- As animats move over time, and if animats are removed once they exceed a take threshold, then the probability of take will decline over time as there are fewer and fewer animats in the field. JASCO used a common technique for keeping the number of animats constant and thus keeping probability of take constant over time by introducing new animats on the opposite side from which an animat had just left (D-49; D-82; D201). It is also not clear if and how animals were removed or replaced once taken. This is especially important where animats were left in the field to accumulate SEL for days or weeks. There are other nuance to re-seeding the sound fields that can result in skewed results, but a full treatment is beyond the scope of this short review.

Take (Acoustic Risk) Thresholds.

Both Level A and Level B thresholds range from more than 100 times higher than best scientific evidence to over 100,000 times higher. There are multiple conservative assumptions that produce this extraordinary outcome: the assumption that exposure equals take, the conservative linkage of permanent hearing decrements to temporary hearing decrements, assumptions about the accumulation of hearing effects over time without recovery between exposures, and assumptions about how many of these exposures actually have any meaningful biological consequences.

The MMPA defines "harassment" with reference to two categories: Level A harassment (potential to "injure") and Level B harassment (potential to "disturb"). NMFS applies acoustic thresholds to estimate the amount of harassment for each category that may result from an activity. The acoustic thresholds are often mistakenly assumed to mean that an injury or mortality will occur, with 100% of the exposed animals being injured or killed, or that 100% of exposures at behavioral thresholds will cause behavioral change and that the consequences of the change are a significant and meaningful loss of food, energy, or some other key biological function. In fact, both thresholds imply a probability of there being an effect upon exposure. BOEM was quite emphatic in stating that exposure does not equal take, but the model still treats any exposure that exceeds threshold as a take. This is the first of many features within the Acoustic Risk Threshold part of the model that lead to large over-estimates of take.

Additionally, the DPEIS is not always clear when and how animals are removed from the model to prevent multiple takes of the same individual (e.g., being counted as a Level B take and then exceeding Level A criteria and also being counted as a Level A take). Removals need to be handled carefully to prevent gradual reductions of model 'animats' in the sound field as "taken" animats are removed.

The most recent threshold criteria for Level A takes are based on empirical data for the threshold at which a temporary decrease in hearing sensitivity (TTS) occurs across a narrow frequency range of hearing (NMFS, 2016; Finneran, 2015). BOEM also variously cites NMFS 1995; Southall et al 2007; Finneran and Jenkins, 2012: it is not yet clear which criteria they plan to use in the Final EIS, making analysis of the DPEIS difficult. JASCO in Appendix D modeled the 1995 threshold

The simplest Level A threshold, long since superseded by scientific data but still in use by NMFS, is 180 dB SPLrms (root mean squared an average over some specified time period, and since it is an average of a logarithmic scale, dB, a square root of the mean of summed square values is required rather than a simple average). Despite being outdated by more than 20 years, BOEM still modeled takes using this hyper-precautionary threshold. This provides a threshold that is some 10 to 1,000 times more precautionary than the current best data derived from TTS thresholds for both impulse and tonal sources; the peak SPL or the summed sound energy over time (SEL), although we shall see later in this section that the SEL has also been subjected to additional conservative assumptions that render it some 10-1,000 times more conservative than SPLpeak. The values of 10 to 1000 times are based on SPLpeak thresholds of 230-200 dB SPLpeak, and an estimate of 180 dB SPL rms being comparable to 190 dB SPL peak (200 dB is ten times 190 dB and 2230 dB is one thousand times 190 dB on the same scale, in this case SPLpeak).

Permanent Threshold Shift (PTS) is not tested directly, and is assumed to occur at a level above TTS consistent with marine mammal TTS data and human/lab animal data. PTS, as for TTS, is not a threshold for deafness or major loss of hearing, but for a small decrement of hearing sensitivity within a narrow frequency range, a 'hearing notch'. This is a liberal interpretation of "injury", since the original sense of the term in MMPA was intended for animals that lost eyes, limbs, or suffered broken bones and spinal injuries during interactions with fisheries or due to being struck by ships, shot at, or otherwise seriously injured.

The criterion is rendered even more conservative by the use of a 15 decibel difference between TTS and PTS when the data from other species, including humans, indicates PTS onset at 20-40 dB above TTS threshold. Since even this conservative addition of only 15 dB to TTS produces thresholds of PTS above the source level of the sound source, Southall et al (2007) and subsequent criteria (NMFS 2016) have arbitrarily set the SPL peak metric for PTS at a mere 6 dB above TTS threshold, or almost ten times lower (and therefore productive of ten times as many exposures and takes).

The best predictor of TTS and therefore PTS, at least for tonal sounds, is SEL, a product of both signal intensity (not amplitude) and duration. It is not clear how well this relationship holds up for an impulse signal like compressed air (CA) sources, so relationships for tonal signals are applied to impulse thresholds. SEL is referenced to a time duration, typically one second, but for sounds less than 1 second long, like impulse sounds, SEL does not always hold up.

Furthermore, models like the BOEM DPEIS treat multiple exposures separated by many seconds or even hours or days, as if the sound exposure had been continuous. Near the source a geophysical survey produced 0.1 s of sound every 10-20 seconds, expressed as a "duty cycle" of approximately 1-2%. Further from the source the energy in the impulse may spread in time, increasing the duty cycle, but at ranges meaningful for Level A determination, the duty cycle remains below 10%, meaning that 90% of the time the ear is capable of recovering from some of the induced fatigue or threshold shift. Early TTS studies noted that the animals recovered from low levels of TTS within seconds or minutes, and subsequent ongoing studies are consistent, suggesting that it make take considerably more intermittent exposures to produce TTS or PTS than would be predicted by simply adding up multiple pulses as if they all occurred in succession without any time for recovery (In other words 12 pulses of 0.1 second duration each are treated as a continuous 1.2 second pulse and not what they are, which 1.2 seconds of sound within ten 15 second intervals or 150 seconds of ambient sound only).

The case for some sort of recovery function is even stronger for intermittent passes of an array that may be separated by 4, 8, 16 or more hours, in which case hearing is likely fully recovered and no accumulation of SEL should be carried forward. NMFS has traditionally carried SEL forward for 24 hours, a scientifically unwarranted precaution that leads to over-estimations of take by another 10-100 times, if not more. The current modeling exercise suggests in places that SEL accumulation was carried forward even further for weeks or even months. Appendix K offers annual summations of SEL and a