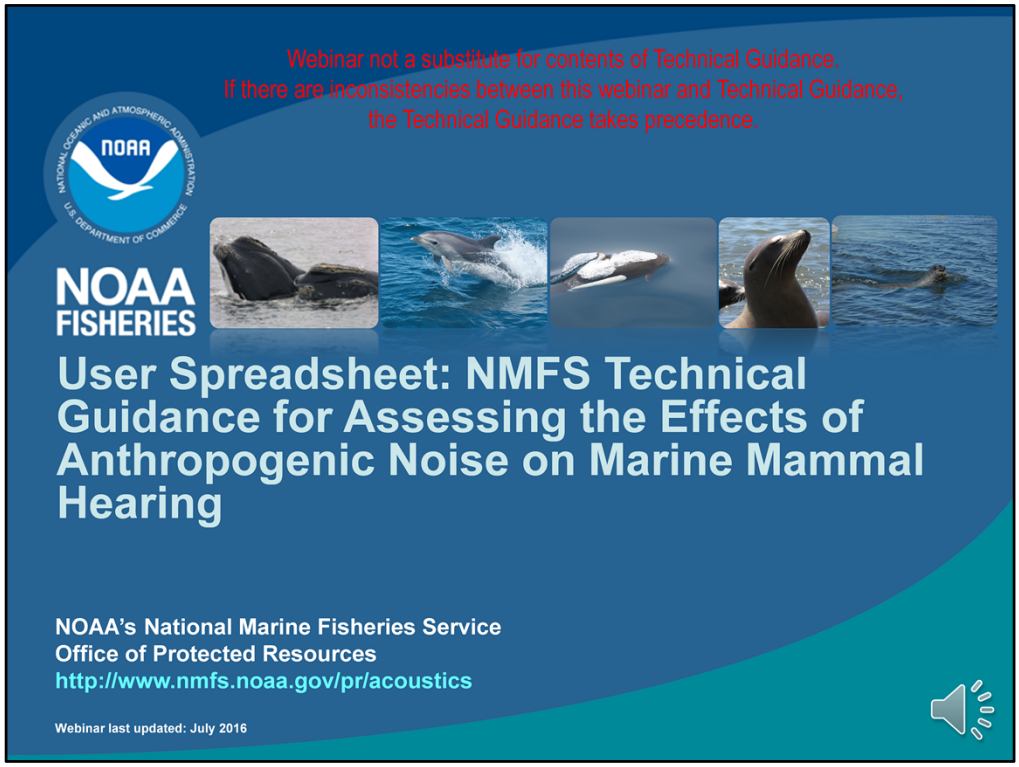
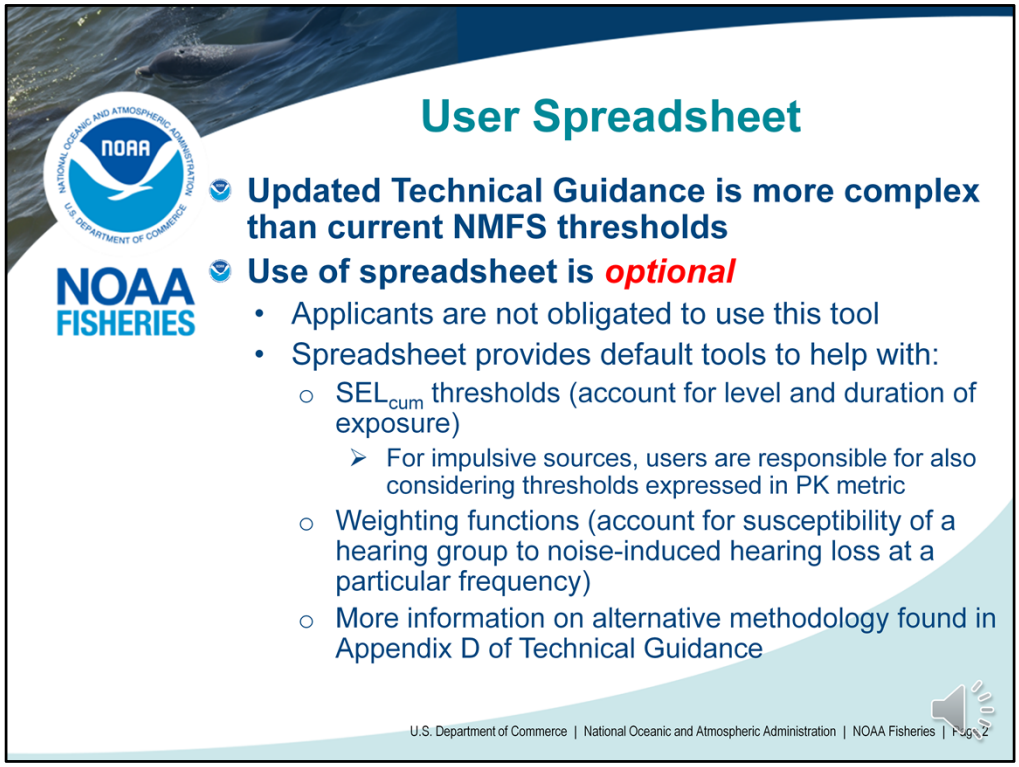


Welcome to this informational webinar on the optional companion User Spreadsheet associated with the NMFS Technical Guidance for Assessing the Effects of Anthropogenic Noise on Marine Mammal Hearing (published as a NOAA Technical Memorandum), which along with the User Spreadsheet, can be accessed via the web site at the bottom of this slide. This webinar is meant to serve as a companion to the Technical Guidance document that was finalized in July 2016.

Note: There is an additional webinar available providing a summary of the Technical Guidance.



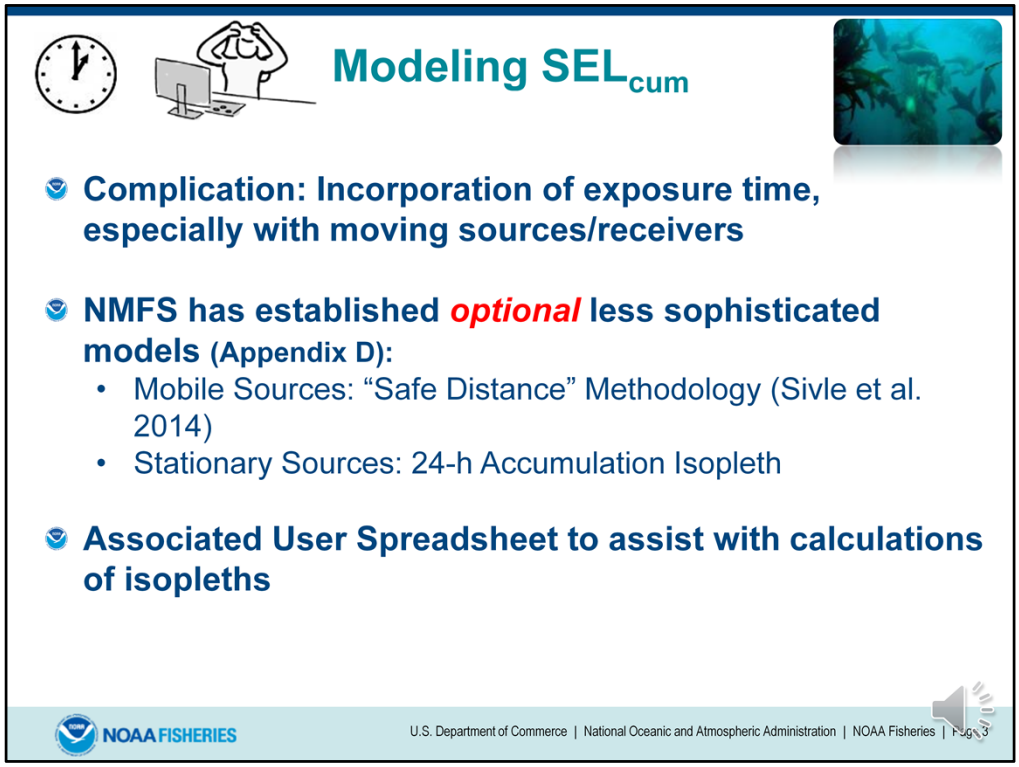
NMFS recognizes that the PTS onset thresholds and marine mammal weighting functions provided in the Technical Guidance are more complex than NMFS's current thresholds. NMFS also recognizes that different applicants may have different levels of modeling capabilities.

Thus, NMFS has provided a companion optional User Spreadsheet for those user's unable to implement thresholds using the SEL_{cum} metric and associated auditory weighting functions.

For impulsive sources, it is important to remember that peak sound pressure level (PK) thresholds also need to be considered as part of the Technical Guidance's dual thresholds and that this User Spreadsheet only pertains to thresholds in the SEL_{cum} metric (i.e., users are responsible for evaluating PK thresholds via their own means).

Note: Applicants are not obligated to use this optional spreadsheet and may perform more sophisticated exposure modeling or consider additional action- or location-specific factors, if able.

More information on these optional methodologies are provided in Appendix D of the Technical Guidance.



Thresholds expressed in the SEL_{cum} metric account for not only the level of exposure but also the duration of exposure, both of which are factors that contribute to the potential for a sound source to induce hearing loss. However, despite the advantages associated with the use of this metric, it is recognized that accounting for duration of exposure is complicated when there are moving animals (receivers), as well as potentially moving sources (i.e., difficult to account for dynamic exposure scenarios that change over space and time).

Thus, NMFS's User Spreadsheet relies on two simple methods to account for this metric for mobile and stationary sources. For mobile sources, the User Spreadsheet relies on the published concept of "safe distance," while for stationary sources, it relies on deriving a 24-h accumulation isopleth. The following slides will briefly discuss both these methodologies.

Mobile: Assumptions

- **Source movement is simple**
  - Moves at constant velocity, in a constant direction
- **Receiver is stationary**
  - No horizontal (avoid/attract to source) or vertical movement
- **Distance between "pulses" for intermittent sources is consistent**
- **Propagation loss is simple**
  - Spherical spreading (20 log R)

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Safe distance" is defined as "the distance from the source beyond which a threshold for that metric (SPL_0 or SEL_0) is not exceeded" (Sivle et al. 2014). This method allows one to model a simple moving source and accounts for 4 main factors: 1) source level; 2) interpulse interval or duty cycle; and 3) transit speed of the source, which are provided by the user and 4) exposure threshold, which is supplied by the Technical Guidance.

There are several assumptions made using this method, including simple source movement (constant velocity, constant direction); receiver is stationary (no avoidance or attraction to the source), as well as no vertical or horizontal movement; distance between "pulses" for intermittent sources is consistent, and propagation is simple (spherical spreading).

Stationary: Assumptions

- **Calculate total exposure (isopleth) from 24-h exposure (or less if activity is less than 24 h)**
- **Receiver is stationary**
  - No horizontal (avoid/attract to source) or vertical movement
- **Propagation can be specified**

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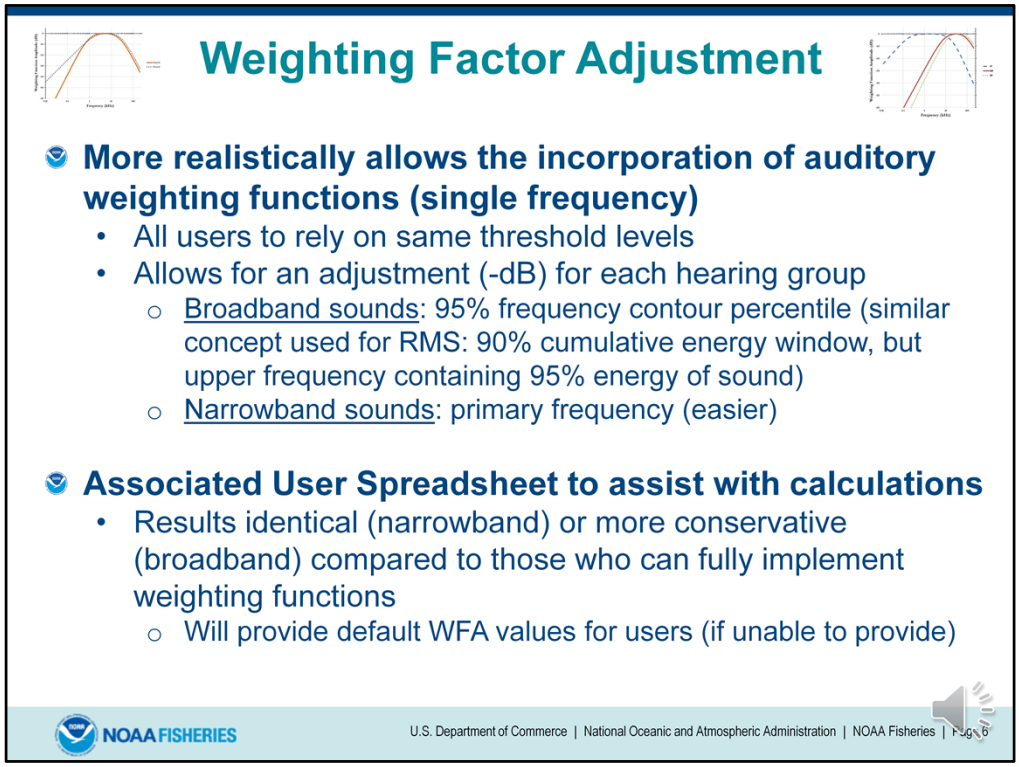
For stationary sources, a 24-h accumulation isopleth is derived, which simply accumulates the total exposure within a 24-h accumulation period (or less than 24-h, if the period over which the activity occurs is less than 24 hours).

This method assumes a receiver (animal) remains stationary and is neither attracted or avoids the source.

Additionally, a specific propagation can be specified using this methodology.

Next we will talk about weighting factor adjustments.



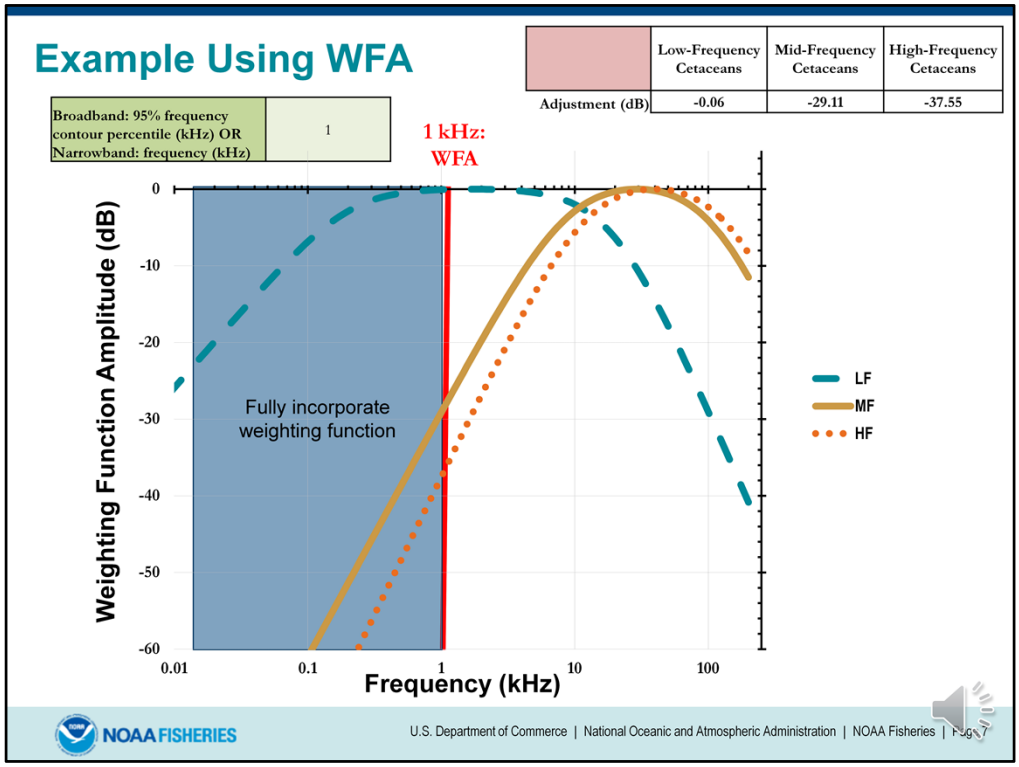
Weighting factor adjustments (WFAs) are another simple tool to help users unable to incorporate the Technical Guidance's marine mammal auditory weighting functions.

WFAs allow for all users to rely on the same PTS onset thresholds but accounts for weighting functions by the incorporation of a single frequency. WFAs automatically make appropriate adjustments for each marine mammal hearing group based on the frequency chosen.

For narrowband sounds, the choice of an appropriate WFA frequency is simple. For broadband sounds, the choice of an appropriate WFA frequency should be based on the 95% frequency contour of the particular sound source (95% frequency contour is defined as upper frequency below which 95% of total cumulative energy is contained).

The Technical Guidance's User Spreadsheet provides users a means to incorporate appropriate WFAs for their sound source. The results from the User Spreadsheet will be nearly identical for narrowband sources and more conservative for broadband sources compared to users who can fully implement the Technical Guidance's weighting functions.

If a user is unable to provide the 95% frequency contour for their source, the User Spreadsheet provides suggested default, conservative values.



This slide illustrates the concept of WFAs, with using a 1 kHz example (which could be from a 1 kHz narrowband source or a broadband source with a 95% frequency contour at 1 kHz).

The User Spreadsheet's sage cell provides where a WFA can be provided by a user based on the specific sound source or a default can be used.

Corresponding rose cells are provided indicating the adjustment (dB) associated with the particular WFA provided. In this example, the adjustment ranges from -0.06 dB for LF cetaceans to -37.55 dB for HF cetaceans. These outputs are calculated automatically within the User Spreadsheet.

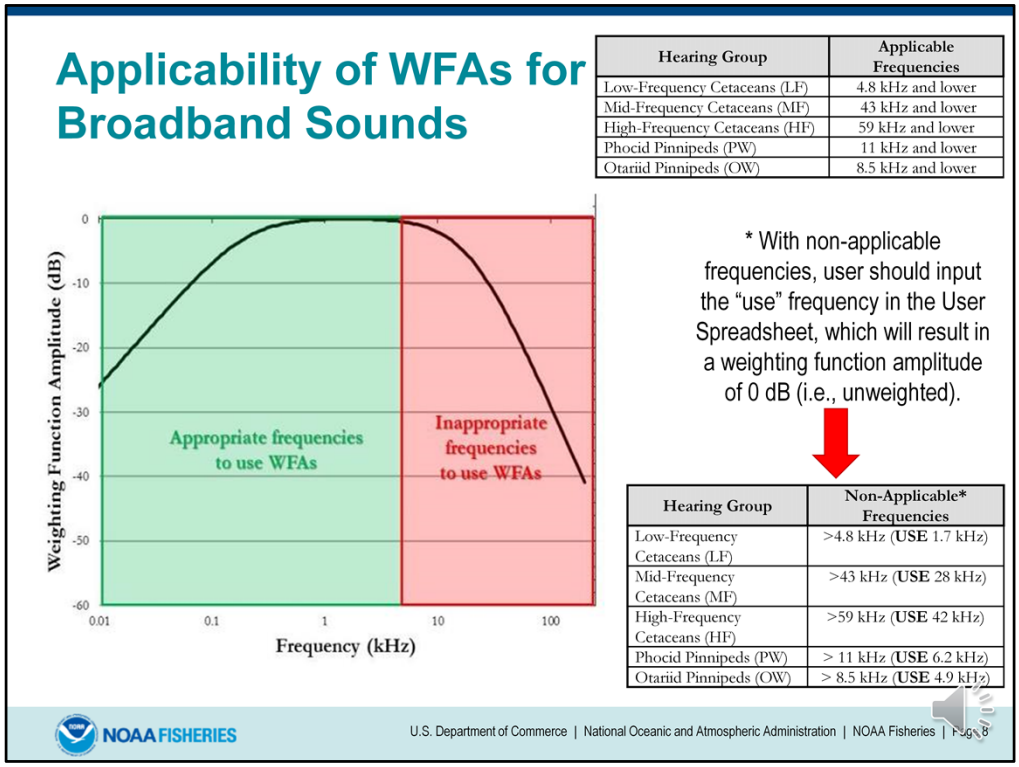
The figure on this slides illustrates how the WFA relates to the corresponding marine mammal auditory weighting functions with the X-axis representing frequency (kHz), and the Y-axis representing the weighting factor amplitude adjustment (dB). In this example the weighting functions for LF, MF, and HF cetaceans are illustrated. Those frequencies in which a marine mammal hearing group is most susceptible to noise-induced hearing loss are those where the weighting function amplitude is at 0 dB. The more negative a weighting function amplitude is for a corresponding hearing group, the less sensitive that frequency is (i.e., less likely to induce noise-induced hearing loss).

Back to this specific 1 kHz WFA example: On the corresponding Figure, one can see where the 1 kHz WFA (red line) occurs relative to the weighting function for LF, MF, and HF cetaceans corresponding to the adjustment provided in the rose cells above. As one can

see, there is a larger adjustment for MF and HF cetaceans compared to LF cetaceans. This because for LF cetaceans, 1 kHz is in this functional hearing group's most susceptible frequency range, while it is outside the most susceptible frequency range for the other two cetacean hearing groups (i.e., MF and HF cetaceans).

The corresponding blue rectangle illustrates that using WFAs is conservative for broadband sounds, since a user who could fully incorporate the weighting function for a particular marine mammal hearing group would also be able to account for adjustments (dB) occurring a multiple frequencies (while WFAs only account for a single frequency adjustment).

If a user is able to incorporate more sophisticated/complete means of accounting for the weighting function, they are capable of including this information within the User Spreadsheet (i.e., user is able to over-ride adjustment values associated with the rose cells in the User Spreadsheet); This will be illustrated in upcoming examples).

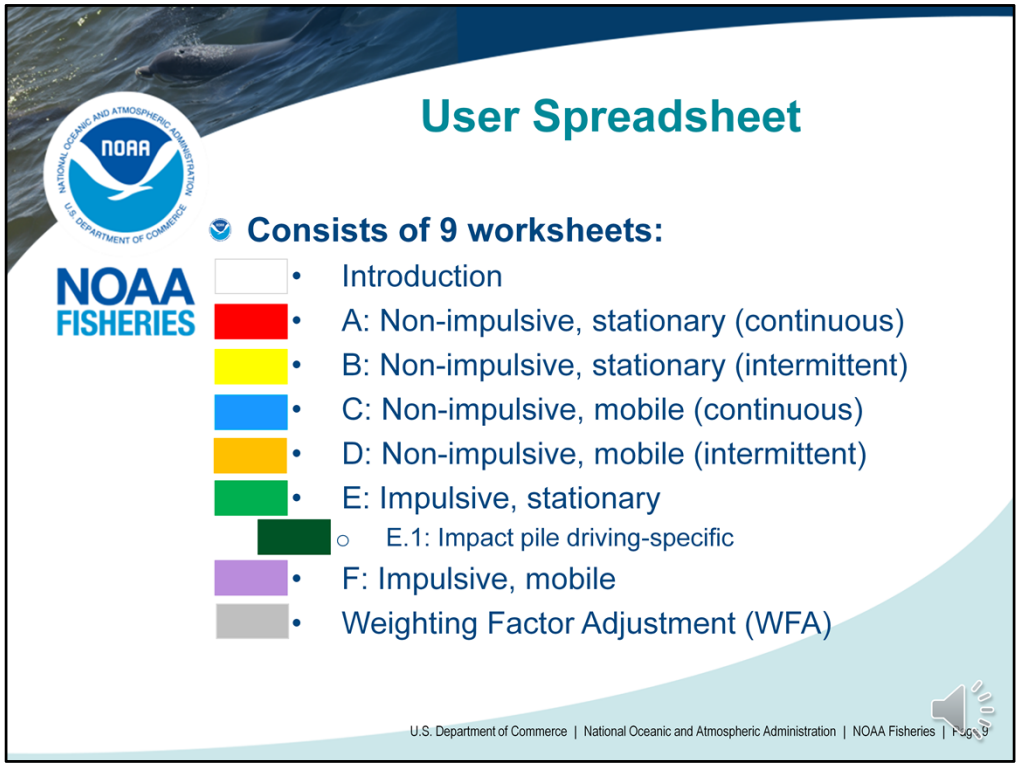


When relying upon WFAs, it is important to note that for each marine mammal hearing group, the are frequencies where using WFAs are appropriate and then there are frequencies where using WFAs are not appropriate. The upper right hand box illustrates those frequencies by marine mammal hearing group.

If a sound source occurs within a hearing groups' non-applicable frequency range, then a user is directed to input a frequency that produces an unweighted isopleth. See the lower right hand box for those frequencies to input, which will result in unweighted isopleths (i.e., frequencies labeled as "USE").

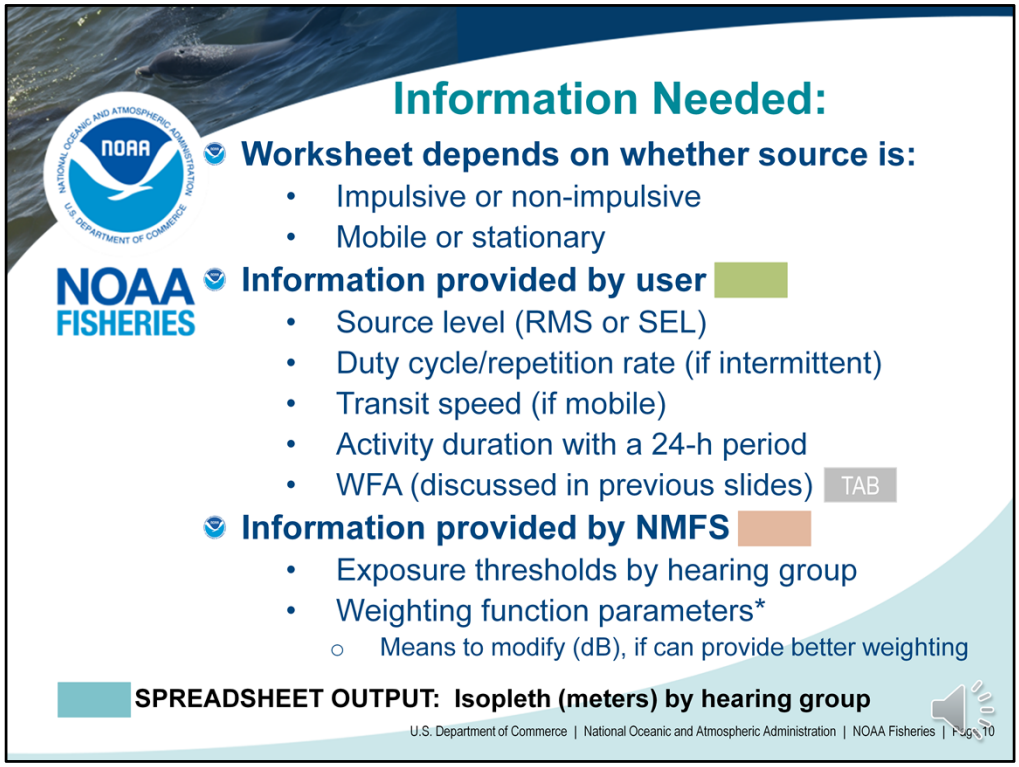
Please note, the applicable and non-applicable frequencies vary by hearing group. If it is necessary to rely upon a frequency resulting in an unweighted isopleth, this applies to isopleths calculated only for the hearing group (i.e., resulting isopleths for this non-applicable frequency adjustment, for other hearing groups, should not be used). For example, if a broadband source WFA was 5 kHz, this would not be appropriate for LF cetaceans BUT would be appropriate for all other marine mammal hearing groups. Thus, the user should input 5 kHz and use the resulting isopleths for all marine mammal groups, and then redo their inputs for LF cetaceans using a WFA of 1.7 kHz to get the isopleth for this hearing group.

Note: This slide only applies to broadband sources. For narrowband sources, there are no non-applicable frequencies.



The User Spreadsheet consists of 9 color-coded worksheets. To determine which spreadsheet is applicable to a particular source, a user is directed to start with the Introduction sheet, which provides general instructions, as well as assumptions in using this optional tool.

Later this webinar will provide a few examples using these various spreadsheets.



As illustrated on the previous slide, what worksheet a user will rely upon depends on the sound type and whether it is mobile or stationary.

Within the appropriate worksheet, the user will notice numerous cells with the following corresponding colors:

Sage cells: Represents information provided by user. There are some basic information a user should be able to provide such as source level (either in RMS or SEL metric), duty cycle or repetition rate (if an intermittent source), transit speed (if mobile source), and appropriate WFA (which can be specific to sound source, if known or a default; See separate Tab on WFA and appropriate frequencies for broadband sounds).

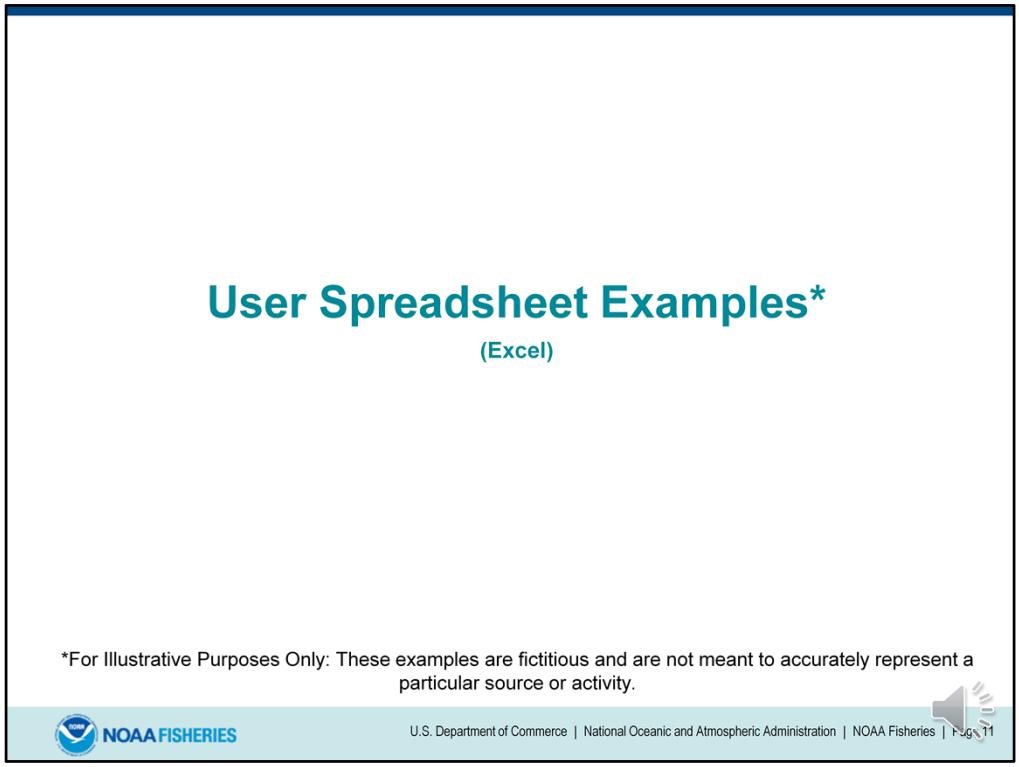
For stationary sources, the user is also required to specify the propagation.

Rose cells: Represent information provided by NMFS that can't be modified by the user. Note that if a user can provide more sophisticated weighting than provided by the WFA for broadband sources, there is a means to modify the adjustment (dB) and by-pass the output created by weighting function parameters. However, the user must provide additional justification supporting this modification.

Sky Blue cells: Represents the User Spreadsheet output in terms of estimated isopleths (meters) by hearing group

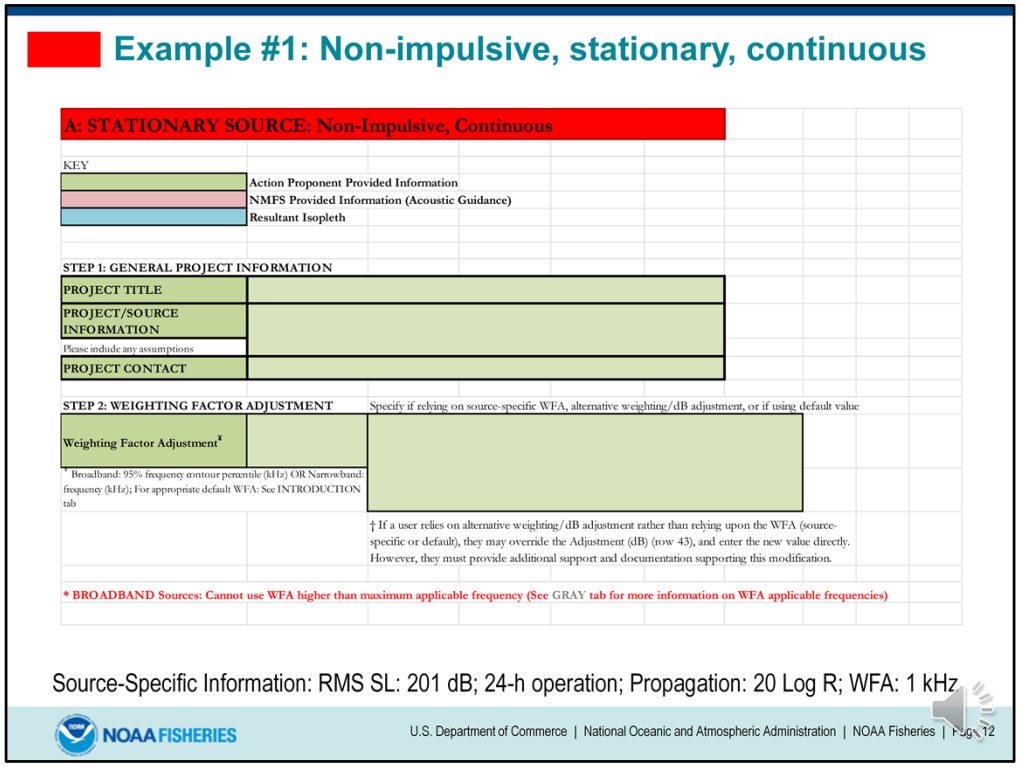
White cells: Represent calculations and factors being done automatically by the spreadsheet (i.e., cells that cannot be modified by user) or are informational.

When an applicant relies on the User Spreadsheet for modeling, they should include a copy of their spreadsheet illustrating their inputs and resulting output (isopleth)

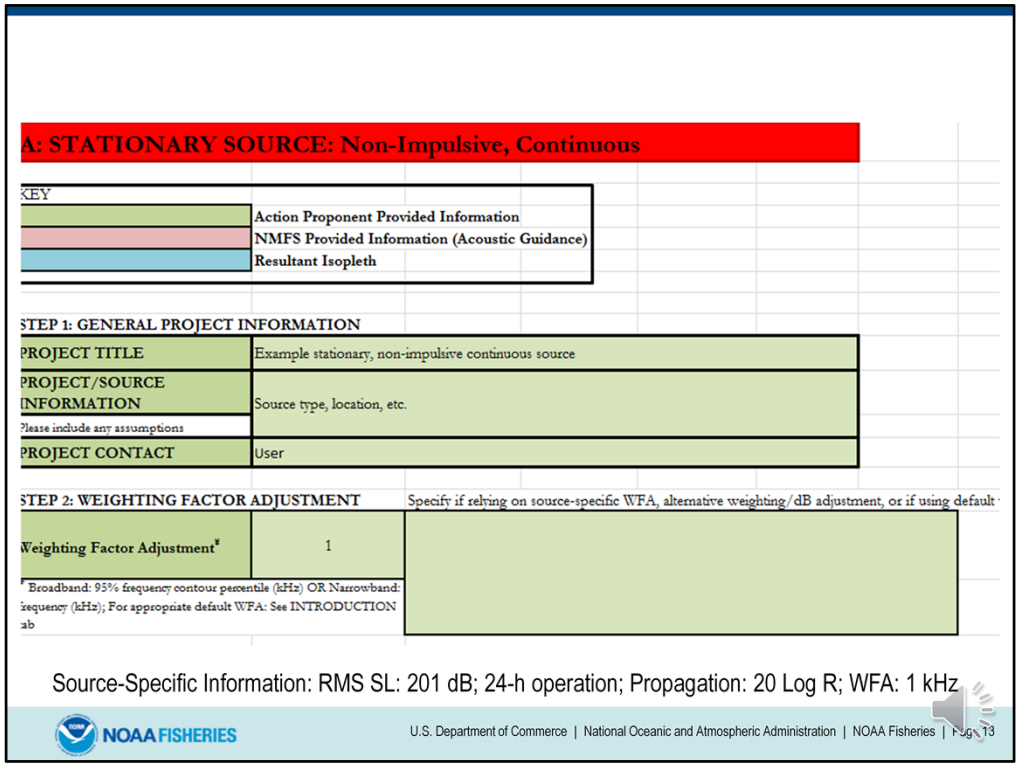


Let's walk through a few examples to illustrate how to use the User Spreadsheet.

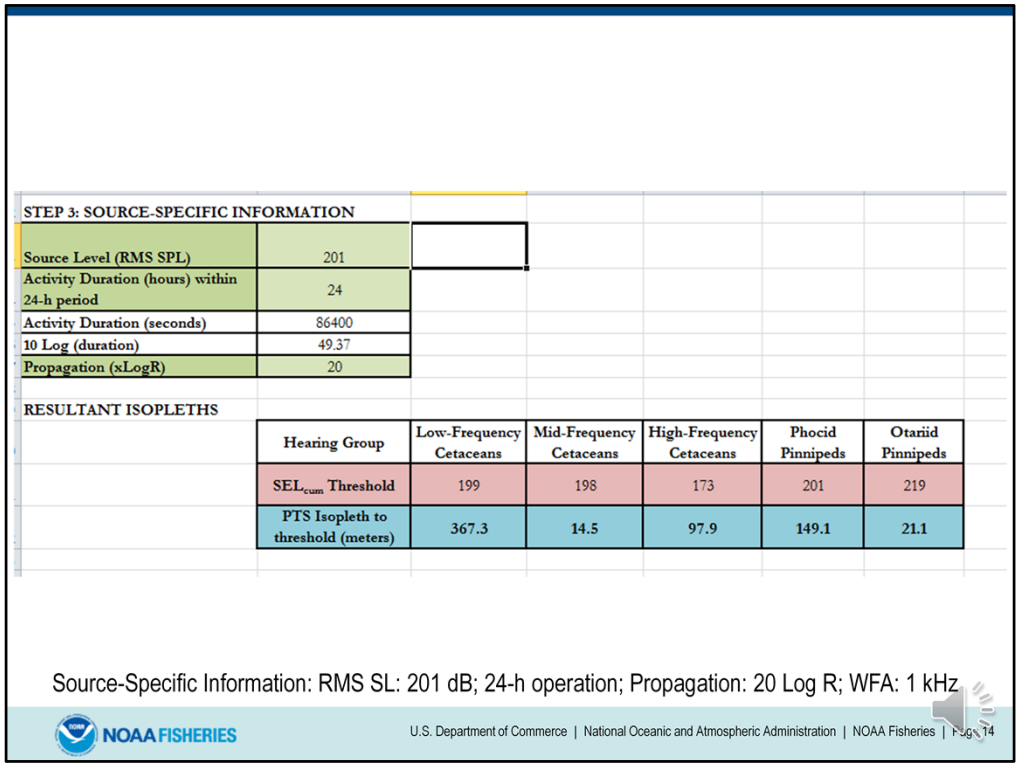
Note: These examples are for illustrative purposes only. They are fictitious and are not meant to accurately represent a particular source or activity.



Example 1 is for a non-impulsive, stationary, continuous source with source specific information provided at the bottom of the slide.



The user would start by filling out all sage boxes with project-specific information. Note: For weighting factor adjustment, please make sure value used is appropriate for the specific hearing group of interest (see Gray tab for more information).



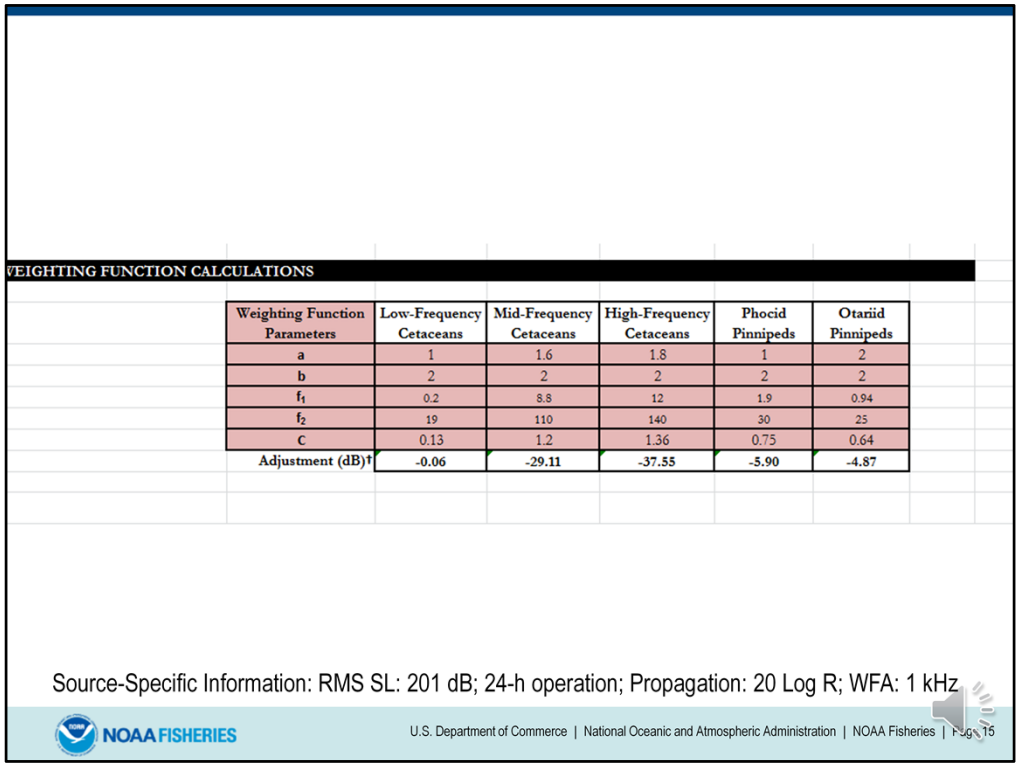
STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	201
Activity Duration (hours) within 24-h period	24
Activity Duration (seconds)	86400
10 Log (duration)	49.37
Propagation (xLogR)	20

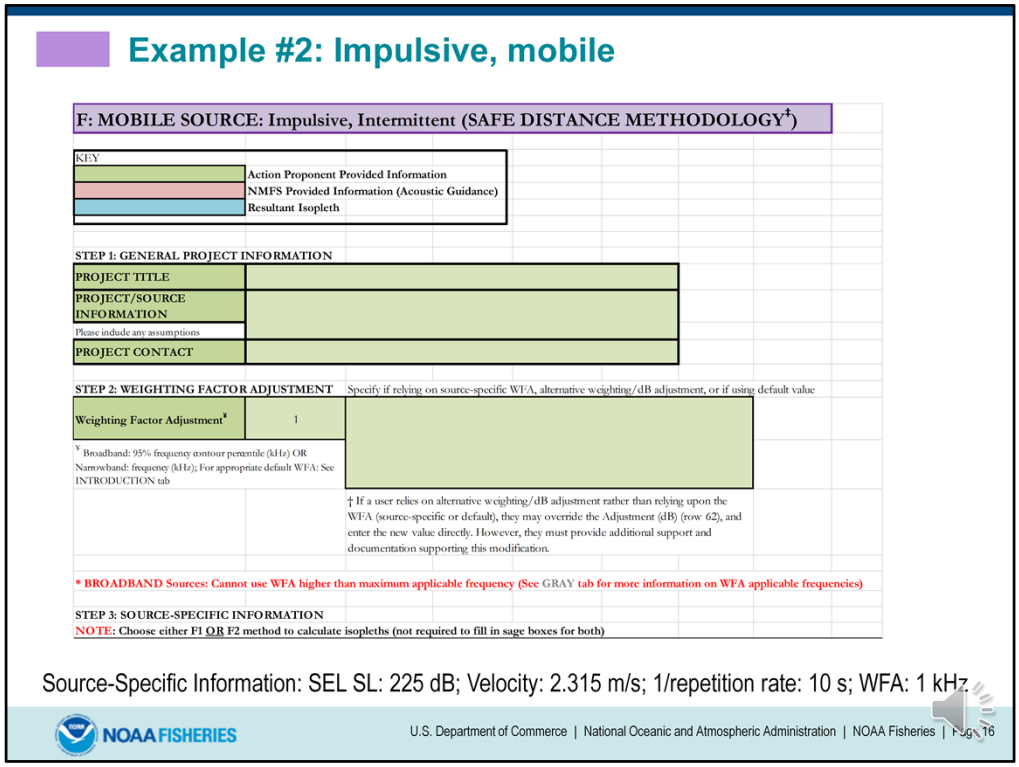
RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**367.3**	**14.5**	**97.9**	**149.1**	**21.1**

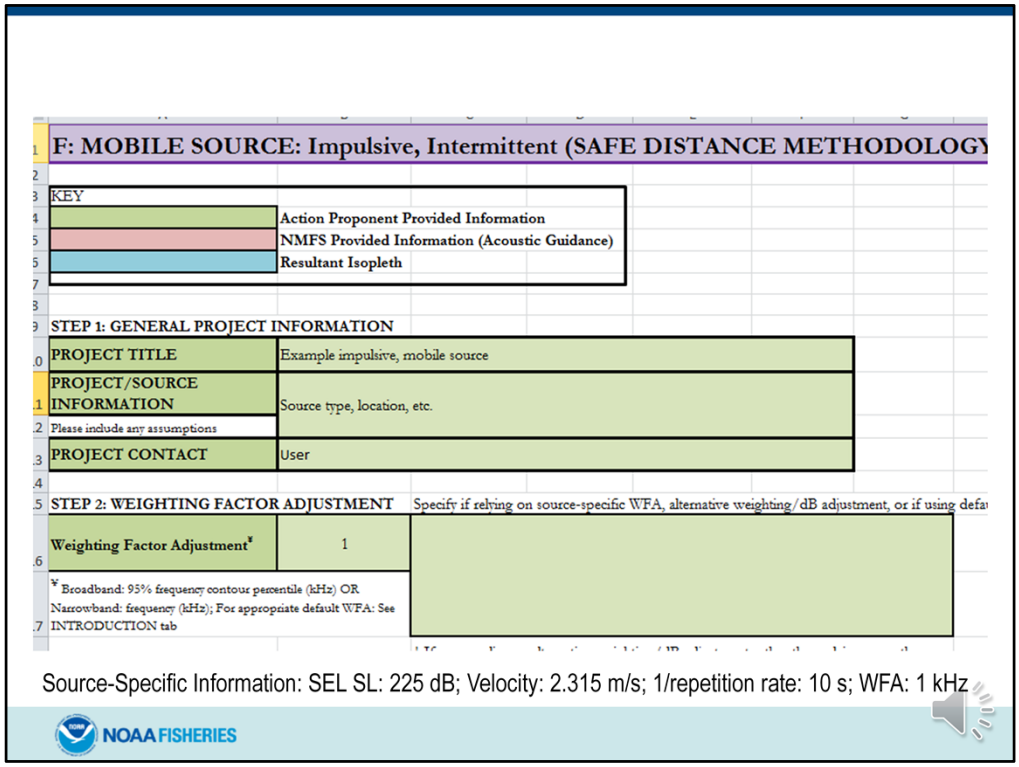
Once all the sage boxes are filled in by the user, the resultant PTS onset isopleths are provided in the sky blue boxes by hearing group.



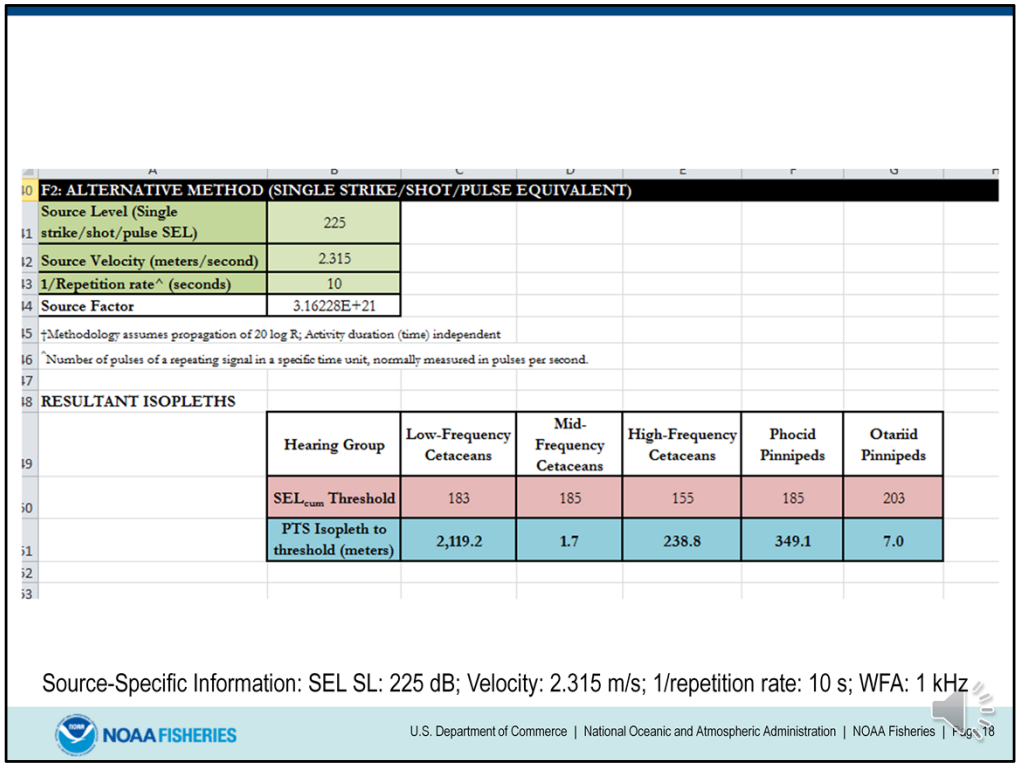
If the user wants to examine how adjustments are made using WFA or if they need to override this adjustment, they can scroll to the bottom of the sheet.



Example 2 is for an impulsive, mobile source with source specific information provided at the bottom of the slide. The user would start by filling out all sage boxes with project-specific information. Note: For weighting factor adjustment, please make sure value used is appropriate for the specific hearing group of interest (see Gray tab for more information).



Also note for this source type, there are two options for calculating isopleths, depending on whether the user has a RMS or SEL SL (the user chooses which method is appropriate and is not required to fill the sage boxes for both methods).



F2: ALTERNATIVE METHOD (SINGLE STRIKE/SHOT/PULSE EQUIVALENT)	
Source Level (Single strike/shot/pulse SEL)	225
Source Velocity (meters/second)	2.315
1/Repetition rate^ (seconds)	10
Source Factor	3.16228E+21

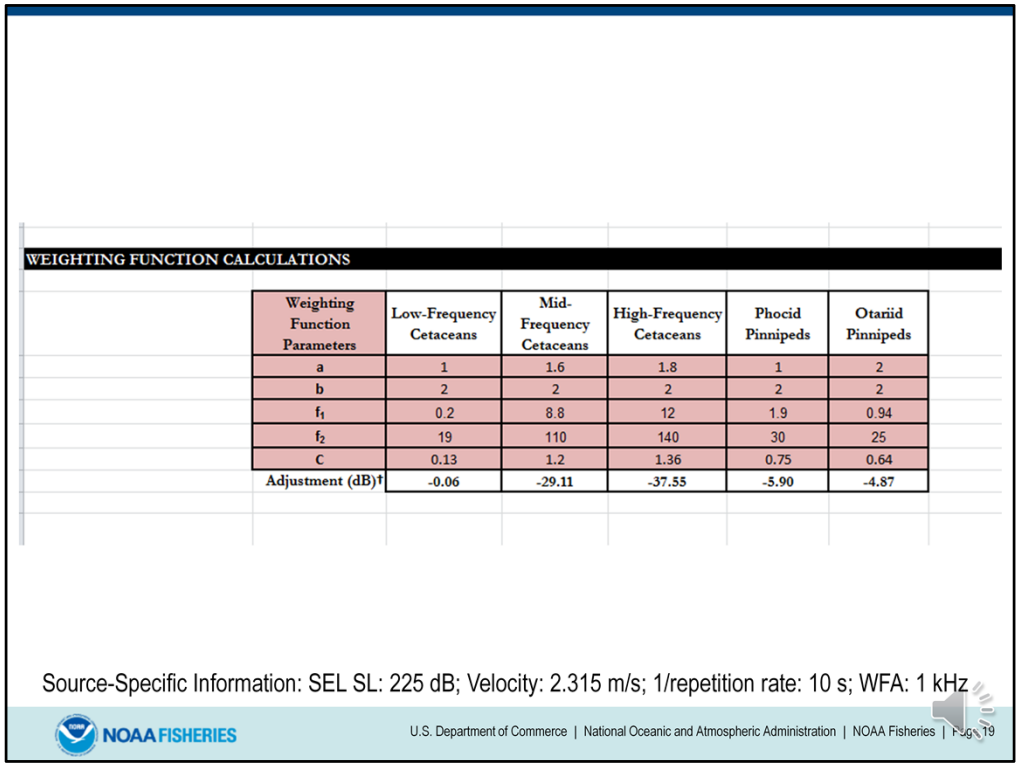
†Methodology assumes propagation of 20 log R; Activity duration (time) independent

^Number of pulses of a repeating signal in a specific time unit, normally measured in pulses per second.

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	183	185	155	185	203
PTS Isopleth to threshold (meters)	2,119.2	1.7	238.8	349.1	7.0

Once all the sage boxes are filled in by the user, the resultant PTS onset isopleths are provided in the sky blue boxes by hearing group.



Again, if the user wants to examine how adjustments are made using WFA or if they need to override this adjustment, they can scroll to the bottom of the sheet.

This concludes this webinar. Thanks for listening. If you have any follow-up questions, comments, or suggestions, please visit our web site (listed at the bottom of this slide).