

### Fish Injury and Disturbance Thresholds

Fish ≥ 2 grams	Behavior effects threshold 150 dB <sub>RMS</sub> <sup>1</sup>	187 dB SEL <sub>cum</sub> <sup>2</sup>
Fish < 2 grams		183 dB SEL <sub>cum</sub> <sup>2</sup>
Fish all sizes		Peak 206 dB

<sup>1</sup>Hastings 2002, as cited in BA Manual

<sup>2</sup>Memorandum on the Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities

### Marine Mammal Injury and Disturbance Thresholds

Functional Hearing Group	In Air Noise Thresholds	Underwater Noise Thresholds				
	Disturbance Threshold	Impulsive Sound Impact Pile Driving			Non- Impulsive Sound Vibratory Pile Driving	
		Auditory Injury Threshold (PTS)	Behavioral Disturbance Threshold	Auditory Injury Threshold (PTS)	Behavioral Disturbance Threshold	
	dB RMS (unweighted)	Peak SPL	dB SEL <sub>cum</sub>	dB RMS	dB SEL <sub>cum</sub>	dB RMS
<b>Low-frequency Cetaceans</b>	NA	219	183 LF, 24h	160	199	120
<b>Mid-frequency Cetaceans</b>	NA	230	185 MF, 24h	160	198	120
<b>High-frequency Cetaceans</b>	NA	202	155 HF, 24h	160	173	120
<b>Harbor Seals</b>	90	218	185 PW,24 h	160	201	120
<b>Non-harbor seal species</b>	100	232	203 OW,24h	160	219	120

New thresholds:

Hearing Frequency Groups:

Low-frequency Cetaceans = baleen whales ( includes humpback ,Northern minke, Sei, gray, blue)

Mid-frequency Cetaceans = dolphins, toothed whales, beaked whales, bottle nose whales ( includes sperm whale, killer whale, bottlenose dolphin, Pacific White-sided dolphin)

High-frequency Cetaceans = true porpoises, river dolphins, cephalorhynchid. ( Dall’s Porpoise)

Phocid Pinnipeds – true seals (harbor seal, Northern elephant sea, ribbon seal).

Otariid Pinnipeds – sea lions, fur seals ( California and Stellars sea lion, northern fur seal)

## Determining In-water Zones of Injury and Zones of Disturbance (Harassment)

### 1. Impact pile driving.

- a. Calculate Injury Threshold (This is a dual threshold and both must be calculated – use the larger of the two isopleths. Note that the threshold varies by Functional Hearing Group -5 groups)
  - i. Peak SPL unweighted – use practical spreading loss model
  - ii. SEL<sub>cum</sub> M weighted – use NOAA calculator sheet E.1 and use the weighting factor adjustment provided in the introduction tab of the spreadsheet. See <http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm>
- b. Calculate Disturbance Threshold (same for all hearing frequency groups)
  - i. 160 dB RMS – use practical spreading loss model

### 2. Vibratory pile driving/ removal

- a. Calculate Injury Threshold (Threshold varies by Functional Hearing Group -5 groups)
  - i. SEL<sub>cum</sub> – using NOAA calculator sheet A. See <http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm>
- b. Calculate disturbance threshold (the same for all Functional Hearing Groups – 5 groups)
  - i. 120 db RMS - use practical spreading loss model

## In-air Disturbance for Pinnipeds

Calculate in air disturbance threshold

- 90 dB RMS un-weighted for Harbor seals – use practical spreading loss model
- 100 dB RMS un-weighted for non-harbor seals – use practical spreading loss model

Functional Hearing Group	In-air Noise Thresholds	Underwater Noise Thresholds						
		Disturbance Threshold	VIBRATORY Pile Driving			IMPACT Pile Driving		
	Behavioral Threshold		Disturbance (TTS) Threshold <sup>1</sup>	Injury (PTS) Threshold <sup>1</sup>	Disturbance (TTS) Threshold <sup>1</sup>		Injury (PTS) Threshold <sup>1</sup>	
	dBA	dB RMS	dB SEL	dB SEL	dB SEL	Peak SPL	dB SEL	Peak SPL
Low-frequency Cetaceans	NA	120	179	199	168	213	183	219
Mid-frequency Cetaceans	NA	120	178	198	170	224	185	230
High-frequency Cetaceans	NA	120	153	173	140	196	155	202
Phocid Pinnipeds	90	120	181	201	170	212	185	218
Otariid Pinnipeds	100	120	199	219	188	226	203	232

<sup>1</sup> NMFS. 2016. Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing: Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 p.