Proposed Incidental Harassment Authorization for Waterfront Repairs at U.S. Coast Guard, Monterey Station: Comments and Responses

We received one comment letter on the proposed incidental harassment authorization during the 30-day comment period, from the Marine Mammal Commission (Commission). The Commission's comments, and the U.S. Fish and Wildlife Service's (Service's) responses, are given in the table below.

Comment	Response
FWS indicated that it used 160 dB re 1 μPa as the threshold for Level B harassment for both impulsive and non-impulsive sources based on the lack of disturbance or any other reaction by sea otters to the 1980s playback studies of Riedman (1983, 1984) and the absence of a clear pattern of disturbance or avoidance behaviors attributable to underwater sound levels up to about 160 dB re 1 μPa resulting from vibratory pile driving during previous monitoring activities. The Riedman (1983, 1984) studies were part of the larger Malme et al. (1983, 1984) playback studies that both were conducted off the California coast to assess responses of migrating gray whales and informed the 160-dB re 1 μPa threshold for impulsive sources. However, Riedman (1983, 1984) was not a true controlled exposure experiment, because it did not provide information regarding received levels paired with an otter's response (or lack thereof) to the associated sound emitted. The Commission questions the use of the Riedman data in general	Based on results from Malme (1983, 1984) and subsequent studies, Malme et al. (1988) concluded that "exposure to levels of 120 dB or more would probably cause avoidance of the area by more than one-half of the gray whales." The concurrent Riedman (1983, 1984) studies do not provide any indication that the respective sensitivities of gray whales and sea otters to underwater noise are comparable or that the 120-dB threshold is applicable to sea otters. While it is unfortunate that the Riedman (1983, 1984) studies did not provide information regarding received sound levels paired with the observed behaviors (i.e., the absence of any disturbance reactions) of sea otters, Riedman (1983) indicates that most sea otter foraging activity before, during, and after the playback experiments took place in waters approximately 3-12 meters (m) in depth, which overlapped partially with the gray whale migration route along the 10-15 m contours observed during the April-May field period (Malme et al. 1983). Thus we can infer that gray whales and sea otters were exposed to similar sound levels at least part of the time. Whereas gray whale behavioral changes were detected in response to playbacks of drilling platform noise (beginning at 2-3 kilometers (km) from the source), drillship noise (beginning at 1-2 km from the source), semisubmersible noise (beginning at 1-2 km from the source), helicopter noise (beginning at 2 km from the source), and production platform noise (beginning at 0.5 km from the source) (Malme et al. 1983), no changes in the behavior of sea otters were detected at any time at any distance from the source, including during (rare) foraging bouts closer than 400 m to the *Varua* (the vessel from which industrial noise recordings were projected). We do not dispute the Commission's assertion that methods associated with controlled exposure experiments have advanced in the last 35 years. However, controlled exposure experiments to determine sea otters' behavioral responses to

but also notes that methods associated with controlled exposure experiments have advanced considerably in the last 35 years.	underwater noise have not been conducted. Therefore, we utilize the Riedman (1983, 1984) data, along with other monitoring data that have been collected in subsequent years and the Ghoul and Reichmuth (2014) work on sea otter auditory profiles, as the best available information on sea otters' sensitivity to sound. We note that the National Marine Fisheries Service's (NMFS's) 120-dB re 1 μPa threshold, which the Commission supports, is itself based on the Malme (1983, 1984) and Malme et al. (1988) studies from 30-35 years ago and thus also does not utilize the methods associated with controlled exposure experiments that the Commission indicates have advanced during the intervening time. Moreover, these studies focused on the responses of gray whales (not sea otters) to underwater sound.
The Commission also is perplexed that FWS accepts the data from the Malme (1983, 1984) studies on gray whale response to impulsive sources but rejects the same studies related to gray whale response to non-impulsive sources (Malme et al. 1988). That choice appears arbitrary.	The Service acknowledges that application to sea otters of NMFS' 160-dB re 1 μPa threshold for impulsive underwater noise, which is also based on the Malme (1983, 1984) studies, is very likely overly precautionary. However, monitoring data for sea otters exposed to activities that generate impulsive noise (e.g., impact hammering of piles or pipes and seismic surveys) are more limited than for sea otters exposed to activities that generate non-impulsive noise (e.g., vibratory pile driving, rig-towing, drilling operations, and deep-well pump operations). For example, impact hammering occurred only briefly during the Parsons Slough project, with 5 (hourly) counts of sea otters occurring during impact hammering versus 42 during vibratory pile driving (ESNERR 2011). During the Cosmopolitan State 2013 Drilling Program in lower Cook Inlet, Alaska, 36 sea otter observations occurred during operations that produced impulsive noise, such as pipe driving and vertical seismic profiling (though none while the hammer or airguns were actively pounding or firing), whereas 5,081 sea otter observations occurred during operations that produced non-impulsive noise, such as rig-towing, drilling, and deep-well pump operations (Owl Ridge Natural Resource Consultants 2014). Because of the paucity of monitoring data on sea otters' behavioral responses during activities that generate underwater impulsive sound, at this time we are retaining our use of NMFS' 160-dB re 1 μPa threshold for impulsive underwater noise. As additional monitoring or other data become available, we may revise our application of this threshold to sea otters.
FWS also indicated that previous monitoring results during vibratory pile driving in	The Service disagrees with the Commission's conclusions regarding ESNERR (2011) that "sea otters are disturbed by or avoid vibratory pile-driving activities well below

California showed no clear pattern of sea otter disturbance or avoidance in relation to the various levels of underwater sound exposure. The Commission disagrees. During vibratory installation of sheet piles, 55 percent of the observed sea otters traveled away from the area or exhibited a startle dive in response to received levels less than 160 dB re 1 µPa (Table 8 in ESNERR 2011). Similarly, 50 percent of the observed sea otters traveled away from the area or exhibited a startle dive in response to received levels ranging from 141–144 dB re 1 µPa during vibratory installation of H-piles, and 33 percent of the observed sea otters traveled away from the area at received levels less than 135 dB re 1 µPa (Table 7 in ESNERR 2011). The pattern is quite clear, sea otters are disturbed by or avoid vibratory pile-driving activities well below 160 dB re 1 µPa. The Commission further notes that these observed responses would equate to a behavioral severity score of 6 or more (based on Southall et al. 2007), which have a greater potential to affect sea otter foraging, reproduction, or survival.	[underwater sound levels of] 160 dB re 1 µPa." Tables 7 and 8 in ESNERR (2011) tabulate sea otter behaviors while vibratory pile driving was occurring along with the corresponding level of airborne and underwater sound exposure at a particular distance from construction activity, but they do not indicate whether the stimulus believed to have caused the reaction was underwater noise, airborne noise, or visual disturbance associated with vibratory pile driving (or, potentially, something unrelated to construction activity). Because sea otters spend the majority of their time at the surface, they are much more likely to be affected by unfamiliar visual stimuli or airborne noise than by underwater noise. Although sea otters become acclimated to routine sights and sounds, cranes and other mechanical equipment with high vertical profiles are unfamiliar sights in the Parson's Slough area, where the ESNERR (2011) project-related monitoring took place, and those visual stimuli, along with the sounds associated with them, could be expected to evoke vigilance behaviors. It should be noted that certain behaviors recorded during the Parson's Slough project, such as head turns and startle dives, are almost certainly associated with airborne noise or other visual, olfactory, or tactile stimuli rather than underwater noise because the behavior begins with the animal's head out of the water. Traveling away without startling (i.e., without performing a startle dive) also typically suggests surface-swimming and thus a response to airborne stimuli, although in certain situations (e.g. when the initial behavioral state is foraging) it might be used to describe an animal's rapid departure from a foraging area. Sea otters often travel underwater while foraging, but a rapid departure could indicate a response to underwater noise encountered while diving/obtaining prey or to airborne noise or visual stimuli encountered after surfacing with prey. To obtain context for the observations recorded in ESNERR (2011), we requested additional information from the Elkhorn Slough National Estuarine Research Reserve, including any observational notes made by monitors (ESNERR unpublished data 2018). Observer notes were not present in many cases, and when they were present, they were often not sufficient to identify the specific stimulus believed to have caused the behavioral response. Nevertheless, the notes do confirm in several cases that airborne noise or visual stimuli, and not underwater sound,

	were responsible for the sea otter's recorded reaction. For instance, during vibratory installation of sheet piles, the single observed startle dive—at a distance of 30-60 m (underwater noise level 156-159 dB re 1 μPa, airborne noise level 84-90 dB re 20 μPa)—was the result of airborne noise, not underwater noise: the observer notes indicate that the sea otter was foraging, apparently normally, in the presence of underwater sound before "splashing & submerg[ing] when pile screeched." Another sea otter traveling away at a distance of 30-60 m is noted to have swum "slowly backwards keeping eye on crane," indicating that the sea otter was surface swimming and apparently reacting to airborne noise and/or visual stimuli. A sea otter at a distance of 120-150 m (underwater noise level 151-152 dB re 1 μPa, airborne noise level 78-81 dB re 20 μPa) was observed "reacting to voices but then went back to foraging," apparently normally, in the presence of underwater sound (ESNERR unpublished data 2018). The observer notes also help to resolve some discrepancies between the data summarized in Table 8 and Figure 16 in ESNERR (2011), including 16 instances of "travel away, no startle" that appear in Table 8 but not in Figure 16. The 16 recorded observations of sea otters traveling away at a distance >180 m (underwater noise level <150 dB re 1 μPa, airborne noise level 75-76 dB re 20 μPa) were in fact 8 sea otters noted at 0910 "as V hammering started" to have "moved west away from noise" and at 0924 "as V hammering started" to have "moved east toward noise" (ESNERR unpublished data 2018). Because the same eight animals moved away from but subsequently toward the construction area when vibratory hammering was initiated, the movements do not appear to reflect an avoidance response. Additionally, sea otters tend to form groups of this size only when resting together at the surface (they do not travel underwater in groups, nor do they forage in groups), so even if the behaviors were related in some way to construction activity, they would be responses to airborne or visual stimuli, not underwater sound. It is most likely, however, that these animals were resting in a group that sculled (surface swimming) in response to currents or another stimulus unrelated to construction activity. Even including known instances when sea otters were responding to airborne noise or visual stimuli, the majority of observations of sea otter behavior during vibratory pile

	driving with sheet piles and H piles were of "no disturbance." During vibratory pile driving with sheet piles at distances 10-180 m from the pile driver (underwater noise level 150-165 dB re 1 μPa, airborne noise level 76-104 dB re 20 μPa), only 15/46 observations, approximately 33%, were of travel or startle reactions. No disturbance (28) or head turns (3) comprised 77% of the observations. During vibratory pile driving with H piles, no water-based reactions occurred beyond 60 m from the pile driver (one travel observation at >180 m was incorrectly included in Table 7 under "water-based behavior" instead of "land-based behavior," meaning the animal was hauled out and could only have been exposed to airborne stimuli). Of the reactions that were observed 10-60 m from the pile driver (underwater noise level 141-150 dB re 1 μPa, airborne noise level 78-94 dB re 20 μPa), only 6/20, or 30%, were of travel or startle reactions. No disturbance (13) or head turns (1) comprised 70% of the observations (ESNERR unpublished data 2018). We also disagree with the Commission's assertion that the "observed responses would equate to a behavioral severity score of 6 or more (based on Southall et al. 2007), which have a greater potential to affect sea otter foraging, reproduction, or survival." First, we question the relevance of the severity scale developed by Southall et al. (2007) to sea otters. Southall et al. (2007) did not consider the behaviors of sea otters, but only those of cetaceans and pinnipeds, when compiling their behavioral severity scale, which they call "an admittedly simplistic way of scaling the strikingly complex and poorly understood behavioral patterns of marine mammals in real-world conditions." Whereas the behavioral patterns of most wild cetaceans and pinnipeds are indeed poorly understood, sea otter behavioral patterns, and the relevance of these patterns to their survival and reproduction, are very well understood as a result of decades of longitudinal studies following hundreds of tagged individuals (instrumented with radio transmitters and time-depth recorders) throughout much or most of their lifetimes. Many of the behaviors listed by Southall et al. (2007) as indicators of severity—such as cessation of vocal behavior, changes in inter-animal distance, aggressive behaviors in response to sound (tail/flipper slapping, fluke displays, jaw clapping, etc.)—have clear relevance to cetaceans but not to sea otters. Conversely, behavioral changes that are of significance to sea otters because of the energy loss involved, such as being startled from a groomed resting state

	at the surface or while hauled out (dry) and forced to dive (become wet) are not captured in the severity scale. Second, many or most of the observed reactions recorded in ESNERR (2011) were likely responses to airborne noise or visual stimuli; therefore, whatever severity score would best characterize these sea otter responses would not reflect responses to the underwater sound levels under discussion but rather sea otter responses to airborne stimuli. Finally, even including known reactions to airborne stimuli, 70-77% of all observations recorded during vibratory pile driving would correspond to a behavioral severity score of 0 or 1 (no observable response or brief orientation response, such as a head turn). After considering the Commission's comments and reviewing the monitoring data (ESNERR 2011 and ESNERR unpublished data 2018), we reaffirm our statement that "project-related monitoring of sea otter behavior in areas exposed to underwater sound levels ranging from approximately 135–165 dB re 1 μPa during vibratory pile driving (ESNERR 2011) showed no clear pattern of disturbance or avoidance in relation to these levels of underwater sound exposure."
FWS asserted that much of the sound generated by vibratory pile driving is expected to be inaudible or marginally audible to sea otters based on their poor hearing sensitivity below 2 kHz (Ghoul and Reichmuth 2014) and most of the acoustic energy emitted during vibratory pile driving being limited to frequencies below 2 kHz (Dahl et al. 2015). Based on the previous monitoring results discussed herein, sea otters can definitely hear vibratory pile driving. Thus, FWS's assertion that vibratory pile driving sound is inaudible is patently false. The assumption that vibratory pile driving sound would be marginally audible also is refuted by the actual reference	The Commission mischaracterizes our statement. We did not assert that "vibratory pile driving sound is inaudible" to sea otters; we stated, "Most of the acoustic energy generated by vibratory pile driving is limited to frequencies lower than 2 kHz, with greatest pressure spectral densities at frequencies below 1 kHz (Dahl et al. 2015). As a result, much of the noise generated by vibratory pile driving is expected to be inaudible or marginally audible to sea otters." In other words, the greatest pressure spectral densities produced by vibratory pile driving occur at frequencies that are within the sea otter's range of poorest hearing sensitivity or below the lowest frequency (125 Hz) tested by Ghoul and Reichmuth (2014). In contrast, gray whales, on which the 120-dB threshold is based, are among the most sensitive of marine mammals to low-frequency sounds (Finneran 2016). The high critical ratios measured by Ghoul and Reichmuth (2014) for the sea otter relative to other marine carnivores (including California sea lions, harbor seals, and elephant seals) further differentiate sea otters from the other marine mammals to which the 120-dB threshold has been applied. These high critical ratios indicate the sea otter's poor ability to detect low-frequency (<2 kHz) noise when spectrally

provided by FWS to support its claim. Ghoul and Reichmuth (2014) indicated that sea otter hearing sensitivity measured from 125 Hz to 2 kHz ranged from 90 to 116 dB re 1 µPa, which are below 120 dB re 1 µPa. An additional point to note is that the Level B harassment thresholds are all unweighted—that is, sound at 125 Hz and 2 kHz are assumed to be perceived by an animal equally and an animal needs to only hear the greatest sound pressure level in any octave band to respond. Sea otters can hear, and thus respond to, vibratory pile-driving sound down to the 120-dB re 1 µPa threshold.	overlapping background noise is present (as it is in the ocean environment). Although NMFS' Level B harassment thresholds are currently unweighted (NMFS has indicated its intention to review and revise its Level B criteria), it is reasonable to consider all relevant factors in determining whether a threshold should be applied. Southall et al. (2007) note the need for frequency-weighted hearing curves to avoid situations in which "extremely low- and high-frequency sound sources that are detected poorly, if at all, might be subject to unrealistic criteria." In light of sea otters' poor hearing sensitivity at the low frequencies generated during vibratory pile driving, their high critical ratios at these low frequencies, and the behavioral evidence described above, we conclude that it would be unrealistic to apply NMFS' 120-dB threshold for Level B harassment (behavioral disruption) due to non-impulsive underwater noise to sea otters.
FWS estimated the distance to the in-air Level B harassment zone to be greater than the in-water Level B harassment zone (20 vs 14 m, respectively). This defies physics and basic underwater acoustic principles, given that sound is transmitted much more efficiently in water than in air.	We used the modeled extent of airborne sound pressure levels reported in Amec Foster Wheeler (2017). While we noted that the modeled distance to the in-air Level B harassment zone was an overestimate because it was based on larger piles than the 14-in steel pipe piles to be used in the project, we did not verify that the sound source levels used to calculate the distance were correct. In fact, Amec Foster Wheeler (2017) incorrectly reported data from the pile replacement project at Naval Base Kitsap (NAVFAC 2012), which it used to calculate the expected distance to airborne thresholds for the current project. Amec Foster Wheeler (2017) used 15 m instead of 10 m as the distance at which airborne sound levels were measured during vibratory driving of a 24-in pile and incorrectly reported the measured average sound pressure level as 97 instead of 92 dB re 20 µPa root mean square (NAVFAC 2012). Using an average pressure level of 92 dB re 20 µPa at 10 m, we calculate the distance to the in-air Level B harassment zone as 4 m. We have corrected the error in our records. We note that the error does not change our analysis of effects or the size of the Level B harassment zone because it is set based on the greatest extent of sound pressure levels equal to or exceeding the relevant thresholds, which is greatest for underwater noise produced by impact hammering,

The Commission again recommends that FWS use the 120- rather than 160-dB re 1 μPa threshold to estimate extent of the Level B harassment zone and numbers of sea otter takes during vibratory pile driving and removal.	The Service has no approved criteria for determining when Level A or Level B take occurs due to sound exposure in sea otters. Until criteria have been established, we will continue to assign thresholds based on the best available information relevant to the situation at hand. The best available information does not support the application of the 120 dB threshold to sea otters for non-impulsive underwater noise such as that generated during vibratory pile driving and removal.
Given that FWS is one of only two regulatory agencies responsible for authorizing the incidental taking of marine mammals based on the various thresholds, the Commission recommends that FWS take a more active role in the development, review, and implementation of any and all acoustic and behavior thresholds for marine mammal species under its jurisdiction.	The Service continues to evaluate impacts resulting from anthropogenic sound on marine mammals under its jurisdiction using the best available information. We are aware of and supportive of the efforts by NMFS and its Science Centers to develop their Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Acoustic Guidelines. Although the Service provided informal comments on an early version of these guidelines, we did not provide additional comments because the guidance is specific to management of species under the jurisdiction of the Department of Commerce, i.e., "the document does not pertain to marine mammal species under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction (e.g., walrus, polar bears, West Indian manatees, sea otters)." The Service will continue to work with our partners, including the U.S. Geological Survey, to obtain the best scientific information concerning potential effects of anthropogenic sound on these species.