Open Water Peer Review Panel
Monitoring Plan Recommendations Report:
Crowley Proposed Dock Upgrades in Kotzebue, Alaska

The Open Water Peer Review Panel (hereafter, "the panel") discussed and reviewed the marine mammal monitoring and mitigation plan (4MP) submitted by Crowley Fuels, LLC, (the applicant) for its proposed dock upgrades in Kotzebue, Alaska. Panel members answered the questions below set forth by the National Marine Fisheries Service's (NMFS) Office of Protected Resources (OPR) and provide the following recommendations. Answers and recommendations are based on the specific questions that were developed using the general monitoring requirements outlined in the Marine Mammal Protection Act (MMPA) implementing regulations and further guidance provided by OPR, which were included in the instruction document and have been copied into this document below the questions.

Questions

I. Will the applicant's stated objectives effectively further the understanding of the impacts of their activities on marine mammals and otherwise accomplish the goals stated below? If not, how should the objectives be modified to better accomplish the goals below?

The objectives of the 4MP are:

1. To monitor the mitigation zones, to estimate the number of marine mammals exposed to noise at (or exceeding) established thresholds, and to document animal responses and behaviors;
2. To minimize impacts to the marine mammal species present in the project area through implementation of mitigation procedures; and
3. To collect data on takes, occurrence, and behavior of marine mammal species in the project area and record and report any potential impacts from the project.

The panel agreed that these objectives, if achieved, would effectively further the understanding of the impacts of the applicant's activities on marine mammals. However, the panel has serious concerns about whether the objectives can be accomplished with Crowley's proposed methods. Below are additional details about those concerns.

II. Can the applicant achieve the stated objectives based on the methods described in the plan? (Note: in the past, applicants have sometimes submitted a strong monitoring plan that would accomplish a good objective that supports NMFS' goals, but the stated objective has been oddly disassociated from the planned work or badly worded. As you answer

questions I & II – keep in mind if the objective might just needed to be re-worded to better fit the planned work).

The panel reviewed the 4MP and concluded that Crowley cannot fully achieve the stated objectives based on the methods described in the plan.

With respect to objective 1, the panel noted that the Level B harassment zones are too large to be monitored effectively using only visual observations by protected species observers (PSOs). This was acknowledged by Crowley in section 3.2 of the 4MP, which states that, due to the geography of the project area, it does not anticipate that PSOs will be able to observe the entire Level B harassment zone. The applicant's estimated radii for the Level B harassment zones range from 100 m for gravel filling to 3,500-5,200 m for pile installation and removal activities. Crowley estimated that the maximum effective observation distance for the PSOs is 2 km.

The panel determined that even a 2 km sighting distance is unrealistic, especially for seals and small cetaceans. Based on data from vessel-based PSOs operating in the Chukchi Sea, more realistic estimates of effective sighting distance are approximately 200 m for seals and harbor porpoises and 1 km for mysticetes (LGL et al. 2011, Figures 3.28 and 3.44). The effective sighting distance for belugas might be slightly larger than 200 m due to their conspicuous coloration in open water, although during windy conditions with white caps belugas are difficult to see (DeMaster et al. 2001). Crowley's final report regarding the distances to observed marine mammals should help provide better information on detection probabilities for land-based PSOs.

Although the charge to the panel was to review the measures outlined in the applicant's 4MP, the panel also reviewed the basis for estimating takes by Level B harassment, as discussed in section 6 and summarized in Table 9 of Crowley's application for an Incidental Harassment Authorization (IHA). Comments and recommendations regarding Crowley's approach are included as an addendum to this report.

Estimating Actual Takes

To account for unobserved takes, the applicant proposed in its 4MP to provide an estimate of the actual number of marine mammals taken using "an extrapolation of the estimated takes by Level B harassment based on the number of observed exposures within the Level B harassment zone and the percentage of the Level B harassment zone that was not visible." However, further details regarding the extrapolation method to be used were not included in the applicant's 4MP. More information is needed to evaluate whether the extrapolation method is a reasonable approach.

The panel noted that the probability of detecting an animal within visible range depends on the distance between the PSO and the animal, the animal's time at the surface, the animal's dive time, and possibly additional variables that affect visibility, such as Beaufort Sea State, precipitation, fog, and glare. When the assumption holds that the distribution of animals is uniform, distance sampling methods (Burt et al. 2014) can be used to reliably estimate the effects of distance and other variables on detection probability, allowing estimation of effective sighting distance. Combining effective sighting distance with an estimate of the probability that an animal will be at the surface and available to be seen by the PSO will result in an estimate of the actual number of animals (or animal density) within visible range. If animal density is constant throughout the entire Level B harassment zone (i.e., within and outside of visible range), it is simple to extrapolate animal density within visible range to estimate the total number of animals exposed within the entire Level B harassment zone.

Unfortunately, the situation is considerably more complicated for the Kotzebue dock monitoring project. First, the assumption of uniform animal density both within visible range and outside of visible range but within the Level B harassment zone is not likely to hold. The bathymetry within the project area is complicated and comprised of channels and shoals. Thus, the panel made the assumption, because of the bathymetry and based on personal observations of the project area, that the distribution and density of undisturbed marine mammals in the operation area would not be uniform. No alternative information on fine-scale marine mammal densities within the Level B zone was provided by Crowley in their application, and the panel acknowledged that information on marine mammal densities in Kotzebue Sound are lacking. Additionally, the sound and disturbance associated with the fuel dock upgrade activities will decrease with increasing distance from the construction site. If animals are attracted to the construction activities, there will be a higher animal density near the construction site and the shore-based PSOs. If animals are displaced by construction activities, there will be a lower animal density nearshore. In this situation, where the effects of diminishing detection probability due to distance are confounded with gradients in habitat and disturbance, distance sampling methods alone cannot be used to derive an accurate estimate of animal density or abundance in the activity area.

To properly estimate actual take, it is necessary to either know the true density distribution of animals in the Level B harassment zone or to use mark-recapture methods (Burt et al. 2014). Although it is theoretically possible to analyze data from multiple PSOs in a mark-recapture framework, it is practically very difficult to determine which sightings are matches between observers; therefore, the panel does not recommend this approach. Alternatively, it is possible to combine data from passive acoustic monitoring (PAM) with that from visual observers in a mark-recapture analysis, but, again, it is challenging to identify matches between the acoustic and visual platforms.

With respect to objective 2, the applicant proposed to delay or cease pile driving activities if a marine mammal approaches or enters the Level A harassment zone (i.e., within 10 m of the proposed pile driving activities). The panel noted that monitoring a 10-m exclusion zone is realistic and achievable, and therefore should prevent Level A harassment of marine mammals. No specific mitigation measures were proposed to minimize takes by Level B harassment. Additional measures to avoid or minimize overall impacts from other project activities were included as best management practices in section 3.6 of the 4MP.

With respect to objective 3, the applicant will be able to collect only limited and incomplete information on actual takes or exposures by Level B harassment. Collection of data on occurrence and behavior of marine mammal species by PSOs in the project area will also be limited and any data collected should not be considered baseline information because it would be collected coincident with disturbance from the construction activities.

III. Are there technical modifications to the proposed monitoring techniques and methodologies proposed by the applicant that should be considered to better accomplish the objectives?

The panel **recommends** the following technical modifications to the proposed monitoring techniques and methodologies to better accomplish the stated objectives:

1. To better understand the potential impacts of the proposed pile driving activities on marine mammals and the spatial variability in animal density throughout the Level B harassment zone, PSO observations (and the PAM recommended in IV below) should occur 2-3 weeks before operations commence; during the entire operation season, including days on which construction activities do not occur; and 2-3 weeks after construction activities end for the season.
2. PSOs should focus on scanning the shoreline and water, alternating scanning by naked eye and using binoculars, to detect as many animals as possible rather than following individual animals for any length of time to collect detailed behavioral information.
3. The PSOs should be stationed on elevated platforms, if possible, to increase sighting distance. Specially-constructed observation scaffolding towers or use of existing structures (e.g., rooftops) should be considered.
4. The position for Observer 3 should be moved to the vicinity of the Nullaġvik Hotel to achieve better coverage of the operations and avoid a gap in visual coverage between Observer 1 and 3 due to the shoreline configuration. The roof of the hotel would make an excellent observation platform, if feasible.
5. PSOs should record visibility conditions at regular intervals and as they change throughout the day. Laser range finders might reliably accomplish this. Alternatively, a series of “landmarks” at varying distances from each observer could be identified, measured on the ground once before operations begin, and referenced throughout the season to record visibility. The landmarks could be buildings, signs, or other stationary objects on land that are located at increasing distances from each observation platform. At regular intervals (e.g., every 5 minutes) or whenever conditions change, each observer should record visibility according to the *farthest* landmark the laser range finder can detect or the PSO can clearly see.
6. The following clarifications need to be made to Appendix B:
    a. There are two codes for whale that need species details: GRWL (presumably gray whale) and KLWL (presumably killer whale);
    b. The “Other” species code should distinguish between “other otariid”, “other phocid”, “other baleen whale”, “other large cetacean”, and “other small cetacean”;
    c. The code for vibratory pile driving (V) should distinguish between installation and extraction;
    d. There are codes for impulse pile driving, dead pull, stabbing, and drilling, none of which are authorized under this project;
    e. There is a code for “bubble curtain” that has not been proposed for use by this project;
    f. Wave Height codes are too broad; should use 0-1, 1-2, 2-3, >3 ft instead, assuming significant lack of sighting ability with wave heights >3 ft;

    g. Construction codes SSV and SSI on observation form are not defined;
    h. Mitigation code SS not defined.
7. A designated person who is on site and associated with the applicant's pile driving operations should keep an activity log to record the precise start and stop dates and times of each type of operation mode.

IV. Are there techniques not proposed by the applicant (i.e., additional monitoring techniques or methodologies) that should be considered for inclusion in the applicant's monitoring program to better accomplish the objectives?

NOTE: Mention of trade names or commercial products does constitute endorsement or recommendation for use.

Passive Acoustic Monitoring

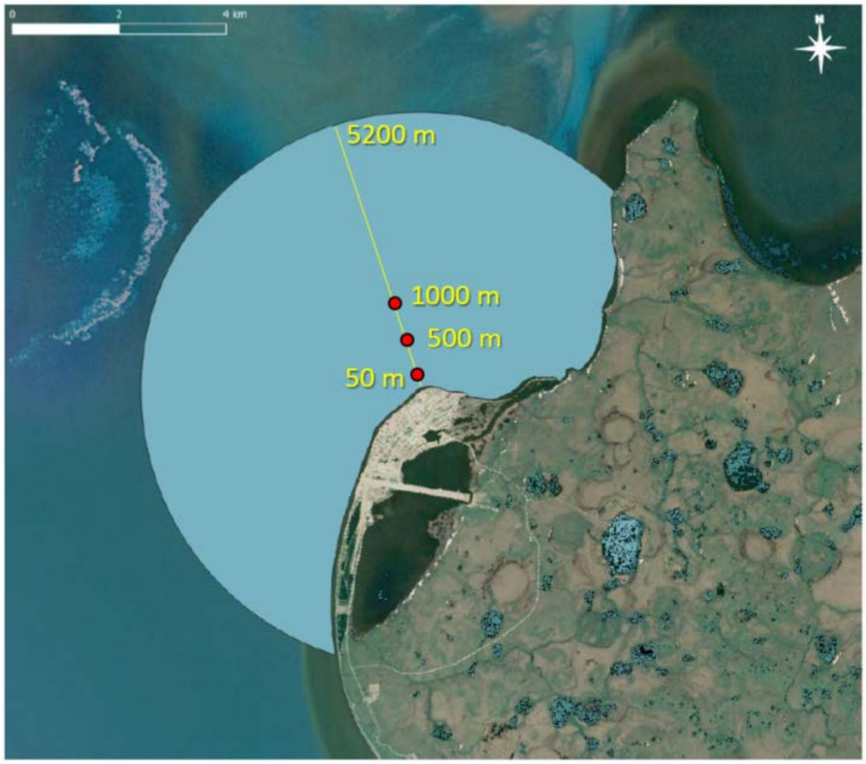
Real-time PAM technology is readily available and could provide many benefits to this project. Examples are the CAB system by SMRU Ltd. and the Observer buoy by JASCO. First, it would improve detection of marine mammals in the portion of the Level B harassment zones where visual detection probability is reduced or zero, thereby providing data to estimate the number of takes by Level B harassment in the far field of the Level B harassment zone. Second, PAM could be used to record received sound levels in the far field and calculate propagation loss, which could be used to back calculate source levels and verify if the predicted isopleth distances used correct source levels and propagation loss.

If real-time PAM is used, it is important that acoustic detections remain independent from PSO observations. Using real-time PAM to guide PSOs to sightings would bias the distance sampling estimate of density if it were not incorporated into the detection function model as a cue. Notification by PAM that an object is in the area likely affects PSO detection probability because a PSO who is warned of an incoming animal would likely detect it farther than if they were not warned. This effect on detectability would bias the effective visibility range for the PSO to be larger than it is in reality (i.e., without notification by PAM). The effective visibility range is in the denominator of the distance sampling density estimator, so the resulting take estimate would be biased low.

Several real-time PAM systems are currently commercially available for leasing. Some involve onboard processing which allows non-specialized users to be able to deploy and interpret data collected using this technology. Some real-time PAM buoys are small, with anchors weighing ~100 lbs, allowing deployment/retrieval operations with just two people in a small raft. Transmission of detections is made via wireless technology (as well as cell phone or satellite channel if needed) to a receiving station that can report simple alerts of detections or more complex data. These systems are calibrated and can be configured to report received levels in different metrics (SEL, SPL, peak, etc.). In general, all data can be archived for further post-processing. The Level B harassment zones proposed by the applicant can be easily covered by wireless technology with an omnidirectional antenna at the buoy and a directional antenna in a mast at the observer's station. For example, a 900 MHz radio system on a base station at 30 feet above water can effectively transmit to 4 km. Using directional or dish antennae, transmission can exceed 10 km. Buoys can be deployed for ~2 weeks before batteries need to be replaced or charged. As a rough reference, the cost of these real-time buoys range in the order of $6-10k per month per buoy. Implementation of real-time PAM would involve a field technician go to the site and spend a few days helping with initial setup and basic training, but they would not be required to be present for the entire operation.

The panel **recommends** using a minimum of two, and preferably three, real-time PAM buoys, to obtain optimal coverage of the Level B harassment zones. Two different deployment configurations are provided for consideration by the applicant.

1) Sound source verification: At the start of pile installation for each pile type or dimension, the two (or three) units should be deployed in a line perpendicular to shore from the pile driver location. The simplest approach would be to follow a near, medium, and far approach with equidistant mooring distances. For example, the first could be deployed in the near field, at 10 to 50 m from the pile, with the second unit deployed at a farther distance, such as 1,000 m from the pile. If a third buoy is available, this should be placed at a medium distance, such as 500 m, providing received levels at 2 to 3 different distances (Fig. 1). Alternatively, a potentially superior placement of moorings would be achieved following a logarithmic approach to deployment, where distance between moorings represent values that are in an equal ratio, for example 10, 100, 1000 m from the pile driver, as the results will likely provide a better fitting for an exponential regression curve to calculate propagation loss. Distances should be discussed with the manufacturer of the PAM system to make sure the dynamic range and system gain is appropriate for this task (i.e., they might want a lower gain for the closer buoys, and higher gain for the farther units). This configuration should be maintained for at least 60 minutes of noise producing activity, to allow calculating median values from a representative time series. For example, after 1 hour of pile driving, the buoys at 50 and 500 m (or 10 and 100 m for the logarithmic approach) can be moved from their locations to another farther away, closer to the edge of the Level B harassment zone, to start the monitoring configuration.



5200 Monitoring Zone

Figure 1: Example of the recommended configuration of the PAM buoys for sound source verification. Three PAM buoys (red dots) would be placed at different distances in line from the pile driver. At least one near-field buoy and one far-field buoy would be required to calculate propagation loss, but a third middle sampling point would increase accuracy.

2) Detection of marine mammals in the far field: This monitoring configuration is designed to maximize detection of marine mammals entering the Level B harassment zone, in those portions of the zone too far for observers to see. Ideally, the two (or preferably three) buoys should be placed at equidistant intervals from each other to maximize and homogeneously distribute coverage, and all at the same distance to the edge of the Level B harassment zone. In order to assume that each acoustic detection is a take, the acoustic detection range from the target marine mammal species should be considered (see Table 1), and that range should be used to place the buoys inside the Level B harassment zone at that specific distance from the edge of the Level B harassment zone. For example, if the detection range for beluga whale vocalizations is estimated to be 3.3 km, all buoys should be placed 3.3 km from the offshore border of the Level B harassment zone (Figure 2). For multiple species, the panel recommends using the farthest detection range for buoy placement.

   If the detection range is larger than the Level B harassment zone, this approach cannot assume each detection yields a take as the calling animal can easily be outside the take zone. Thus, in this case an alternative method could be to use the received level of the call, and only assume it is a take if the level exceeds a threshold. This threshold should reflect the propagation loss equivalent to the distance from the mooring to the Level B harassmnet zone border.

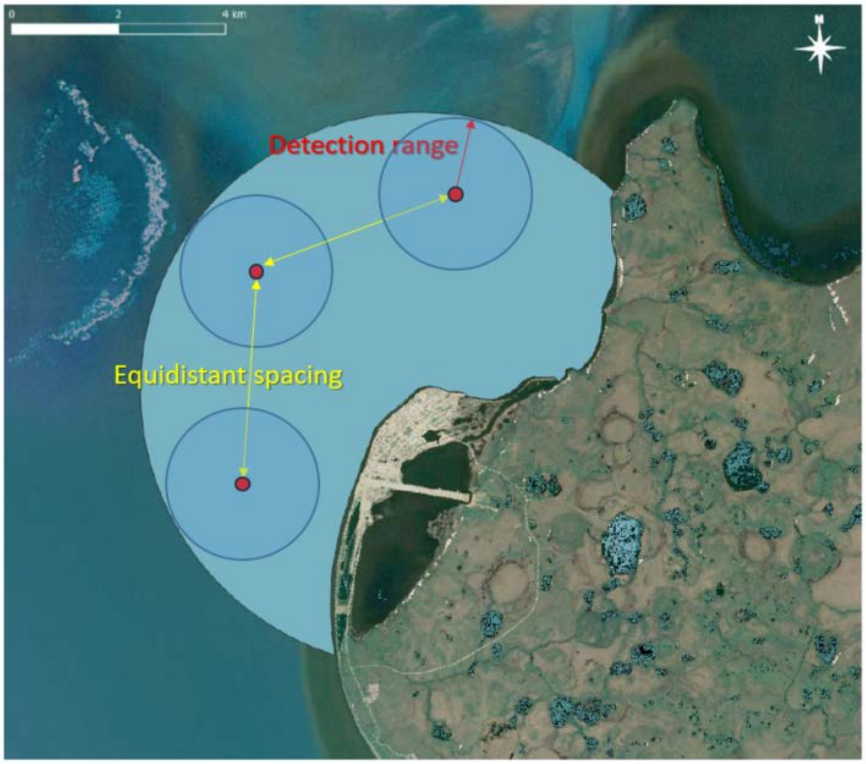
For example, consider that moorings are placed at 860 m from the border of the Level B harassment zone for beluga whales. The propagation loss for 860 m is 44 dB; thus any bearded seal trill (assumed to be emitted at 155 dB; Table 1) exceeding 111 dB should be considered a take.

Table 1: Suggested approach to obtain detection distances for marine mammal species most likely to be in the operation area. The source level of their vocalizations (from Miller 2006 for killer whale, Lebot 2016 for beluga, Matthews et al. 2017 for harbor seal, Villadsgaard et al. 2007 for harbor porpoise, and Fournet et al. 2019 for bearded seal) are used to calculate the distance at which received levels drop to ambient noise levels and thus are no longer detectable. This table assumes a generic ambient noise of 100 RMS dB and practical spreading (except as noted below). These suggested distances should be corrected with the appropriate ambient noise level and propagation loss obtained when real-time acoustic buoys are deployed.

Species	Source Level (RMS dB)	Detection range (m)
Harbor porpoise*	180	400
Beluga whale	144	860
Harbor seal	144	860
Killer whale (average for whistles and calls)	146	1,170
Bearded seal♦	155	4,650

*Due to the narrowband high frequency nature of the 130-140 kHz clicks of porpoises, practical spreading is not applicable; detection range is based on cited reference.
♦Median value of the source level for bearded seal trills (Fournet et al. 2019).

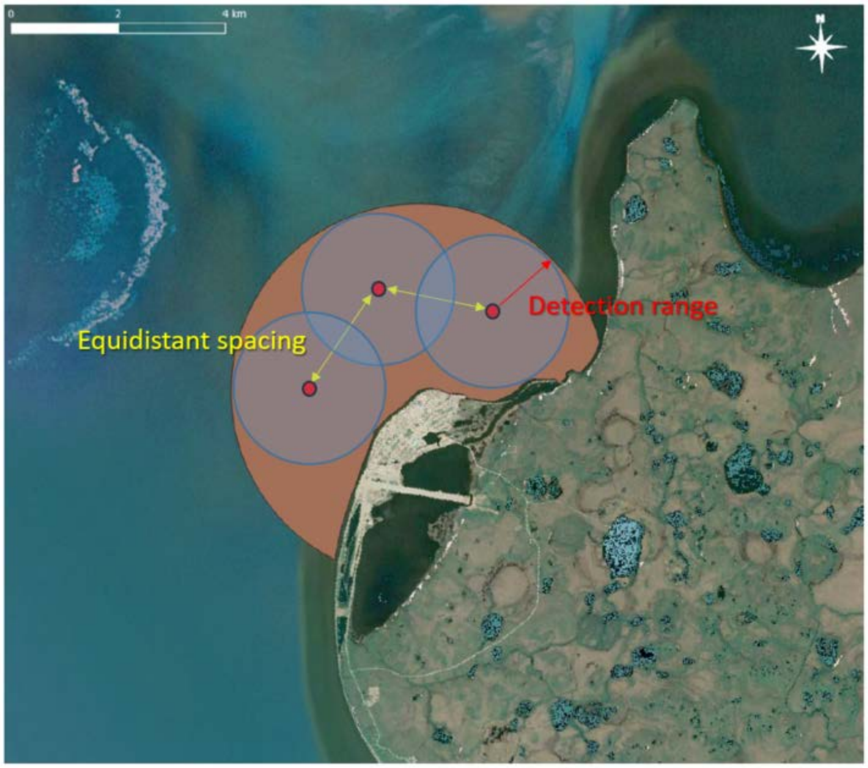
One caution is that practical spreading might not be the best approach to estimate propagation loss for these types of signals. For example, beluga whales in Cook Inlet have a maximum range of 3.3 km for calls and whistles, and a maximum range of 900 m for echolocation (Lammers et al. 2013, Castellote et al. 2016). These distances differ substantially from what is listed in Table 1. Thus, these detection ranges should be properly calculated with the actual results for propagation loss and ambient noise levels in the area.



5200 Monitoring Zone

Figure 2: Example of buoy configuration to monitor for marine mammals using real-time PAM. Three moorings (red dots) placed at equidistant intervals from each other, and with their respective detection ranges of ~3.3 km (blue areas) corresponding to their distance to the edge of the 5,200 m Level B zone.

The monitoring configuration should be revised for every change in Level B harassment zone. For example, if the activity switches from a 5,200 m (vibrating sheer piles) to a 3,500 m Level B harassment zone (temporary template pile), the buoys should be moved to their respective new locations closer to the piling activity to maintain their distances to the edge of the newer and smaller Level B harassment zone (Fig 3).



3500 Monitoring Zone

Figure 3: Example of monitoring configuration for real-time PAM. Three moorings (red dots) placed at equidistant intervals from each other, and with their respective detection ranges of ~3.3 km (blue areas) corresponding to their distance to the edge of the 3,500 m Level B harassment zone.

An alternative to real-time PAM would be to use archival bottom mounted recorders instead of real-time units. However, these would not allow for in-season tally of exposures or relocation, as they do not typically contain a surface buoy to reduce self-noise. Also, data can only be accessed after recovery, thus missing the benefit of sound source verification at the start of installation of each pile type and real-time detections of marine mammals.

<u>Estimating Actual Take</u>

The panel **recommends** the following modification to the methods for estimating actual takes by Level B harassment. To estimate takes by Level B harassment within the effective visual range of the PSOs, the panel encourages the use of distance sampling methods (Burt et al. 2014) to correct for animals that may not be detected or detectable by PSOs, in spite of the concerns listed above about violating assumptions underlying the analytical methods.

To estimate takes by Level B harassment outside of the effective visual range of the PSOs, the panel recommends that the following two methods both be used and the results compared and reported to NMFS. First, as proposed in the original IHA application and 4MP, assume that animal density is uniform throughout the Level B harassment zone and use distance sampling methods (Burt et al. 2014) based only on the shore-based PSOs to estimate actual takes by Level B harassment for the entire Level B harassment zone.

Second, use real-time passive acoustic monitoring (PAM) to estimate takes by Level B harassment only in the far field. For simplicity, each acoustic detection that occurs during pile driving or removal should be considered a take by Level B harassment, despite uncertainties as to whether a single acoustic detection is equivalent to a take. Add the estimated takes derived from applying distance sampling to the PSO data for the near field to the estimated takes derived from PAM for the far field in order to get a total estimate of takes. Variability in marine mammal group size and the fact that PAM detects only animals that are making sounds within the detection range of the recording instrument would tend to result in underestimates of number of takes by Level B harassment. In contrast, if a single marine mammal is detected multiple times within the Level B harassment zone, takes by Level B harassment would be overestimated. The magnitude and direction of the overall bias from these factors is unknown. Nevertheless, the panel believes that this method may provide a reasonable estimate of actual takes by Level B harassment for the area beyond the effective visual range of PSOs.

Regardless of the degree of similarity between the two estimates of take by Level B harassment for the far field, both estimates should be reported to NMFS.

Sound Attenuation Devices

Due to the limited visible range of the land-based PSOs and the inability of PAM to estimate group size and detect silent animals, the applicant should consider deployment of one or more sound attenuation devices to decrease the size of the Level B harassment zone. The deployment of sound attenuation devices has become standard practice during pile driving in the marine environment to minimize disturbance of marine mammals, fish, and other marine wildlife. As such, the deployment of sound attenuation devices would more effectively address objective 2—minimizing impacts to marine mammal species present in the project area. Examples of sound attenuation devices to consider include bubble curtains, noise mitigation screens, and hydro sound dampers (nets with air-filled or foam-filled elastic balloons) (Bellman 2014; Elmer and Savery 2014). The panel **recommends** that Crowley consider deploying some type of sound attenuation device to minimize the potential for takes by Level B harassment, as this would also reduce the uncertainty in takes for distances exceeding the PSO capacity.

V. What is the best way for an applicant to present their data and results (formatting, metrics, graphics, etc.) in the required reports that are to be submitted to NMFS (i.e., 90-day report and comprehensive report)?

The panel **recommends** that the applicant provide tables or figures summarizing the following:

a. Total number of hours during which each construction activity type occurred;
b. Total number of hours that PSOs were on watch during each construction activity type;
c. Total number of hours that PSOs were on watch during periods of no construction activity;

d. Number of hours of observation that occurred during various visibility and sea state conditions;
e. Number of animals sighted, by species and operation mode (including no activity periods as the “undisturbed” condition);
f. Number of acoustic detections, by species and operation mode (including no activity periods as the “undisturbed” condition);
g. Elevation of observers above sea level;
h. Histograms of perpendicular distances to PSO sightings, by species (or species group, if sample sizes are small);
i. Maps showing visual and acoustic detections by species and construction activity type.
j. Obtained calculations of received levels in metrics applicable to the NOAA Acoustic Guidelines (dB RMS, dBpeak, SEL 24h), propagation loss results, isopleth distances, and estimated source levels.
k. Sighting and acoustic detection rates summarized into daily or weekly periods for the before, during, and after construction periods, if available.

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Additional Comments regarding the applicant's take estimates

Although the charge to the panel was to review the measures outlined in the applicant's 4MP, we also reviewed the basis for estimating takes by Level B harassment, as discussed in section 6 and summarized in Table 9 of the application. The applicant provided an estimate of takes by Level B harassment in Table 9 of its incidental harassment authorization (IHA) application. The applicant stated that its requested takes are based on the estimated abundance of marine mammals in the project area, the estimated area of ensonification for each of the proposed activities, and the duration of those activities. The panel offers the following comments and recommendations.

1. The 'estimated rate of take (per day)' in Table 9 of the application is not used consistently for seals vs. cetaceans. For seals, the estimated rate of take (per day) appears to be the same as species density, which is then multiplied by the areas of impact and the days of construction to derive total takes. For cetaceans, the estimated rate of take (per day) does not refer to species density. Instead it is a daily take rate, regardless of the area of impact, and is multiplied directly by the days of construction to derive total takes. NMFS generally requires that applicants specify and use the same three metrics for estimating total takes: species density, ensonified area (per day), and days of activity. In cases where densities are not available or are outdated, alternate metrics may be more appropriate but should be fully explained and documented in the application, and reference to what those alternative metrics represent should be clarified. Accordingly, Table 9 should be revised to clarify which metrics are being used to estimate takes for each species.

2. As noted above, the estimated total takes of cetaceans by Level B harassment were based on sightings data, rather than density estimates. Although NMFS typically requires IHA applications to use species densities to estimate total takes, in this case the panel agreed that densities are not available for cetaceans in the Kotzebue Sound area and alternate metrics may be more appropriate.

3. The applicant references outdated sightings data for some cetacean species that do not reflect best available science. For example, the applicant requested authorization to take up 100 beluga whales by Level B harassment per day, for a total take of 12,300 beluga whales. That daily rate of take was based on outdated sightings data (Frost et al. 1983) which are no longer representative of the abundance of beluga whales in the Kotzebue area. The number of beluga whales in Kotzebue Sound has declined considerably since the mid-1980s (Frost and Lowry 1990; ABWC 2008) and now may number less than 50 animals per year. The panel recommends that the applicant revise its predicted take of beluga whales based on a more current estimate of the number of beluga whales in Kotzebue Sound during the project's proposed operating period. Based on more recent sightings data, the panel **recommends** that Crowley's estimated take of beluga whales by Level B harassment be revised. Crowley should consult with NMFS OPR to further discuss this issue but the panel thinks that 200 beluga whales might be a reasonable take request.

Monitoring Plan Requirements

The MMPA implementing regulations generally indicate that each Incidental Harassment Authorization (IHA) applicant's monitoring program should be designed to accomplish one or more of the following: document the effects of the activity (including acoustic) on marine mammals; document or estimate the actual level of take as a result of the activity (in this case, seismic surveys or exploratory drilling programs); increase the knowledge of the affected species; or increase knowledge of the anticipated impacts on marine mammal populations. As additional specific guidance beyond that provided in the MMPA regulations, NMFS further recommends that monitoring measures prescribed in MMPA authorizations should be designed to *accomplish or contribute to one or more of the following top-level goals*:

(a) An increase in our understanding of the likely occurrence of marine mammal species in the vicinity of the action, i.e., presence, abundance, distribution, and/or density of species.

(b) An increase in our understanding of the nature, scope, or context of the likely exposure of marine mammal species to any of the potential stressor(s) associated with the action (e.g., sound, explosive detonation, or expended materials), through better understanding of one or more of the following: 1) the action itself and its environment (e.g., sound source characterization, propagation, and ambient noise levels); 2) the affected species (e.g., life history or dive patterns); 3) the likely co-occurrence of marine mammal species with the action (in whole or part) associated with specific adverse effects, and/or; 4) the likely biological or behavioral context of exposure to the stressor for the marine mammal (e.g., age class of exposed animals or known pupping, calving or feeding areas).

(c) An increase in our understanding of how individual marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level).

(d) An increase in our understanding of how anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: 1) the long-term fitness and survival of an individual; or 2) the population, species, or stock (e.g., through effects on annual rates of recruitment or survival).

(e) An increase in our understanding of the effectiveness of mitigation and monitoring measures.

(f) A better understanding and record of the manner in which the authorized entity complies with the incidental take authorization and incidental take statement.

(g) An increase in the probability of detecting marine mammals (through improved technology or methodology), both specifically within the exclusion zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals.