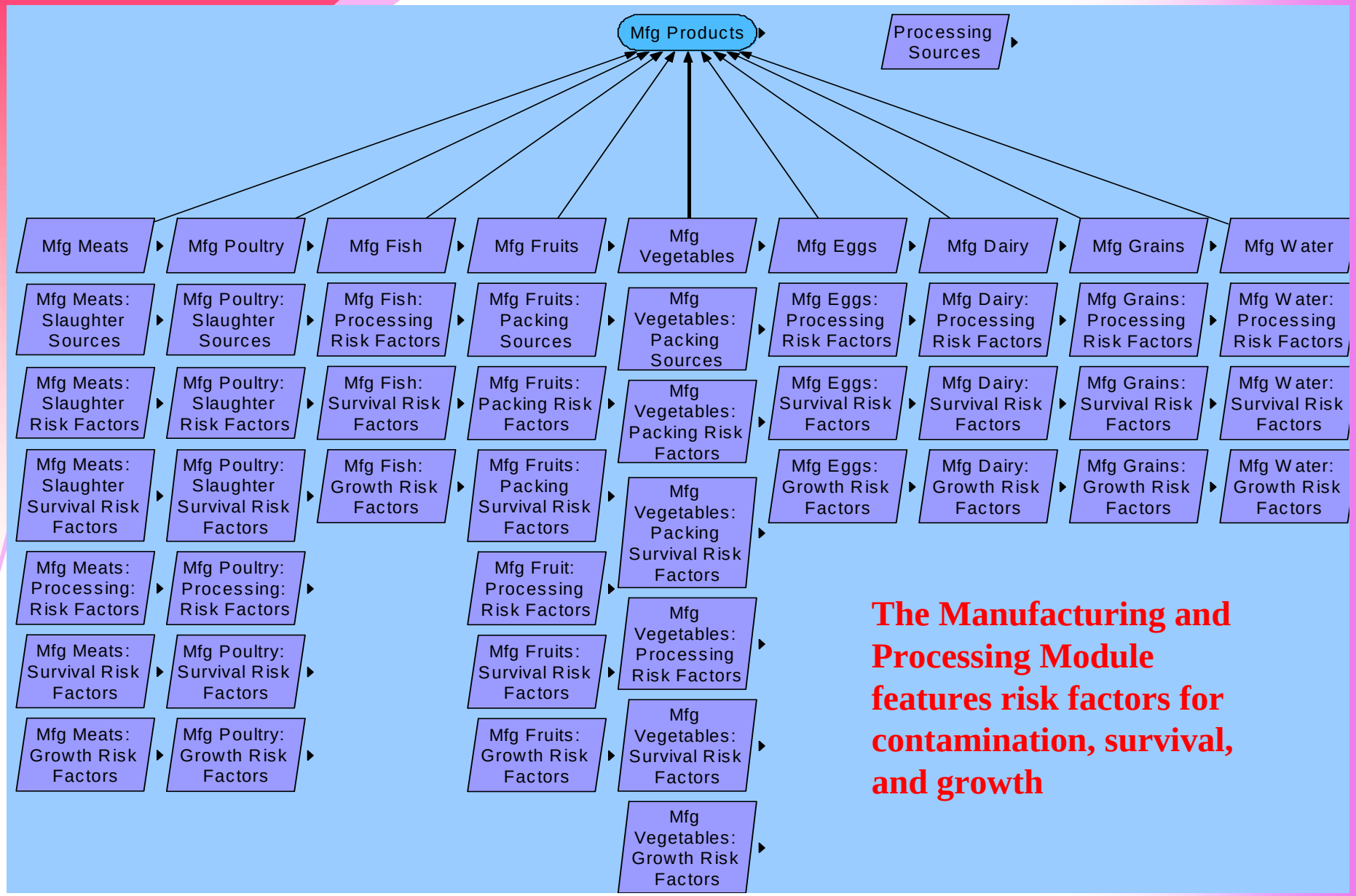
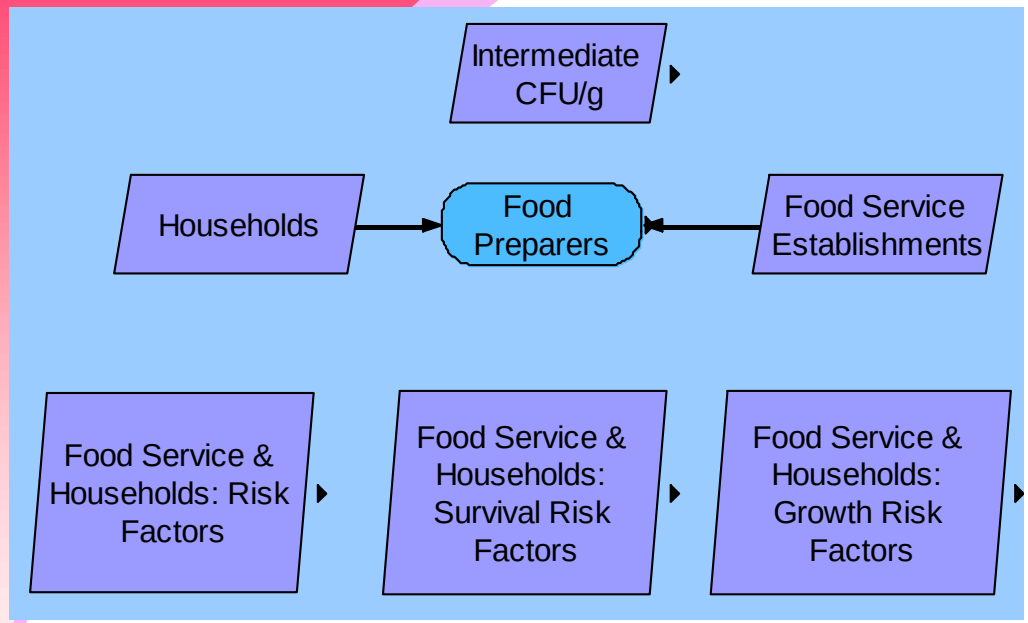


The Manufacturing and Processing Module features risk factors for contamination, survival, and growth

How Is the Model Structured?

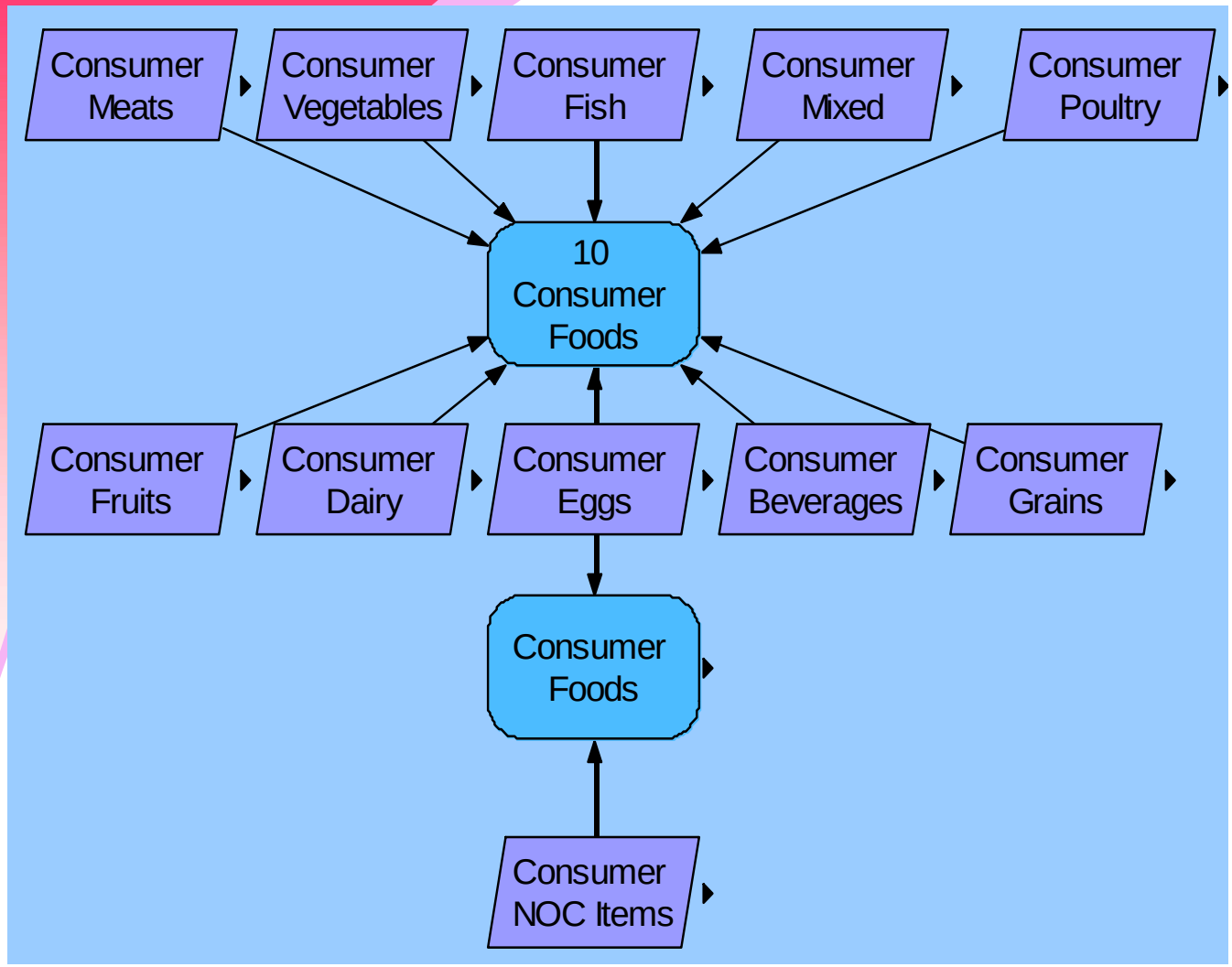


The Food Handling Module distinguishes between Food Service handling practices and Household handling practices, and allows for differences in risk factors based on categories of Food Service establishments and Household demographics

Single Female, age<60
Single Male, age<60
Single Parent with Children
Couple without Children
Couple with Children
Single Senior Female, age>=60
Single Senior Male, age>=60
Senior Couple, age>=60
NOC Households

Full-Service Restaurants
Mixed-Service Restaurants
Fast Food Restaurants
Temporary Establishments
Street Vendors
Catering Services
Grocery Stores: Food Service
Convenience Stores: Food Service
Child Care Centers
Hospital Food Service
School Food Service
Nursing Home Food Service
NOC Food Service

How Is the Model Structured?

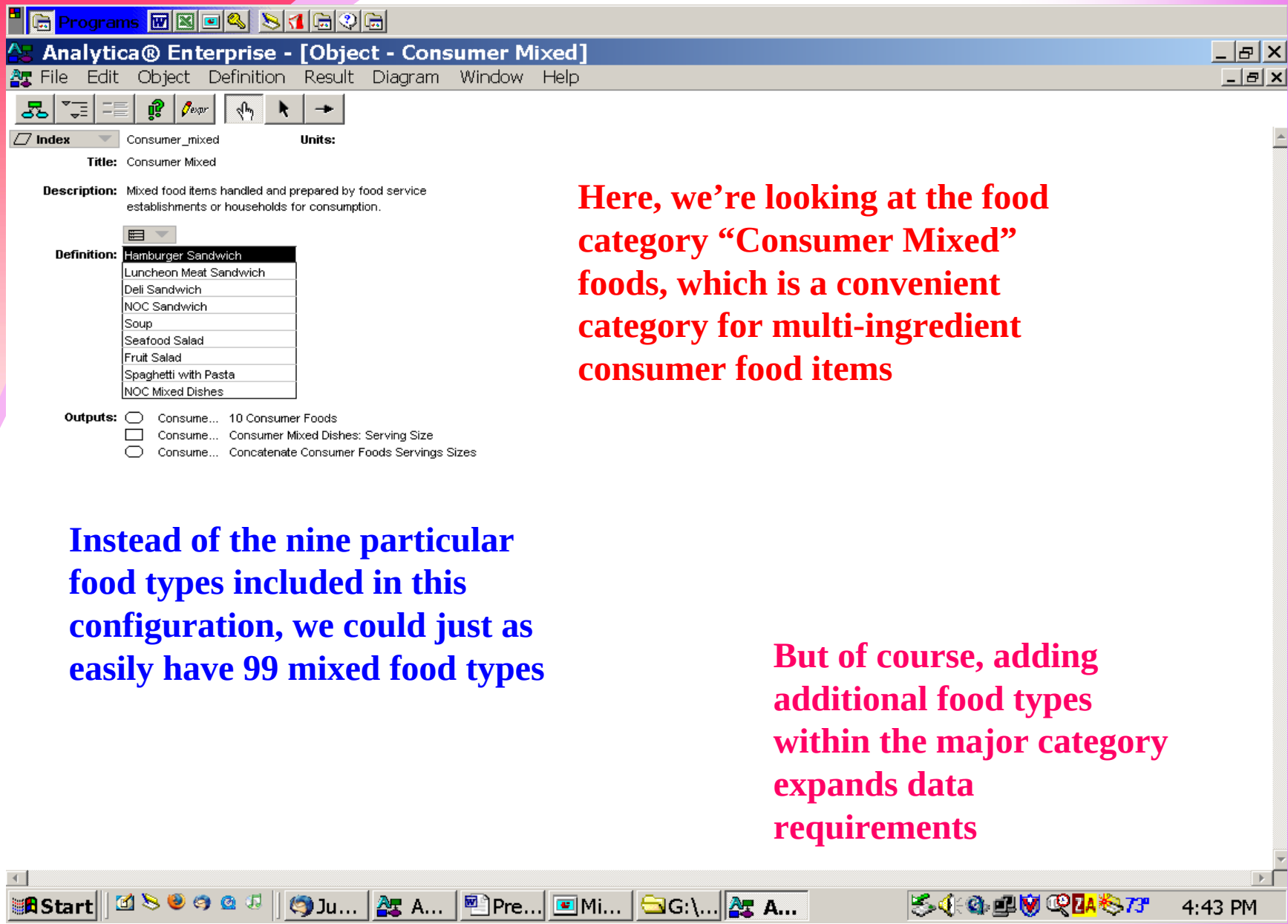


The Consumption and Foodborne Disease Module defines food in terms of typical consumer food items, partitioned into 11 food groups

Moving from farm to fork, the definitions of food and the units of measurement change from commodities, to manufactured foods, and finally to servings of common consumer food items

In each stage of the FHPM, there is no limit on how many different specific types of food may be included in each major food category

How Is the Model Structured?

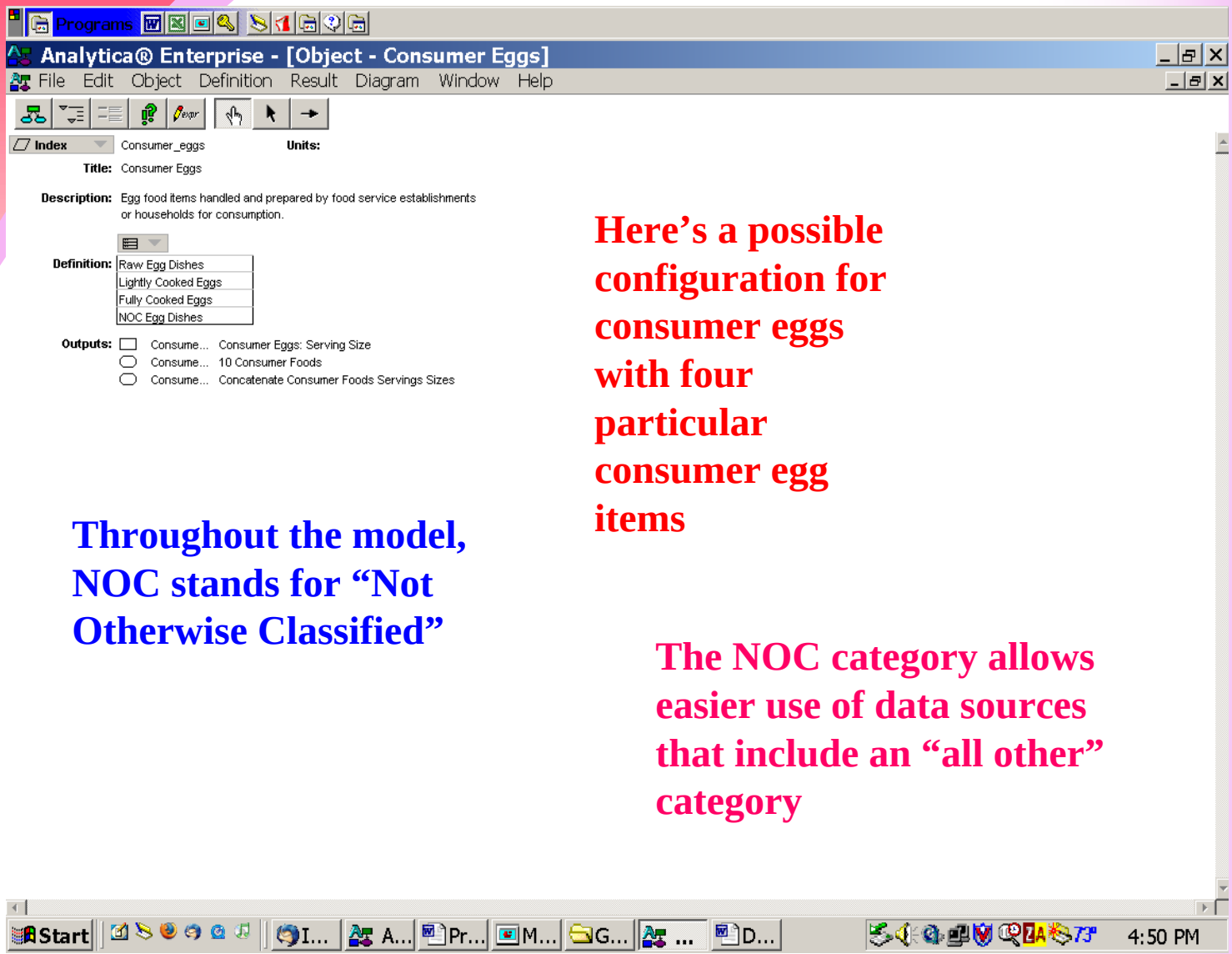


Here, we're looking at the food category "Consumer Mixed" foods, which is a convenient category for multi-ingredient consumer food items

Instead of the nine particular food types included in this configuration, we could just as easily have 99 mixed food types

But of course, adding additional food types within the major category expands data requirements

How Is the Model Structured?

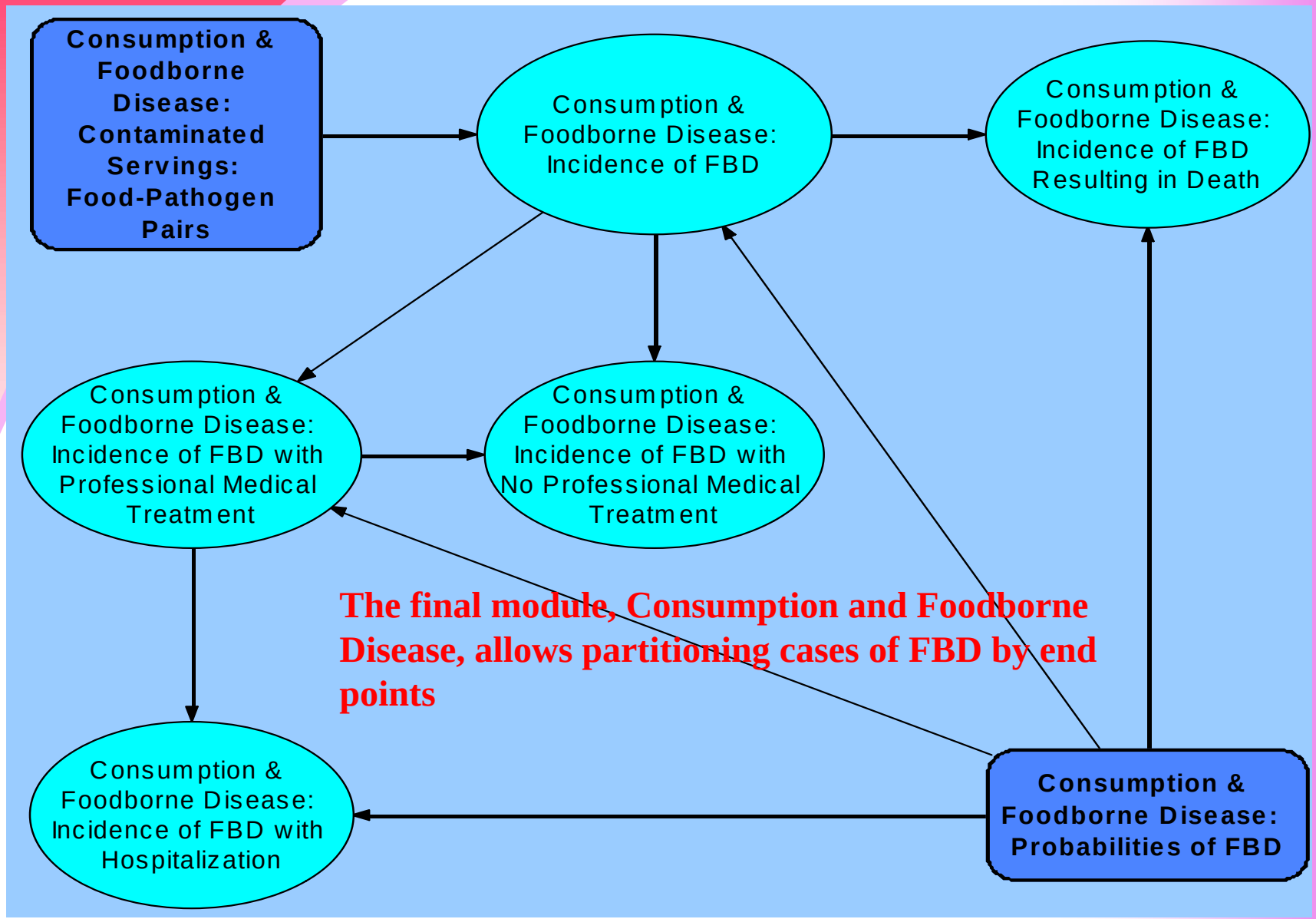


Here's a possible configuration for consumer eggs with four particular consumer egg items

Throughout the model, NOC stands for "Not Otherwise Classified"

The NOC category allows easier use of data sources that include an "all other" category

How Is the Model Structured?



How Is the Model Structured?

Analytica® Enterprise - [Result - Consumption & Foodborne Disease: Incidence of FBD]

File Edit Object Definition Result Diagram Window Help

Mid Value of Consumption & Foodborne Disease: Incidence of FBD (annual cases)

Foodborne Pathog... "Totals"

Scenarios Baseline Scenario

Final CFU/g "Totals"

Food Preparers "Totals"

Consumer Foods Totals

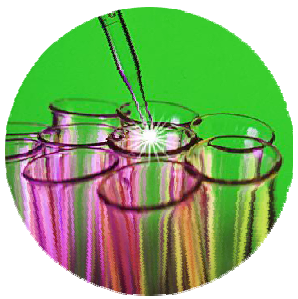
Consumer Demographics (persons) Totals

	Normal IS, 5<=age<60	Pregnant	Elderly, age>=60	Neonates, age<1	Very Young, 1<=age<5	Compromised IS 5<=age<60	Totals
Ground Beef Dishes	11.829K	2413	6033	0	241	3620	24.136K
NOC Meat Dishes	0	0	0	0	0	0	0
Roast Chicken	0	0	0	0	0	0	0
NOC Poultry	0	0	0	0	0	0	0
Oysters on the Half Shell	0	0	0	0	0	0	0
NOC Fish	10	1	4	0	1	3	19
Raw Fruits	51.234K	10.247K	25.618K	0	0	15.372K	102.471K
NOC Fruit	179.833K	34.436K	88.002K	0	76.523K	3827	382.621K
Raw Lettuce	0	0	0	0	0	0	0
NOC Vegetable Dishes	208	42	106	0	5	63	424
Lightly Cooked Eggs	1360	330	549	14	137	358	2748
NOC Egg Dishes	0	0	0	0	0	0	0
Pasteurized Milk	0	0	0	0	0	0	0
NOC Dairy Foods	0	0	0	0	0	0	0
Bakery Goods	2801	562	1120	0	279	838	5600
NOC Grain-Based Foods	424	84	212	0	0	126	846
Tap Water	0	0	0	0	0	0	0
NOC Beverages	0	0	0	0	0	0	0
Hamburger Sandwich	263	51	130	0	111	5	560
NOC Mixed Dishes	1497	306	612	30	151	458	3054
Ice	9	1	5	0	5	0	20
NOC Food Items or Dishes	7665	1564	3128	157	782	2347	15.643K

The Food Handling Practices Model Does Not Include Economic Valuation of the Incidence of Foodborne Disease, but does partition cases of FBD by pathogen, level of contamination, preparer, consumer food item, and consumer risk group

How Transparent Is the FHPM?

- the FHPM can be completely transparent to skilled mathematical modelers who are conversant with Analytica
- Users who are not familiar with mathematical modeling methods or with Analytica will find the user interface easy to understand and use
- The logical structure of the FHPM is reasonably straightforward, although the actual mathematical expressions used require a certain degree of mathematical and statistical knowledge



What Data Are Required?

- FHPM requires several data types for calibration
  - 4 population parameters
  - 4 market share parameters
  - 4 probabilities of occurrence of particular risk factors
  - 4 conditional probabilities of occurrence of foodborne disease, given the occurrence of particular risk factors
  - 4 probabilities that consumption of food contaminated with low, moderate, or high CFU/g will cause a case of foodborne disease (probabilistic dose/response data)
- The first two categories of data are reasonably available; the final three categories are challenging, but in principle, can be and are being developed through continuing research

What Data Are Required?

- *Ag Poultry: Per Capita Consumption*
- *Ag Poultry: Pounds Per Bird*
- *Ag Poultry: Source Shares*
- *Ag Poultry: Probabilities of Risk Factors*
- *Ag Poultry: Conditional Probabilities*

The "easy" data

- *Poultry Slaughter: Source Shares*
- *Mfg Poultry: Processing Source Shares*
- *Mfg Poultry: Slaughter: Pounds per Carcass*
- *Mfg Poultry: Ag to Mfg Shares*

The "challenging" data

- *Mfg Poultry: Poultry Slaughter: Probabilities of Risk Factors*
- *Mfg Poultry: Livestock Slaughter: Probabilities of Survival*
- *Mfg Poultry: Processing: Probabilities of Risk Factors.*
- *Mfg Poultry: Probabilities of Survival: Risk Factors*
- *Mfg Poultry: Probabilities of Growth: Risk Factors*
- *Mfg Poultry: Poultry Slaughter: Conditional Probabilities*
- *Mfg Poultry: Poultry Slaughter: Survival: Conditional Probabilities*
- *Mfg Poultry: Processing: Conditional Probabilities*
- *Mfg Poultry: Survival: Conditional Probabilities*
- *Mfg Poultry: Growth: Conditional Probabilities*

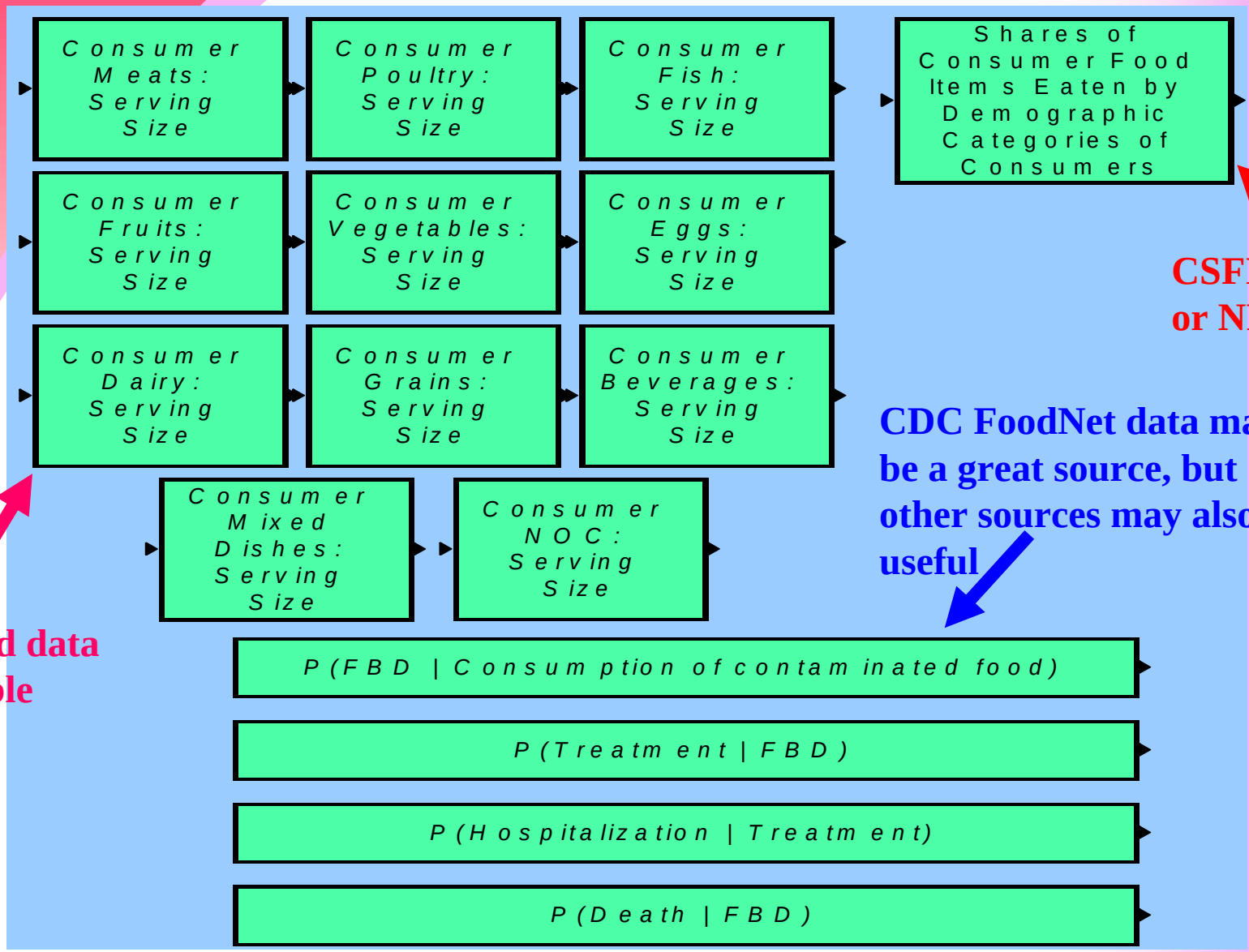
What Data Are Required?

Available from CSFII data and commercial sources such as NPD

Potentially available through research

"Challenging"--- perhaps requiring expert elicitation methods

What Data Are Required?



What Data Are Required?

- The FHPM provides a logical, consistent framework for incorporating a wide range of data
- Data may be developed in a variety of ways
  - 4 experimental measurement
  - 4 survey research
  - 4 expert elicitation
- Some say that expert elicitation amounts to assuming data that isn't available; others consider expert elicitation to be a useful Bayesian approach to estimating probabilities

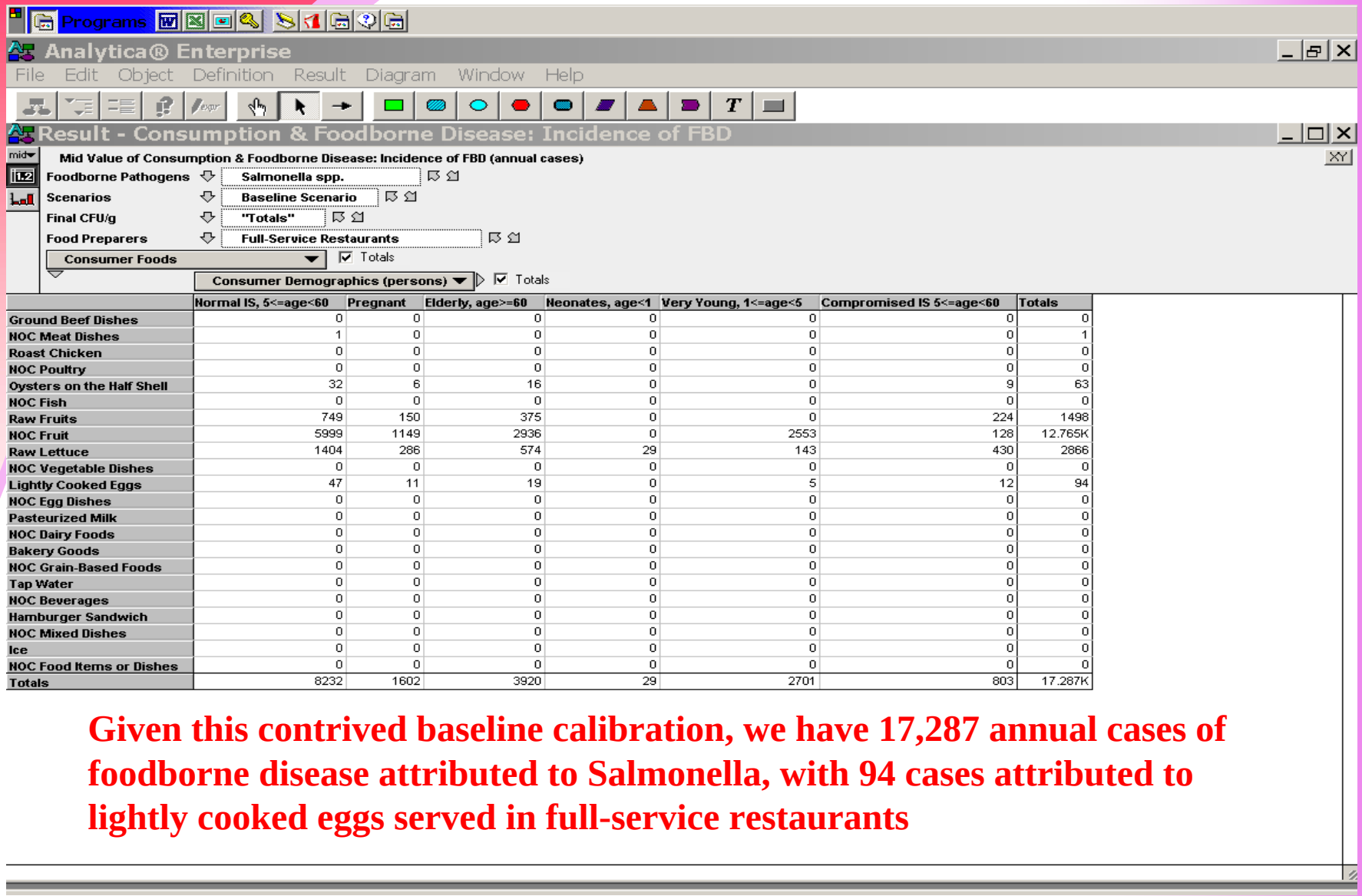
Using the Model

- Calibrate Model Parameters for a Baseline Scenario (lots of flexibility about what to include and what to leave out)

2) Recalibrate selected Parameters to Reflect a Change Scenario (requires art and science)

3) Compare Distributions from the Baseline Scenario and the Change Scenario for Marginal and Total Effects (no “built in” risk ranking or economic evaluation)

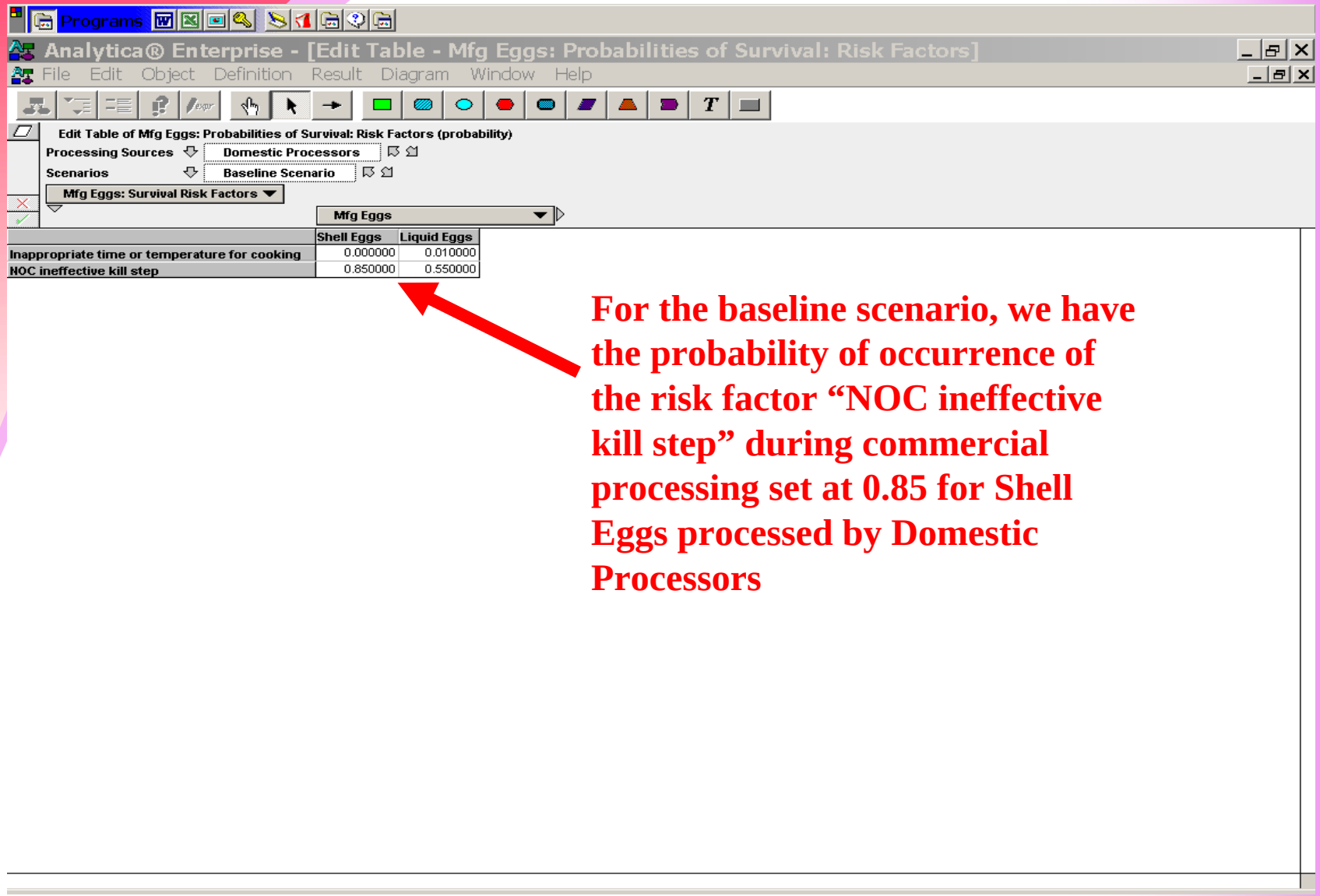
A Contrived Example



	Normal IS, 5<=age<60	Pregnant	Elderly, age>=60	Neonates, age<1	Very Young, 1<=age<5	Compromised IS 5<=age<60	Totals
Ground Beef Dishes	0	0	0	0	0	0	0
NOC Meat Dishes	1	0	0	0	0	0	1
Roast Chicken	0	0	0	0	0	0	0
NOC Poultry	0	0	0	0	0	0	0
Oysters on the Half Shell	32	6	16	0	0	9	63
NOC Fish	0	0	0	0	0	0	0
Raw Fruits	749	150	375	0	0	224	1498
NOC Fruit	5999	1149	2936	0	2553	128	12.765K
Raw Lettuce	1404	286	574	29	143	430	2866
NOC Vegetable Dishes	0	0	0	0	0	0	0
Lightly Cooked Eggs	47	11	19	0	5	12	94
NOC Egg Dishes	0	0	0	0	0	0	0
Pasteurized Milk	0	0	0	0	0	0	0
NOC Dairy Foods	0	0	0	0	0	0	0
Bakery Goods	0	0	0	0	0	0	0
NOC Grain-Based Foods	0	0	0	0	0	0	0
Tap Water	0	0	0	0	0	0	0
NOC Beverages	0	0	0	0	0	0	0
Hamburger Sandwich	0	0	0	0	0	0	0
NOC Mixed Dishes	0	0	0	0	0	0	0
Ice	0	0	0	0	0	0	0
NOC Food Items or Dishes	0	0	0	0	0	0	0
Totals	8232	1602	3920	29	2701	803	17.287K

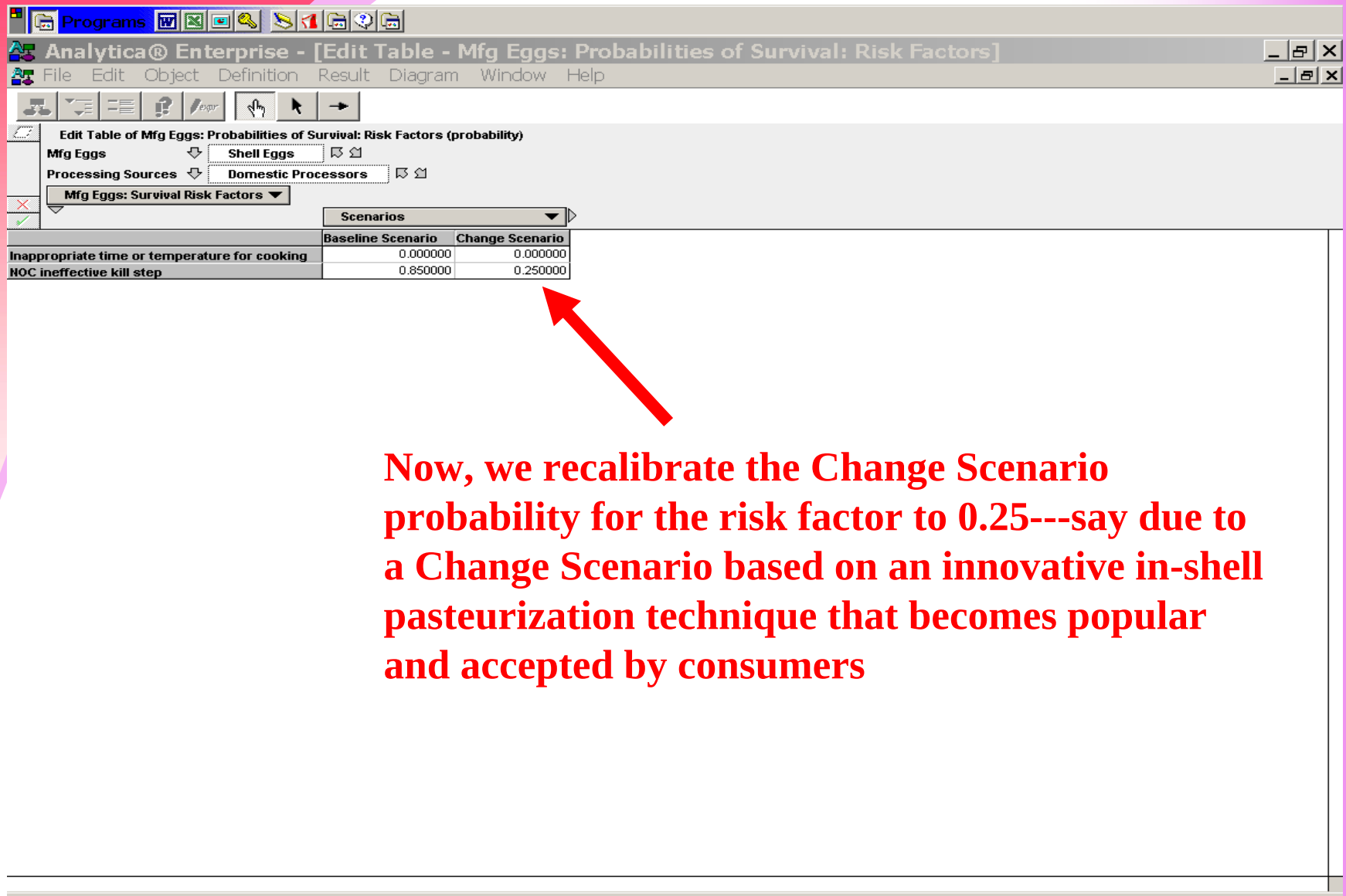
Given this contrived baseline calibration, we have 17,287 annual cases of foodborne disease attributed to Salmonella, with 94 cases attributed to lightly cooked eggs served in full-service restaurants

A Contrived Example



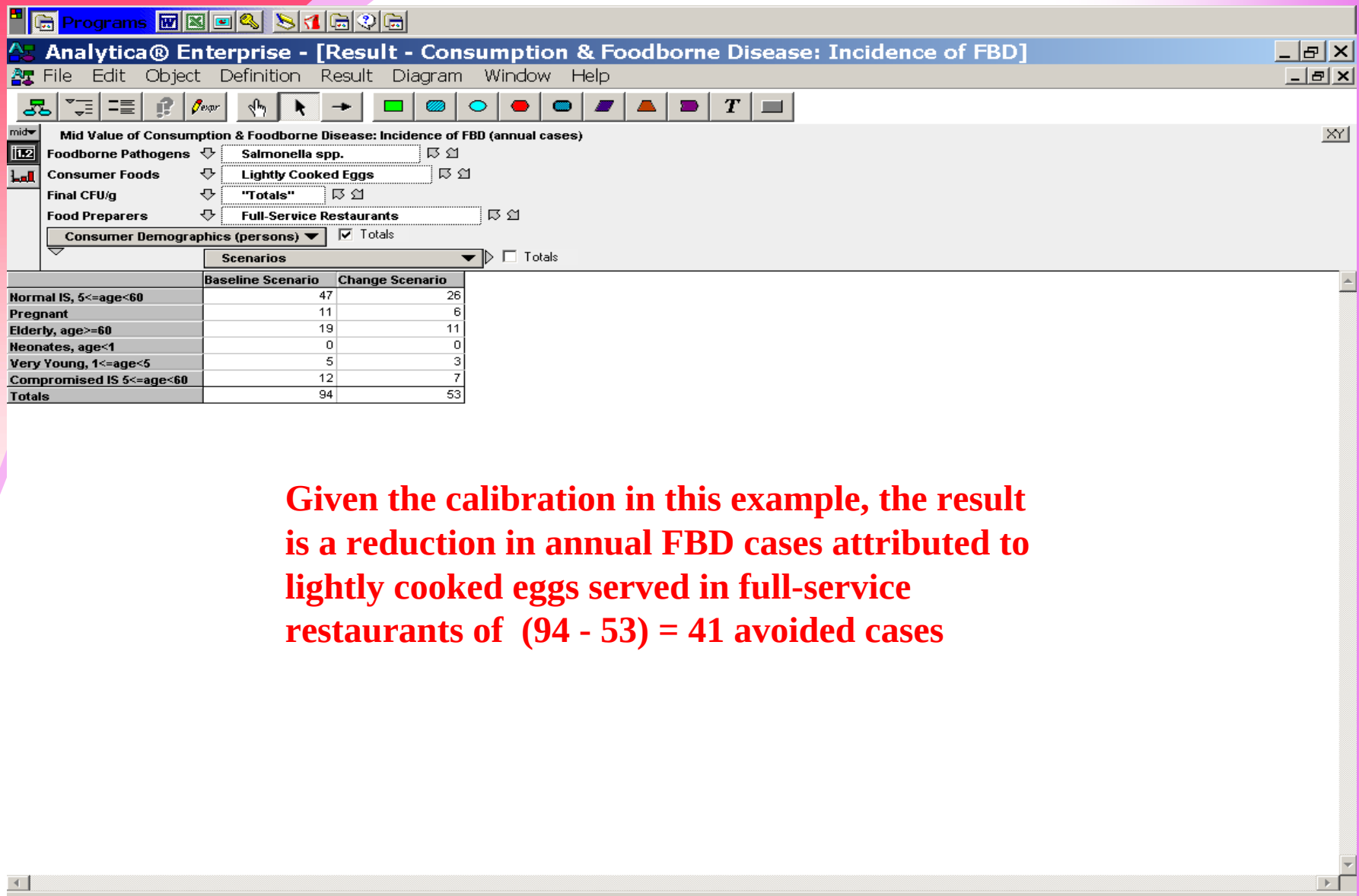
For the baseline scenario, we have the probability of occurrence of the risk factor "NOC ineffective kill step" during commercial processing set at 0.85 for Shell Eggs processed by Domestic Processors

A Contrived Example



Now, we recalibrate the Change Scenario probability for the risk factor to 0.25---say due to a Change Scenario based on an innovative in-shell pasteurization technique that becomes popular and accepted by consumers

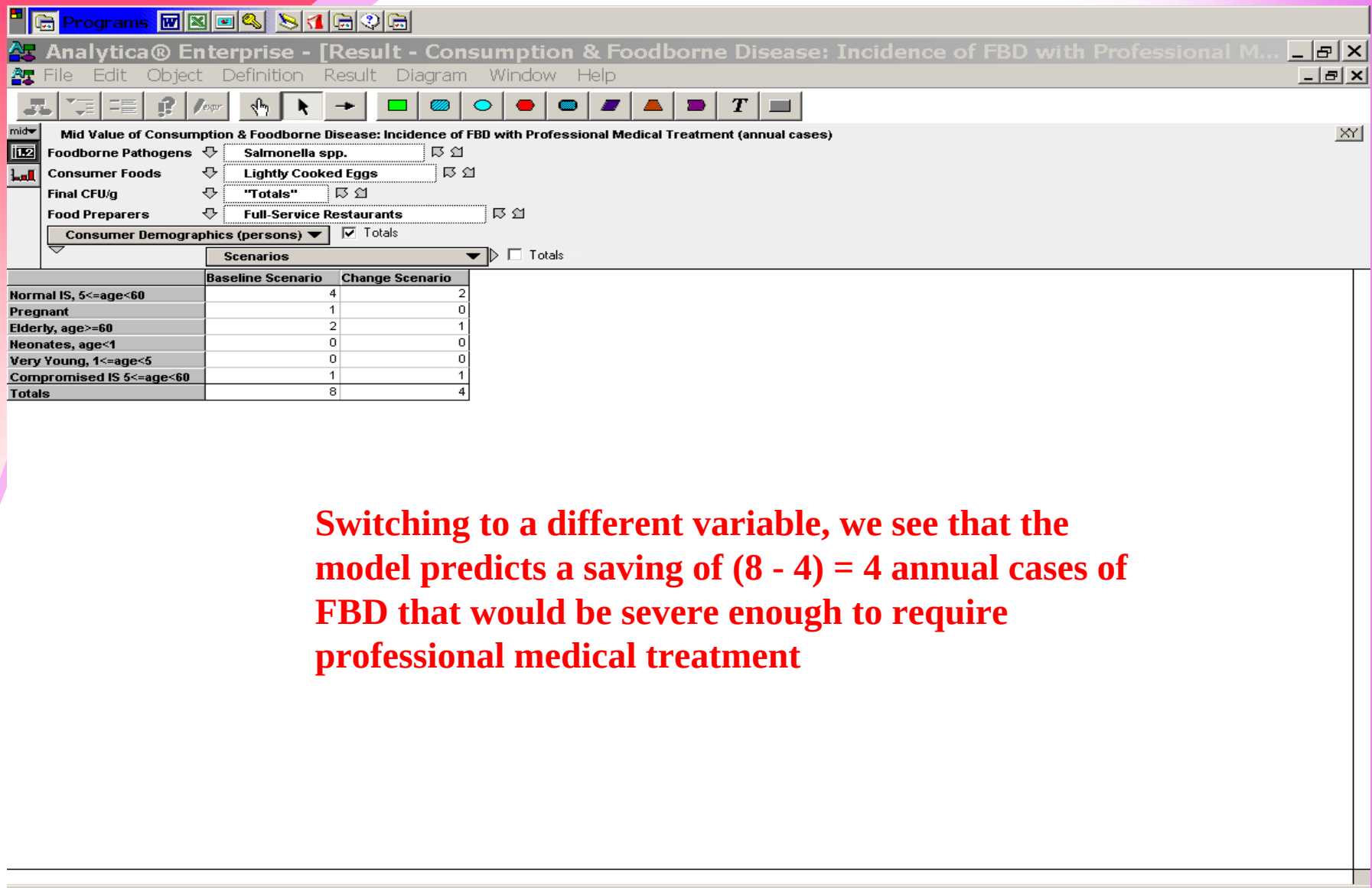
A Contrived Example



	Baseline Scenario	Change Scenario
Normal IS, 5<=age<60	47	26
Pregnant	11	6
Elderly, age>=60	19	11
Neonates, age<1	0	0
Very Young, 1<=age<5	5	3
Compromised IS 5<=age<60	12	7
Totals	94	53

Given the calibration in this example, the result is a reduction in annual FBD cases attributed to lightly cooked eggs served in full-service restaurants of (94 - 53) = 41 avoided cases

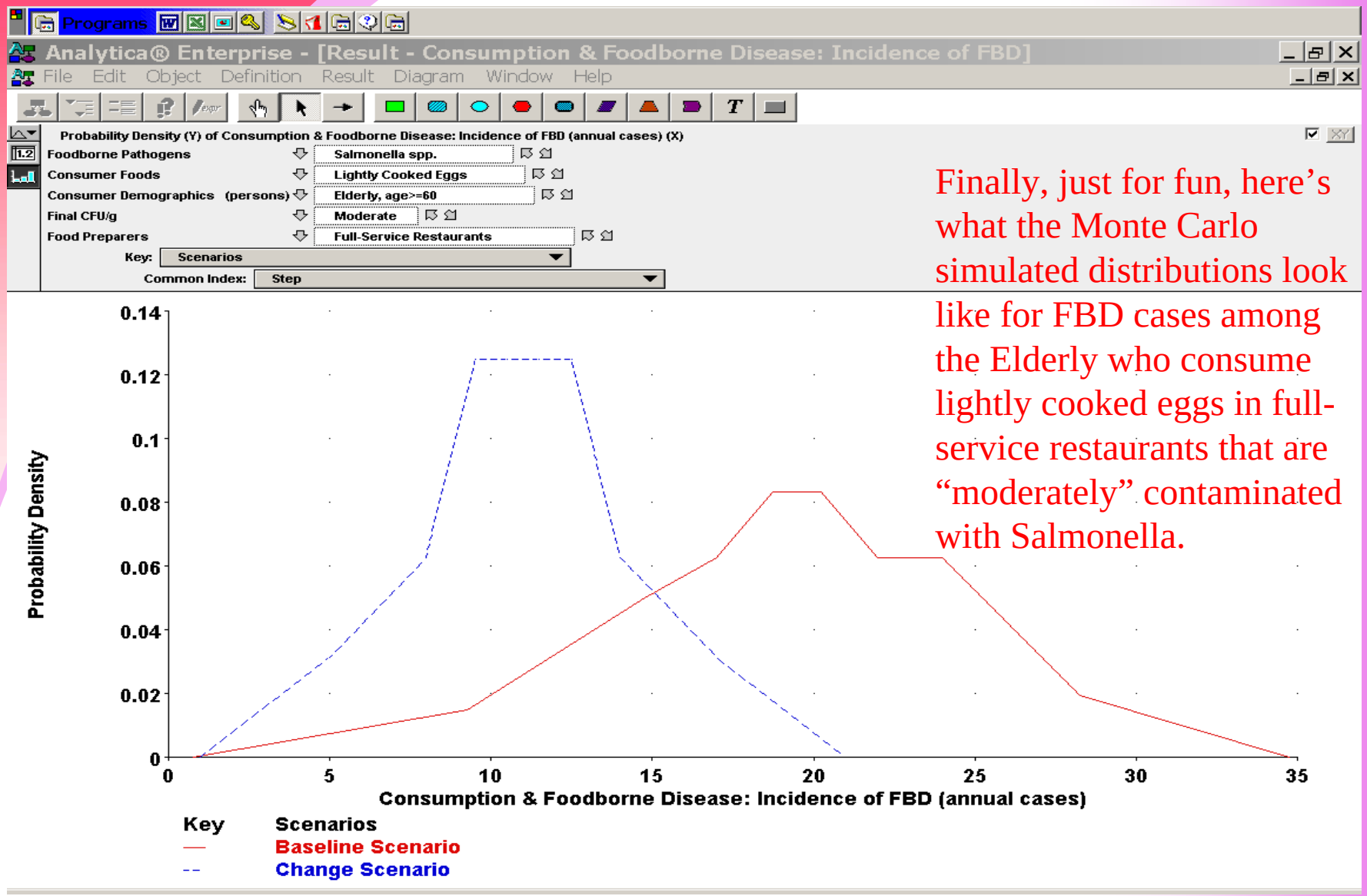
A Contrived Example



	Baseline Scenario	Change Scenario
Normal IS, 5<=age<60	4	2
Pregnant	1	0
Elderly, age>=60	2	1
Neonates, age<1	0	0
Very Young, 1<=age<5	0	0
Compromised IS 5<=age<60	1	1
Totals	8	4

Switching to a different variable, we see that the model predicts a saving of (8 - 4) = 4 annual cases of FBD that would be severe enough to require professional medical treatment

A Contrived Example



Finally, just for fun, here's what the Monte Carlo simulated distributions look like for FBD cases among the Elderly who consume lightly cooked eggs in full-service restaurants that are "moderately" contaminated with Salmonella.

Time’s Up---the End