# Memorandum

**Project No. 4628-02**
**Task 1-4: Special Studies & Site Surveys**

**May 31, 2023**

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**Subject:** **Pile Removal and Driving Sound Assessment**

This memo provides a preliminary assessment of challenges and solutions related to pile removal/driving generated underwater noise for the Humboldt Bay Offshore Wind Heavy Lift Marine Terminal Project (Project). The following assessment focuses on biological impacts of sound from pile removal/driving on sensitive wildlife underwater rather than impacts to humans and terrestrial species. Potential impacts from sound depend on: (1) sound frequency relative to the hearing frequency range of the animal and (2) sound source intensity, energy, type (e.g., impulsive versus non-impulsive) and duration received by an animal. Exposure to anthropogenic sound can constitute a large area based on the frequency, duration, and magnitude of sound produced and the fact that sound travels far underwater. Further analysis and strategizing to evaluate feasibility of minimization measures will be required after technical details of pile removal/driving (e.g., the number and size of required piles, and methods of pile driving) are determined.

## General Specifications

The final Project specifications are still being determined and will be available at a later date in a detailed Project Description. The Project anticipates using 36 inch diameter steel pipes with 1 inch wall thickness. These steel piles may be driven to depths between 40 and 155 feet. Each wharf (and the pier) will likely require different numbers of new piles. Preliminary specifications suggest there may be up to 1,700 individual steel piles for an individual wharf.

## Birds

Pile removal/driving could result in sound that disturbs special status birds in the Project area. The significance of acoustic disturbance will depend on many factors such as the type, magnitude and duration of sound, proximity of birds and their habitats to sound sources, and the levels of background ambient sound. The

primary impact would be on bird behavior. For example, above water sound may disturb roosting, nesting, or foraging birds and cause them to flush from the area. Also, underwater sounds could disturb foraging behavior or disturb prey that water birds forage on, or result in auditory and non-auditory injury for species such as marbled murrelet (SAIC 2011). Special status land and shorebird bird species that could be affected by pile removal/driving generated underwater sound from the Project include the following:

| Species | Status |
|---|---|
| Marbled murrelet (*Brachyramphus marmoratus*) | FESA Threatened, CESA Endangered |
| Western snowy plover (*Charadrius nivosus nivosus*) | FESA Endangered |
| California brown pelican (*Pelecanus occidentalis californicus*) | CDFW Fully Protected |
| American peregrine falcon (*Falco peregrinus anatum)* | CDFW Fully Protected, CDFW Wait List |
| Bald eagle (*Haliaeetus leucocephalus*) | CDFW Fully Protected |
| Black brant (*Branta bernicula nigricans*) | California Species of Special Concern |
| Osprey (*Pandion haliaetus*) | CDFW Waitlist |
| Double-crested cormorant (*Phalacrocorax auritus*) | CDFW Wait List |

FESA = Federal Endangered Species Act; CESA = CA Endangered Species Act; CDFW = CA Department of Fish and Wildlife

There is not a clear threshold of sound levels that will result in behavioral effects for most bird species. However, for marbled murrelet, guidelines for a threshold for underwater sound (from activities such as pile driving) that results in behavioral effects such as flushing and avoidance is 150 dB root-mean-square pressure (USFWS 2014), and for auditory injury is 202 dB SEL (SAIC 2011).

## Marine Mammals

Marine mammals generate sound (e.g., vocalizations) and use sound for various biological functions, including social interactions, foraging, orientation, and predator detection. Cetaceans in particular have highly developed acoustic abilities and can detect underwater sounds at great distances. The following five marine mammals that can occur in Humboldt Bay could be affected by pile removal/driving generated sound from the Project:

| Species | Status |
|---|---|
| Steller sea lion (*Eumetopias jubatus*) | MMPA Protected |
| Pacific harbor seal (*Phoca vitulina richardii*) | MMPA Protected |
| California sea lion (*Zalophus californianus*) | MMPA Protected |
| Harbor porpoise (*Phocoena phocoena*) | MMPA Protected |
| Orca (*Orcinus orca*) | MMPA Protected, FESA Endangered |

MMPA = Marine Mammal Protection Act; FESA = Federal Endangered Species Act

Anthropogenic sound sources, especially at higher sound pressure levels (e.g., >150 decibels [dB]), can cause behavior modifications that may reduce long-term growth and survival (NMFS 2018). Interference with producing or receiving sounds could have adverse consequences on individuals, including impaired foraging

efficiency from masking (occurs when environmental noise is great enough to cover or mask other sounds including those used for communications between individuals or for locating prey), altered movement of prey (due to avoidance of sound sources by prey), difficulty detecting prey, increased energetic expenditures, and temporary or permanent hearing threshold shifts due to chronic stress from noise (Southall et al. 2019, 2021).

Detailed technical guidelines for assessing the effects of underwater noise on marine mammals (NMFS 2018) and a summary document outlining current marine mammal acoustic thresholds (NMFS 2023) are key references for identifying effects of acoustic stressors on marine mammals.

## Fish

Pile removal/driving may result in sound pressure, particle motion, and vibration that have effects on fish (Hawkins et al. 2020). Exposure of fish to underwater sound (generally) can result in physical, physiological or behavioral effects (Hawkins et al. 2020, Molnar et al. 2020). The following special status fish may be affected by pile removal/driving generated underwater sound from the Project:

| Species | Status |
|---|---|
| Southern DPS of green sturgeon (*Acipenser medirostris*) | FESA Threatened |
| Longfin smelt (*Spirinchus thaleichthys*) | FESA Candidate; CESA Threatened |
| Pacific lamprey (*Entosphenus tridentatus*) | California Species of Special Concern |
| Coho salmon (*Oncorhynchus kisutch*) Southern Oregon-Northern Coastal California ESU | FESA Threatened; CESA Threatened |
| Northern California steelhead (*Oncorhynchus mykiss irideus*) DPS | FESA Threatened |
| California coastal Chinook salmon (*Oncorhynchus tshawytscha*) ESU | FESA Threatened |
| Coastal cutthroat trout (*Oncorhynchus clarkii clarkii*) | California Species of Special Concern |

FESA = Federal Endangered Species Act; CESA = CA Endangered Species Act; DPS = Distinct Population Segment; ESU = Evolutionarily Significant Unit

The type of acoustic effect is determined by whether the sound is from a long-term accumulation of increased sound, or an acute, singular event. Acute events above a certain sound threshold may result in physical injury: physical injury and impacts to fish are primarily related to effects of sound pressure levels on species with swim bladders (Hawkins et al. 2020). Tissue damage from underwater sound may occur when sound passes through muscle into a gas void (e.g., swim bladder), since gas is more compressible. When exposed to sound pressure, gas in the swim bladder may expand more than the surrounding tissue and may contract during periods of overpressure. This expansion and contraction may result in swim bladder tissue damage and even a ruptured swim bladder (page [p.] 3-4 *in* Molnar et al. 2020). These physical injuries have short or long-term effects, depending on whether the individual fish can recover. Salmon have ducted swim bladders connected to the esophagus via a thin tube, thus allowing them to expel air from their swim bladder and out of the mouth (p. 3-

3 *in* Molnar et al. 2020). Their swim bladders are more distant from the ear and are more sensitive to particle motion, which may protect them from acute sound events (Hawkins et al. 2020).

Physiological impacts on fish from sound include changes in stress levels and metabolism, and reduced energy reserves, which may negatively impair their key life functions. Behavioral responses and physiological effects are most detrimental if fishes become more exposed to predators, are displaced from feeding or spawning grounds, and disrupted during migration or during communication between individuals (Hawkins et al. 2020).

Impacts to fish populations are only experienced when effects lead to a loss of key life function and a reduction in individual fitness. Sound mechanisms such as pile removal/driving during the construction phase of the Project are highly localized and do not necessarily affect an entire population (Mortenson et al. 2021), and adult fish disturbed by sound during construction can temporarily relocate elsewhere in Humboldt Bay.

## Impact Minimization Measures

As described below, temporal avoidance and measures that minimize sound are the primary mechanisms to reduce biological sound impacts from pile driving.

### Temporal Avoidance

To minimize sound impacts, the ideal work window for land birds is November through April. This is similar to the ideal work window for marine mammals, December through March. However, the ideal work window for salmonids is May/June through September. The conflicting work windows between birds and marine mammals, and salmonids make it impossible to minimize impacts to each group through seasonal work restrictions. Typically, the in-water work window for salmonids is followed; however, green sturgeon are present in Humboldt Bay June-October, and longfin smelt may be present in Humboldt Bay year-round. This is because the potential impacts to fish species (including FESA and CESA listed species) may be less avoidable than to birds and marine mammals, which can be monitored for presence and if present, pile driving operations can be adjusted to avoid impacts. Additionally, by operating only from May/June through September, impacts to salmonids can often be fully avoided.

**Ideal Work Windows for Pile Driving:**

| | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Land birds** | | | | | | | | | | | | |
| **Marine Mammals** | | | | | | | | | | | | |
| **Salmonids** | | | | | | | | | | | | |

### Sound Level Minimization

There are several different ways to minimize underwater noise from pile driving. These include reducing the noise at its source, absorbing it, or breaking its transmission path (Wochner 2019). The following measures are commonly used to reduce sound levels of pile removal/driving and should be considered for the Project:

- Use vibratory rather than impact pile installation methods to the extent feasible. Vibratory methods produce non-impulsive sound of less pressure compared to impulsive sound from pile driving and can be used for certain soil types. This is a way to reduce noise from the source. The feasibility of pile driving methods will be determined through geotechnical surveys and cost analyses.
- Use bubble curtains to minimize sound levels and break the transmission path of noise. Confining the bubble curtains within a casing (typically plastic or metal) may be beneficial at the Project site due to strong tidal currents.
- Use gas contained within coiled fire lines or balloons attached to nets to dampen sound. This is another method to break the transmission path of noise.
- Use double-walled piles that provide an air space between an inner and outer pile to break transmission path of noise while the inner pile is being driven.
- Install coffer dams, typically constructed with sheet piles or water bladders, within discrete areas while pile installation occurs to break the transmission path of noise.

The use of sound minimization measures that reduce noise by breaking its transmission path (e.g., bubble curtains, gas, and coffer dams) should be evaluated as a next step. Bellmann (2014) and WSDOT (2020) provide useful background information on various noise mitigation systems. The feasibility of methods likely depends on operational constraints and cost: the trade-off between cost of sound minimization method and time to complete pile driving activities will need to be considered. The diameter of the pile and blow energy used during pile driving will be factors to consider as well.

## Regulatory Approvals and Next Steps

The Project will require numerous regulatory approvals with specific agency consultations. A marine mammal and fisheries monitoring plan will also likely be required for compliance with federal and state environmental regulations. These consultations and analyses are intended to identify potential effects of the Project, evaluate feasibility and identify minimization measures. The following permitting efforts will be required to address underwater sound impacts after technical details of pile removal/driving (see next section) are determined:

- Detailed project description that incorporates the information presented in the following section of this document.
- Review the marine geotechnical survey results that were conducted to identify the feasibility of different pile driving methods, and collect additional geotechnical data as needed. No species-specific surveys are needed at this time and are not expected to be nrecessary.

- Federal Endangered Species Act listed fish, marine mammals and birds may be impacted. This will be assessed through an endangered species act Section 7 consultation between the U.S. Army Corps of Engineers (Army Corps) and the National Marine Fisheries Service (NMFS; with jurisdiction over listed fishes and marine mammals) and U.S. Fish and Wildlife Service (USFWS; jurisdiction over listed birds). It will culminate in a biological opinion with an incidental take statement covering. NMFS and USFWS will likely have recommendations that may be required by the Army Corps for cumulative sound limits.

- The California Endangered Species Act (CESA) listed longfin smelt and marbled murrelet may be impacted and a CESA Section 2081(b) incidental take permit from the CA Department of Fish and Wildlife may be required. Under CESA, take from underwater sound must be fully mitigated and therefore compensatory mitigation such as habitat restoration could be required.

- Marine mammal impacts may require an Incidental Harassment Authorization (IHA) from NMFS. Based on the IHA, marine mammal monitoring may be required during pile driving and driving may be paused during periods when marine mammals are too close to the sound source. IHAs are limited to a duration of 1 year if the Project results in harassment, but can be renewed. Depending on the duration of pile driving, and whether the Project is planned for multiple years or results in serious injury or mortality, it may be necessary to obtain a Letter of Authorization (LOA) from NMFS. A LOA is effective for up to 5 years.

## Outstanding Information Needs

Typically in California, permitting requires assessment of impacts based on sound source modeling to evaluate the potential area where impacts could occur, with validation monitoring and reporting required during pile driving (Molnar et al. 2020). This may involve developing a construction noise, vibration and hydroacoustic assessment to support agency consultations and using the NMFS Pile Driving Calculator as a tool to calculate the effects of elevated levels of underwater sound from pile driving noise on ESA-listed species (Molnar et al. 2020). This tool is designed to calculate the area that sound levels are likely to exceed acoustic thresholds and assess whether incidental take will occur. However, certain technical details and Project design information must be finalized first. The outstanding information needed (to use the NMFS Pile Driving Calculator) includes:

- Construction process information such as the hammer type, production pile driving rate, durations (number of piles anticipated to be installed per day).

- Pile driving parameters from the Project design such as the number of strikes per pile, number of piles driven per day, and estimated number of strikes per day.

- Acoustic measurements from the Project design such as peak sound pressure level, sound exposure level, root mean square, and noise reduction due to abatement measurements.

Other design information needed for agency consultations include:

- Specifications on the number of permanent and temporary piles, including their size and location.

- Project phasing for pile driving indicating the duration of the work project, and proposed work windows (i.e., project timing).
- Plans illustrating the approximate locations of the piles, with information on water depth. This information will be determined from the data collected during geotechnical surveys.
- A defined Project action area (for pile driving), including information on the distance to which the underwater noise attenuates and injury thresholds, and a defined acoustic impact area.
- Avoidance, minimization and mitigation measures (e.g., project timing, best management practices, attenuation devices, mitigation measures for take of listed species, performance and monitoring measures).

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