



MARINE MAMMAL COMMISSION

21 February 2014

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Office of Protected Resources
National Marine Fisheries Service
Attn. Acoustic Guidance
1315 East-West Highway
Silver Spring, MD 20910-3225

Dear Ms. LeBoeuf:

The Marine Mammal Commission (the Commission), in consultation with its Committee of Scientific Advisors on Marine Mammals, has reviewed the National Marine Fisheries Service's¹ (NMFS) 27 December 2013 notice (78 Fed. Reg. 78822) to issue guidance regarding the acoustic thresholds for activities causing an onset permanent threshold shift (PTS) and temporary threshold shift (TTS) for marine mammal species under NMFS's jurisdiction and application of those thresholds under the regulatory context of the Marine Mammal Protection Act (the MMPA), Endangered Species Act (the ESA), and National Marine Sanctuaries Act.

RECOMMENDATIONS

The Marine Mammal Commission recommends that, prior to publishing the final guidance, the National Marine Fisheries Service—

- for all future interagency and public reviews of draft guidance regarding criteria and thresholds for assessing the effects of anthropogenic sound on marine mammals, provide (1) all peer reviewer and interagency comments and NMFS's responses to those comments and (2) at least a 60-day comment period;
- include in its final guidance regarding PTS and TTS the criteria and thresholds for mortality (extensive lung injury) and injury (both slight lung and gastrointestinal (GI) tract) as stipulated in Finneran and Jenkins (2012);
- use the low-frequency M-weighting function based on Southall et al. (2007), including the upper frequency hearing range extension to 30 kHz, rather than NMFS's proposed low-frequency weighting function and the M-weighted cumulative sound exposure level (SEL_{cum}) thresholds for low-frequency cetaceans accordingly²;
- require all action proponents to use weighting functions and the associated weighted thresholds rather than give action proponents the choice of using unweighted thresholds as denoted in Table 7;

¹ The draft guidance was provided on behalf of NMFS and the National Ocean Service, referred to collectively as NMFS herein.

² The M-weighted PTS thresholds should be 215 and 198 dB re 1 μPa^2 -sec for non-impulsive and impulsive sources, respectively. The TTS thresholds should be 195 and 183 dB re 1 μPa^2 -sec for non-impulsive and impulsive sources, respectively.

- remove the list of qualitative factors listed in Table 6b and incorporate them by reference in the text, but not allow action proponents to use those factors to modify isopleths or numbers of takes resulting from the quantitative thresholds in Table 6a;
- for activities that last at least 24 hours³, (1) require action proponents to use at least a 24- rather than 1-hour accumulation or reset time and (2) consult with scientists and acousticians regarding the applicability of an accumulation time that exceeds 24 hours for proposed activities that occur in a confined or small geographic area during an extended period of time and that may affect resident populations or marine mammals involved in certain behavior states (e.g., feeding, breeding/nursing, socializing);
- use 169 rather than 172 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the weighted TTS threshold and 184 rather than 187 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the weighted PTS threshold for mid-frequency cetaceans exposed to impulsive sources in Table 6a—if NMFS does not follow the Commission's recommendation of using the M-weighting function and relevant thresholds for low-frequency cetaceans, the thresholds for low-frequency cetaceans should be corrected in the same manner as those for mid-frequency cetaceans;
- use 186 and 201 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the unweighted TTS and PTS thresholds, respectively, for both low- and mid-frequency cetaceans exposed to impulsive sources in Table 7, if NMFS does not require all action proponents to use weighting functions and the associated weighted thresholds as recommended previously herein;
- (1) use 148 rather than 151 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the weighted TTS threshold for high-frequency cetaceans exposed to non-impulsive sources, (2) use 145 rather than 146 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the weighted TTS threshold for high-frequency cetaceans exposed to impulsive sources, and (3) adjust the PTS thresholds for non-impulsive and impulsive sources by increasing the TTS thresholds by 20 and 15 dB, respectively, in Table 6a;
- (1) use 163 rather than 172 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the unweighted TTS threshold for high-frequency cetaceans exposed to non-impulsive sources (for narrowband ≥ 3 kHz sources), (2) use 190 rather than 170 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the unweighted TTS threshold for high-frequency cetaceans exposed to non-impulsive sources (for all other sources), (3) use 164 rather than 165 dB re 1 $\mu\text{Pa}^2\text{-sec}$ as the unweighted TTS threshold for high-frequency cetaceans exposed to impulsive sound, and (4) adjust the unweighted PTS thresholds for non-impulsive sources and impulsive sources by increasing the TTS thresholds by 20 and 15 dB, respectively, in Table 7, if NMFS does not require all action proponents to use weighting functions and the associated weighted thresholds as recommended previously herein;
- use 212 dB re 1 $\mu\text{Pa}_{\text{peak}}$ as the TTS threshold and 218 dB re 1 $\mu\text{Pa}_{\text{peak}}$ as the PTS threshold for both phocids and otariids exposed to non-impulsive and impulsive sources in Table 6a and Table 7, if NMFS includes Table 7 in the final guidance;
- require action proponents to use SEL_{cum} (and SPL_{peak}) thresholds for determining the relevant isopleths associated with activities that use multiple sound sources in the same area and during the same timeframe rather than requiring action proponents to apply the thresholds to discrete sources used during a specific activity;

³ This includes activities that last at least 24 hours that are punctuated by some period of silence (e.g., during (1) use of non-continuous sound sources like sonar, echosounders, sub-bottom profilers, other similar acoustic sources, vibratory pile driving, airguns, underwater detonations, (2) implementation of mitigation measures, or (3) operational delays).

- provide guidance on how to determine the total ensonified area and subsequently the numbers of takes for action proponents that do not use models that incorporate moving sound sources;
- consult with scientists and acousticians to determine the relevant accumulation time—which should be more than a few shots, pings, or hammer strikes but likely less than 24 hours—that action proponents should use to determine the exclusion zones based on the associated PTS SEL_{cum} thresholds and include that accumulation time in the final guidance;
- provide clear guidance regarding (1) if action proponents should implement the proposed PTS and TTS thresholds and (2) how action proponents should incorporate the TTS thresholds in their analyses under the various statutes and when developing mitigation and monitoring measures; and
- require all action proponents to implement the final thresholds until such time that they are amended or revised by NMFS.

BACKGROUND

NMFS proposed to issue guidance regarding criteria and thresholds for assessing the effects of anthropogenic sound on marine mammals in 2005 (70 Fed. Reg. 1871). In spring 2013, NMFS asked the Commission to nominate peer reviewers with expertise in marine mammal bioacoustics, marine mammal ecology, noise-induced hearing loss, behavioral response to sound and other similar stressors, acoustic ecology, and statistical analyses to review the draft guidance⁴. The Commission nominated 10 peer reviewers with the relevant expertise in May 2013, of which 4 subsequently served as peer reviewers and provided comments on the draft guidance in summer 2013.

In fall of 2013, NMFS provided the draft guidance to various agencies during an abbreviated interagency review. The Commission provided a few general comments on the draft guidance in its 20 September 2013 letter. One of the Commission's concerns was that an interagency review period of two weeks was insufficient to conduct the detailed technical review required, and the Commission requested that NMFS provide sufficient time for related interagency reviews in the future. The Commission further suggested that NMFS take the necessary time to resolve with the peer reviewers their comments and concerns and to address any other concerns raised in the interagency review prior to publishing the draft guidance in the *Federal Register*. Finally, the Commission encouraged NMFS to provide at least a 60-day comment period to provide ample time for public review due to the complexity of the documents and the significance of the acoustic thresholds to be used by NMFS when evaluating and authorizing sound-producing anthropogenic activities under the MMPA and other federal statutes. NMFS did not provide the peer reviewers' comments or describe agency concerns, nor did NMFS provide its responses to those comments and concerns when it published its request for public review of the draft guidance on 27 December 13. NMFS did provide the peer reviewers' comments and NMFS's responses on 4 February, but never provided agency comments or concerns. Furthermore, rather than providing a 60-day comment period in its 27 December 2013 notice, NMFS published the *Federal Register* notice allowing for only 30 days for public comment. NMFS did allow for an additional 45 days for public comment, but interested parties were not notified until the evening of 22 January and the public was not notified via the *Federal Register* until

⁴ The draft guidance is deemed a highly influential scientific assessment by the Office of Management and Budget; http://www.cio.noaa.gov/services_programs/prplans/ID43.html.

29 January, which was two days after the close of the public comment period. Since the current guidance is incomplete with respect to thresholds for mortality, slight lung and GI tract injury, and behavior, this subject will need to be revisited in future notices. Accordingly, the Commission recommends that, for all future interagency and public reviews of draft guidance regarding criteria and thresholds for assessing the effects of anthropogenic sound on marine mammals, NMFS provide (1) all peer reviewer and interagency comments and NMFS's responses to those comments and (2) at least a 60-day comment period.

RATIONALE

Mortality and injury criteria and thresholds

NMFS originally planned to provide guidance regarding thresholds for PTS and TTS for all sound-producing activities and for behavior specifically in response to seismic surveys. However, due to comments received during the interagency review, NMFS has decided to move forward only with its proposed PTS and TTS thresholds and will revise further its behavior thresholds.

Once it became apparent that NMFS planned to take that approach, the Commission encouraged NMFS informally to provide a more complete guidance document that would not only assess PTS but also mortality and injury—effectively criteria and thresholds for mortality and all types of Level A harassment. The criteria and thresholds for mortality (extensive lung injury) and injury (both slight lung and GI tract) primarily are used to assess the effects of underwater detonations on marine mammals. They have been vetted through the public review process multiple times since 1998 for the USS SEAWOLF, WINSTON S. CHURCHILL, and MESA VERDE shock trials and recently with Navy compliance documents for its range complexes and training and testing areas (TAP I beginning in 2009 and Phase II beginning in 2013; see Finneran and Jenkins (2012) for the most current Navy criteria and thresholds). Portions of the thresholds have been amended slightly over the years, with the Navy currently using species-specific calf masses for the mortality and slight lung injury thresholds rather than assuming a dolphin calf mass is representative of all marine mammals. Even with those amendments, the theory and equations that underlie the mortality and injury criteria and thresholds have not changed, and the Commission is unaware of issues or specific concerns regarding the continued use of the mortality or injury criteria and thresholds. If this is indeed the case, then incorporating those criteria and thresholds should not be a problem—especially when, as the Commission understands it, NMFS has required (and is continuing to require) action proponents to use the updated mortality and injury criteria and thresholds for underwater detonations from Finneran and Jenkins (2012).

The value of a guidance document is based, in part, on its level of completeness. In this instance, some of the relevant criteria and thresholds for determining injury are lacking. NMFS should strive to publish complete guidance documents rather than requiring action proponents to use criteria and thresholds based on various guidance documents, informal policies, and final rules. The Commission therefore recommends that NMFS include in its final guidance regarding PTS and TTS the criteria and thresholds for mortality (extensive lung injury) and injury (both slight lung and GI tract) as stipulated in Finneran and Jenkins (2012).

Weighting functions

NMFS used various weighting functions to adjust the received sound levels (i.e., SEL_{cum}) at different frequencies based on the hearing sensitivity of various groups of marine mammals at those frequencies. Those weighting functions were derived by Southall et al. (2007), Finneran and Jenkins (2012), and NMFS. The weighting functions based on Southall et al. (2007) are flat over a wide range of frequencies and then decline at the extremes of the animal's hearing range—those functions continue to be used for pinnipeds, with proposed adjustments of greater (for phocids) and lesser (for otariids) high-frequency hearing limits than the original pinniped weighting function from Southall et al. (2007). For mid- and high-frequency cetaceans, NMFS used the weighting functions from Finneran and Jenkins (2012) by combining the precautionary Southall et al. (2007) functions with equal loudness weighting functions derived from empirical studies of bottlenose dolphins (Finneran and Schlundt 2011). For low-frequency cetaceans, NMFS chose not to use the weighting functions derived by Finneran and Jenkins (2012; Equation 4) but rather developed its own auditory weighting function using the equation from Finneran and Jenkins (2012) and NMFS's revised weighting function parameters.

NMFS did indicate a general lack of empirical data regarding low-frequency cetaceans' hearing capabilities and therefore based the weighting function parameters on the vocalization range and hypothesized sensitivity to lower frequency sounds. The Commission believes that the general shape of the low-frequency weighting function may reflect low-frequency cetaceans' hearing capabilities, but the parameters for that curve currently are not based on empirical data. The Commission understands that when data are lacking, assumptions must be made. But those assumptions must be substantiated. For the equal loudness portion of the curve, NMFS used values for the lower and upper hearing limits (a and b parameters, respectively) based on the assumption that vocalization range equates to potential auditory capabilities. That assumption is reasonable but the actual values for the parameters could prove to be under- or overestimated once empirical data are obtained on the hearing capabilities of low-frequency cetaceans. Further, NMFS assumed that the amplitude adjustment of -16.5 (K parameter) from the mid-frequency weighting function would apply similarly to the low-frequency weighting function. No data exist to support that assumption. Until data are available to support the equal loudness portion of the low-frequency weighting function, the Commission recommends that NMFS use the low-frequency M-weighting function based on Southall et al. (2007), including the upper frequency hearing range extension to 30 kHz, rather than NMFS's proposed low-frequency weighting function and the M-weighted SEL_{cum} thresholds for low-frequency cetaceans accordingly⁵.

NMFS indicated that unweighted PTS and TTS thresholds (Table 7) should be used if it is not possible for action proponents to use the weighting functions (and associated weighted thresholds). However, NMFS did not indicate what criteria would need to be met or what circumstances would necessitate the use of the unweighted thresholds. The Commission does not see the utility of having both sets of thresholds. If an action proponent can calculate or determine the isopleths (distances) to the relevant thresholds (weighted or unweighted), then that same action proponent can apply the weighting functions, which is a simple calculation and not onerous. NMFS

⁵ The M-weighted PTS thresholds should be 215 and 198 dB re 1 μPa^2 -sec for non-impulsive and impulsive sources, respectively. The TTS thresholds should be 195 and 183 dB re 1 μPa^2 -sec for non-impulsive and impulsive sources, respectively.

indicated that it had compiled, interpreted, and synthesized the best available science to produce the new thresholds. Accordingly, NMFS should require action proponents to use the best available science, which in this case would mean using weighting functions and relevant weighted thresholds. Therefore, the Commission recommends that NMFS require all action proponents to use weighting functions and the associated weighted thresholds rather than give action proponents the choice of using unweighted thresholds as denoted in Table 7.

Further, NMFS identified qualitative factors in Table 6b that could be considered in conjunction with the weighting functions and relevant thresholds and may be useful in a larger assessment. However, it is unclear how and when an action proponent can and should use such factors. The Commission agrees that the factors stated in Table 6b are true in a general sense, but indicating that those factors are useful in a larger assessment without guidance on how and when to apply them is not practical. The approach of considering qualitative factors identified in Table 6b could allow for take estimates in the larger assessment to be reduced based on subjective judgments rather than best available science as embodied in Table 6a. Thus, the Commission recommends that NMFS remove the list of qualitative factors listed in Table 6b and incorporate them by reference in the text, but not allow action proponents to use those factors to modify isopleths or numbers of takes resulting from the quantitative thresholds in Table 6a.

24- vs. 1-hour reset time

For action proponents with the ability to model moving sources and/or animals that accumulate sound at each receiver, NMFS proposed that 24 hours (or the length of the activity, whichever is less) be used as the accumulation time (commonly referred to as the reset time or the total time sound exposure or energy is accumulated and then assumed to reset to zero). However, for models that do not incorporate animal movement, NMFS indicated that it is not appropriate to assume animals would remain at a constant distance from the source, thus accumulating energy for 24 hours. Additionally, if sound accumulation cannot be modeled, NMFS indicated an alternative method should be used. In those situations, NMFS proposed an accumulation time of 1 hour.

The Commission believes that an action proponent would be able to model sound accumulation, as all of the proposed thresholds⁶ are based on SEL_{cum} . Further, action proponents that have not used animals have determined the total ensonified area based on a model accumulating the energy for 24 hours and then multiplying that ensonified area by the marine mammal density to determine the total number of takes. That approach does not assume a constant distance from the source, but rather a total ensonified area associated with activity lasting 24 hours (or less if appropriate) and a uniform density.

In addition, the Commission offers the following examples of when a 24-hour reset is more appropriate than a 1-hour reset. For seismic surveys, tracklines can be quite close to one another, the isopleths are wide, and ship speed is slow at around 5 knots. If an animal remains in the area, it could be exposed to impulsive sound for longer than 1 hour. This is especially true for animals that are feeding, breeding/nursing, or socializing rather than migrating through the area. For stationary activities like pile driving and drilling or dynamic activities that occur in a confined or small

⁶ Dual metrics for both TTS and PTS thresholds include both SEL_{cum} and peak sound pressure level (SPL_{peak}) for all marine mammal groups and all types of sources.

geographical area during an extended period of time, resident populations or animals that are involved in certain activities or behavior states (e.g., feeding, breeding/nursing, socializing) are more likely to be affected for periods exceeding 1 hour and potentially more than 24 hours. The accumulation time should account for not only specifics of the activity but also the biology, ecology, and ecological setting (e.g., semi-enclosed bay, steep-sided underwater canyon) of the affected animals. For all of these reasons, the Commission recommends that, for activities that last at least 24 hours⁷, NMFS (1) require action proponents to use at least a 24- rather than 1-hour accumulation or reset time and (2) consult with scientists and acousticians regarding the applicability of an accumulation time that exceeds 24 hours for proposed activities that occur in a confined or small geographic area during an extended period of time and that may affect resident populations or marine mammals involved in certain behavior states (e.g., feeding, breeding/nursing, socializing).

Mid-frequency cetacean thresholds

As stated previously, NMFS adjusted the SEL_{cum} thresholds based on the appropriate weighting function amplitudes. NMFS indicated that it used a TTS threshold of 186 dB re $1 \mu Pa^2$ -sec from Finneran et al. (2002) for exposure of mid-frequency cetaceans to impulsive sources, adjusted by the appropriate weighting function amplitude. But if the proposed method of subtracting 17 dB from that threshold (as specified in Tables 2 or A2) is used, the resulting weighted SEL_{cum} would be 169 rather than 172 dB re $1 \mu Pa^2$ -sec. In addition, the TTS thresholds serve as the basis for the PTS thresholds. Thus, the PTS threshold also has been overestimated by 3 dB. Therefore, the Commission recommends that NMFS use 169 rather than 172 dB re $1 \mu Pa^2$ -sec as the weighted TTS threshold and 184 rather than 187 dB re $1 \mu Pa^2$ -sec as the weighted PTS threshold for mid-frequency cetaceans exposed to impulsive sources in Table 6a—if NMFS does not follow the Commission’s recommendation of using the M-weighting function and relevant thresholds for low-frequency cetaceans, the thresholds for low-frequency cetaceans should be corrected in the same manner as those for mid-frequency cetaceans.

Moreover, in Table 7⁸ of the guidance, NMFS used the ‘weighted’ TTS and PTS thresholds of 172 and 187 dB re $1 \mu Pa^2$ -sec rather than the unweighted thresholds of 186 and 201 dB re $1 \mu Pa^2$ -sec for low-frequency cetaceans exposed to impulsive sources. NMFS also appears to have inserted the incorrect thresholds for mid-frequency cetaceans into Table 7. The unweighted TTS and PTS thresholds for mid-frequency cetaceans should be 186 and 201 dB re $1 \mu Pa^2$ -sec, based on NMFS’s justification in Appendix B, rather than 189 and 204 dB re $1 \mu Pa^2$ -sec. If NMFS does not require all action proponents to use weighting functions and the associated weighted thresholds as recommended previously herein, the Commission recommends that NMFS use 186 and 201 dB re $1 \mu Pa^2$ -sec as the unweighted TTS and PTS thresholds, respectively, for both low- and mid-frequency cetaceans exposed to impulsive sources in Table 7.

⁷ This includes activities that last at least 24 hours that are punctuated by some period of silence (e.g., during (1) use of non-continuous sound sources like sonar, echosounders, sub-bottom profilers, other similar acoustic sources, vibratory pile driving, airguns, underwater detonations, (2) implementation of mitigation measures, or (3) operational delays).

⁸ All thresholds in Table 7 are to be unweighted.

High-frequency cetacean thresholds

For non-impulsive sources, NMFS based the TTS threshold for high-frequency cetaceans on a harbor porpoise responding to octave-band sound centered at 4 kHz during a 1-hour exposure session (Kastelein et al. 2012), which was an unweighted SEL_{cum} threshold of 172 dB re $1 \mu Pa^2\text{-sec}$. Although data exist for a 2-hour exposure session (unweighted SEL_{cum} threshold of 163 dB re $1 \mu Pa^2\text{-sec}$), NMFS stated that the 2-hour timeframe exceeded its protocol for data analysis because exposure was greater than 1 hour and was considered unlikely to be encountered by wild individuals. As stated previously, the Commission does not agree with that rationale and believes the 163 dB re $1 \mu Pa^2\text{-sec}$ should have been used. NMFS also appears to have used an amplitude adjustment factor of approximately 12 rather than 15 dB (as specified in Table A3 for 4 kHz). It is unclear why NMFS did not adjust the threshold by the appropriate amplitude in Table 6a.

For impulsive sources, NMFS used an unweighted TTS threshold of 164.3 dB re $1 \mu Pa^2\text{-sec}$ (Lucke et al. 2009) reduced by 18.3 dB. However, the appropriate weighting function amplitude appears to be approximately 19.4 dB (Table 2). The Commission is concerned that the TTS thresholds for both types of sources not only are greater than they should be, based on the methods described, but also are used as the basis for the PTS thresholds. To address these concerns, the Commission recommends that NMFS (1) use 148 rather than 151 dB re $1 \mu Pa^2\text{-sec}$ as the weighted TTS threshold for high-frequency cetaceans exposed to non-impulsive sources, (2) use 145 rather than 146 dB re $1 \mu Pa^2\text{-sec}$ as the weighted TTS threshold for high-frequency cetaceans exposed to impulsive sources, and (3) adjust the PTS thresholds for non-impulsive and impulsive sources by increasing the TTS thresholds by 20 and 15 dB, respectively, in Table 6a.

Although the Commission does not support the use of Table 7, it has found a few more errors in the unweighted thresholds. As stated previously, the Commission believes NMFS should use 163 dB re $1 \mu Pa^2\text{-sec}$ as the unweighted non-impulsive (for narrowband ≥ 3 kHz sources) TTS threshold for high-frequency cetaceans. In addition, the unweighted impulsive and non-impulsive (for all other sources) TTS thresholds for high-frequency cetaceans in Table 7 do not reflect the data presented in Appendix B. The unweighted TTS threshold should be 190 rather than 179 dB re $1 \mu Pa^2\text{-sec}$ for non-impulsive sources (all other sources; Table B16) and 164 rather than 165 dB re $1 \mu Pa^2\text{-sec}$ for impulsive sources (section 4.2.2). If NMFS does not require all action proponents to use weighting functions and the associated weighted thresholds as recommended previously herein, the Commission recommends that NMFS (1) use 163 rather than 172 dB re $1 \mu Pa^2\text{-sec}$ as the unweighted TTS threshold for high-frequency cetaceans exposed to non-impulsive sources (for narrowband ≥ 3 kHz sources), (2) use 190 rather than 170 dB re $1 \mu Pa^2\text{-sec}$ as the unweighted TTS threshold for high-frequency cetaceans exposed to non-impulsive sources (for all other sources), (3) use 164 rather than 165 dB re $1 \mu Pa^2\text{-sec}$ as the unweighted TTS threshold for high-frequency cetaceans exposed to impulsive sound, and (4) adjust the unweighted PTS thresholds for non-impulsive sources and impulsive sources by increasing the TTS thresholds by 20 and 15 dB, respectively, in Table 7.

Pinniped thresholds

Direct TTS and PTS threshold data are lacking for most pinnipeds. For determining TTS thresholds for phocids exposed to non-impulsive and impulsive sources, NMFS used extrapolation methods discussed in Southall et al. (2007)—specifically NMFS applied a 5-dB increase to the mid-

frequency cetacean SPL_{peak} threshold of 224 dB re 1 μPa_{peak} to extrapolate to 229 dB re 1 μPa_{peak} for phocids. The Commission is unsure if that method is valid. To determine SPL_{peak} thresholds for pinnipeds, Southall et al. (2007) first determined the SEL_{cum} thresholds. They assumed that the known difference between the pinniped and cetacean thresholds for non-pulses (non-impulsive sources) also would apply to pulses (impulsive sources). Specifically, Southall et al. (2007) indicated that harbor seals experience TTS at levels 12 dB below that of mid-frequency cetaceans exposed to nonpulses (183 and 195 dB re 1 μPa^2 -sec (unweighted); Schlundt et al. 2000, Finneran et al. 2005, Kastak et al. 2005). They then applied the same 12-dB extrapolation factor to the mid-frequency cetacean SPL_{peak} threshold of 224 dB re 1 μPa_{peak} to yield a threshold of 212 dB re 1 μPa_{peak} for pinnipeds. In both instances, the pinniped TTS threshold is less than the mid-frequency cetacean threshold.

NMFS made a similar assumption regarding the difference between pinniped and cetacean thresholds. However, NMFS based their extrapolation method for non-impulsive sources on an unweighted phocid threshold of 183 dB re 1 μPa^2 -sec and a weighted mid-frequency threshold of 178 dB re 1 μPa^2 -sec, effectively assuming that phocids experience TTS at levels 5 dB above that of mid-frequency cetaceans. That 5-dB extrapolation factor then was used to determine the SPL_{peak} threshold for phocids. Southall et al. (2007) used an extrapolation method based on weighting functions that had similar shapes (Figure 1 in Southall et al. (2007)) and did not include an area of heightened sensitivity, as currently are proposed only for cetaceans (Figures 1–3 in the draft guidance). The Commission is unsure how NMFS can extrapolate thresholds based on completely different weighting functions, thus proposing thresholds adjusted by various amplitude factors ranging from 12–20 dB. Rather, the Commission believes that NMFS should have used the extrapolation method from Southall et al. (2007), which was based on unweighted thresholds. Therefore, the 212 dB re 1 μPa_{peak} threshold for non-impulsive and impulsive sources should have been used by NMFS rather than the 229 dB re 1 μPa_{peak} for non-impulsive and impulsive sources. Finneran and Jenkins (2012) similarly used the 212 dB re 1 μPa_{peak} threshold for phocids exposed to impulsive sources.

Further, NMFS then used the phocid threshold of 229 dB re 1 μPa_{peak} as a surrogate for the otariid SPL_{peak} TTS threshold. NMFS noted that if the same protocol (i.e., using the extrapolation method founded on thresholds that have been adjusted by various amplitudes, which were based on weighting functions of different shapes) was used to derive the SPL_{peak} TTS threshold for otariids, an unrealistically high onset level (i.e., 252 dB re 1 μPa_{peak}) would result. Rather than question whether the extrapolation method used for phocids might be similarly flawed, NMFS simply abandoned the extrapolation method for otariids and chose to use the phocid threshold. Given the limited data available, the Commission supports the decision to use the phocid threshold as a surrogate provided that the otariid threshold is reduced to 212 dB re 1 μPa_{peak} as described in the previous paragraph. Again, the TTS thresholds serve as the basis for the PTS thresholds and NMFS should reduce those thresholds as well. For all these reasons, the Commission recommends that NMFS use 212 dB re 1 μPa_{peak} as the TTS threshold and 218 dB re 1 μPa_{peak} as the PTS threshold for both phocids and otariids exposed to non-impulsive and impulsive sources in Table 6a and Table 7, if NMFS includes Table 7 in the final guidance.

Implementation and policy

NMFS stated that the SEL_{cum} metric is proposed to be applied to discrete activities/sources and is not meant to accumulate sound exposure for multiple activities occurring within the same area or during the same time. The Commission is unsure specifically what NMFS meant by that statement. But, because the SEL_{cum} metric is the only metric that incorporates the element of time, the Commission believes that SEL_{cum} is the best way to account for the use of multiple simultaneous sources by the relevant action proponent(s) in the same general area during the same timeframe (e.g., multibeam echosounders and sub-bottom profilers simultaneously with airguns during a seismic survey, various types of sonar and/or impulsive sources used simultaneously during a military exercise). Accordingly, the Commission recommends that NMFS require action proponents to use SEL_{cum} (and SPL_{peak}) thresholds for determining the relevant isopleths associated with activities that use multiple sound sources in the same area and during the same timeframe rather than requiring action proponents to apply the thresholds to discrete sources used during a specific activity.

In addition, NMFS did not provide guidance on how action proponents should use the isopleths associated with the various thresholds to determine the total ensonified area and subsequently the number of Level A and B harassment takes. The Commission is aware that not all action proponents use models that incorporate moving sources within the proposed activity scenario. To determine the total ensonified area, some action proponents currently use the greatest isopleths and multiply them either by (1) the length of tracklines for the entire activity or (2) the length of tracklines in a given day and multiply that area by the number of days the activity would occur. In either case, the greatest isopleths would have to be multiplied by another factor to determine the total ensonified area. Action proponents cannot merely use the area associated with the greatest isopleth and multiply it by a density. Therefore, the Commission recommends that NMFS provide guidance on how to determine the total ensonified area and subsequently the numbers of takes for action proponents that do not use models that incorporate moving sound sources.

Implementation guidance regarding how to calculate the exclusion zones based on PTS (Level A harassment) was not provided by NMFS in its draft guidance. Some of the currently used criteria are based on SPL_{peak} , SPL_{rms} ⁹, or impulse thresholds, which are fairly easy to implement when determining the appropriate exclusion zone based on Level A harassment. However, it is much more difficult to determine the timeframe that should be used for determining exclusion zones based on SEL_{cum} thresholds. For example, the Navy appears to base its ranges to PTS (which then serve as the basis for its exclusion or mitigation zones) on a single ping of its sonar sources and it assumes that marine mammals would not maintain a nominal speed of 10 knots parallel to a ship and thereby would not receive sound from more than a single ping. The Navy also assumes marine mammals would leave the area near the sound source after the first 3–4 pings. The Commission has questioned those assumptions in the past and remains unconvinced of their validity, potentially leading to an underestimation of the exclusion zone. Additionally, seismic and geological/geophysical surveys emit sound at a higher duty cycle and vessels transit at slower speeds than Navy operations that use hull-mounted sonar. The Commission has raised similar concerns for stationary sources that emit sound at multiple pings per minute in small geographical areas. Further, pile driving activities also emit sound at very high duty cycles and often occur in coastal regions

⁹ Sound pressure level based on root mean square.

inhabited by resident populations of marine mammals. In these cases, it would not be appropriate to base an exclusion zone on a few shots, pings, or hammer strikes. Thus, the Commission recommends that NMFS consult with scientists and acousticians to determine the relevant accumulation time—which should be more than a few shots, pings, or hammer strikes but likely less than 24 hours—that action proponents should use to determine the exclusion zones based on the associated PTS SEL_{cum} thresholds and include that accumulation time in the final guidance. Without such information, the guidelines provide no guidance for determining when injury could occur or for mitigating the effects caused by various sound sources.

NMFS indicated that it is in the process of developing new thresholds for onset of behavioral effects. When that process is completed, TTS would be addressed for purposes of take quantification. In the meantime, NMFS stated that the proposed TTS thresholds represent the best available science and would be used in the comprehensive effects analyses under the MMPA and ESA and may inform the development of mitigation and monitoring measures. The Commission is unsure (1) how NMFS plans to use the proposed TTS thresholds in its analyses and (2) if the action proponents would be required to determine the isopleths to the various TTS thresholds and estimate the numbers of animals to be taken to inform their effects analyses (under the National Environmental Policy Act, MMPA, or ESA) or to develop or refine the mitigation and monitoring measures. It is unclear if NMFS will default to the current behavioral thresholds until they are updated—TTS thresholds now merely serve as the basis for the PTS thresholds and would not be required to be implemented until the behavioral thresholds are finalized. This is further complicated because the Navy has updated its criteria and thresholds with each round of environmental impact statements and rulemakings, which creates uncertainty as to which PTS and TTS thresholds the Navy (and all other Department of Defense action proponents) would be required to use when the current guidance is finalized. Accordingly, the Commission recommends that NMFS provide clear guidance regarding (1) if action proponents should implement the proposed PTS and TTS thresholds and (2) how action proponents should incorporate the TTS thresholds in their analyses under the various statutes and when developing mitigation and monitoring measures.

Furthermore, NMFS stated that an alternative approach may be proposed (by federal agencies or other action proponents) and used if case-specific information or data indicate that the alternative approach is likely to produce a more accurate estimate of Level A Harassment, harm, or auditory injury for the proposed activities and if NMFS determines that approach satisfies the requirements of the applicable statutes and regulations. NMFS has not provided any criteria under which such an exception could be invoked. Rather, NMFS has given action proponents the ability to waive the proposed thresholds and, when in effect, the final thresholds. The Commission does not understand why NMFS would go through the effort of proposing (and revising on a proposed 3–5 year cycle) thresholds, considered to be based on best available science, and yet allow an action proponent to argue for an alternative approach on a case-by-case basis. The Commission does not support such a policy and recommends that NMFS require all action proponents to implement the final thresholds until such time that they are amended or revised by NMFS.

The Commission appreciates the opportunity to provide comments on NMFS's draft guidance. Please contact me if you have questions concerning the Commission's recommendations or rationale.

Sincerely,

A handwritten signature in blue ink that reads "Rebecca J. Lent".

Rebecca J. Lent, Ph.D.
Executive Director

References

- Finneran, J.J., D.A. Carder, C.E. Schlundt, and S.H. Ridgway. 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. *Journal of the Acoustical Society of America* 118:2696–2705.
- Finneran, J.J., and A.K. Jenkins. 2012. Criteria and thresholds for U.S. Navy acoustic and explosive effects analysis. SPAWAR Marine Mammal Program, San Diego, California, 64 pages.
- Finneran, J.J., and C.E. Schlundt. 2011. Subjective loudness level measurements and equal loudness contours in a bottlenose dolphin (*Tursiops truncatus*). *Journal of the Acoustical Society of America* 130(5):3124–3136.
- Finneran, J.J., C.E. Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway. 2002. Temporary shift in masked hearing thresholds in odontocetes after exposure to single underwater impulses from a seismic watergun. *Journal of the Acoustical Society of America* 111:2929–2940.
- Kastak, D., B.L. Southall, R.J. Schusterman, and C.R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: effects of noise level and duration. *Journal of the Acoustical Society of America* 118:3154–3163.
- Kastelein, R.A., R. Gransier, L. Hoek, and J. Olthuis. 2012. Temporary hearing threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4 kHz. *Journal of the Acoustical Society of America* 132:3525–3537.
- Lucke, K., U. Siebert, P.A. Lepper, and M-A. Blanchet. 2009. Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *Journal of the Acoustical Society of America* 125:4060–4070.
- Schlundt, C.E., J.J. Finneran, D.A. Carder, and S.H. Ridgway. 2000. Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncatus*, and white whales, *Delphinapterus leucas*, after exposure to intense tones. *Journal of the Acoustical Society of America* 107:3496–3508.
- Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, J.H. Miller, P.E. Nachtigall, W.J. Richardson, J.A. Thomas, and P.L. Tyack. 2007. Marine mammal noise exposure criteria: Initial scientific recommendation. *Aquatic Mammals* 33(4):411–521.