Chapter 2: Methodology

1. Theory

The theoretical concept underlying the PAWSA process is the proven Delphi method of converting the opinions of local subject matter experts into quantified results. This method is used so that those quantified results can be compared internally (i.e., the results for one risk factor can be compared to those for other risk factors and the results from one stage (e.g., *Book 1*) can be compared to the results from other stages (e.g., *Book 3*) during the workshop) and externally (i.e., the results from one waterway can be compared to the results from other waterways). The strength of the PAWSA process derives from several sources:

(1) the sponsor carefully selects the participants because they are knowledgeable with respect to a particular maritime interest and so that all important interests are represented within the group;

(2) before converting their opinions into numbers, the participants thoroughly discuss the issues being judged;

(3) the same 1 to 9 scale is used repeatedly throughout the process; and

(4) all quantified inputs are weighted by the relative expertise of each participant team with respect to each risk category in the Waterway Risk Model.

Proof that the PAWSA process works (i.e., produces valid results) comes from the internal consistency checks that are built into the results spreadsheets within the Excel™ workbook (PAWSA software) used to capture and analyze the participants' quantified inputs. Those consistency checks have repeatedly shown that workshop participants develop strong consensus about the levels of risk in the waterway and the effectiveness of various risk mitigation strategies. This consensus emerges in spite of the fact that the participants typically represent widely different interests within the overall maritime community and in spite of the fact that the 1 to 9 measurement scale used is correlated only loosely with qualitative descriptors for each value on that scale. (See Chapters 6 and 7 for elaboration.)

The rest of this chapter specifically describes *Books 1 – 4*. Understanding how each book is used, the methodology behind each book, and how the PAWSA software relates to each book are critical to understanding the overall PAWSA process.

2. Book 1: Establishing Baseline Risk Levels

To determine a risk level value for every factor in the Waterway Risk Model, *Book 1: Baseline Risk Levels* uses the same four qualitative descriptors for each risk factor as were used in *Book 2*. In theory those qualitative descriptors are written in absolute terms; that is, the risk level values that are produced by *Book 3* do NOT take into account any actions already implemented to reduce risk in the waterway. In practice, PAWSA participants sometimes have difficulty thinking in such absolute terms and the effects of existing mitigations tend to creep into the discussion and evaluation of this workshop stage.

Key to achieving strong consensus in the *Book 3* results is the discussion period that immediately precedes filling out this quantitative evaluation. During that discussion the various perspectives concerning each risk factor are voiced and, sometimes, debated. Often participants refer to read-ahead

material provided by the sponsor (or readily available to them via other means), especially for risk factors amenable to measurement and/or quantification (e.g., volume of traffic, wind conditions, cargo volumes). Once the discussions have run their course, participants simply check the box next to the qualitative descriptor for a particular risk factor that best matches conditions in the waterway being evaluated.

If a team checks the first box (describing the best case), then a 1 is entered into the *Bk 3 Input* spreadsheet, obviously corresponding to a value of 1.0 for that input. If a team checks the second box, then a 2 is entered into the spreadsheet and the computer algorithm assigns the "B" value from the aggregate risk measuring scale for that factor to that input. In like manner, a check in the third box is entered as a 3 and assigned the "C" value; a check in the fourth box (describing the worst case) is entered as a 4 and assigned a value of 9.0.

Building on the same three team Wind Conditions example from previous sections, hypothesize the following *Book 3* inputs:

	Team 1	Team 2	Team 3
Box Checked	Third	Second	Third
Spreadsheet Entry	3	2	3
Risk Value	C	B	C
Value Assigned	5.50	2.59	5.50

The inputs for each team for each factor are multiplied by their team expertise scores and then added together to produce the baseline risk value for that factor. Continuing our example:

	Team 1	Team 2	Team 3	Sum
Value Assigned	5.50	2.59	5.50	
Expertise Score	.43	.14	.43	
Product	2.36	.36	2.36	5.08

Thus, for this example, the baseline risk value for the Wind Conditions factor is 5.1. (Note: All results are displayed rounded to one decimal place because the qualitative descriptors that underlie these quantitative results are not precise enough for greater numerical precision.) The results from *Book 3* for each risk factor in the Waterway Risk Model become the baseline from which the effectiveness of existing mitigation strategies are evaluated in *Book 4*. Those baseline numbers are marked on the *Book 4* assessment forms using a highlighter pen.

3. Book 2: Team Expertise Cross-Assessment

There is no expectation that every participant invited to a PAWSA workshop will be equally knowledgeable with respect to all of the risk factors included in the Waterway Risk Model. The 24 risk factors in the model were developed to provide the foundation for discussions that could include the very broad range of maritime safety issues found throughout the United States and internationally.

Because the PAWSA participants are expected to have varying expertise with respect to the risk categories in the Waterway Risk Model, *Book 2: Team Expertise Cross-Assessment* is used early in the session (towards the end of Day 1) to weigh the relative strengths of each team with respect to the six risk categories. After being presented with the concepts underlying the model, each participant team is asked to discuss (among themselves) how their background and experience aligns with the model. They then verbally present their conclusions to the larger group. This presentation gives all

teams a sense of where everyone thinks they are strong – or perhaps not so strong. After all teams have spoken, each team evaluates whether they think they are in the top, middle, or lower third of all teams present in knowledge about the six risk category areas. Throughout the workshop, these expertise evaluations are used to produce results for all other Books.

The teams, in doing the expertise evaluation, conceptually are dividing up six expertise pies (risk categories) into different sized slices, with the relative size of each slice from each pie equaling the expertise of each team relative to the other teams for that risk category. An example for the Navigational Conditions Risk Category:

Team 1: Circles a 1 indicating they are in the Top 1/3 of all teams present

Team 2: Circles a 3 indicating they are in the Lower 1/3 of all teams present

Team 3: Circles a 1 indicating they, also, are in the Top 1/3 of all teams present

These responses are entered into the data input cells in the *Bk 2 Input* spreadsheet in the *All Books (waterway name)* workbook. Those inputs are inverted, i.e., all inputs are subtracted from 4 so that a 1 becomes a 3 and a 3 becomes a 1. This is done so that the Top 1/3 teams get the biggest slice of the pie. Those inverted scores are added up (showing that, in this case, the total pie size = 3 + 1 + 3 = 7). Then each team's slice is computed by dividing their inverted score by the total pie size. For our example:

Team 1: 3/7 = .429 (≈ 43% of the Navigational Conditions expertise pie)

Team 2: 1/7 = .143 (≈ 14% of the Navigational Conditions expertise pie)

Team 3: 3/7 = .429 (≈ 43% of the Navigational Conditions expertise pie)

Obviously, but mathematically very important, adding all of the slices together equals 100% of each expertise pie. These computations are done independently for each of the six risk categories (expertise pies). Each team's relative expertise in each category (size of their slice) is multiplied by their inputs for the four risk factors <u>in that category</u> during all of the other quantitative evaluations (*Books 3* and *4*). When this multiplication is done, the products that result are the weighted inputs for that team for that book. Because the sum of the expertise for each category equals 100%, the sum of the weighted inputs equals the risk level.

4. <u>Book 3: Mitigation Effectivness</u>

Again, the key to good consistency in results from the *Book 3: Mitigation Effectiveness* stage is the discussion that immediately precedes filling out the quantitative evaluations. Those discussions should focus on three issues: (1) the specifics of what has been done to reduce the risk associated with a particular factor; (2) the effectiveness of those mitigation actions; and (3) whether existing mitigations are well balanced with the baseline risk value.

Once the discussions are complete, the participants are asked to do two things: (1) circle a number on the 1 to 9 scale that shows the effectiveness of existing mitigations in reducing risk below the absolute levels determined via *Book 1* and (2) circle Yes (or No) depending on whether they think existing mitigations adequately balance the risks for each factor (or not).

The vast majority of the time, participants will circle a number on the 1 to 9 scale to the left of (smaller than) the highlighter mark denoting the *Book 1* result. However, if they conclude that actions taken previously are having no effect on reducing the baseline risk, they will circle the *Book 1* result

mark. Though unusual, participants might state (and then evaluate) that existing mitigations actually increase the risk for some factor(s). For example, while discussing the Dimensions risk factor, participants cite as an existing risk mitigation strategy that a range light has been established to help waterway users keep from running aground in a narrow channel, but state that the range is out of alignment with the channel, thereby increasing the risk of groundings. They then could evaluate the effect of that mitigation by circling a higher number (i.e., to the right) of the *Book 1* result mark.

The numbers that are circled by the participants are entered exactly as indicated into the *Bk 3 Scores* spreadsheet with two exceptions: (1) if the participants circle the space between two whole numbers, the entry is invalid and the team is required to reassess providing a whole number entry; and (2) if the participants circle the *Book 1* result mark, a lower case "e" is entered and the computer algorithms convert that entry into the *Book 1* results value.

As with *Books 1 and 4*, *Book 3* numerical entries are multiplied by the *Book 2* expertise scores and then those products are added together to produce the present risk level, which takes into account the effectiveness of existing mitigations.

Continuing our example from previous sections:

	Team 1	Team 2	Team 3	Sum
Number Circled	3	Highlighter mark	4	
Spreadsheet Entry	3	e	4	
Value Assigned	3	5.08	4	
Expertise Score	.43	.14	.43	
Product	1.29	.71	1.72	3.72

Rounding this result to one decimal place, we see that the effectiveness of existing mitigations in reducing Wind Conditions risk is judged to be: 5.1 – 3.7 = 1.4 points.

As the final step in *Book 3*, participants make a subjective evaluation, based on the preceding discussions, as to whether they think risks are adequately balanced with existing mitigations for each factor. They do this by circling Yes (they are balanced) or No (they are not balanced) on the line in *Book 3* for each factor. Those Yes / No answers are coded into the *Bk 3 Y-N* spreadsheet as lower case "y" or "n". If 2/3 or more of the participant team expertise indicates Yes, then that risk factor is dropped from further discussion / evaluation in *Book 4: Additional Interventions*. This condition is denoted by a green *Balanced* on the *Book 3* results display spreadsheet (*Bk 3 Disp*). If 2/3 or more of the participant team expertise indicates No, then that risk factor should definitely be discussed / evaluated in *Book 4*. That condition is denoted by a red *NO* on the *Book 3* results display. If there is less than 2/3 consensus about the efficacy of existing mitigations then a yellow *Maybe* is displayed. Those "Maybe" risk factors should also be discussed / evaluated in *Book 4*. Finally, if the present risk level is evaluated as being HIGHER than the risk level from *Book 1* or, when appropriate, is higher than the risk level determined during a previous PAWSA held for the same waterway (see *Appendix A: Converting Risk Model Scores*), then a red *RISING* is shown on the *Book 3* results display.

5. Book 4: Additional Interventions

In the final quantitative evaluation stage of the PAWSA process, discussion is focused on those risk factors where the present risk level is not *Balanced*. For each risk factor displaying a *NO*, *RISING*, or *Maybe* flag, the *Book 3* results are marked using a highlighter on blank copies of the *Book 4: Additional Interventions* evaluation forms. This serves as a starting point for evaluating the possible effectiveness of new mitigation strategies. For each risk factor so marked, the workshop participants

are asked to offer ideas about what should be done to reduce the present risk level. Again, the quality of the discussion directly affects consistency of results obtained.

Analysis of risk mitigation ideas offered to date showed that those ideas usually fall into nine major implementation categories. Those categories are:

- Coordination / Planning
- Voluntary Training
- Rules & Procedures
- Enforcement
- Navigation / Hydrologic Information
- Radio Communications
- Active Traffic Management
- Waterway Changes
- Other Actions

Those categories are fully described in Chapter 6, are provided in each participant's folder under *Appendix H: Glossary of Terms* (see Chapter 5), and also are defined on the first page of *Book 4*.

After the participants have presented / discussed their risk mitigation ideas, they are asked to write short phrases (3 to 5 words each) describing the ideas they think have merit. Those short phrases are written on the lines next to the categories into which the ideas best fit. For example, if the risk factor being discussed is Wind Conditions and the idea being considered is "Install wind sensor at Long Point", then the participants would write those words on the line next to the Nav / Hydro Info intervention category under that risk factor. After recording an idea, the participants indicate what risk level would result from implementing that idea. This is done by circling a number to the left of (lower than) the *Book 3* risk level mark on the 1 to 9 scale next to the implementation category where the idea was written. As in *Book 3*, only whole numbers are used; therefore, if the participants circle the space <u>between</u> two whole numbers, the entry is invalid and the team is required to reassess providing a whole number entry. The closer that circle is to 1, the more effective the participant team feels the idea to be. Those evaluations are again multiplied by the team's expertise scores and then

those products are added together to get the possible risk level resulting from implementing the ideas written down for a particular category.

Again using our Wind Conditions example:

	Team 1	Team 2	Team 3	Sum
Number Circled	2	3	2	
Spreadsheet Entry	2	3	2	
Expertise Score	.43	.14	.43	
Product	.86	.42	.86	2.14

The algorithms for the *Book 4* display spreadsheet (*Bk 4 Disp*) determine which implementation category most teams have chosen and then how much risk improvement would result from the ideas

written down for that category. Those *Book 4* display algorithms also determine which implementation category was judged to be most effective (i.e., had the biggest delta between the *Book 4* and *Book 3* results). A yellow *Caution* flag is displayed if the most chosen implementation category is NOT the same as the most effective category AND either fewer than 50% of the teams chose the most chosen category OR more than 50% of the teams chose the most effective category. The presence of the yellow *Caution* flag for any risk factor indicates the possibility that there is more than one "best" mitigation measure to use to achieve further risk reduction for that factor.

Chapter 2 - Appendix A

Converting Risk Model Scores

Converting Risk Model Scores

As of January, 2015, 50 PAWSA sessions have been held. The risk assessment model used during those sessions has evolved over time. For those communities who are doing a follow-on risk assessment to an earlier PAWSA session, there is a need to compare the risk level scores produced in that earlier session to the scores derived using the methodology and the Waterway Risk Model described in this guide. This section tells how to insert the risk level scores from that earlier session into the quantitative assessment Excel™ workbook, so that those earlier scores can be compared to the results obtained from the present session.

In the table below, look up the date of the earlier PAWSA session and note both which risk model was used and the number of the assessment book that was used to evaluate the risk levels that existed at the time of the earlier session.

PAWSA Session Name	Workshop Dates	Risk Model Used	Risk Level Results
Mobile, Alabama	9 – 10 August 1999	Original	Book 4
Pascagoula, Mississippi	11 – 12 August 1999	Original	Book 4
Corpus Christi, Texas	30 – 31 August 1999	Original	Book 4
Port Lavaca, Texas	1 - 2 September 1999	Original	Book 4
Port Arthur, Texas	22 – 23 September 1999	Original	Book 4
Charleston, South Carolina	13 – 14 October 1999	Original	Book 4
San Francisco, California	16 – 17 November 1999	Original	Book 4
Honolulu, Hawaii	13 – 14 December 1999	Original	Book 4
Houston, Texas	25 – 26 January 2000	Original	Book 4
San Juan, Puerto Rico	7 - 8 February 2000	Original	Book 4
Ponce, Puerto Rico	9 – 10 February 2000	Original	Book 4
Morgan City, Louisiana	3 - 4 April 2000	Original	Book 4
Port Fourchon, Louisiana	5 - 6 April 2000	Original	Book 4
Lake Charles, Louisiana	25 – 26 April 2000	Original	Book 4
Sault Ste. Marie, Michigan	23 – 24 May 2000	Original	Book 4
Boston, Massachusetts	19 – 20 June 2000	Original	Book 4
Miami, Florida	24 – 25 July 2000	Revised	Book 4
Port Everglades, Florida	26 – 27 July 2000	Revised	Book 4
Texas City, Texas	21 August 2000	Revised	Book 4
Coos Bay, Oregon	7 September 2000	Revised	Book 4
Lower Columbia River, Oregon	11 – 12 September 2000	Revised	Book 4
Cook Inlet, Alaska	10 – 11 October 2000	Revised	Book 4
Philadelphia, Pennsylvania	11 – 12 December 2000	Revised	None
Cincinnati, Ohio	18 January 2001	Revised	Book 4
Baltimore, Maryland	21 – 22 February 2001	Revised	Book 4
Los Angeles / Long Beach, CA	21 March 2001	Revised	Book 4
Portland, Maine	1 - 2 May 2001	Revised	Book 4
Hampton Roads, Virginia	27 – 28 June 2001	Revised	Book 4

PAWSA Session Name	Workshop Dates	Risk Model Used	Risk Level Results
Louisville, Kentucky	13 – 14 February 2002	Final	Book 3
Haro Strait / Boundary Pass, WA	25 – 26 February 2002	Final	Book 3
Tampa, Florida	7 – 8 January 2003	Final	Book 4
Detroit, Michigan	12 – 13 February 2003	Final	Book 4
San Diego, California	12 – 13 March 2003	Final	Book 4
Buzzards Bay, Massachusetts	9 – 10 September 2003	Final	Book 4
Torres Strait, Australia	22 – 23 March 2004	Final	Book 4
Narragansett Bay, Rhode Island	7 – 8 September 2004	Final	Book 4
Long Island Sound, NY / CT	3 – 4 May 2005	Final	Book 4
Aleutian Islands, Alaska	24 – 25 July 2006	Final	Book 4
Passamaquoddy Bay, Maine	3 – 4 October 2006	Final	Book 4
Cincinnati, Ohio	29 – 30 July 2008	Final	?
New York Harbor, New York	9 – 10 September 2008	Final	?
San Francisco, California	12 – 13 August 2008	Final	?

Next, review the *Workshop Report* (sometimes called the *After Action Report*) from that earlier session and find the results for the risk level evaluation, i.e., the results for the book number found in the table above. Using the table below, determine the values to be used for each factor in the Waterways Risk Model. Insert those values into cells A4:F10 of the *All Books (waterway name) / Previous PAWSA* template. Leave empty the cell(s) for any risk factor(s) shown below as [Not Addressed].

Waterway Risk Model	Final Port Risk Model	Revised Port Risk Model	Original Port Risk Model
Deep Draft Vessel Quality	**Average** of: (Mariner Proficiency or Deep Draft Mariner Proficiency) **and** (Seaworthiness or Vessel Quality)	Percentage of High Risk Deep Draft and High Risk Shallow Draft	% High Risk Deep Draft Cargo & Passenger Vessels
Shallow Draft Vessel Quality	**Average** of: (Mariner Proficiency or Shallow Draft Mariner Proficiency) **and** (Seaworthiness or Vessel Quality)	Percentage High Risk Shallow Draft	% High Risk Shallow Draft Cargo & Passenger Vessels
Commercial Fishing Vessel Quality	**Average** of: (Mariner Proficiency or Shallow Draft Mariner Proficiency) **and** (Seaworthiness or Vessel Quality)	Percentage of High Risk Shallow Draft	% High Risk Shallow Draft Cargo & Passenger Vessels

Waterway Risk Model	**Final Port Risk Model**	**Revised Port Risk Model**	**Original Port Risk Model**
Small Craft Quality	**Average** of: (Boater Proficiency or Recreational Boater Proficiency) **and** (Seaworthiness or Vessel Quality)	Percentage of High Risk Shallow Draft	% High Risk Shallow Draft Cargo & Passenger Vessels
Volume of Commercial Traffic	Commercial or Volume of Commercial Traffic	**Average** of: Volume of Deep Draft **and** Volume of Shallow Draft	**Average** of: Volume of Deep Draft **and** Volume of Shallow Draft
Volume of Small Craft Traffic	Recreational or Volume of Recreational Traffic	Volume of Fishing & Pleasure Craft	Volume of Fishing & Pleasure Craft
Traffic Mix	Traffic Mix	[Not addressed]	[Not addressed]
Congestion	Congestion	Traffic Density	Traffic Density
Winds	Winds	Wind Conditions	Wind Conditions
Water Movement	Water Movement or Currents	Tide & River Currents	Currents, Tides and Rivers
Visibility Restrictions	Visibility Restrictions	Visibility Conditions	Visibility Conditions
Obstructions	Obstructions	Ice Conditions	Ice Conditions
Visibility Impediments	Visibility Impediments	Visibility Obstructions	Visibility Obstructions
Dimensions	Dimensions	Channel Width	Passing Arrangements
Bottom Type	Bottom Type	Bottom Type	Channel and Bottom
Configuration	Configuration	Waterway Complexity	Waterway Complexity
Personnel Injuries	Injuries or Personal Injuries	Volume of Passengers	Number of People on Waterway
Petroleum Discharge	Hazardous Discharge or Petroleum Discharge	Volume of Petroleum	Volume of Petroleum Cargoes
Hazardous Materials Release	Hazardous Discharge or Hazardous Materials Release	Volume of Chemicals	Volume of Hazardous Chemical Cargoes
Mobility	Mobility or [Not addressed]	[Not addressed]	[Not addressed]

Waterway Risk Model	**Final Port Risk Model**	**Revised Port Risk Model**	**Original Port Risk Model**
Health and Safety	Health and Safety	Health & Safety Impacts	Health and Safety Impacts
Environmental	Environment or Environmental	Environmental Impacts	Environmental Impacts
Aquatic Resources	Aquatic Resources	[Not addressed]	[Not addressed]
Economic	Economic	Economic Impacts	Economic Impacts
[Not addressed]	Significant Vessels		
[Not addressed]	Property Damage		
[Not addressed]	Port Impact		

Column B of the *All Books (waterway name) / Bk 4 Rslts* spreadsheet will show either the risk level results from the previous PAWSA session or, if one or more cells in the *All Books (waterway name) / Previous PAWSA* spreadsheet is empty because that risk factor was [Not Addressed], the *All Books (waterway name) / Bk 4 Rslts* spreadsheet will show the results from *Book 3: Baseline Risk Levels*. If the risk level results from the present workshop are higher than the results from the previous PAWSA session for any risk factors, then Column G:H of the *All Books (waterway name) / Bk 4 Rslts* spreadsheet will say RISING. **Note:** This red flag also will occur if the *Book 4: Mitigation Effectiveness* results are higher than the *Book 3: Baseline Risk Levels* results for any factor.