Northeast Fisheries Science Center
Bottom Trawl Survey Station Validation Computer Codes
T.O.G.A.
Guide for Stock Analysts

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Overview
It is important to understand that some aspects of station validation are subjective. These NEFSC Bottom Trawl Survey station validation codes serve as a guideline for qualifying a survey tow in a standardized manor and aid in the decision process for determining if a survey tow is valid. These codes are for use with the NEFSC Standard 4 Seam, 3 Bridle Survey Trawl and NOAA Ship *Henry B. Bigelow*.

Each standard survey tow is evaluated based on four categories, Type, Operational, Gear and Acquisition (T.O.G.A.). Type (T), Operational (O) and Gear (G) categories are used to validate each tow; the Acquisition (A) category is additional information not used for validation. T.O.G.A. is a detailed analysis of survey trawl and vessel performance during each tow, utilizing available data from trawl mensuration systems and vessel sensors not previously analyzed by the historical Station, Haul, and Gear (S.H.G.) coding system.

Tolerance limits and optimal values were calculated from data collected during the NEFSC calibration experiments. These tolerance limits are intended to promote consistency of trawl geometry and towing procedure to validate comparison of the collected trawl survey data with results from the calibration experiments.

Excluding Tows from Stock Analysis
TYPE (T): Tows included in NEFSC Bottom Trawl Survey abundance estimates should be conducted following the protocols of the random and stratified statistical design. Standard NEFSC BTS tows are coded with a T value = 1. Station Type is coded values between 1 and 8; see section: T-TYPE of Station for details.

OPERATIONAL (O): The operational category is coded values between 1 and 4. O Values= 1, 2 or 3 are considered Representative; O Value= 4 is considered non-representative and should not be used in NEFSC BTS calculated abundance estimates. See section: O-OPERATIONAL Code for details.

GEAR (G): The gear category is coded values 1, 2 or 4 (there is no G value=3). G Values= 1 or 2 are considered Representative; G Value=4 is considered Non-Representative and should not be used in NEFSC BTS calculated abundance estimates. See section: G-GEAR Code for details.

ACQUISITION (A): Acquisition category is coded values between 1 and 4. The A Value does not determine the validity of a tow. A Values= 1, 2, 3 and 4 are considered Representative. Tows coded with A Value=4 force an O Value=3 (O is coded with a value=4 if the operational parameters evaluate to that). See section: A-ACQUISITION Code for details.

T.O.G.A. CATEGORY DETAIL

T – TYPE of Station Details

This category defines the type of sampling conducted at each station. Tows included in NEFSC Bottom Trawl Survey abundance estimates should be conducted following the protocols of the random and stratified statistical design. Standard NEFSC BTS tows are coded with a T value = 1. The T value=1 is subdivided into 6 components to further detail the tow and the proximity to the preselected station location as follows:

- 1- RANDOM TOW, within 1nm Radius
  Location selected according to the random and stratified statistical design, and portion of tow occurs within a 1 nautical mile radius of the preselected station location.
- 1- RANDOM TOW, outside 1nm, within 3nm Radius
  Location selected according to the random and stratified statistical design. Tow occurs outside of 1nm radius, but within a 3nm radius of the preselected station location.
- 1- REPEAT TOW
  Repeat of a random tow.
- 1- RANDOM ALTERNATE
  Alternate station location within a stratum, randomly preselected. To be conducted if original randomly preselected location is un-towable.
- 1- RANDOM OFFSHORE CONTINENTAL SHELF
  Tow conducted in offshore continental shelf edge strata from eastern Georges Bank south to Cape Hatteras following secondary NEFSC BTS protocols for sampling these strata.
- 1- ALTERNATE OFFSHORE PROTOCOL
  Alternate tow location conducted in offshore continental shelf edge strata from eastern Georges Bank south to Cape Hatteras following secondary NEFSC BTS protocols for sampling these strata.

Tow types other than NEFSC BTS standard random tows are defined by the following code values:

- 2- NON-RANDOM TOW
  Tow is not conducted according a random and stratified statistical design. Tow must follow all other NEFSC BTS protocols.
- 3- SURVEY STANDARDIZATION
  Tow conducted to evaluate NEFSC BTS standardization (i.e. gear testing). Tow may or may not follow all other NEFSC BTS protocols, therefore values defining O, G and A categories may not determine tow validity.
- 4- COMPARISON TOW
  Tow conducted in comparison of other gears, surveys, vessels or operating procedures. Tow may or may not follow all other NEFSC BTS protocols, therefore values defining O, G and A categories may not determine tow validity.
- 5- ABORTED TOW
  Gear set but timed tow duration never started (aborted tow).
- 6- SITE SPECIFIC

Non-random tow conducted in a specific, targeted region. Tow must follow all other NEFSC BTS protocols

- 7- EXPERIMENTAL SURVEY DESIGN
  Survey design type other than random and stratified (i.e. transect, depletion study, grid, fixed etc.). Tow may or may not follow all other NEFSC BTS protocols, therefore values defining O, G and A categories may not determine tow validity.
- 8 – OTHER
  Tows that do not fall into the previous categories. Detailed description of the tow type shall be recorded. Tow may or may not follow all other NEFSC BTS protocols, therefore values defining O, G and A categories may not determine tow validity.

O – OPERATIONAL Code Details

O Value= 4 is considered non-representative and should not be included in NEFSC calculated abundance estimates.

This code defines the tow in terms of the operational characteristics. (i.e. tow duration, vessel speed, scope ratio, depth, trawl performance, winch performance, stratum boundaries). The Tow Evaluation software calculates and provides the value of the O code. For tows coded with an O value=4, the data is considered non-representative and should not be used for stock analysis. More than one operational characteristic will often define the value. The O value provided by the software may be amended by the Watch Chief or Chief Scientist if they choose, based on individual tow circumstances.

- 1- GOOD PERFORMANCE
  All operational parameters are within optimal tolerance range.
- 2- REPRESENTATIVE
  Tow duration 18.00min – 19.49min or 20.50min-21.00min.
  75-99% on-bottom tow distance within the correct stratum.
  Door Spread mean outside optimal but within the tolerance limit.
  Wing Spread mean outside optimal but within the tolerance limit.
  (Door and Wing spread are depth dependant calculations).
  Headrope Height mean outside optimal but within the tolerance limit.
  (Optimal Height is 3.2-4.1m)
- 3- REPRESENTATIVE
  Tow duration 16.00min – 17.99min.
  Acquisition Code Value = 4 (details given with A code).
  Door Spread Standard Deviation High (greater than 4.5m)
  Wing Spread Standard Deviation High (greater than 2.0m)
  Headrope Height Spread Standard Deviation High (Greater than 1.0m)
  Scope Ratio outside tolerance limit. (+/- 25%)
- 4- NON-REPRESENTATIVE
  Tow duration less than 16.00min or greater than 21.00min.
  Tow distance less than 0.8nm or greater than 1.20nm.
  Door Spread mean outside tolerance limit. (Depth dependant)
  Wing Spread mean outside tolerance limit. (Depth dependant)
  Headrope Height mean outside tolerance limit. (Less than 2.7m or greater than 4.7m)

Speed Over Ground mean outside tolerance limit. (Less than 2.6 or greater than 3.4kts)
Depth mean outside tolerance limit. (EK6018kHz, must be within +/- 10% of set depth, or +/-5m at depths less than 50m)
Mean Starboard and Mean Port Block Tension not equalized within ±0.5t.
Difference between mean Starboard and Port Winch calculated wire out lengths greater than 10m.
Difference between mean Starboard and Port Block wire out lengths greater than 10m.
Less than 75% of on-bottom tow distance within correct stratum.
Trawl Depth greater than 20% difference of vessel tow depth.
Chief Scientist or Watch Chief Failed tow- tow considered unsatisfactory based on vessel or gear performance. Detailed comments shall be recorded.

G – GEAR Code Details

This code defines gear condition, damage and/or malfunction. Gear is defined as trawl net, cod-end, liner, sweep, doors and rigging. The gear category is coded values 1, 2 or 4 (there is no G value=3). G Values= 1 or 2 are considered Representative; G Value=4 is considered Non-Representative and should not be used in NEFSC BTS calculated abundance estimates.

- 1- GOOD TOW
  No damage to webbing, frame ropes, sweep doors or rigging. Trawl properly rigged and considered to be in standard configuration.
- 2- REPRESENTATIVE
  Minor Small Holes or Tears in webbing (including cod-end and liner). Tears shall be easily and quickly repaired to be coded G-Value=2.
  Slightly larger holes or tears in Jibs, Wings, Bunts, Square or 1st and 2nd Top Bellies.
  Hole not thought to significantly alter fish capture.
  Obstruction IN/ON gear, not thought to significantly alter fish capture.
  Minor Hang. No significant gear damage.
  Hang, definitively occurring after 16.00min tow duration. Tow duration should be adjusted to time hang occurred.
  Insignificant sweep damage (i.e. slight damage to rockhoppers not thought to increase fish escapement).
  Loss or damage to less than 12 floats.
  Very large catch. Deck tow of dogfish or other species.
  Other gear damage/malfunction not thought to significantly alter fish capture. (Detailed comments shall be recorded).

- 4- NON-REPRESENTATIVE
  Significant holes or tears OR large holes occurring in bottom bellies, or any portion of webbing aft of 2nd belly.
  Major Gear Damage. (i.e. rim-rack, whole sections torn out, loss of trawl door(s) etc.).
  Open Cod-end.
  Improperly Attached Liner OR Open Liner OR Significant Catch Outside Liner.
  Twisted Wing(s).
  Significant Loss of bottom contacts (4min duration or longer).
  Improper Rigging.

Collapsed Doors.
Crossed Doors.
Major Sweep Damage. (Parted sweep and/or major damage(i.e. loss of more than one rockhopper, or damage to sweep components thought to significantly increase fish escapement).
Damaged Frame Rope(s). (headrope, up&down line, bolshline).
Open Gore.
Twisted or Crossed Bridle(s).
Parted Legs.
Loss or damage to 12 or more floats.
Significant damage to wing-end extension (i.e. loss, broken or altered length).
Significant Hang. Occurring at less than 16.00min tow duration (OR unknown tow duration).
Large Obstruction IN/ON gear thought to alter catch efficiency or trawl geometry (i.e. pot stuck in front opening of cod-end).
Catch not landed on deck.
Damage to main towing cable(s).
Other gear damage/malfunction thought to significantly alter catch efficiency by Watch Chief or Chief Sci.

A – ACQUISITION Code Details

This code defines the tow concerning data acquisition. (i.e. SCS data, trawl mensuration, SCS event button press). **The A code value does not determine the acceptance of a tow.** Tows coded with A Value=4 force an O Value=3 (or O Value=4 if the operational parameters evaluate to that).

- 1- No Data Acquisition Errors.
  All data acquisition 75% or greater valid.
- 2- REPRESENTATIVE
  Door Spread 50.00% - 74.99% data acquisition.
  Wing Spread 50.00% - 74.99% data acquisition.
  Height 50.00% - 74.99% data acquisition.
  Trawl Depth 50.00% - 74.99% data acquisition.
  Winch Tension 50.00% - 74.99% data acquisition.
  Winch Wire Out 50.00% - 74.99% data acquisition.
  Block Tension 50.00% - 74.99% data acquisition.
  Block Wire Out 50.00% - 74.99% data acquisition.
  Speed Over Ground 50.00% - 74.99% data acquisition.
  Vessel Depth 50.00% - 74.99% data acquisition.
  Event Button Pressed More Than Once. Actual event time recorded.
- 3- REPRESENTATIVE
  Door Spread 25.00% - 49.99% data acquisition.
  Wing Spread 25.00% - 49.99% data acquisition.
  Height 25.00% - 49.99% data acquisition.
  Trawl Depth 25.00% - 49.99% data acquisition.
  Winch Tension 25.00% - 49.99% data acquisition.

Winch Wire Out 25.00% - 49.99% data acquisition.
Block Tension 25.00% - 49.99% data acquisition.
Block Wire Out 25.00% - 49.99% data acquisition.
Speed Over Ground 25.00% - 49.99% data acquisition.
Vessel Depth 25.00% - 49.99% data acquisition.

- 4- NON-REPRESENTATIVE DATA
  Door Spread Less Than 25.00% data acquisition.
  Wing Spread Less Than 25.00% data acquisition.
  Height Less Than 25.00% data acquisition.
  Trawl Depth Less Than 25.00% data acquisition.
  Winch Tension Less Than 25.00% data acquisition.
  Winch Wire Out Less Than 25.00% data acquisition.
  Block Tension Less Than 25.00% data acquisition.
  Block Wire Out Less Than 25.00% data acquisition.
  Speed Over Ground Less Than 25.00% data acquisition.
  Vessel Depth Less Than 25.00% data acquisition.
  Error Recording Event Data. Trawl event data missing.
  Critical Button Press Error, Unknown Event Time(s).

CALCULATIONS AND TOLERANCE LIMITS

Operational and Acquisition code values are calculated by Tow Evaluation Software. The Tow Evaluation software is a tool used to quickly summarize data relevant to the evaluation of a standard tow. The Tow Evaluation software displays all the summary statistics along with graphs of each parameter to aid the Watch Chief in the decision making process to validate the tow. All statistics are calculated for the on-bottom tow duration, based on the trawl event button presses: START TOW to HAUL BACK. Each parameter is checked against the tolerance limits to determine the correct Operational code value and Acquisition code value. The Type code and Gear code values are determined by the Watch Chief and/or Chief Scientist. Sensor data used for tow validation are filtered prior to calculation of summary statistics (Table 1).

Table 1. Relevant data collected for tow validation indicating the sensor from which the data is obtained and the defined data filtering that occurs.

Trawl Mensuration Data	**Primary Sensor**	**Data Filtered**
Door Spread	Scanmar Distance	≤0 & >50m
Wing Spread	Scanmar Distance	≤0 & >30m
Headrope Height	Scanmar Trawl Sounder	≤0 & >10m
Trawl Depth	Scanmar Depth	≤0 & >1000m
Vessel Tow Data		
Speed Over Ground	MX420	<0 & >20kts
Tow Duration	derived	n/a
Depth	EK60-18kHz	≤0 & >1000m
Tow Location	POS MV	not null
Tow Distance	derived	n/a
Winch Data Port and Starboard		
Winch Wire Out	Rapp Hydema Autotrawl System	<0 & >2000m
Winch Tension	Rapp Hydema Autotrawl System	<0 & >50t
Block Wire Out	Block Counter	<0 & >2000m
Block Tension	Block Load Cell	<0 & >50t

Tow Evaluation Software evaluates each parameter against set tolerance limits after calculating summary statistics. Trawl geometry parameters (door spread, wing spread and head rope height) are evaluated against tolerance limits and optimal values as well. For trawl geometry parameters, standard deviations greater than the set tolerance limit are coded with and O Value=3. For all other parameters, standard deviation is not evaluated for the operational code, however, a standard deviation equal to 0 is reflected in the acquisition code as less than 25% data acquisition. The tolerance limits for each parameter used to define the operational code values are given in table 2. (See A-ACQUISITION CODE DETAILS for defined acquisition code values).

Table 2. Tolerance limits for each evaluated parameter and the associated operational code values. *See section: Depth Dependent Spread Calculations for details.

Parameter	Operational Code Value	Acceptance Range Mean	Standard Deviation
Door Spread	1	Depth Dependent* Within Optimal	≤ 4.5m
	2	Depth Dependent* Outside Optimal, Within tolerance	
	3	N/A	> 4.5m
	4	Depth Dependent* Outside Tolerance	
Wing Spread	1	Depth Dependent* Within Optimal	≤ 2.0m
	2	Depth Dependent* Outside Optimal, Within tolerance	
	3	N/A	> 2.0m
	4	Depth Dependent* Outside Tolerance	
Head Rope Height	1	3.2m to < 4.2m Within Optimal	≤ 1.0m
	2	2.7m to < 3.2m OR 4.2m to 4.7m Outside Optimal, Within tolerance	
	3	N/A	> 1.0m
	4	< 2.7m OR > 4.7m Outside Tolerance	
Speed Over Ground	1	2.6kts to 3.4kts	N/A
	4	< 2.6kts OR > 3.4kts	
Tow Duration	1	19.5 to 20.49min	N/A
	2	18.00 to 19.49min or 20.50 to 21.00min	
	3	16.00 to 17.99min	
	4	< 16min OR > 21min	
Depth	1	Mean tow depth within ±10% setdepth OR when set depth is <50m, mean tow depth within ±5m of setdepth	N/A
	4	Mean tow depth > ±10% setdepth OR when set depth is <50m, mean tow depth > ±5m of setdepth	
Tension (all calculations are Mean Strb minus Mean Port)			
Turning Block Load Cells			
Starb vs. Port Δ	1	-0.5t to +0.5t	N/A
	4	< -0.5t OR > +0.5t	
Wire Out (all calculations are Mean Strb minus Mean Port)			
Auto-trawl winch			
Starb vs. Port Δ	1	-10m to +10m	N/A
	4	< -10m OR > +10m	
Turning Block Wire Counter			
Starb vs. Port Δ	1	-10m to +10m	N/A
	4	< -10m OR > +10m	

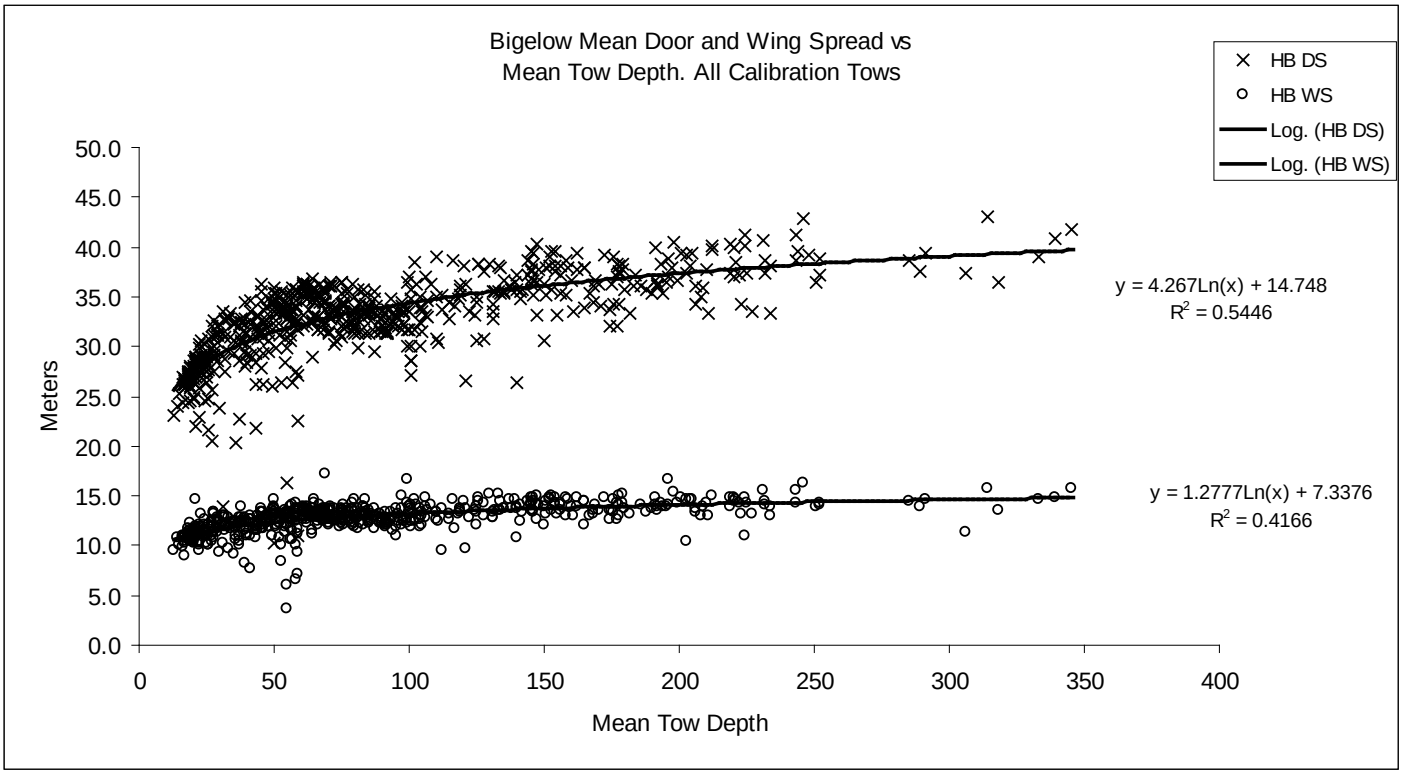
Depth Dependent Spread Calculations

It is expected that spread varies with depth. To avoid excluding only the shallowest and deepest tows, the tolerance limits and optimal values for mean door spread and mean wing spread are depth dependent. Based on the data collected during the NEFSC BTS calibration experiments, equations to calculate depth dependent predicted door spread and depth dependent predicted wing spread were derived. Mean door spread and mean wing spread from the full calibration data set were plotted as a function of mean tow depth (Figure 1). Each parameter was then normalized to mean tow depth using the following regression equations:

a) Door Spread: Predicted Door Spread= 4.267*Ln(Mean Tow Depth) + 14.748

b) Wing Spread: Predicted Wing Spread= 1.2777*Ln(Mean Tow Depth) + 7.3376

Figure 1.



Upper and lower tolerance limits were then set by calculating 95% confidence bands for the entire regression line (full depth range of the survey; 15m-500m) for both door and wing spread, based on the methods in [1]Netter et al., 1985, section 5.2.

[1]Netter, J., W. Wasserman, and M.H. Kutner. 1985. Applied Linear Statistical Models, 2nd ed. Homewood, Ill.: Richard D. Irwin Inc., pp. 154-155.

METHODS

Upper and Lower Boundary Levels of the Confidence Band:

$$\hat{Y}_h \pm W*s(\hat{Y}_h)$$

Where:
$\hat{Y}_h$= predicted spread
$s(\hat{Y}_h)$= estimated standard deviation of $\hat{Y}_h$
$W= \sqrt{(2*F(1-a; 2; n-2))}$

Calculate the variance of the predicted spread:

$$s^2(\hat{Y}_h) = MSE[1 + \frac{1}{n} + \frac{(X_h - \bar{X})^2}{\sum(X_i - \bar{X})^2}]$$

Where:

$\hat{Y}_h$= predicted spread	$s^2(\hat{Y}_h)$= estimated variance of $\hat{Y}_h$
n= # of tows	X_h= mean tow depth at prediction
$\bar{X}$=mean depth of all tows	X_i= mean depth at tow *i*
MSE= mean square error	

Door Spread Values from Calibration Data Set:

$$s^2(\hat{Y}_h)= 8.38\ [1+1/618+(\frac{\text{Mean Tow Depth} - 89.3}{2522376.42})^2\ ]$$

n=618; $\bar{X}$=89.3; $\Sigma(X_i - \bar{X})^2$= 2522376.42; MSE= 8.38
F(.95; 2; ∞) = 3.00; W= 2.45
$s = \sqrt{s^2(\hat{Y}_h)}$

Wing Spread Values from Calibration Data Set:

$$s^2(\hat{Y}_h)= 1.24\ [1+1/592+(\frac{\text{Mean Tow Depth} - 88.1}{2371779.12})^2\ ]$$

n=592; $\bar{X}$=88.1; $\Sigma(X_i - \bar{X})^2$= 2371779.12; MSE= 1.24
F(.95; 2; ∞) = 3.00; W= 2.45
$s = \sqrt{s^2(\hat{Y}_h)}$

*NOTE: Tows were not excluded from analyses based on spread values. However, only tows with 25% and greater valid spread data acquisition were used for analyses; thus, the estimated variance calculations for door and wing spread use different values of n, $\bar{X}$ and $\Sigma(X_i - \bar{X})^2$.

The upper and lower optimal boundary levels were calculated by removing the W statistic and simply multiplying the predicted spread by the estimated standard deviation:

$$\hat{Y}_h \pm s(\hat{Y}_h)$$

Figure 2. Mean door spread depth dependent tolerance limits and optimal limits, based on 95% confidence bands over the full depth range of the survey. Values 1, 2 and 4 indicate the operational code values.

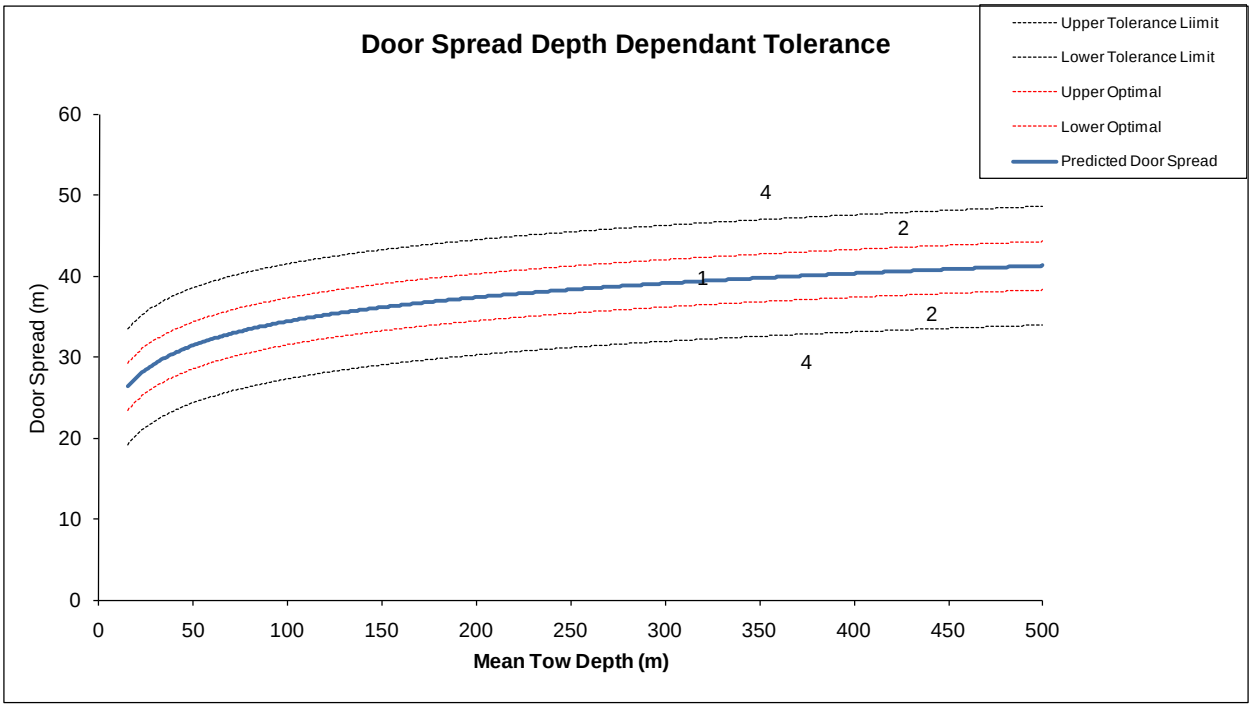
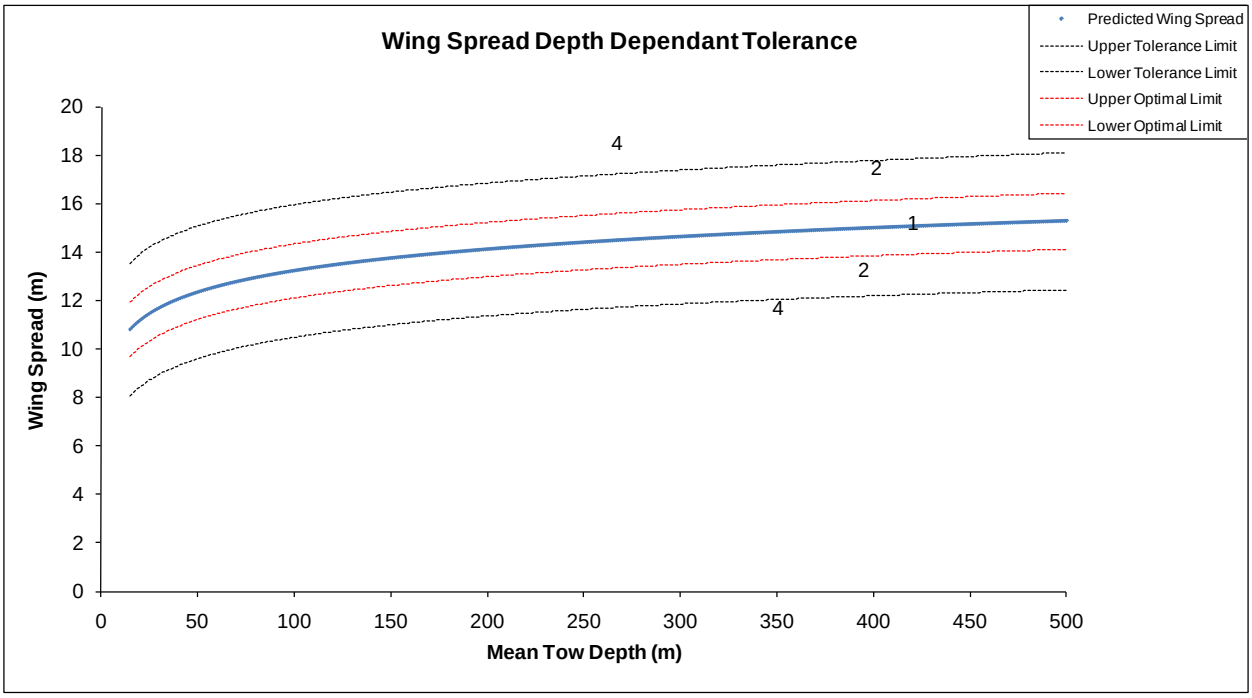



Figure 3. Mean wing spread depth dependent tolerance limits and optimal limits, based on 95% confidence bands over the full depth range of the survey. Values 1, 2 and 4 indicate the operational code values.