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Food Handling Practices Model: User's Guide

Version 1.0

Prepared for

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1

Introduction

This user's guide for the Food Handling Practices Model (FHPM) provides step-by-step instructions on how to install the FHPM and operate the model. It explains in detail how to load baseline scenarios, create and save new baseline scenarios, run baseline simulations, recalibrate the model for a change scenario, select your choice of outputs, and save the simulation outputs you create.

1.1 HOW TO USE THE USER'S GUIDE

This user's guide employs several formatting features to help you use it.

- All model terms in **boldface** are defined in the glossary in Appendix A.
- All terms in *italics* are names of screens within the FHPM user interface.
- All terms [*italicized within brackets*] are the button or menu choices you may select.

1.2 OVERVIEW OF THE FOOD HANDLING PRACTICES MODEL

The FHPM is a stochastic simulation model that allows users to estimate changes in annual cases of foodborne illness (FBI), given one or more changes in the prevalence of food handling practices used in retail food establishments or in households. Food handling practices represented in the model are called contributing factors of two types:

- contributing factors that may contaminate food, and
- contributing factors that may allow survival and growth of pathogens in food.

The FHPM operates by simulating, tracking, and counting servings of food that become contaminated with one or more pathogens, followed by survival and growth of pathogens, followed by ingestion that causes noticeable illness.

The FHPM includes four modeling stages organized in two distinct channels, as summarized below. Each modeling stage includes several random variables associated with the incidence of FBI.

- I. Source Contamination Stage
- II. Retail and Household Contamination Stage: Contributing Factors that May Contaminate Food
 - 1) Retail channel
 - 2) Household channel
- III. Retail and Household Pathogen Control Stage: Contributing Factors that May Allow Survival and Growth of Pathogens in Food
 - 1) Retail channel
 - 2) Household channel
- IV. Foodborne Illness Stage
 - 1) Retail channel
 - 2) Household channel

The final project report for “Modeling the Effects of Food Handling Practices on the Incidence of Foodborne Illness” (Contract No. 223-01-2466, Task Order 1) provides a detailed mathematical description of the FHPM. Although the model has several potential uses, its primary purpose is to allow users to analyze the effect of changes in food handling practices on the incidence of FBI. To produce quantitative estimates of changes in cases of FBI, given change in one or more food handling practices, users conduct the following steps:

- (1) Define a Baseline Scenario
- (2) Calibrate the Baseline Scenario
- (3) Simulate the Baseline Scenario
- (4) Define a Change Scenario
- (5) Recalibrate the FHPM for the Change Scenario
- (6) Simulate the Change Scenario

(7) Compare Output of the FHPM for the Baseline and Change Scenarios

This user's guide explains how to use the FHPM to conduct Steps 1 through 7.

2

Installing and Opening the Model

In this section you will learn about minimum software requirements for running the FHMP, how to install software files needed to operate the FHMP, and how to open and exit the model.

2.1 MINIMUM SOFTWARE REQUIREMENTS

The model runs Monte Carlo simulations using MS Excel and Palisade @Risk. The model retrieves data from a database file stored in Microsoft Access. The FHMP requires the following minimum software versions to operate:

- Excel version 2000 or higher
- @RISK version 4.5
- Access version 2000 or higher

2.2 INSTALLING THE MODEL'S SOFTWARE FILES

Before running the FHMP, you must install the program files on your personal computer. RTI advises you to create a separate folder on your hard drive (or desktop) to keep the model files together. To do this,

- Open Windows Explorer, and highlight Desktop. Click [*File*], then [*New*], then [*Folder*]. Alternatively, you can right-click on your desktop screen and select [*New*], then [*Folder*]. A new folder will appear; type in the desired folder name (e.g., FHMP).

- Highlight the following files on the FHPM CD and drag them into the FHPM folder on your desktop:
 - ✓ three Excel workbook files:
 - FHPM.xls
 - FHPMGraph.xls
 - FHPMStats.xls
 - ✓ one Access database file:
 - BaselineScenarios.mdb

2.3 OPENING THE FHPM

- Open the model by double-clicking the FHPM.xls file.
- Your computer settings may require you to click [*Enable Macros*] on the dialog box. Wait for Excel to load the program files completely.
- The model opens with nine Excel worksheets visible. The Menu Bar toolbar at the top of your screen will include drop-down menus for FHPM and @RISK.

2.4 EXITING THE FHPM

To exit the model, do one of the following:

- Click [*File*] on the Menu Bar toolbar, then [*Close*] or [*Exit*].
- Click on the X in the top right corner of the screen.

3

Operating the Model with the User Interface

The FHPM includes a user interface to help you operate the model. Once you are familiar with the model, its worksheets, and its parameter inputs, you may opt to calibrate and operate the model directly from its Excel worksheets, using the full operational capabilities of @Risk. Section 4 of the user's guide provides more detail about using the FHPM without the user interface. Each user interface screen has a HELP feature to provide information about the FHPM and its operation.

3.1 THE FHPM MENU

At the top of the screen on the Excel Menu Bar you will see a drop-down FHPM menu. The FHPM menu allows you to operate the model and navigate through its functions. The FHPM menu provides seven options:

- Load or Modify Baseline Scenario
- Run Baseline Scenario Simulation
- Save Baseline Scenario
- Recalibrate for Change Scenario
- Run Change Scenario Simulation
- Delete Baseline Scenario
- About FHPM

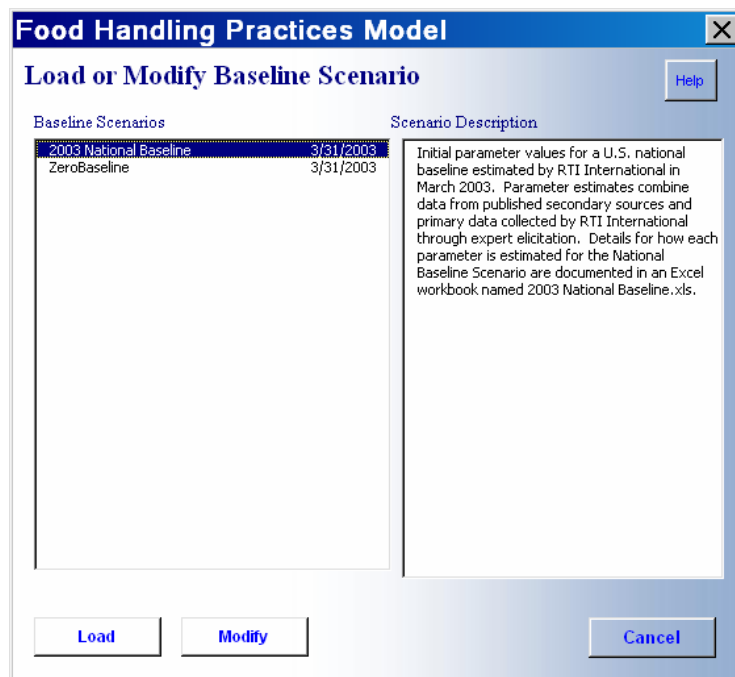
If all seven options are not visible, click on the down arrow at the bottom of the menu. Sections 3.2 through 3.7 describe each menu option in detail.

3.2 LOAD OR MODIFY BASELINE SCENARIO

A **Baseline Scenario** is a complete specification of all 1,546 parameters in the FHPM. RTI included two baseline scenarios with Version 1.0 of the FHPM. Given the large number of parameters in the model, you will typically begin any specific analysis by selecting and perhaps modifying a baseline scenario that has been previously saved in the **Baseline Scenario Database**. The FHPM automatically loads the **ZeroBaseline scenario** when you open the model, which means all of the model's parameters are set to zero initially. To begin using the model,

- Select the FHPM menu.
- Select [*Load or Modify Baseline Scenario*] to open the interface screen shown in Figure 3-1.

Figure 3-1. Load or Modify Baseline Scenario Screen



The listing of baseline scenarios, in the left column of the *Load or Modify Baseline Scenario* screen, shows all saved baseline scenarios available. The list automatically updates as you create and save new baseline scenarios. The right panel of the interface screen provides a description for the selected baseline scenario.

3.2.1 Load a Baseline Scenario

To load a baseline scenario,

- ▶ Highlight the baseline scenario you want, then click [*Load*]. The FHPM sets all parameters of the model to values stored in the baseline scenario record you selected.

After loading a baseline scenario, you are ready to run a **Baseline Scenario Simulation** (see Section 3.3). Running a baseline scenario simulation will generate baseline output distributions for all random variables in the FHPM.

3.2.2 Modify a Baseline Scenario

Use this option to create a new baseline scenario. Given the large number of parameters in the FHPM, you will usually create a new baseline scenario by modifying a previously saved baseline scenario, which we call a **Progenitor Baseline Scenario**. To minimize the number of parameters that require different values for the new baseline scenario, select a progenitor baseline scenario that closely matches the definition of the new baseline scenario you want to create. In some cases, you may want to use the ZeroBaseline scenario as the progenitor for the new baseline scenario, particularly when the new baseline scenario includes only a few categories of foods, types of pathogens, categories of retail establishments, or types of contributing factors. To modify a progenitor baseline scenario to create a new baseline scenario,

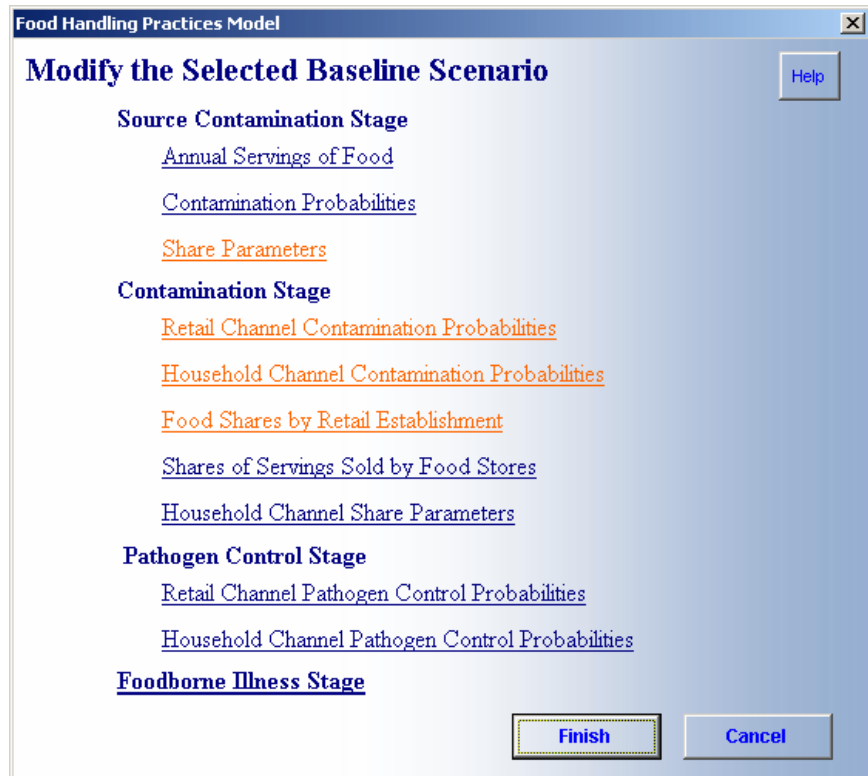
- ▶ Highlight a baseline scenario to modify from the *Load or Modify Baseline Scenario* screen.
- ▶ Click [*Modify*] to open the screen shown in Figure 3-2, which shows the four stages of the FHPM.
 - ✓ Source Contamination Stage
 - ✓ Contamination Stage
 - ✓ Pathogen Control Stage
 - ✓ Foodborne Illness Stage

Changing Parameters in the Source Contamination Stage

The **Source Contamination Stage** has three categories of parameters that you can modify to calibrate a new baseline scenario:

- ✓ Annual Servings of Food

Figure 3-2. Modify the Selected Baseline Scenario Screen



- ✓ Contamination Probabilities
- ✓ Share Parameters

Annual Servings of Food. Click this option to open the screen shown in Figure 3-3 and enter new values for annual servings of food (N_{si}) for up to nine food categories. The categories Food A and Food B allow for user-defined food categories.

- Click in one of the cells next to the appropriate food category, and key in a new number of servings. Use the [Tab] or [Enter] key to move through the food categories. Values you change will appear in red when you tab out of the cell.
- Click [Reset Values] to display original baseline values.
- Click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.
- Save the modified scenario to the baseline scenario database (see page 3-20) or continue to modify additional parameters.

Contamination Probabilities. Click this option to open the screen shown in Figure 3-4 to select a particular food category and enter new values for one or more **Source Contamination Probabilities**, $P(A_{ij})$.

Figure 3-3. Calibrate Annual Servings of Food Screen

Food Category	Annual Servings
Dairy	345,702,400,000
Eggs	57,203,110,000
Meat	162,753,100,000
Poultry	129,219,100,000
Produce	614,966,500,000
Seafood	26,022,690,000
Water	626,586,000,000
Food A	0
Food B	0

Buttons: **Reset Values**, **Finish**, **Cancel**, **Help**

Figure 3-4. Select a Food Category to Calibrate Source Contamination Probabilities Screen

Food categories listed as underlined text:

- Dairy
- Eggs
- Meat
- Poultry
- Produce
- Seafood
- Water
- Food A
- Food B

Buttons: **Finish**, **Cancel**, **Help**

- Click on a food category you want to modify to open a screen like the one shown in Figure 3-5.
- Click into one of the cells next to a pathogen, and key in a changed source contamination probability. Use the [Tab] or [Enter] key to move to other cells.
- Select one of the five options at the bottom of the screen:
 - ✓ Click [Next] or [Back] to save changes and move forward or back to another food category.

Figure 3-5. Calibrate Source Contamination Probabilities: Dairy Screen

Pathogen	Probability
<i>Bacillus cereus</i>	0.335775
<i>Salmonella</i>	0.0
<i>Campylobacter jejuni</i>	0.0
All other non-typhoidal <i>Salmonella</i> spp	0.0
<i>Clostridium perfringens</i>	0.17
<i>S. gella</i> spp.	0.0
<i>Cryptosporidium parvum</i>	0.0
<i>Streptococcus</i> spp.	0.0
<i>Cyclospora cayentanensis</i>	0.0
<i>Staphylococcus aureus</i>	0.0
<i>E. coli</i> O157:H7	0.0
<i>Vibrio</i> spp.	0.0
other <i>E. coli</i> spp	0.0
<i>Yersinia enterocolitica</i>	0.0
Hepatitis A	0.0
Pathogen A	0.0
<i>Listeria</i>	0.006137
Pathogen B	0.0
Norovirus	0.0

- ✓ Click [*Reset Values*] to display original baseline values.
- ✓ Click [*OK*] to save changes and return to the *Select a Food Category To Calibrate Source Contamination Probabilities* screen, or click [*Cancel*] to return to the previous screen without saving changes.
- After modifying all parameters necessary to define the new baseline scenario, click [*Finish*] to save changes and return to the *Modify the Selected Baseline Scenario* screen.
- Save the modified baseline scenario to the baseline scenario database (see page 3-20) or continue to modify additional parameters.

Share Parameters. Click this option to open the screen shown in Figure 3-6 and enter new values for **Food Shares to the Retail Channel**, c_i . Example: enter 0.990 for the proportion of the Dairy Food Category that reaches the household channel through a **Retail Food Establishment**, which implies that 0.010 is the proportion of the dairy food category that reaches the household channel without passing through the retail channel.

- Click into one of the cells next to the appropriate food category, and key in the changed proportion of servings. Use the [*Tab*] or [*Enter*] key to move through the food categories.
- Click [*Reset Values*] to display original baseline values.
- Click [*Finish*] to save changes and return to the *Modify Selected Baseline Scenario* screen, or click [*Cancel*] to return to the previous screen without saving changes.

Figure 3-6. Calibrate Food Shares to the Retail Channel Screen

Food Category	Value
Dairy	0.993
Eggs	0.988
Meat	0.998
Poultry	0.996
Produce	0.981
Seafood	0.989
Water	0.999
Food A	0.0
Food B	0.0

- Save the modified scenario to the scenario database (see page 3-20) or continue to modify additional parameters.

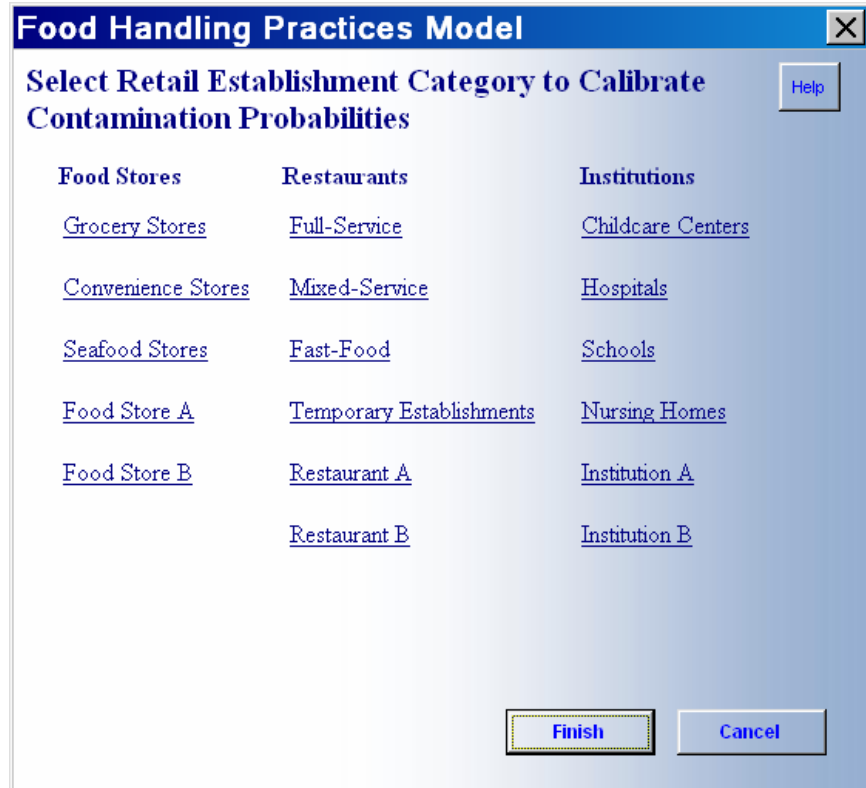
Changing Parameters in the Contamination Stage

The contamination stage has five categories of parameters that you can modify to create a new baseline scenario:

- ✓ Retail Channel Contamination Probabilities
- ✓ Household Channel Contamination Probabilities
- ✓ Food Shares by Retail Establishment
- ✓ Shares of Food Sold by Food Stores
- ✓ Household Channel Share Parameters

Retail Channel Contamination Probabilities. Click this option to open the screen shown in Figure 3-7 to select a particular retail establishment category and enter new values for one or more **Retail Channel Contamination Probabilities**, $P(B'_{jk})$ or $P(B'_{jk}|C'_{jk})$.

Figure 3-7. Select Retail Establishment Category to Calibrate Contamination Probabilities Screen



- Click on a retail establishment category you want to modify to open a screen like the one shown in Figure 3-8. The categories Food Store A, Food Store B, Restaurant A, Restaurant B, Institution A, and Institution B allow for user-defined retail establishment categories.

The food handling practices listed are contributing factors that may contaminate food in retail establishments. Each food handling practice has two associated probabilities— $P(B'_{jk})$, the probability of occurrence of the k^{th} contributing factor during preparation or handling by the j^{th} category of retail establishment, and the conditional probability $P(B'_{jk}|C'_{jk})$, which is the probability that an occurrence of the k^{th} contributing factor contaminates a serving of food during preparation or handling by the j^{th} category of retail establishment.

- To change one or more of the probabilities, click into one of the cells next to a food handling practice, and key in the new probability. Use the [Tab] or [Enter] key to move between food handling practices.

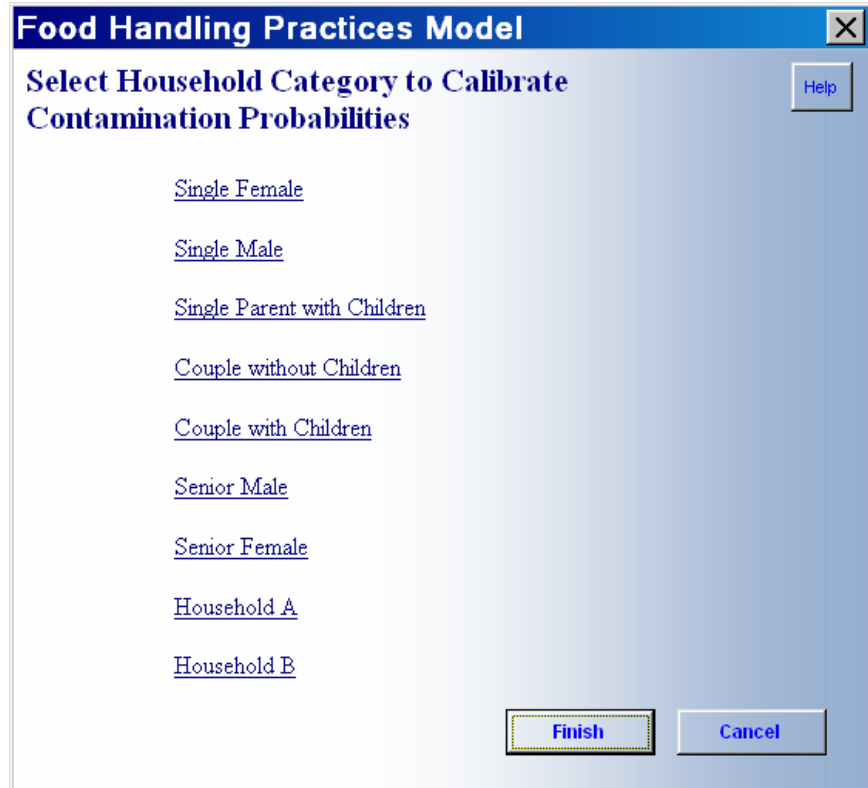
Figure 3-8. Calibrate Retail Contamination Probabilities: Grocery Stores Screen

	Probability Practice Occurs	Probability Food is Contaminated
Inappropriate hand washing	0.409	0.1833
Inappropriate bare-hand contact with RTE foods	0.149	0.0817
Inappropriate bare-hand contact with RTC foods	0.07	0.0717
Inappropriate gloved-hand contact with RTE foods	0.107	0.0136
Inappropriate gloved-hand contact with RTC foods	0.023	0.0361
Inappropriate cleaning of cutting boards/surfaces	0.249	0.0333
Food handling by ill worker	0.166	0.02
Food handling by colonized, asymptomatic carrier	0.099	0.05
Inappropriate sanitation of equipment or utensils	0.408	0.0339
Sanitation & hygiene factor A	0.0	0.0
Sanitation & hygiene factor B	0.0	0.0

- Select one of the five options at the bottom of this screen:
 - ✓ Click [Next] or [Back] to save changes and move forward or backward to another retail establishment category.
 - ✓ Click [Reset Values] to display original baseline values.
 - ✓ Click [OK] to save changes and return to the *Select Retail Establishment to Calibrate Contamination Probabilities* screen, or click [Cancel] to return to the previous screen without saving changes.
- After making all changes desired, click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.
- Save the modified scenario to the baseline scenario database (see page 3-20) or continue to modify additional parameters.

Household Channel Contamination Probabilities. Click this option to open the screen shown in Figure 3-9 to select a particular household category and enter new values for one or more **Household Channel Contamination Probabilities** $P(B^*_{jk})$ or $P(B^*_{jk}|C^*_{jk})$.

Figure 3-9. Select Household Category to Calibrate Contamination Probabilities Screen



- Click on a household category you want to modify to open a screen like the one shown in Figure 3-10. The categories Household A and Household B allow for user-defined household categories.

The food handling practices listed are contributing factors that may contaminate food in households. Each food handling practice has two associated probabilities— $P(B^*_{jk})$, the probability of occurrence of the k^{th} contributing factor during preparation or handling by the j^{th} category of household, and the conditional probability $P(B^*_{jk}|C^*_{jk})$, which is the probability that an occurrence of the k^{th} contributing factor contaminates a serving of food during preparation or handling by the j^{th} category of household.

- To change one or more of the probabilities, click into one of the cells next to a food handling practice, and key in the new probability. Use the [Tab] or [Enter] key to move between food handling practices.
- Select one of the five options at the bottom of the screen:
 - ✓ Click [Next] or [Back] to save changes and move between household categories.
 - ✓ Click [Reset Values] to display original baseline values.

Figure 3-10. Calibrate Household Contamination Probabilities: Single Female Screen

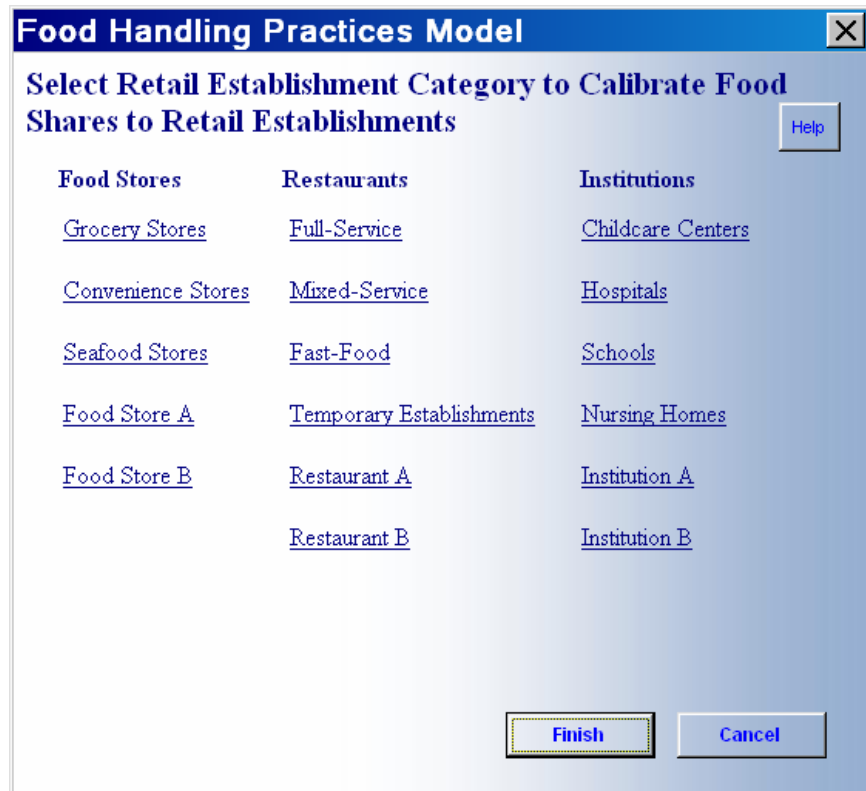
	Probability Practice Occurs	Probability Food is Contaminated
Inappropriate hand washing	0.4202	0.1567
Inappropriate bare-hand contact with RTE foods	0.244	0.08
Inappropriate bare-hand contact with RTC foods	0.0861	0.0053
Inappropriate gloved-hand contact with RTE foods	0.0196	0.0007
Inappropriate gloved-hand contact with RTC foods	0.0085	0.0003
Inappropriate cleaning of cutting boards/surfaces	0.2707	0.2233
Food handling by ill person	0.114	0.0767
Food handling by colonized, asymptomatic carrier	0.088	0.0467
Inappropriate sanitation of equipment or utensils	0.319	0.0833
Sanitation & hygiene factor A	0.1121	0.0
Sanitation & hygiene factor B	0.0	0.0

- ✓ Click [OK] to save changes and return to the *Select Household Category To Calibrate Contamination Probabilities* screen, or click [Cancel] to return to the previous screen without saving changes.
- After making all changes desired, click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.
- Save the modified scenario to the scenario database (see page 3-20) or continue to modify additional parameters.

Food Shares by Retail Establishment. Click this option to open the screen shown in Figure 3-11 to select a particular retail establishment category and enter new values for one or more **Food Shares to Retail Establishments**, b_{ij} .

- Click on a retail establishment category you want to modify to open a screen like the one shown in Figure 3-12. The categories Food Store A, Food Store B, Restaurant A, Restaurant B, Institution A, and Institution B allow for user-defined retail establishment categories.

Figure 3-11. Select Retail Establishment Category to Calibrate Food Shares to Retail Establishments Screen



- To change the shares, click into one of the cells next to a food category, and key in a new value. Example: enter 0.60 to express the share of annual servings of the dairy food category that are served or sold to consumers by hospitals. Use the [Tab] or [Enter] key to move through the food categories.
- Select one of the five options at the bottom of the screen:
 - ✓ Click [Next] or [Back] to save changes and move between retail establishment categories.
 - ✓ Click [Reset Values] to display original baseline values.
 - ✓ Click [OK] to save changes and return to the *Select Retail Establishment Category to Calibrate Food Shares to Retail Establishments* screen, or click [Cancel] to return to the previous screen without saving changes.
- After making all changes desired, click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.
- Save the modified scenario to the scenario database (see page 3-20) or continue to modify additional parameters.

Figure 3-12. Calibrate Food Shares for Grocery Stores Screen

Food Category	Value
Dairy	0.466
Eggs	0.688
Meat	0.755
Poultry	0.726
Produce	0.74
Seafood	0.184
Water	0.0
Food A	0.0
Food B	0.0

Shares of Servings Sold by Food Stores. Click this option to open the screen shown in Figure 3-13 to enter new values for one or more **Shares of Servings Sold by Food Stores to Households for Further Preparation**, $(1-w_j)$.

Only retail food stores appear on this screen, because all other categories of retail establishments prepare and serve only food that is not further prepared by households.

- To change the shares, click into one of the cells next to a food store category, and key in a new value. Example: enter 0.875 to express the share of annual servings of food that are bought by households from grocery stores for further preparation by households before consumption, which implies that 0.125 is the share bought by households from grocery stores that is consumed without further preparation by households. Use the [Tab] or [Enter] key to move through the food categories.
- Click [Reset Values] to display original baseline values.
- Click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.

Figure 3-13. Calibrate Shares of Servings Sold by Food Stores to the Household Channel for Household Preparation

Store Category	Share Value
Grocery Stores	0.8865
Convenience Stores	0.886
Seafood Stores	0.886
Food Store A	0.0
Food Store B	0.0

- Save the modified scenario to the baseline scenario database (see page 3-20) or continue to modify additional parameters.

Household Channel Share Parameters. Click this option to open the screen shown in Figure 3-14 to select a particular retail establishment category and enter new values for one or more

Household Channel Share Parameters, u_{jk} .

- To change the shares, click into one of the cells next to a household category, and key in a new value. Example: enter 0.040 to express the share of annual servings of food that are prepared by single female households. The sum of the (u_i) across all household categories must equal 1. Use the [Tab] or [Enter] key to move through the food categories.
- Click [Reset Values] to display original baseline values.
- Click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.
- Save the modified scenario to the scenario database (see page 3-20) or continue to modify additional parameters.

Figure 3-14. Calibrate Food Shares to the Household Channel Screen

Category	Value
Single Female	0.0445
Single Male	0.0258
Single Parent with Children	0.0632
Couple without Children	0.2278
Couple with Children	0.4396
Senior Male	0.0145
Senior Female	0.0382
Household A	0.1464
Household B	0.0

Changing Parameters in the Pathogen Control Stage

The pathogen control stage has two categories of parameters that you may modify to create a new baseline scenario.

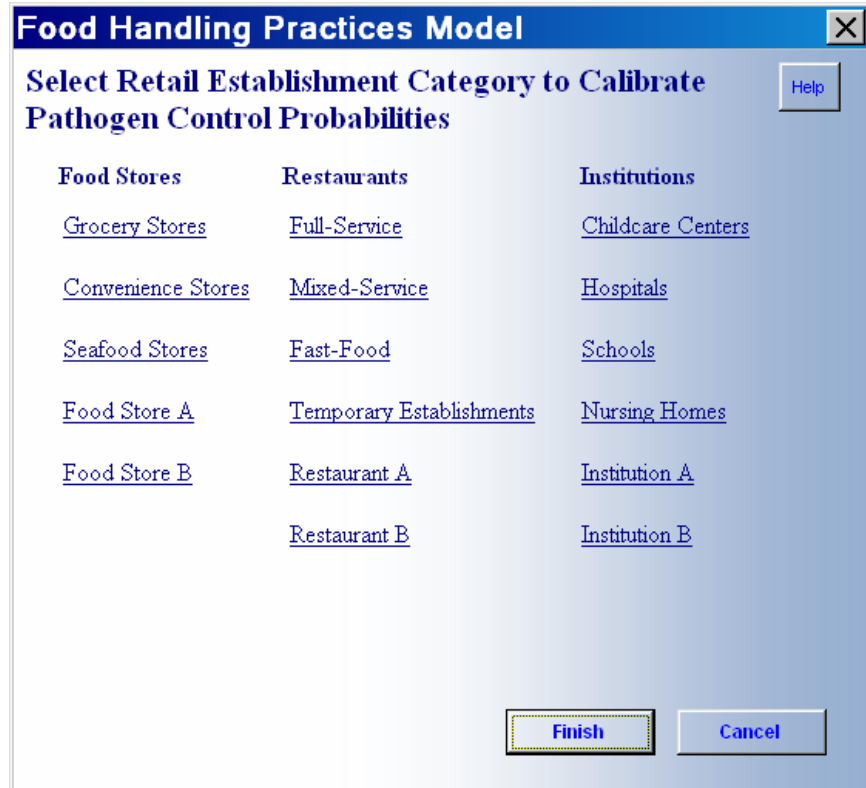
- ✓ Retail Channel Pathogen Control Probabilities
- ✓ Household Channel Pathogen Control Probabilities

Retail Channel Pathogen Control Probabilities. Click this option to open the screen shown in Figure 3-15 to select a particular retail establishment category and enter new values for one or more **Retail Channel Pathogen Control Probabilities** $P(B''_{jk})$ or $P(B''_{jk}|C''_{jk})$.

- Click on a retail establishment category you want to modify to open a screen like the one shown in Figure 3-16. The categories Food Store A, Food Store B, Restaurant A, Restaurant B, Institution A, and Institution B allow for user-defined retail establishment categories.

The food handling practices listed are contributing factors that may allow pathogens to survive and grow in food in retail establishments. Each food handling practice has two associated probabilities— $P(B''_{jk})$, the probability of occurrence of the k th

Figure 3-15. Select Retail Establishment Category to Calibrate Pathogen Control Probabilities



contributing factor during preparation or handling by the j^{th} category of retail establishment, and the conditional probability $P(B''_{jk}|C''_{jk})$, which is the probability that an occurrence of the k^{th} contributing factor allows pathogens to survive and grow in a serving of pathogen-contaminated food prepared by the j^{th} category of retail establishment.

- To change one or more of the probabilities, click into one of the cells next to a food handling practice, and key in the new probability. Use the [Tab] or [Enter] key to move between food handling practices.
- Select one of the five options at the bottom of this screen:
 - ✓ Click [Next] or [Back] to save changes and move forward or backward to another retail establishment category.
 - ✓ Click [Reset Values] to display original baseline values.
 - ✓ Click [OK] to save changes and return to the *Select a Retail Establishment Category to Calibrate Pathogen Control Probabilities* screen, or click [Cancel] to return to the previous screen without saving changes.
- After making all changes desired, click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.

Figure 3-16. Calibrate Retail Pathogen Control Probabilities: Full-Service Restaurants Screen

	Probability Practice Occurs	Probability Pathogens Survive or Grow
Inappropriate time or temperature for cooking	0.2775	0.1617
Inappropriate time or temperature for reheating	0.2425	0.0379
Inappropriate time or temperature for cooling	0.54	0.115
Inappropriate time or temperature for cold holding	0.5063	0.2
Inappropriate advance preparation	0.29	0.1625
Inappropriate time or temperature for hot holding	0.3288	0.0875
Food kept at room temperature too long	0.3275	0.1617
Inappropriate thawing of frozen foods	0.2625	0.0084
Food served raw or lightly cooked	0.04	0.145
Survival & amplification factor A	0.0	0.0
Survival & amplification factor B	0.0	0.0

- Save the modified scenario to the scenario database (see page 3-20) or continue to modify additional parameters.

Household Channel Contamination Probabilities. Click this option to open the screen shown in Figure 3-17 to select a particular household category and enter new values for one or more **Household Channel Pathogen Control Probabilities** $P(B^{**}_{jk})$ or $P(B^{**}_{jk}|C^{**}_{jk})$.

- Click on a household category you want to modify to open a screen like the one shown in Figure 3-18. The categories Household A and Household B allow for user-defined household categories.

The food handling practices listed are contributing factors that may allow pathogens to survive and grow in food in households. Each food handling practice has two associated probabilities— $P(B^{**}_{jk})$, the probability of occurrence of the k^{th} contributing factor during preparation or handling by the j^{th} category of household, and the conditional probability $P(B^{**}_{jk}|C^{**}_{jk})$, which is the probability that an occurrence of the k^{th} contributing factor allows pathogens to survive and grow in a serving of pathogen-contaminated food prepared by the j^{th} category of household.

Figure 3-17. Select Household Category to Calibrate Pathogen Control Probabilities Screen

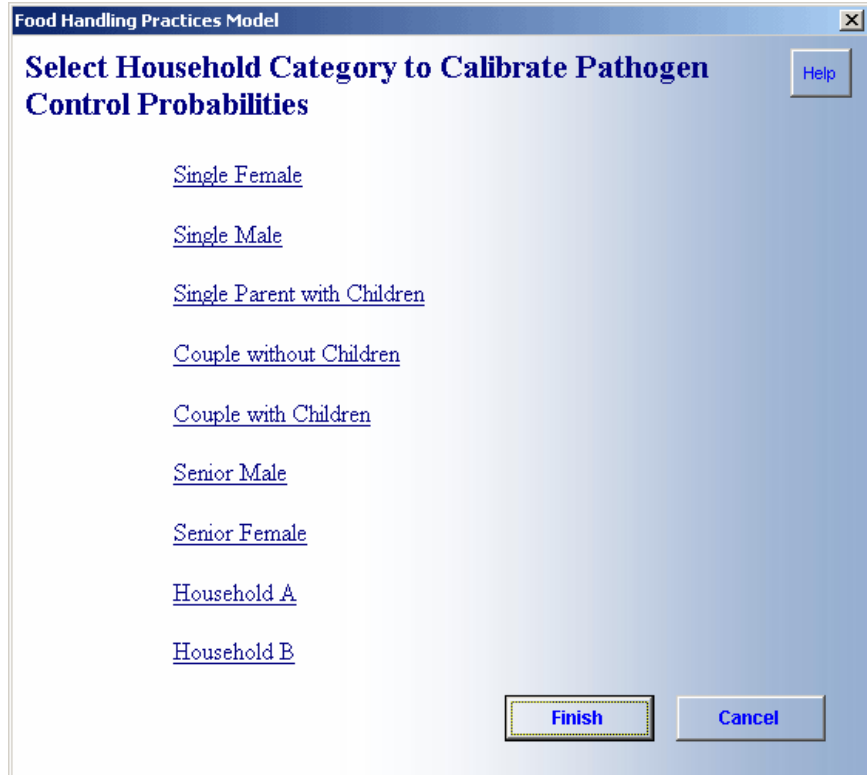
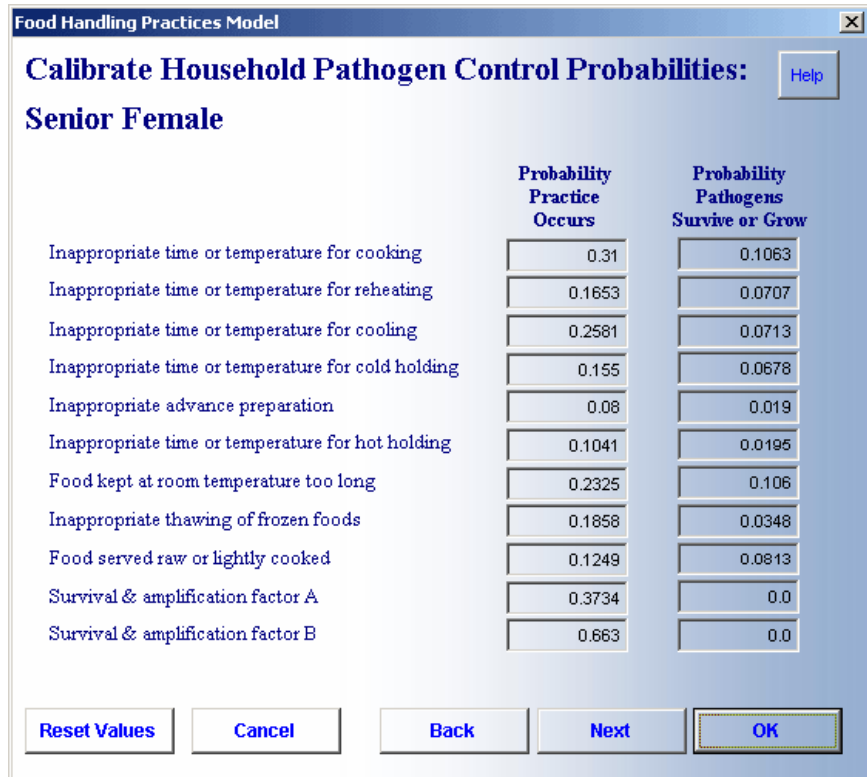


Figure 3-18. Calibrate Household Pathogen Control Probabilities: Senior Female Screen



- To change one or more of the probabilities, click into one of the cells next to a food handling practice, and key in the new probability. Use the [Tab] or [Enter] key to move between food handling practices.
- Select one of the five options at the bottom of this screen:
 - ✓ Click [Next] or [Back] to save changes and move forward or backward to another household category.
 - ✓ Click [Reset Values] to display original baseline values.
 - ✓ Click [OK] to save changes and return to the *Select a Household Category to Calibrate Pathogen Control Probabilities* screen, or click [Cancel] to return to the previous screen without saving changes.
- After making all changes desired, click [Finish] to save changes and return to the *Modify the Selected Baseline Scenario* screen, or click [Cancel] to return to the previous screen without saving changes.
- Save the modified scenario to the scenario database (see page 3-20) or continue to modify additional parameters.

Changing Parameters in the Foodborne Illness Stage

Click this option to open the screen shown in Figure 3-19 and enter new values for probabilities that ingestion of a serving of pathogen-contaminated food causes a case of foodborne illness in the retail and household channels.

In the FHPM, $P(\text{FBI}) = P(\text{ingesting a serving of pathogen-contaminated food causes a "noticeable" case of foodborne illness})$. By “noticeable” we mean that the illness produces symptoms that are apparent to the patient, even though the symptoms may not be identified by the patient as related to a foodborne illness and may not be severe enough to require medical treatment.

Untreated FBI are cases of foodborne illness for which the patient does not seek professional medical treatment. Medically treated FBI comprise three subcategories: physician treated, hospitalizations, or deaths. The three subcategories of medically treated FBI are not mutually exclusive. In the FHPM, we assume that all hospitalizations and deaths are physician treated, and all deaths are first hospitalizations, but not all physician-treated cases result in hospitalization or death.

Figure 3-19. Calibrate FBI Probabilities Screen

	Retail Channel	Household Channel
P(FBI) Probability that ingestion of a serving of pathogen-contaminated food causes a noticeable case of FBI	0.000424	0.000424
P(FBI _m) Probability that ingestion of a serving of pathogen-contaminated food results in a case of foodborne illness sufficiently severe that treatment of a physician is sought	0.08	0.08
P(FBI _h FBI _m) Probability that a case of foodborne illness that requires professional medical treatment becomes sufficiently severe to require hospitalization	0.053125	0.053125
P(FBI _d FBI _h) Probability that a case of foodborne illness that requires medical treatment by a physician becomes sufficiently severe that death occurs	0.016099	0.016099


Buttons: **Reset Values**, **Finish**, **Cancel**, **Help**

- To change one or more of the probabilities, click into one of the cells next to a probability parameter, and key in the new probability. Use the [Tab] or [Enter] key to move between the retail and household channels.
- Click [Reset Values] to display original baseline values.
- Click [Finish] to save changes and return to the *Modify Selected Baseline Scenario* screen.
- Save the modified scenario to the scenario database (see the following section) or continue modifying another stage.

Saving the New Baseline Scenario

- On the user interface screen, *Modify the Selected Baseline Scenario*, click [Finish].
- A dialog box asks, "Would you like to Save and Describe the Modified Baseline?"
- Clicking [Yes] opens the screen shown in Figure 3-20.
 - ✓ Type in the scenario name of no more than 40 characters.
 - ✓ Type a description for the new baseline scenario, with no limit to the number of words. Your description should be complete enough to allow you and other users to understand how the new baseline scenario is defined.

Figure 3-20. Save Modified Baseline Scenario Screen



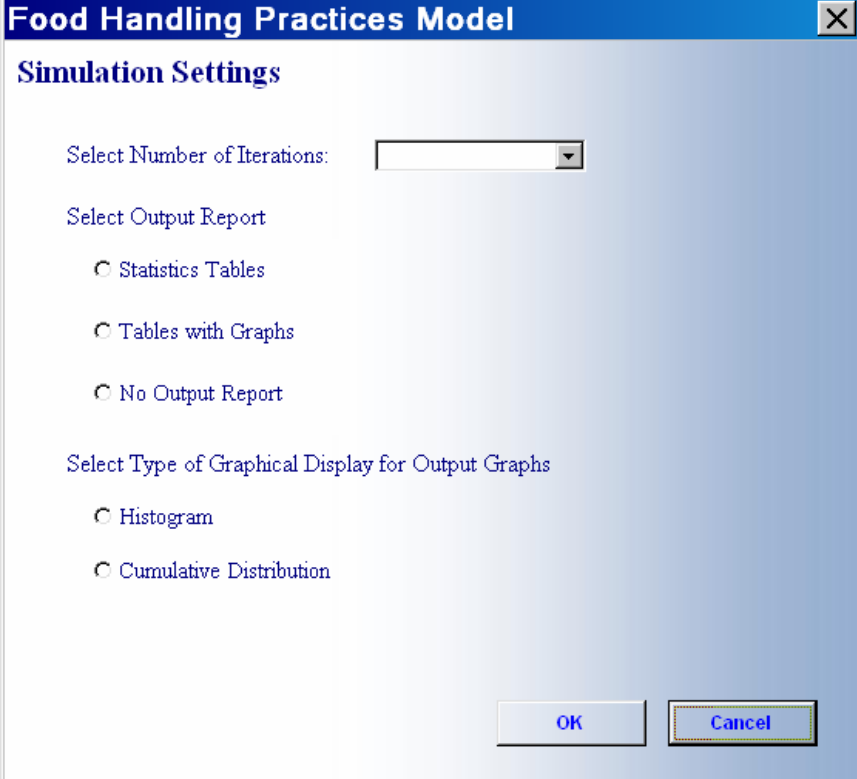
The screenshot shows a dialog box titled "Food Handling Practices Model" with a close button (X) in the top right corner. The main heading inside the dialog is "Save Modified Baseline Scenario". Below the heading, there is a "Scenario Name" label followed by a text input field. Underneath that is a "Scenario Description" label followed by a larger text area. At the bottom right of the dialog, there are two buttons: "Save" and "Cancel".

- ✓ Click [Save]. (Clicking [Cancel] will return you to the previous screen without saving the modified baseline scenario).
- If you click [No], the user interface screen closes and you return to the model worksheets. The parameters you modified are loaded into the spreadsheet but are not saved as a new baseline scenario. You may want to run a **Baseline Simulation** before you save the new scenario. Section 3.4 explains how to save the new baseline scenario after you run a trial baseline simulation.

3.3 RUNNING A BASELINE SCENARIO SIMULATION

After loading or modifying a baseline scenario, you can run a baseline simulation by performing the following steps:

- Select the FHPM drop-down menu.
- Select [*Run Baseline Scenario Simulation*] to open the screen shown in Figure 3-21.

Figure 3-21. Simulation Settings Screen

The screenshot shows a dialog box titled "Food Handling Practices Model" with a close button (X) in the top right corner. The main title of the dialog is "Simulation Settings".

Under "Simulation Settings", there are three sections:

- Select Number of Iterations:** A drop-down menu.
- Select Output Report:** Three radio button options:
 - Statistics Tables
 - Tables with Graphs
 - No Output Report
- Select Type of Graphical Display for Output Graphs:** Two radio button options:
 - Histogram
 - Cumulative Distribution

At the bottom right, there are two buttons: "OK" and "Cancel".

- Select the number of **iterations** from the drop-down menu. Higher numbers of iterations require more time to run but generate more complete distributions for the model's random variables.
- Select the desired output report. If you select [*Tables with Graphs*], you must also select the type of graph (histogram or cumulative distribution). The output option [*Tables with Graphs*] require more time for the simulation to run, and due to errors in @Risk, some graphs may not be drawn correctly.
- Click [OK].
 - ✓ A simulation run time indicator appears in the lower left corner of your screen. When the simulation finishes, the model creates a new Excel worksheet, titled with a book number. You may print the output file, save it, or discard it.
 - ✓ The table columns titled "change scenario" in the output tables are blank and the columns titled "delta" display a negative number, since "delta" is the change scenario output minus the baseline scenario output. Once you recalibrate for a change scenario (see Section 3.5) and run a change scenario simulation (see Section 3.6), all columns in the output tables will display values.

3.4 SAVE BASELINE SCENARIO

To create and save a baseline scenario that corresponds to whatever parameter calibration values are currently displayed in the model worksheets, select the FHPM drop-down menu and click [*Save Baseline Scenario*], which opens the screen shown in Figure 3-20. You may use the [*Save Baseline Scenario*] at any time, for example, after changing parameter values directly on the FHPM worksheets or after running a trial simulation of a modified baseline scenario. Invoking [*Save Baseline Scenario*] will allow you to name and save as a baseline scenario whatever parameter values are currently in the cells of the FHPM worksheets.

- ▶ Type in the scenario name of no more than 40 characters.
- ▶ Type a description of the new baseline scenario, with no limit to the number of words. Your description should be complete enough to allow you and other users to understand how the new baseline scenario is defined.
- ▶ Click [*Save*]. (Clicking [*Cancel*] will return you to the previous screen without saving the modified baseline scenario).

3.5 RECALIBRATE FOR CHANGE SCENARIO

A **Change Scenario** is a particular calibration of parameters in the FHPM that reflects changes that you expect to occur following implementation of a regulation, rule, or some other change under analysis.

You may recalibrate for a change scenario only after first running a baseline simulation using the FHPM menu command [*Run Baseline Scenario Simulation*].

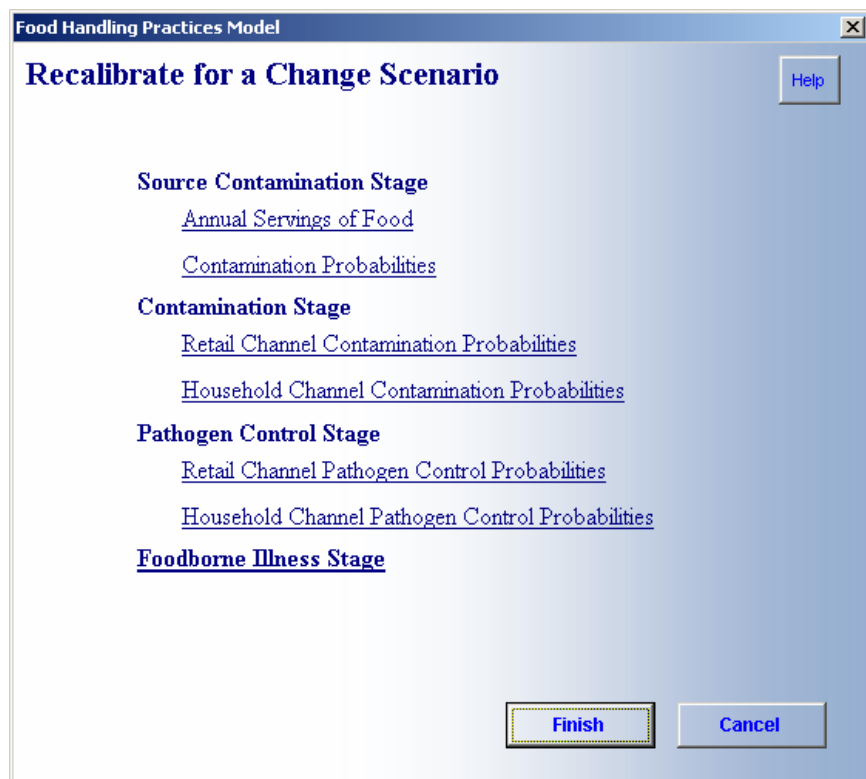
After recalibrating for a change scenario, and then running a **Change Scenario Simulation** (see Section 3.6), the FHPM will calculate change in the distributions of random variables in the model, based on the latest baseline scenario simulation you ran using the FHPM drop-down menu command, [*Run Baseline Scenario Simulation*]. If you select [*Recalibrate for a Change Scenario*] in the FHPM drop-down menu without first running a baseline simulation, the FHPM prompts you to run a baseline scenario simulation.

Recalibrating for a change scenario is quite similar to modifying a baseline scenario, as described in Section 3.2. One difference, though, is that you will not want to recalibrate share parameters for a change scenario, since share parameters are not likely to change as the result of a regulation. Consequently, as shown in Figure 3-22, the user interface provides only for changing probability parameters and annual servings of food to recalibrate for a change scenario. A second difference is that after using the interface to recalibrate for a change scenario, the interface prompts you to run a change scenario simulation, which the interface does not do after you modify a progenitor baseline scenario to create a new baseline scenario.

To recalibrate for a change scenario,

- Select the FHPM drop-down menu and click [*Recalibrate for Change Scenario*] to open the screen shown in Figure 3-22.

Figure 3-22. Recalibrate for a Change Scenario Screen



- Select the desired option within one of the four stages of the model to recalibrate one or more parameter values:
 - ✓ Source Contamination Stage—to recalibrate annual servings of food or contamination probabilities (see page 3-3). Click [*Finish*] to return to the *Recalibrate for a Change Scenario* screen.

- ✓ Contamination Stage—to recalibrate retail channel or household channel contamination probabilities (see page 3-7). Click [*Finish*] to return to the *Recalibrate for a Change Scenario* screen.
- ✓ Pathogen Control Stage—to recalibrate retail channel or household channel pathogen control probabilities (see page 3-15). Click [*Finish*] to return to the *Recalibrate for a Change Scenario* screen.
- ✓ Foodborne Illness Stage—to recalibrate the probability parameters for treatment, hospitalization, and death (see page 3-19). Click [*Finish*] to return to the *Recalibrate for a Change Scenario* screen.
- Click [*Finish*] after completing all changes you want for the change scenario. A dialog box asks, “*Run Change Scenario Simulation?*”
- If you click [*Yes*], a simulation run time indicator appears in the lower left corner of your screen. When the simulation is complete, the model creates a new Excel worksheet, titled with a book number. You may print the output file, save it, or discard it.
- If you click [*No*], the user interface screen closes and you return to the model worksheets. The modified values are input into the worksheets but are not saved. Section 3.6 explains how to run the change scenario simulation at a later time.

3.6 RUN CHANGE SCENARIO SIMULATION

After running a baseline scenario simulation using the FHPM menu command, [*Run Baseline Scenario Simulation*], followed by recalibrating for a change scenario—either by using the FHPM menu command, [*Recalibrate for Change Scenario*], or by changing parameter values directly on the FHPM worksheets—you are ready to run a **Change Scenario Simulation**.

In fact, the FHPM will run a change scenario simulation any time after you have run a baseline scenario simulation, even if you have made no changes to parameter values in the FHPM worksheets. But if you run a change scenario simulation without making changes to the baseline last simulated, you will simply get an output file that shows change in distributions of random variables resulting purely from chance selection during the Monte Carlo trials simulated by @Risk.

You may run only one change scenario simulation after you run each baseline scenario simulation. To run an additional change

scenario simulation, you must first run an additional baseline scenario simulation, which of course, should be calibrated to reflect a baseline scenario you intend to simulate.

The change scenario simulation uses the same simulation settings (i.e., number of iterations, type of output report) that you used to run the baseline scenario simulation. To run a change scenario simulation,

- Select [*Run Change Scenario Simulation*] from the FHPM menu.
- A simulation run time indicator appears in the lower left corner of your screen. When the simulation is complete, the model creates a new Excel worksheet, titled with a book number. You may print the output file, save it, or discard it.

Comparing outputs from running a change scenario simulation to outputs of the baseline scenario simulation that immediately precedes it allows users to analyze change in FBI attributable to changes reflected in the change scenario. The output file that is created and displayed by the FHPM during a change scenario simulation shows output values for the baseline scenario, the change scenario, and delta values calculated as (change scenario value) minus (baseline scenario value) for each random variable of the FHPM.

3.7 DELETE BASELINE SCENARIO

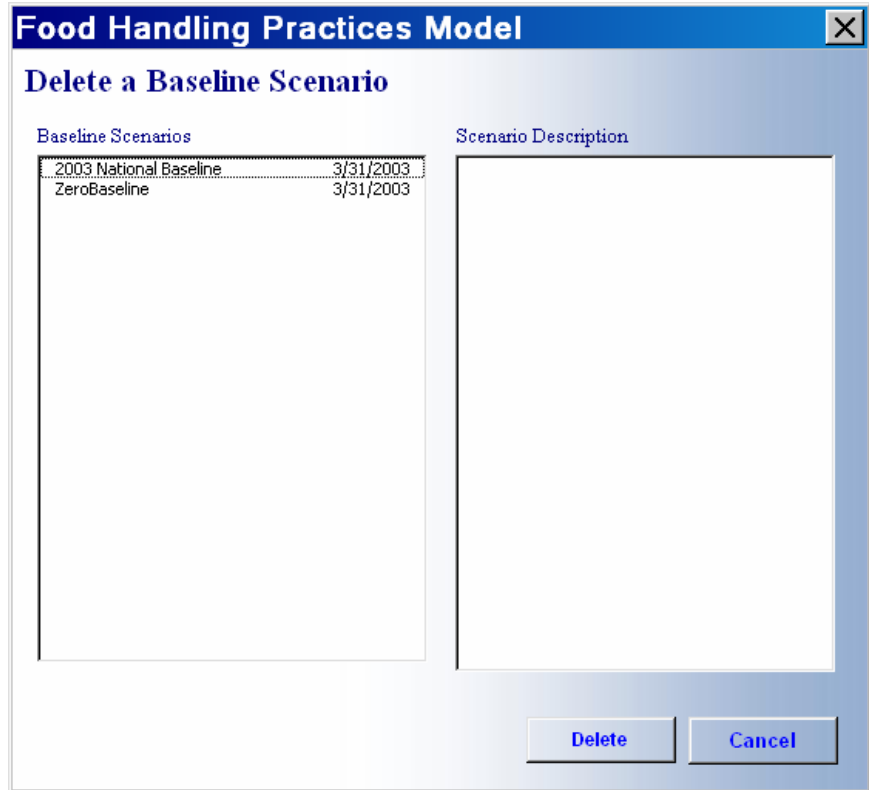
You can delete from the baseline scenario database new baseline scenarios you have created. You cannot delete the 2003 national baseline or the zerobaseline scenarios, because they are two basic progenitor baseline scenarios for the FHPM.

Please take care when deleting baseline scenarios, because once you delete a baseline scenario, you cannot retrieve or restore it.

To delete a baseline scenario from the baseline scenarios database, perform the following steps:

- Select [*Delete Baseline Scenario*] in the FHPM drop-down menu to open the screen shown in Figure 3-23.
- Select the baseline scenario you want to delete. Click [*Delete*].
- A dialog box asks, "*Permanently delete this file?*" Click [*Yes*].

Figure 3-23. Delete a Baseline Scenario Screen



- Click [*Cancel*] to clear the screen and return to the spreadsheets (without deleting).

4

Operating the Model Without the User Interface

Experienced users of the FHPM may frequently want to operate the FHPM without using the user interface. Experienced users can do so by entering parameter values directly in appropriate cells in one or another of the worksheets of the FHPM. But users should make changes directly to the Excel worksheets only after they have a thorough understanding of how the model works, where particular parameter values are in the FHPM worksheets, and what the user interface commands do. The FHPM worksheets include comments, typically in column A, that define model elements. Reading the comments and learning nomenclature for the FHPM will help you become a skillful user.

Each FHPM worksheet has cells that contain formulas that should not be changed. Because of limitations of @Risk, not all cells containing formulas can be locked, which means certain cells that contain formulas are unlocked during simulations.

When making entries directly on the FHPM worksheets, please use caution not to change the contents of a cell that contains a model formula.

As an experienced user, you will likely operate the model using a combination of direct entries to the FHPM spreadsheets and using the FHPM menu interchangeably. For example, you might load a baseline scenario and run a baseline scenario simulation using the

FHPM menu, but then you might change a parameter directly on one of the model worksheets and run a second baseline scenario simulation using the FHPM menu command. Alternatively, if you are familiar with features of @Risk, you might run a simulation and analyze results using the commands and capabilities of @Risk, without using the FHPM menu. But remember; when you initiate a simulation—either through the FHPM menu or using the capabilities and commands in available in @Risk, the model runs the simulation based on whatever parameter values are in the model's worksheets, as they appear on your screen.

4.1 EXCEL WORKSHEETS

This section describes each of the nine worksheets and provides instructions for how to change model parameters directly on the FHPM worksheets.

4.1.1 Source Worksheet

The Source Worksheet contains the input variables Annual Servings of Food and the Source Contamination Probabilities for up to 17 pathogens and up to nine food categories.

- ▶ Change any parameters for Row 10, Annual Servings of Food, N_{s_i} , annual servings of the i^{th} food category consumed in a specific geographic region.
- ▶ Change any parameters for Rows 12 through 30, Source Contamination Probabilities, $P(A_{ij})$, the probability that a serving of the i^{th} food category is contaminated with the j^{th} pathogen when it leaves the final manufacturing source.

▶ Caution: Do not change any cells for Rows 3 through 8, "Output to PCD Stage" and "Calculated Parameters."

4.1.2 Source to Retail Worksheet

The Source to Retail Worksheet contains share parameters for the proportion of each food category that reaches final consumers through a retail food establishment.

- ▶ Change any parameter in Row 7, c_i , proportion of annual servings of the i^{th} food category bought by consumers from a retail food establishment

- ▶ Change any parameters for Rows 9 through 25, b_{ij} , the proportion of annual servings of the i^{th} food category bought by consumers from the j^{th} category of retail food establishment

▶ Caution: Do not change any cells for Row 4, “Output to Retail Channel.”

4.1.3 Source to House Worksheet

The Source to House Worksheet contains intermediate calculations but no parameters to be changed by users. RTI locked this worksheet to protect the formulas, which do not involve @Risk simulation.

4.1.4 Retail Worksheet

The Retail Worksheet contains contamination probabilities for retail food establishments and the share parameters, w_j .

- ▶ Change any parameters for Row 12, w_j , the proportion of annual servings of food prepared by the j^{th} category of retail food establishment for direct sale to consumers without further preparation by households.
- ▶ Change the parameters for Rows 14 through 24, $P(B'_{jk})$, the probability of occurrence of the k^{th} contributing factor during preparation or handling by the j^{th} category of retail establishment.
- ▶ Change the parameters for Rows 26 through 36, $P(C'_{jk}|B'_{jk})$, the conditional probability that an occurrence of the k^{th} contributing factor contaminates a serving of food during preparation or handling by the j^{th} category of retail establishment.

▶ Caution: Do not change any cells for Rows 2 through 11, “Output to Retail PCD and Household Contamination,” “Calculated Parameters,” and “Inputs” formulas.

4.1.4 Retail to House Worksheet

The Retail to House Worksheet contains formulas but no parameters to be changed by users. RTI locked this worksheet to protect the formulas, which do not involve @Risk simulation.

4.1.5 Household Worksheet

The Household Worksheet contains contamination probabilities $P(B^*_{jk})$ and $P(C^*_{jk} | B^*_{jk})$ for households and the share parameters, u_j .

- ▶ Change any parameters for Row 12, u_j , the proportion of annual servings of food prepared by the j^{th} category of household
- ▶ Change the parameters for Rows 14 through 24, $P(B^*_{jk})$, the probability of the occurrence of the k^{th} contributing factor during preparation or handling by the j^{th} category of household.
- ▶ Change the parameters for Rows 26 through 36, $P(C^*_{jk} | B^*_{jk})$, the conditional probability that an occurrence of the k^{th} contributing factor contaminates a serving of food during preparation or handling by the j^{th} category of household

▶ Caution: Do not change any cells for Rows 3 through 11, "Output to Household PCD," "Calculated Parameters," and "Inputs" formulas.

4.1.6 Retail PCD Worksheet

The Retail PCD Worksheet contains pathogen control probabilities $P(B''_{jk})$ and $P(C''_{jk} | P(B''_{jk}))$ for retail establishments.

- ▶ Change any parameters for Rows 13 through 23, $P(B''_{jk})$, the probability of occurrence of the k^{th} food handling practice in the j^{th} retail establishment.
- ▶ Change any parameters for Rows 25 through 35, $P(C''_{jk} | P(B''_{jk}))$, the probability that an occurrence of the k^{th} contributing factor allows pathogens to survive and grow in a serving of pathogen-contaminated food prepared by the j^{th} category of retail establishment.

▶ Caution: Do not change any cells for Rows 3 through 11, "Output to Foodborne Illness Stage," "Calculated Parameters," and "Inputs" formulas.

4.1.7 House PCD Worksheet

The House PCD Worksheet contains pathogen control probabilities $P(B^{**}_{jk})$ and $P(C^{**}_{jk} | P(B^{**}_{jk}))$ for households.

- ▶ Change any parameters for Rows 15 through 25, $P(B^{**}_{jk})$, the probability of an occurrence of the k^{th} contributing factor during preparation or handling by the j^{th} category of household.

- ▶ Change any parameters for Rows 27 through 37, $P(C^{**}_{jk}|P(B^{**}_{jk}))$, the probability that an occurrence of the k^{th} contributing factor allows pathogens to survive and grow in a serving of pathogen-contaminated food prepared by the j^{th} category of household.

▶ Caution: Do not change any cells for Rows 3 through 13, “Output to Foodborne Illness Stage,” “Calculated Parameters,” and “Inputs” formulas.

4.1.8 FBI Worksheet

The FBI worksheet contains probabilities that ingesting a serving of pathogen-contaminated food will cause a case of FBI in the household and retail channels.

- ▶ Change parameters in the following rows:
 - ✓ Row 11: $P(\text{FBI})$ —Probability that ingestion results in noticeable FBI but is not treated by a physician
 - ✓ Row 15: $P(\text{FBI}_M)$ —Probability of FBI requiring medical treatment
 - ✓ Row 19: $P(\text{FBI}_H|\text{FBI}_M)$ —Probability of FBI requiring hospitalization
 - ✓ Row 23: $(\text{FBI}_D|\text{FBI}_H)$ —Probability of FBI causing death

▶ Caution: Do not change any cells for Rows 5 through 8, “Annual Cases of Foodborne Illness.” Do not change any standard deviation cells for Rows 12, 16, 20, and 24.

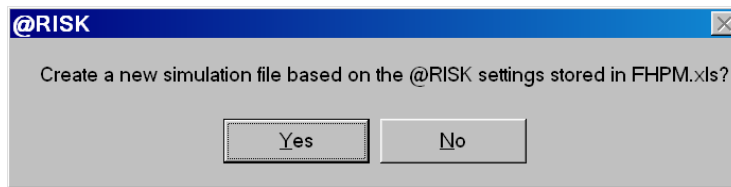
4.2 RUNNING MONTE CARLO SIMULATIONS USING @RISK

The Monte Carlo simulation engine used by the FHPM is @Risk. Consequently, users who are familiar with @Risk may use the full graphical and analytical power of the software to create user-specified graphs, conduct sensitivity analysis, and run multiple scenarios.

4.3 NOTES

If the dialog box displayed below (Figure 4-1) appears while you are using the FHPM or when you first open the FHPM, please select [No].

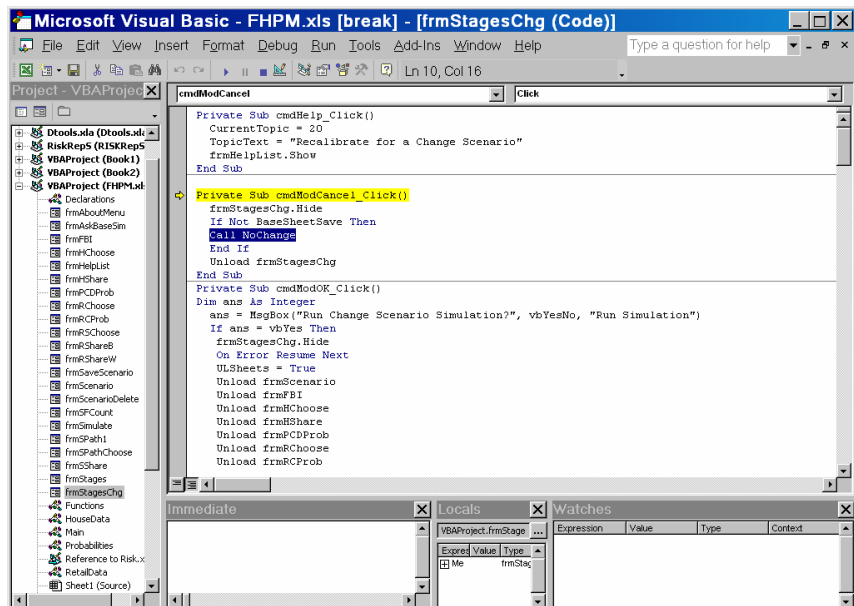
Figure 4-1. @Risk Dialog Box



The software application @Risk generates this dialog box under certain conditions that are unnecessary for operation of the FHPM. If you select [Yes], @Risk will run a simulation and create an @Risk output window, which is not a problem, but it may not be what you intend.

If while operating the FHPM you encounter a problem that generates an Excel or Visual Basic error message, such as the one displayed below in Figure 4-2, please press the keys Alt-Print Screen on your keyboard, which will place a snapshot of the screen on the clip board. You may then paste the screen shot into an MS Word file and send it via email attachment to RTI for debugging analysis.

Figure 4-2. Visual Basic Error Message



A

Glossary of Terms

Annual Servings of Food

Annual servings of food consumed in a specific region; key input variables for the FHPM.

Baseline Scenario

A set of calibration values for all 1,546 parameters in the FHPM. Depending on the specific definition of a baseline scenario, many of the model's parameters may have zero values.

Baseline Scenario Database

A Microsoft Access database whose records contain previously saved baseline scenarios.

Baseline Scenario Simulation

A Monte Carlo simulation that creates baseline output distributions for random variables of the FHPM.

Change Scenario

A calibration of parameters in the FHPM that reflects changes in a baseline scenario that the user expects to occur following implementation of a regulation, rule, or any other change under analysis. Users define change scenarios by recalibrating a baseline scenario that has just been simulated.

Change Scenario Simulation

A Monte Carlo simulation that creates change scenario output distributions for random variables in the FHPM. Comparing output distributions from the change scenario simulation to output distributions from the baseline scenario simulation shows effects of the change.

Contamination Stage

One of four modeling stages in the FHPM. The contamination stage has two channels, retail and household. The contamination stage of the FHPM includes random variables and parameters to model food handling practices that may contaminate food.

Foodborne Illness Stage

One of four modeling stages in the FHPM. The foodborne illness stage has two channels, retail and household. The foodborne illness stage of the FHPM includes random variables and parameters to model the incidence and severity of cases of foodborne illness caused by ingestion of pathogen-contaminated food.

Food Shares to the Retail Channel

Proportion of annual servings of the i^{th} food category bought by consumers from a retail food establishment. The complement of this parameter is the share of annual servings of the i^{th} food category consumed by households without passing through a retail food establishment; e.g. from gardens, direct farm sales, and sport fishing.

Food Shares to Retail Establishments

Proportion of annual servings of the i^{th} food category bought by consumers from the j^{th} category of retail food establishment

Household Channel Pathogen Control Probabilities

The probability of occurrence of a contributing factor in the household category that may allow pathogens in food to survive or grow.

Household Channel Share Parameters

Share of annual servings of food prepared by the j^{th} category of household.

Iteration

A Monte Carlo trial simulated by @Risk, which in the FHPM corresponds to specific outcomes for all random variables in the FHPM for a single year.

Pathogen Control Stage

One of four modeling stages in the FHPM. The pathogen control stage has two channels, retail and household. The pathogen control stage of the FHPM includes random variables and parameters to model food handling practices that may all survival and growth of pathogens in food.

Progenitor Baseline Scenario

A previously saved baseline scenario that serves as the starting point for defining, calibrating and saving a new baseline scenario.

Recalibrate for a Change Scenario

Changing one or more parameter values of the FHPM to reflect changes the user expects to occur upon implementation of a regulation or any other change under analysis.

Retail Channel Contamination Probabilities

The probability of occurrence of a contributing factor that may contaminate food in retail establishments.

Retail Channel Pathogen Control Probabilities

The probability of an occurrence of a contributing factor in retail establishments that may allow pathogens in food to survive and grow.

Retail Establishment Category

One of 11 types of retail food service establishments grouped into three broad categories, food stores, restaurants, and institutions.

Shares of Servings Sold by Food Stores to Households for Further Preparation

Share of annual servings of food sold by the j th retail food service establishment that is bought by households and further prepared by households before consumption.

Source Contamination Probabilities

Probability that a serving of the i^{th} food category is contaminated with the j^{th} pathogen when it leaves the final manufacturing supply source.

Source Contamination Stage

One of four modeling stages in the FHPM. The source contamination stage of the FHPM includes random variables and parameters to model the prevalence of pathogen contamination of servings of food when food leaves the final manufacturing source.

ZeroBaseline Scenario

A baseline scenario in which all probability parameters and share parameters are set to zero.