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Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals; Notice

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

RIN 0648–XA830

Takes of Marine Mammals Incidental to Specified Activities; Taking Marine Mammals Incidental to a Wharf Construction Project

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice; proposed incidental harassment authorization; request for comments.

SUMMARY: NMFS has received an application from the U.S. Navy (Navy) for an Incidental Harassment Authorization (IHA) to take marine mammals, by harassment, incidental to construction activities as part of a wharf construction project. Pursuant to the Marine Mammal Protection Act (MMPA), NMFS is requesting comments on its proposal to issue an IHA to the Navy to take, by Level B Harassment only, six species of marine mammals during the specified activity.

DATES: Comments and information must be received no later than January 20, 2012.

ADDRESSES: Comments on the application should be addressed to Michael Payne, Chief, Permits and Conservation Division, Office of Protected Resources, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910–3225. The mailbox address for providing email comments is *ITP.Laws@noaa.gov.* NMFS is not responsible for email comments sent to addresses other than the one provided here. Comments sent via email, including all attachments, must not exceed a 10-megabyte file size.

Instructions: All comments received are a part of the public record and will generally be posted to *http://www.nmfs.noaa.gov/pr/permits/incidental.htm* without change. All Personal Identifying Information (*e.g.,* name, address) voluntarily submitted by the commenter may be publicly accessible. Do not submit Confidential Business Information or otherwise sensitive or protected information.

An electronic copy of the application containing a list of the references used in this document may be obtained by writing to the address specified above, telephoning the contact listed below (see **FOR FURTHER INFORMATION CONTACT**), or visiting the Internet at: *http://www.nmfs.noaa.gov/pr/permits/incidental.htm.* Documents cited in this notice may also be viewed, by appointment, during regular business hours, at the aforementioned address.

FOR FURTHER INFORMATION CONTACT: Ben Laws, Office of Protected Resources, NMFS, (301) 427–8401.

SUPPLEMENTARY INFORMATION:

Background

Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq.*) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings shall be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined ''negligible impact'' in 50 CFR 216.103 as ''* * * an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.''

Section 101(a)(5)(D) of the MMPA established an expedited process by which citizens of the U.S. can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Section 101(a)(5)(D) establishes a 45-day time limit for NMFS review of an application followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of marine mammals. Within 45 days of the close of the comment period, NMFS must either issue or deny the authorization. Except with respect to certain activities not pertinent here, the MMPA defines ''harassment'' as:

> Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Summary of Request

NMFS received an application on May 25, 2011 from the Navy for the taking of marine mammals incidental to pile driving and removal in association with a wharf construction project in the Hood Canal at Naval Base Kitsap in Bangor, WA (NBKB). The Navy submitted a revised version of the application on August 11, 2011, and, responsive to discussions with NMFS as well as new information about species in the area, submitted a final version deemed adequate and complete by NMFS on November 3, 2011. The wharf construction project is proposed to occur over multiple years; however, this IHA would cover only the initial year of the project, from July 16, 2012, through July 15, 2013. Pile driving and removal activities would occur only within an approved in-water work window from July 16–February 15. Six species of marine mammals are known from the waters surrounding NBKB: Steller sea lions (*Eumetopias jubatus*), California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), killer whales (*Orcinus orca*), Dall's porpoises (*Phocoenoides dalli*), and harbor porpoises (*Phocoena phocoena*). These species may occur year-round in the Hood Canal, with the exception of the Steller sea lion, which is present only from fall to late spring (October to mid-April), and the California sea lion, which is only present from late summer to late spring (August to early June). Additionally, while the Southern Resident killer whale (listed as endangered under the Endangered Species Act [ESA]) is resident to the inland waters of Washington and British Columbia, it has not been observed in the Hood Canal in over 15 years and was therefore excluded from further analysis.

NBKB provides berthing and support services for OHIO Class ballistic missile submarines (SSBN), also known as TRIDENT submarines. The Navy proposes to begin construction of the Explosive Handling Wharf #2 (EHW–2) facility at NBKB in order to support future program requirements for TRIDENT submarines berthed at NBKB. The Navy states that construction of EHW–2 is necessary because the existing EHW alone will not be able to support future TRIDENT program requirements. Under the proposed action—which includes only the portion of the project that would be completed under this proposed 1-year IHA—a maximum of 195 pile driving days would occur. All piles would be driven with a vibratory hammer for their initial embedment depths, while select piles would be impact driven for their final 10–15 ft (3–4.6 m) for proofing, as necessary. Proofing involves striking a driven pile with an impact hammer to verify that it provides the required load-bearing capacity, as indicated by the number of hammer blows per foot of pile advancement. Sound attenuation measures (*i.e.,* bubble curtain) would be used during all impact hammer operations.

For pile driving activities, the Navy used NMFS-promulgated thresholds for assessing pile driving and removal impacts (NMFS, 2005b, 2009), outlined later in this document. The Navy used recommended spreading loss formulas (the practical spreading loss equation for underwater sounds and the spherical spreading loss equation for airborne sounds) and empirically-measured source levels from other 30–66 in (0.8–1.7 m) diameter pile driving events to estimate potential marine mammal exposures. Predicted exposures are outlined later in this document. The calculations predict that no Level A harassments would occur associated with pile driving or construction activities, and that as many as 18,225 Level B harassments may occur during the wharf construction project from sound produced by pile driving activity.

Description of the Specified Activity

NBKB is located on the Hood Canal approximately twenty miles (32 km) west of Seattle, Washington (see Figures 2–1 through 2–4 in the Navy's application). NBKB provides berthing and support services for OHIO Class ballistic missile submarines (SSBN), also known as TRIDENT submarines. The Navy proposes to begin construction of the EHW–2 facility at NBKB in order to support future program requirements for TRIDENT submarines berthed at NBKB. The Navy states that construction of EHW–2 is necessary because the existing EHW alone will not be able to support future TRIDENT program requirements. The proposed actions with the potential to cause harassment of marine mammals within the waterways adjacent to NBKB, under the MMPA, are vibratory and impact pile driving operations, as well as vibratory removal of falsework piles, associated with the wharf construction project. The proposed activities that would be authorized by this IHA would occur between July 16, 2012, and July 15, 2013. All in-water construction activities within the Hood Canal are only permitted during July 16–February 15 in order to protect spawning fish populations.

As part of the Navy's sea-based strategic deterrence mission, the Navy Strategic Systems Programs directs research, development, manufacturing, testing, evaluation, and operational support for the TRIDENT Fleet Ballistic Missile program. Development of necessary facilities for handling of explosive materials is part of these duties. The EHW–2 would consist of two components: (1) The wharf proper (or Operations Area), including the warping wharf; and (2) two access trestles. Please see Figures 1–1 and 1–2 of the Navy's application for conceptual and schematic representations of the proposed EHW–2. The Operations Area would include a support building and wharf cover. A warping wharf is a long, narrow wharf extension used to position submarines prior to moving into the Operations Area. The access trestles would allow vehicles to travel between the Operations Area and the shore.

The wharf proper would lie approximately 600 ft (183 m) offshore at water depths of 60–100 ft (18–30 m), and would consist of the main wharf, a warping wharf, and lightning protection towers, all pile-supported. It would include a slip (docking area) for submarines, surrounded on three sides by operational wharf area. The main wharf would include an operations support building providing office and storage space and mechanical/electrical system component housing. Additional facility support at the wharf would include heavy duty cranes suspended from the cover, power utility booms, six large lightning protection towers, and camels (operational platforms that float next to a moored vessel).

The access trestles would connect the wharf to the shore. There would be an entrance trestle and an exit trestle; these would be combined over shallow water to reduce overwater area. The trestles would be pile-supported on 24-in (0.6-m) steel pipe piles driven approximately 30 ft (9 m) into the seafloor. Spacing between bents (rows of piles) would be 25 ft (8 m). Concrete pile caps would be cast in place and would support pre-cast concrete deck sections.

For the entire project, a total of up to 1,250 permanent piles ranging in size between 24–48 in (0.6–1.2 m) in diameter would be driven in-water to construct the wharf, with up to three vibratory rigs and one impact driving rig operating simultaneously. Construction would also involve temporary installation of up to 150 falsework piles used as an aid to guide permanent piles to their proper locations. Falsework piles, which would be removed upon installation of the permanent piles, would likely be steel pipe piles and would be driven and removed using a vibratory driver. It has not been determined exactly what parts or how much of the project would be constructed during the first year; however, a maximum of 195 days of pile driving would occur. The analysis contained herein is based upon the maximum of 195 pile driving days, rather than any specific number of piles driven, and assumes that (1) all marine mammals available to be incidentally taken within the relevant area would be; and (2) individual marine mammals may only be incidentally taken once in a 24-h period—for purposes of authorizing specified numbers of take—regardless of actual number of exposures in that period. Table 1 summarizes the number and nature of piles required for the entire project, rather than what subset of piles may be expected to be driven during the first year of construction proposed for this IHA.

Feature	Quantity
Total number of permanent in-water piles.	Up to 1,250.
Size and number of main wharf piles.	24-in: 140. 36-in (0.9-m): 157. 48-in: 263.
Size and number of warping wharf piles.	24-in: 80. 36-in: 190.
Size and number of lightning tower piles.	24-in: 40. 36-in: 90.
Size and number of trestle piles.	24-in: 57. 36-in: 233.
Falsework piles	Up to 150, 18- to 24-in.
Maximum pile driving duration.	195 days (under 1-year IHA).

Pile installation would utilize vibratory pile drivers to the greatest extent possible, and the Navy anticipates that most piles would be able to be vibratory driven to within several feet of the required depth. Pile drivability is, to a large degree, a function of soil conditions and the type of pile hammer. The soil conditions encountered during geotechnical explorations at NBKB indicate existing conditions generally consist of fill or sediment of very dense glacially overridden soils. Recent experience at two other construction locations along the NBKB waterfront indicates that most piles should be able to be driven with a vibratory hammer to proper embedment depth. However, difficulties during pile driving may be encountered as a result of obstructions that may exist throughout the project area. Such obstructions may consist of rocks or boulders within the glacially overridden soils. If difficult driving conditions occur, increased usage of an impact hammer would occur.

Unless difficult driving conditions are encountered, an impact hammer will only be used to proof the load-bearing capacity of approximately every fourth or fifth pile. The industry standard is to proof every pile with an impact hammer; however, in an effort to reduce blow counts from the impact hammer, the engineer of record has agreed to only proof every fourth or fifth pile. A maximum of 200 strikes would be required to proof each pile. Pile production rates are dependent upon required embedment depths, the potential for encountering difficult driving conditions, and the ability to drive multiple piles without a need to relocate the driving rig. Under best-case scenarios (*i.e.,* shallow piles, driving in optimal conditions, using multiple driving rigs), it may be possible to install enough pilings with the vibratory hammer that proofing may be required for up to five piles in a day. Under this likely scenario, with a single impact hammer used to proof up to five piles per day at 200 strikes per pile, it is estimated that up to a maximum of 1,000 strikes from an impact hammer would be required per day.

If difficult subsurface driving conditions (*i.e.,* cobble/boulder zones) are encountered that cause refusal with the vibratory equipment, it may be necessary to use an impact hammer to drive some piles for the remaining portion of their required depth. The worst-case scenario is that a pile would be driven for its entire length using an impact hammer. Given the uncertainty regarding the types and quantities of boulders or cobbles that may be encountered, and the depth at which they may be encountered, the number of strikes necessary to drive a pile its entire length could be approximately 1,000 to 2,000 strikes per pile. The Navy estimates that a possible worst-case daily scenario would require driving three piles full length (at a worst-case of 2,000 strikes per pile) after the piles have become hung on large boulders early in the installation process, with proofing of an additional two piles (at 200 strikes each) that were able to be installed primarily via vibratory means. This worst-case scenario would therefore result in a maximum of 6,400 strikes per day. All piles driven or struck with an impact hammer would be surrounded by a bubble curtain or other sound attenuation device over the full water column to minimize in-water sound. Up to three vibratory rigs and one impact rig would be used at a time. Pile production rate (number of piles driven per day) is affected by many factors: size, type (vertical vs. angled), and location of piles; weather; number of driver rigs operating; equipment reliability; geotechnical (subsurface) conditions; and work stoppages for security or environmental reasons (such as presence of marine mammals).

Pile driving would typically take place 6 days per week. The allowable season for in-water work, including pile driving, at NBKB is July 16 through February 15, which was established by the Washington Department of Fish and Wildlife in coordination with NMFS and the U.S. Fish and Wildlife Service (USFWS) to protect juvenile salmon. Impact pile driving during the first half of the in-water work window (July 16 to September 15) would only occur between 2 hours after sunrise and 2 hours before sunset to protect breeding marbled murrelets (an ESA-listed bird under the jurisdiction of USFWS). Between September 16 and February 15, construction activities occurring in the water would occur during daylight hours (sunrise to sunset). Other construction (not in-water) may occur between 7 a.m. and 10 p.m., year-round.

The number of construction barges (derrick and material) on site at any one time would vary between two and eight depending on the type of construction taking place. The maximum number of eight barges would likely be present at the beginning of construction, with multiple rigs and their support barges required to complete the work at various areas of the wharf. As pile installation progresses, the area will become congested, limiting the space available to support the pile driving rigs and barges. Also, as sections of the wharf are completed the need for some of the rigs/barges will be reduced. As a result, fewer barges would likely be necessary as the project progresses. Tug boats would tow barges to and from the construction site and position the barges for construction activity. Tug boats would leave the site once these tasks were completed and so would not be on site for extended periods; there would be no more than two tug boats on site at any one time. Up to six smaller skiff-type boats would be on site performing various functions in support of construction and monitoring requirements.

Operation of the EHW–2 would not result in an increase in boat traffic along the NBKB waterfront. Rather, a portion of the ongoing operations and boat traffic at the existing EHW and other facilities within the Waterfront Restricted Area (*e.g.,* Delta Pier and Marginal Wharf) would be diverted to the EHW–2. The EHW–2 may be used as a backup explosives handling facility for TRIDENT submarines currently homeported at NBKB when there are no TRIDENT operations at the existing EHW. The EHW–2 may also provide temporary berthing when no ordnance handling operations are occurring at either wharf. No increase in boat traffic would be required to achieve planned operations. The increase in future operations at the waterfront would only require that boats remain at an EHW longer when in port for maintenance and upgrades. The overall level of traffic and activity along the NBKB waterfront would not increase as a result of operating the EHW–2. Operation of the EHW–2 may require approximately twenty additional military and civilian personnel. The EHW–2 would be staffed 24 hours per day, 7 days per week. Maintenance of the EHW–2 would include routine inspections, repair, and replacement of facility components as required. It would not be necessary to replace piles during the design life of the EHW–2. Fouling organisms would not be removed from piles.

Description of Sound Sources

Sound travels in waves, the basic components of which are frequency, wavelength, velocity, and amplitude. Frequency is the number of pressure waves that pass by a reference point per unit of time and is measured in Hz or cycles per second. Wavelength is the distance between two peaks of a sound wave; lower frequency sounds have longer wavelengths than higher frequency sounds and attenuate more rapidly in shallower water. Amplitude is the height of the sound pressure wave or the 'loudness' of a sound and is typically measured using the decibel (dB) scale. A dB is the ratio between a measured pressure (with sound) and a reference pressure (sound at a constant pressure, established by scientific standards). It is a logarithmic unit that accounts for large variations in amplitude; therefore, relatively small changes in dB ratings correspond to large changes in sound pressure. When referring to SPLs (SPLs; the sound force per unit area), sound is referenced in the context of underwater sound pressure to 1 microPascal (μPa). One pascal is the pressure resulting from a force of one newton exerted over an area of one square meter. The source level represents the sound level at a distance of 1 m from the source (referenced to 1 μPa). The received level is the sound level at the listener's position.

Root mean square (rms) is the quadratic mean sound pressure over the duration of an impulse. Rms is calculated by squaring all of the sound amplitudes, averaging the squares, and then taking the square root of the average (Urick, 1975). Rms accounts for both positive and negative values; squaring the pressures makes all values positive so that they may be accounted for in the summation of pressure levels (Hastings and Popper, 2005). This measurement is often used in the context of discussing behavioral effects, in part because behavioral effects, which often result from auditory cues, may be better expressed through averaged units than by peak pressures.

When underwater objects vibrate or activity occurs, sound-pressure waves are created. These waves alternately compress and decompress the water as the sound wave travels. Underwater sound waves radiate in all directions away from the source (similar to ripples on the surface of a pond), except in cases where the source is directional. The compressions and decompressions associated with sound waves are detected as changes in pressure by aquatic life and man-made sound receptors such as hydrophones. Underwater sound levels ('ambient sound') are comprised of multiple sources, including physical (*e.g.,* waves, earthquakes, ice, atmospheric sound), biological (*e.g.,* sounds produced by marine mammals, fish, and invertebrates), and anthropogenic sound (*e.g.,* vessels, dredging, aircraft, construction). Even in the absence of anthropogenic sound, the sea is typically a loud environment. A number of sources of sound are likely to occur within Hood Canal, including the following (Richardson *et al.,* 1995):

- *Wind and waves:* The complex interactions between wind and water surface, including processes such as breaking waves and wave-induced bubble oscillations and cavitation, are a main source of naturally occurring ambient noise for frequencies between 200 Hz and 50 kHz (Mitson, 1995). In general, ambient noise levels tend to increase with increasing wind speed and wave height. Surf noise becomes important near shore, with measurements collected at a distance of 8.5 km (5.3 mi) from shore showing an increase of 10 dB in the 100 to 700 Hz band during heavy surf conditions.
- *Precipitation noise:* Noise from rain and hail impacting the water surface can become an important component of total noise at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times.
- *Biological noise:* Marine mammals can contribute significantly to ambient noise levels, as can some fish and shrimp. The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz.
- *Anthropogenic noise:* Sources of ambient noise related to human activity include transportation (surface vessels and aircraft), dredging and construction, oil and gas drilling and production, seismic surveys, sonar, explosions, and ocean acoustic studies (Richardson *et al.,* 1995). Shipping noise typically dominates the total ambient noise for frequencies between 20 and 300 Hz. In general, the frequencies of anthropogenic sounds are below 1 kHz and, if higher frequency sound levels are created, they will attenuate (decrease) rapidly (Richardson *et al.,* 1995). Known sound levels and frequency ranges associated with anthropogenic sources similar to those that would be used for this project are summarized in Table 2. Details of each of the sources are described in the following text.

TABLE 2—REPRESENTATIVE SOUND LEVELS OF ANTHROPOGENIC SOURCES

Sound source	Frequency range (Hz)	Underwater sound level (dB re 1 μPa)	Reference
Small vessels	250–1,000	151 dB rms at 1 m (3.3 ft)	Richardson *et al.,* 1995.
Tug docking gravel barge	200–1,000	149 dB rms at 100 m (328 ft)	Blackwell and Greene, 2002.
Vibratory driving of 72-in (1.8 m) steel pipe pile.	10–1,500	180 dB rms at 10 m (33 ft)	Illingworth and Rodkin, 2007.
Impact driving of 36-in steel pipe pile	10–1,500	195 dB rms at 10 m	WSDOT, 2007.
Impact driving of 66-in cast-in-steel-shell pile.	10–1,500	195 dB rms at 10 m	Reviewed in Hastings and Popper, 2005.

In-water construction activities associated with the project would include impact pile driving and vibratory pile driving and removal. The sounds produced by these activities fall into one of two sound types: pulsed and non-pulsed (defined in next paragraph). The distinction between these two general sound types is important because they have differing potential to cause physical effects, particularly with regard to hearing (*e.g.,* Ward, 1997 in Southall *et al.,* 2007). Please see Southall *et al.,* (2007) for an in-depth discussion of these concepts.

Pulsed sounds (*e.g.,* explosions, gunshots, sonic booms, and impact pile driving) are brief, broadband, atonal transients (ANSI, 1986; Harris, 1998) and occur either as isolated events or repeated in some succession. Pulsed sounds are all characterized by a relatively rapid rise from ambient pressure to a maximal pressure value followed by a decay period that may include a period of diminishing, oscillating maximal and minimal pressures. Pulsed sounds generally have an increased capacity to induce physical injury as compared with sounds that lack these features.

Non-pulse (intermittent or continuous sounds) can be tonal, broadband, or both. Some of these non-pulse sounds can be transient signals of short duration but without the essential properties of pulses (*e.g.,* rapid rise time). Examples of non-pulse sounds include those produced by vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems. The duration of such sounds, as received at a distance, can be greatly extended in a highly reverberant environment.

Impact hammers operate by repeatedly dropping a heavy piston onto a pile to drive the pile into the substrate. Sound generated by impact hammers is characterized by rapid rise times and high peak levels, a potentially injurious combination (Hastings and Popper, 2005). Vibratory hammers install piles by vibrating them and allowing the weight of the hammer to push them into the sediment. Vibratory hammers produce significantly less sound than impact hammers. Peak SPLs may be 180 dB or greater, but are generally 10 to 20 dB lower than SPLs generated during impact pile driving of the same-sized pile (Caltrans, 2009). Rise time is slower, reducing the probability and severity of injury (USFWS, 2009), and sound energy is distributed over a greater amount of time (Nedwell and Edwards, 2002; Carlson *et al.,* 2001).

Ambient Sound

The underwater acoustic environment consists of ambient sound, defined as environmental background sound levels lacking a single source or point (Richardson *et al.,* 1995). The ambient underwater sound level of a region is defined by the total acoustical energy being generated by known and unknown sources, including sounds from both natural and anthropogenic sources. The sum of the various natural and anthropogenic sound sources at any given location and time depends not only on the source levels (as determined by current weather conditions and levels of biological and shipping activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor, and is frequency-dependent. As a result of the dependence on a large number of varying factors, the ambient sound levels at a given frequency and location can vary by 10–20 dB from day to day (Richardson *et al.,* 1995).

In the vicinity of the project area, the average broadband ambient underwater sound levels were measured at 114 dB re 1µPa between 100 Hz and 20 kHz (Slater, 2009). Peak spectral sound from industrial activity was noted below the 300 Hz frequency, with maximum levels of 110 dB re 1µPa noted in the 125 Hz band. In the 300 Hz to 5 kHz range, average levels ranged between 83–99 dB re 1µPa. Wind-driven wave sound dominated the background sound environment at approximately 5 kHz and above, and ambient sound levels flattened above 10 kHz.

Airborne sound levels at NBKB vary based on location but are estimated to average around 65 dBA (A-weighted decibels) in the residential and office park areas, with traffic sound ranging from 60–80 dBA during daytime hours (Cavanaugh and Tocci, 1998). The highest levels of airborne sound are produced along the waterfront and at the ordnance handling areas, where estimated sound levels range from 70–90 dBA and may peak at 99 dBA for short durations. These higher sound levels are produced by a combination of sound sources including heavy trucks, forklifts, cranes, marine vessels, mechanized tools and equipment, and other sound-generating industrial or military activities.

Sound Attenuation Devices

Sound levels can be greatly reduced during impact pile driving using sound attenuation devices. There are several types of sound attenuation devices including bubble curtains, cofferdams, and isolation casings (also called temporary noise attenuation piles [TNAP]), and cushion blocks. Bubble curtains create a column of air bubbles rising around a pile from the substrate to the water surface. The air bubbles absorb and scatter sound waves emanating from the pile, thereby reducing the sound energy. Bubble curtains may be confined or unconfined. An unconfined bubble curtain may consist of a ring seated on the substrate and emitting air bubbles from the bottom. An unconfined bubble curtain may also consist of a stacked system, that is, a series of multiple rings placed at the bottom and at various elevations around the pile. Stacked systems may be more effective than non-stacked systems in areas with high current and deep water (Caltrans, 2009).

A confined bubble curtain contains the air bubbles within a flexible or rigid sleeve made from plastic, cloth, or pipe. Confined bubble curtains generally offer higher attenuation levels than unconfined curtains because they may physically block sound waves and they prevent air bubbles from migrating away from the pile. For this reason, the confined bubble curtain is commonly used in areas with high current velocity (Caltrans, 2009).

An isolation casing is a hollow pipe that surrounds the pile, isolating it from the in-water work area. The casing is dewatered before pile driving. This device provides levels of sound attenuation similar to that of bubble curtains (Caltrans, 2009). Sound levels can be reduced by 8 to 14 dB. Cushion blocks consist of materials (*e.g.,* wood, nylon) placed atop piles during impact pile driving activities to reduce source levels. Typically sound reduction can range from 4 to a maximum of 26 dB.

Cofferdams are often used during construction for isolating the in-water work area, but may also be used as a sound attenuation device. Dewatered cofferdams may provide the highest levels of sound reduction of any attenuation device; however, they do not eliminate underwater sound because sound can be transmitted through the substrate (Caltrans, 2009). Cofferdams that are not dewatered provide very limited reduction in sound levels.

Both environmental conditions and the characteristics of the sound attenuation device may influence the effectiveness of the device. According to Caltrans (2009):

- In general, confined bubble curtains attain better sound attenuation levels in areas of high current than unconfined bubble curtains. If an unconfined device is used, high current velocity may sweep bubbles away from the pile, resulting in reduced levels of sound attenuation.
- Softer substrates may allow for a better seal for the device, preventing leakage of air bubbles and escape of sound waves. This increases the effectiveness of the device. Softer substrates also provide additional attenuation of sound traveling through the substrate.
- Flat bottom topography provides a better seal, enhancing effectiveness of the sound attenuation device, whereas sloped or undulating terrain reduces or eliminates its effectiveness.
- Air bubbles must be close to the pile; otherwise, sound may propagate into the water, reducing the effectiveness of the device.
- Harder substrates may transmit ground-borne sound and propagate it into the water column.

The literature presents a wide array of observed attenuation results for bubble curtains (*e.g.,* WSF, 2009; WSDOT, 2008; USFWS, 2009; Caltrans, 2009). The variability in attenuation levels is due to variation in design, as well as differences in site conditions and difficulty in properly installing and operating in-water attenuation devices. As a general rule, reductions of greater than 10 dB cannot be reliably predicted (Caltrans, 2009).

Sound Thresholds

Since 1997, NMFS has used generic sound exposure thresholds to determine when an activity in the ocean that produces sound might result in impacts to a marine mammal such that a take by harassment might occur (NMFS, 2005b). To date, no studies have been conducted that examine impacts to marine mammals from pile driving sounds from which empirical sound thresholds have been established. Current NMFS practice regarding exposure of marine mammals to sound is that cetaceans and pinnipeds exposed to impulsive sounds of 180 and 190 dB rms or above, respectively, are considered to have been taken by Level A (*i.e.,* injurious) harassment. Behavioral harassment (Level B) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB rms for impulse sounds (*e.g.,* impact pile driving) and 120 dB rms for continuous sound (*e.g.,* vibratory pile driving), but below injurious thresholds. For airborne sound, pinniped disturbance from haul-outs has been documented at 100 dB (unweighted) for pinnipeds in general, and at 90 dB (unweighted) for harbor seals. NMFS uses these levels as guidelines to estimate when harassment may occur.

Distance to Sound Thresholds

Underwater Sound Propagation Formula—Pile driving would generate underwater noise that potentially could result in disturbance to marine mammals in the project area. Transmission loss (TL) is the decrease in acoustic intensity as an acoustic pressure wave propagates out from a source. TL parameters vary with frequency, temperature, sea conditions, current, source and receiver depth, water depth, water chemistry, and bottom composition and topography. A practical sound propagation modeling technique was used by the Navy to estimate the range from the pile driving activity to various SPL thresholds in water. This model follows a geometric propagation loss based on the distance from the driven pile, resulting in a 4.5 dB reduction in level for each doubling of distance from the source. In this model, the SPL at some distance away from the source (*e.g.,* driven pile) is governed by a measured source level, minus the transmission loss of the energy as it dissipates with distance. The formula for underwater TL is:

$TL = 15 * \log_{10}(R_1/R_2)$, where

R_1 = the distance of the modeled SPL from the driven pile, and

R_2 = the distance from the driven pile of the initial measurement.

The degree to which underwater sound propagates away from a sound source is dependent on a variety of factors, most notably by the water bathymetry and presence or absence of reflective or absorptive conditions including in-water structures and sediments. Spherical spreading occurs in a perfectly unobstructed (free-field) environment not limited by depth or water surface, resulting in a 6 dB reduction in sound level for each doubling of distance from the source (20*log[range]). Cylindrical spreading occurs in an environment in which sound propagation is bounded by the water surface and sea bottom, resulting in a reduction of 3 dB in sound level for each doubling of distance from the source (10*log[range]). The propagation environment along the NBKB waterfront conforms to neither spherical nor cylindrical spreading; as the receiver moves away from the shoreline, the water increases in depth, resulting in an expected propagation environment that would lie between spherical and cylindrical spreading loss conditions. Since there is no available data regarding propagation loss along the NBKB waterfront, a practical spreading loss model was adopted as the most likely approximation of the sound propagation environment. Hydroacoustic monitoring results from the Navy's Test Pile Project (see 76 FR 38361; July 30, 2011) will be used, when available, to confirm the validity of the practical spreading model for estimating acoustic propagation in the project area. That project concluded on October 31, 2011.

Underwater Sound From Pile Driving—The intensity of pile driving sounds is greatly influenced by factors such as the type of piles, hammers, and the physical environment in which the activity takes place. A large quantity of literature regarding SPLs recorded from pile driving projects is available for consideration. In order to determine reasonable SPLs and their associated affects on marine mammals that are likely to result from pile driving at NBKB, studies with similar properties to the proposed action were evaluated. Sound levels associated with vibratory pile removal are assumed to be the same as those during vibratory installation (Caltrans, 2007)—which is likely a conservative assumption—and have been taken into consideration in the modeling analysis. Overall, studies which met the following parameters were considered: (1) Pile size and materials: Steel pipe piles (30–72 in diameter); (2) Hammer machinery: Vibratory and impact hammer; and (3) Physical environment: shallow depth (less than 100 ft [30 m]).

TABLE 3—UNDERWATER SPLS FROM MONITORED CONSTRUCTION ACTIVITIES USING IMPACT HAMMERS

Project and location	Pile size and type	Water depth	Measured SPLs
Eagle Harbor Maintenance Facility, WA	30-in (0.8 m) steel pipe pile	10 m (33 ft)	192 dB re 1 µPa (rms) at 10 m (33 ft).
Friday Harbor Ferry Terminal, WA	30-in steel pipe pile	10 m	196 dB re 1 µPa (rms) at 10 m.
Unknown, CA	36-in steel pipe pile	10 m	193 dB re 1 µPa (rms) at 10 m.
Mukilteo Test Piles, WA	36-in steel pipe pile	7.3 m (24 ft)	195 dB re 1 µPa (rms) at 10 m.
Anacortes Ferry, WA	36-in steel pipe pile	12.8 m (42 ft)	199 dB re 1 µPa (rms) at 10 m.
Carderock Pier, NBKB, WA	42-in steel pipe pile	14–22 m (48–70 ft)	195 dB re 1 µPa (rms) at 10 m.
Russian River, CA	48-in steel pipe pile	2 m (6.6 ft)	195 dB re 1 µPa (rms) at 10 m.
Unknown, CA	60-in cast-in-steel-shell	10 m	195 dB re 1 µPa (rms) at 10 m.
Richmond-San Rafael Bridge, CA	66-in steel pipe pile	4 m (13 ft)	195 dB re 1 µPa (rms) at 10 m.

Sources: WSDOT, 2005, 2008; Caltrans, 2007; Reyff, 2005; JASCO, 2005; Laughlin, 2005; Navy, 2009.

The tables presented here detail representative pile driving SPLs that have been recorded from similar construction activities in recent years. Due to the similarity of these actions and the Navy's proposed action, these values represent reasonable SPLs which could be anticipated, and which were used in the acoustic modeling and analysis. Table 3 represents SPLs that may be expected during pile installation using an impact hammer. Table 4 represents SPLs that may be expected during pile installation using a vibratory hammer.

TABLE 4—UNDERWATER SPLS FROM MONITORED CONSTRUCTION ACTIVITIES USING VIBRATORY HAMMERS

Project and location	Pile size and type	Water depth	Measured SPLs
Keystone Ferry Terminal, WA [1]	30-in (0.8 m) steel pipe pile	5 m (15 ft)	164 dB re 1 µPa (rms) at 10 m (33 ft).
Keystone Ferry Terminal, WA [1]	30-in steel pipe pile	8 m (28 ft)	165 dB re 1 µPa (rms) at 10 m.
Vashon Ferry Terminal, WA [2]	30-in steel pipe pile	6 m (20 ft)	165 dB re 1 µPa (rms) at 10 m.
Unknown, CA	36-in steel pipe pile	5 m	170 dB re 1 µPa (rms) at 10 m.
Unknown, CA	36-in steel pipe pile	5 m	175 dB re 1 µPa (rms) at 10 m.
Unknown, CA	72-in steel pipe pile	5 m	170 dB re 1 µPa (rms) at 10 m.
Unknown, CA	72-in steel pipe pile	5 m	180 dB re 1 µPa (rms) at 10 m.

Sources: Laughlin, 2010a; Laughlin, 2010b; Caltrans, 2007.

As described previously in this document, sound attenuation measures, including bubble curtains, can be employed during impact pile driving to reduce the high source pressures. For the wharf construction project, the Navy intends to employ sound reduction techniques during impact pile driving, including the use of sound attenuation systems (*e.g.,* bubble curtain). See ''Proposed Mitigation'', later in this document, for more details on the impact reduction and mitigation measures proposed. The calculations of the distances to the marine mammal sound thresholds were calculated for impact installation with the assumption of a 10 dB reduction in source levels from the use of sound attenuation devices, and the Navy used the mitigated distances for impact pile driving for all analysis in their application. The Navy will analyze data from the Test Pile Program to confirm the level of achieved sound attenuation from use of a bubble curtain or similar device using site-specific conditions.

All calculated distances to and the total area encompassed by the marine mammal sound thresholds are provided in Table 5. The Navy used source values of 185 dB for impact driving (the mean SPL of the values presented in Table 3, less 10 dB of sound attenuation from use of a bubble curtain or similar device) and 180 dB for vibratory driving (the worst-case value from Table 4). The 195 dB mean SPL of values presented in Table 3 was considered appropriate because it matched values from projects where larger-size pile was used and, in addition, matched the value obtained from the Carderock project, which was located at the NBKB waterfront and involved similar pile materials, water depth, and bottom type. The maximum value from Table 4 of 180 dB was deemed appropriate for vibratory driving because no data were available for 48-in and 60-in piles. As a result, the most conservative value was selected. Under likely construction scenarios, up to three vibratory drivers would operate simultaneously with one impact driver. Although radial distance and area associated with the zone ensonified to 160 dB (the behavioral harassment threshold for pulsed sounds, such as those produced by impact driving) are presented in Table 5, this zone would be subsumed by the 120 dB zone produced by vibratory driving. Thus, behavioral harassment of marine mammals associated with impact driving is not considered further here. Since the 160 dB threshold and the 120 dB threshold both indicate behavioral harassment, pile driving effects in the two zones are equivalent. Although such a day is not planned, if only the impact driver was operated on a given day, incidental take on that day would likely be lower because the area ensonified to levels producing Level B harassment would be smaller (although actual take would be determined by the numbers of marine mammals in the area on that day). The use of multiple vibratory rigs at the same time would result in a small additive effect with regard to produced SPLs; however, because the sound field produced by vibratory driving would be truncated by land in the Hood Canal, no increase in actual sound field produced would occur. There would be no overlap in the 190/180-dB sound fields produced by rigs operating simultaneously.

TABLE 5—CALCULATED DISTANCE(S) TO AND AREA ENCOMPASSED BY UNDERWATER MARINE MAMMAL SOUND THRESHOLDS DURING PILE INSTALLATION

Threshold	Distance	Area, km^2 (mi^2)
Impact driving, pinniped injury (190 dB)	4.9 m (16.1 ft)	0.0001
Impact driving, cetacean injury (180 dB)	22 m (72.2 ft)	0.002 (0.0008)
Impact driving, disturbance (160 dB)[2]	724 m (2,375 ft)	1.65 (0.64)
Vibratory driving, pinniped injury (190 dB)	2.1 m (6.9 ft)	< 0.0001
Vibratory driving, cetacean injury (180 dB)	10 m (32.8 ft)	0.0003 (0.0001)
Vibratory driving, disturbance (120 dB)	13,800 m (45,276 ft)[3]	41.4 (15.98)

[1] SPLs used for calculations were: 185 dB for impact and 180 dB for vibratory driving.

[2] Area of 160-dB zone presented for reference. Estimated incidental take calculated on basis of larger 120-dB zone.

[3] Hood Canal average width at site is 2.4 km (1.5 mi), and is fetch limited from N to S at 20.3 km (12.6 mi). Calculated range (over 222 km) is greater than actual sound propagation through Hood Canal due to intervening land masses. 13.8 km (8.6 mi) is the greatest line-of-sight distance from pile driving locations unimpeded by land masses, which would block further propagation of sound.

Hood Canal does not represent open water, or free field, conditions. Therefore, sounds would attenuate as they encounter land masses or bends in the canal. As a result, the calculated distance and areas of impact for the 120 dB threshold cannot actually be attained at the project area. See Figure 6–1 of the Navy's application for a depiction of the size of areas in which each underwater sound threshold is predicted to occur at the project area due to pile driving.

Airborne Sound Propagation Formula—Pile driving can generate airborne sound that could potentially result in disturbance to marine mammals (specifically, pinnipeds) which are hauled out or at the water's surface. As a result, the Navy analyzed the potential for pinnipeds hauled out or swimming at the surface near NBKB to be exposed to airborne SPLs that could result in Level B behavioral harassment. The appropriate airborne sound threshold for behavioral disturbance for all pinnipeds, except harbor seals, is 100 dB re 20 μPa rms (unweighted). For harbor seals, the threshold is 90 dB re 20 μPa rms (unweighted). A spherical spreading loss model, assuming average atmospheric conditions, was used to estimate the distance to the 100 dB and 90 dB re 20 μPa rms (unweighted) airborne thresholds. The formula for calculating spherical spreading loss is:

$TL = 20\log(R_1/R_2)$

TL = Transmission loss

R_1 = the distance of the modeled SPL from the driven pile, and

R_2 = the distance from the driven pile of the initial measurement.

Airborne Sound From Pile Installation—As was discussed for underwater sound from pile driving, the intensity of pile driving sounds is greatly influenced by factors such as the type of piles, hammers, and the physical environment in which the activity takes place. In order to determine reasonable airborne SPLs and their associated effects on marine mammals that are likely to result from pile driving at NBKB, studies with similar properties to the proposed action, as described previously, were evaluated. Table 6 details representative pile driving activities that have occurred in recent years. Due to the similarity of these actions and the Navy's proposed action, they represent reasonable SPLs which could be anticipated.

TABLE 6—AIRBORNE SPLS FROM SIMILAR CONSTRUCTION ACTIVITIES

Project & location	Pile size &type	Method	Water depth	Measured SPLs
Northstar Island, AK[1]	42-in (1.1 m) steel pipe pile	Impact	Approximately 12 m (40 ft)	97 dB re 20 μPa (rms) at 160 m (525 ft).
Keystone Ferry Terminal, WA[3].	30-in (0.8 m) steel pipe pile	Vibratory	Approximately 9 m (30 ft)	97 dB re 20 μPa (rms) at 13 m (40 ft).

Sources: Blackwell *et al.,* 2004; Laughlin, 2010b.

Based on in-situ recordings from similar construction activities, the maximum airborne sound levels that would result from impact and vibratory pile driving are estimated to be 97 dB rms re 20 μPa at 160 m and 97 dB rms re 20 μPa at 13 m, respectively (Blackwell *et al.,* 2004; Laughlin, 2010b). The distances to the airborne thresholds were calculated with the airborne transmission loss formula presented previously. The Navy has analyzed the combined sound field produced under the multi-rig scenario and calculated the radial distances to the 90 and 100 dB airborne thresholds as 361 m (1,184 ft) and 114 m (374 ft), respectively, equating to areas of 0.41 km^2 (0.16 mi^2) and 0.04 km^2 (0.02 mi^2), respectively. These distances would be significantly less for the vibratory driver alone, approximately 28 m (92 ft) and 9 m (30 ft), respectively.

All airborne distances are less than those calculated for underwater sound thresholds. Protective measures would be in place out to the distances calculated for the underwater thresholds, and the distances for the airborne thresholds would be covered fully by mitigation and monitoring measures in place for underwater sound thresholds. Construction sound associated with the project would not extend beyond the buffer zone for underwater sound that would be established to protect pinnipeds. No haul-outs or rookeries are located within the airborne harassment radii. See Figure 6–2 of the Navy's application for a depiction of the size of areas in which each airborne sound threshold is predicted to occur at the project area due to pile driving.

Description of Marine Mammals in the Area of the Specified Activity

There are six marine mammal species, three cetaceans and three pinnipeds, which may inhabit or transit through the waters nearby NBKB in the Hood Canal. These include the transient killer whale, harbor porpoise, Dall's porpoise, Steller sea lion, California sea lion, and the harbor seal. While the Southern Resident killer whale is resident to the inland waters of Washington and British Columbia, it has not been observed in the Hood Canal in over 15 years, and therefore was excluded from further analysis. The Steller sea lion is the only marine mammal that occurs within the Hood Canal which is listed under the ESA; the Eastern DPS is listed as threatened. All marine mammal species are protected under the MMPA. This section summarizes the population status and abundance of these species, followed by detailed life history information. Table 7 lists the marine mammal species that occur in the vicinity of NBKB and their estimated densities within the project area during the proposed timeframe. Daily maximum abundance data only is presented for sea lions because sightings data have no defined survey area.

TABLE 7—MARINE MAMMALS PRESENT IN THE HOOD CANAL IN THE VICINITY OF NBKB

Species	Stock abundance[1]	Relative occurrence in Hood Canal	Season of occurrence	Density during in-water work season[3] (individuals/km^2)
Steller sea lion				
Eastern U.S.DPS	58,334–72,223[2]	Occasional presence	Fall to late spring (Oct to mid-April).	[3] 1.2
California sea lion				
U.S. Stock	238,000	Common	Fall to late spring (Aug to early June).	[3] 26.2
Harbor seal				
WA inland waters stock	14,612 (CV = 0.15).	Common	Year-round; resident species in Hood Canal.	[4] 1.31
Killer whale				
West Coast transient stock	354	Rare to occasional presence	Year-round	[5] 0.038
Dall's porpoise				
CA/OR/WA stock	42,000 (CV = 0.33).	Rare to occasional presence	Year-round	[6] 0.014
Harbor porpoise				
WA inland waters stock	10,682 (CV = 0.38).	Possible regular to occasional presence.	Year-round	[7] 0.250

[1] NMFS marine mammal stock assessment reports at: *http://www.nmfs.noaa.gov/pr/sars/species.htm.*

[2] Range calculated on basis of total pup counts 2006–2009 and extrapolation factors derived from vital rate parameters estimated for an increasing population.

[3] Density for sea lions is not calculated due to the lack of a defined survey area for sightings data. Abundance calculated as the average of the maximum number of individuals present during shore-based surveys at NBKB waterfront during the in-water construction season.

[4] Jeffries *et al.,* 2003; Huber *et al.,* 2001.

[5] Density calculated as the maximum number of individuals present at a given time during occurrences of killer whales at Hood Canal in 2003 and 2005 (London 2006) divided by the area of Hood Canal.

[6] Density calculated from number of individuals observed in 18 vessel-based surveys of NBKB waterfront area (Tannenbaum *et al.,* 2009, 2011).

[7] Density calculated from number of individuals observed during vessel-based surveys conducted during Test Pile Program and corrected for detectability (Navy, in prep.).

Steller Sea Lion

Species Description—Steller sea lions are the largest members of the Otariid (eared seal) family. Steller sea lions show marked sexual dimorphism, in which adult males are noticeably larger and have distinct coloration patterns from females. Males average approximately 1,500 lb (680 kg) and 10 ft (3 m) in length; females average about 700 lb (318 kg) and 8 ft (2.4 m) in length. Adult females have a tawny to silver-colored pelt. Males are characterized by dark, dense fur around their necks, giving a mane-like appearance, and light tawny coloring over the rest of their body (NMFS, 2008a). Steller sea lions are distributed mainly around the coasts to the outer continental shelf along the North Pacific Ocean rim from northern Hokkaido, Japan through the Kuril Islands and Okhotsk Sea, Aleutian Islands and central Bering Sea, southern coast of Alaska and south to California. The population is divided into the Western and the Eastern Distinct Population Segments (DPSs) at 144°W (Cape Suckling, Alaska). The Western DPS includes Steller sea lions that reside in the central and western Gulf of Alaska, Aleutian Islands, as well as those that inhabit coastal waters and breed in Asia (*e.g.,* Japan and Russia). The Eastern DPS extends from California to Alaska, including the Gulf of Alaska.

Status—Steller sea lions were listed as threatened range-wide under the ESA in 1990. After division into two stocks, the western stock was listed as endangered under the ESA in 1997 and the eastern stock remained classified as threatened. Animals found in the project area are from the eastern stock (NMFS, 1997a; Loughlin, 2002; Angliss and Outlaw, 2005). The eastern stock breeds in rookeries located in southeast Alaska, British Columbia, Oregon, and California; there are no rookeries located in Washington. A final revised species recovery plan addresses both stocks (NMFS, 2008a).

Critical habitat was designated for Steller sea lions in 1993. Critical habitat is associated with breeding and haul-out sites in Alaska, California, and Oregon, and includes so-called 'aquatic zones' that extend 3,000 ft (0.9 km) seaward in state and federally managed waters from the baseline or basepoint of each major rookery in Oregon and California (NMFS, 2008a). Three major rookery sites in Oregon (Rogue Reef, Pyramid Rock, and Long Brown Rock and Seal Rock on Orford Reef at Cape Blanco) and three rookery sites in California (Ano Nuevo I, Southeast Farallon I, and Sugarloaf Island and Cape Mendocino) are designated critical habitat (NMFS, 1993). There is no designated critical habitat within the project area.

Limiting factors for recovery of Steller sea lions include reduced food availability, possibly resulting from competition with commercial fisheries; incidental take and intentional kills during commercial fish harvests; subsistence take; entanglement in marine debris; disease; pollution; and harassment. The change in food availability, associated with lowered nutritional status of females and consequent reduced juvenile recruitment, may be the primary cause of the decline (60 FR 51968). Declines of this species in the early 1980s were associated with exceedingly low juvenile survivorship, whereas declines in the 1990s were associated with disproportionately low fecundity (Holmes and York, 2003). Steller sea lions are also sensitive to disturbance at rookeries (during pupping and breeding) and haul-out sites.

The abundance of the Eastern DPS of Steller sea lions is increasing throughout the northern portion of its range (Southeast Alaska and British Columbia), and stable or increasing slowly in the central portion (Oregon through central California). In the southern end of its range (Channel Islands in southern California), it has declined significantly since the late 1930s, and several rookeries and haul-outs have been abandoned. Changes in ocean conditions (*e.g.,* warmer temperatures) may be contributing to habitat changes that favor California sea lions over Steller sea lions in the southern portion of the Steller's range (NMFS, 2007).

The eastern stock was estimated by NMFS in the Recovery Plan for the Steller Sea Lion to number between 45,000 to 51,000 animals (NMFS, 2008a). This stock has been increasing approximately three percent per year over the entire range since the late 1970s (NMFS, 2008a; Pitcher *et al.,* 2007). The most recent population estimate for the eastern stock is a minimum of 52,847 individuals; this estimate is not corrected for animals at sea. Actual population is estimated to be within the range 58,334 to 72,223 (Allen and Angliss, 2010). The most recent minimum count for Steller sea lions in Oregon and Washington was 5,813 in 2002 (Pitcher *et al.,* 2007; Allen and Angliss, 2010).

The eastern U.S. stock of Steller sea lion is currently listed as threatened under the ESA, and is therefore designated as depleted and classified as a strategic stock under the MMPA. However, the eastern stock of Steller sea lions has been considered a potential candidate for removal from listing under the ESA by the Steller sea lion recovery team and NMFS (NMFS, 2008), based on its annual rate of increase of approximately three percent since the mid-1970s. Although the stock size has increased, the status of this stock relative to its Optimum Sustainable Population (OSP) size is unknown. The overall annual rate of increase of 3.1 percent throughout most of the range (Oregon to southeastern Alaska) of the eastern stock has been consistent and long-term, and may indicate that this stock is reaching OSP size (Pitcher *et al.,* 2007).

Behavior and Ecology—Steller sea lions forage near shore and in pelagic waters. They are capable of traveling long distances in a season and can dive to approximately 1,300 ft (400 m) in depth. They also use terrestrial habitat as haul-out sites for periods of rest, molting, and as rookeries for mating and pupping during the breeding season. At sea, they are often seen alone or in small groups, but may gather in large rafts at the surface near rookeries and haul-outs. Steller sea lions prefer the colder temperate to sub-arctic waters of the North Pacific Ocean. Haul-outs and rookeries usually consist of beaches (gravel, rocky or sand), ledges, and rocky reefs. In the Bering and Okhotsk Seas, sea lions may also haul-out on sea ice, but this is considered atypical behavior (NOAA, 2010a).

Steller sea lions are gregarious animals that often travel or haul out in large groups of up to 45 individuals (Keple, 2002). At sea, groups usually consist of female and subadult males; adult males are usually solitary while at sea (Loughlin, 2002). In the Pacific Northwest, breeding rookeries are located in British Columbia, Oregon, and northern California. Steller sea lions form large rookeries during late spring when adult males arrive and establish territories (Pitcher and Calkins, 1981). Large males aggressively defend territories while non-breeding males remain at peripheral sites or haul-outs. Females arrive soon after and give birth. Most births occur from mid-May through mid-July, and breeding takes place shortly thereafter. Most pups are weaned within a year. Non-breeding individuals may not return to rookeries during the breeding season but remain at other coastal haul-outs (Scordino, 2006).

Steller sea lions are opportunistic predators, feeding primarily on fish and cephalopods, and their diet varies geographically and seasonally (Bigg, 1985; Merrick *et al.,* 1997; Bredesen *et al.,* 2006; Guenette *et al.,* 2006). Foraging habitat is primarily shallow, nearshore and continental shelf waters; freshwater rivers; and also deep waters (Reeves *et al.,* 2008; Scordino, 2010). Steller sea lions occupy major winter haul-out sites on the coast of Vancouver Island in the Strait of Juan de Fuca and the Georgia Basin (Bigg, 1985; Olesiuk, 2008); the closest breeding rookery to the project area is at Carmanah Point near the western entrance to the Strait of Juan de Fuca. There are no known breeding rookeries in Washington (NMFS, 1992; Angliss and Outlaw, 2005) but Eastern stock Steller sea lions are present year-round along the outer coast of Washington at four major haul-out sites (NMFS, 2008a). Both sexes are present in Washington waters; these animals are likely immature or non-breeding adults from rookeries in other areas (NMFS, 2008a). In Washington, Steller sea lions primarily occur at haul-out sites along the outer coast from the Columbia River to Cape Flattery. In inland waters, Steller sea lions use haul-out sites along the Vancouver Island coastline of the Strait of Juan de Fuca (Jeffries *et al.,* 2000; COSEWIC, 2003; Olesiuk, 2008). Numbers vary seasonally in Washington waters with peak numbers present during the fall and winter months (Jeffries *et al.,* 2000). The highest breeding season Steller sea lion count at Washington haul-out sites was 847 individuals during the period from 1978 to 2001 (Pitcher *et al.,* 2007). Non-breeding season surveys of Washington haul-out sites reported as many as 1,458 individuals between 1980 and 2001 (NMFS, 2008a).

Steller sea lions are occasionally present at the Toliva Shoals haul-out site in south Puget Sound (Jeffries *et al.,* 2000) and a rock three miles south of Marrowstone Island (NMFS, 2010). Fifteen Steller sea lions have been observed using this haul-out site. At NBKB, Steller sea lions have been observed hauled out on submarines at Delta Pier on several occasions from 2008 through 2011 during fall through spring months (October to April) (Navy 2010). Other potential haul-out sites may include isolated islands, rocky shorelines, jetties, buoys, rafts, and floats (Jeffries *et al.,* 2000). Steller sea lions likely utilize foraging habitats in Hood Canal similar to those of the California sea lion and harbor seal, which include marine nearshore and deeper water habitats.

Acoustics—Like all pinnipeds, the Steller sea lion is amphibious; while all foraging activity takes place in the water, breeding behavior is carried out on land in coastal rookeries (Mulsow and Reichmuth 2008). On land, territorial male Steller sea lions regularly use loud, relatively low-frequency calls/roars to establish breeding territories (Schusterman *et al.,* 1970; Loughlin *et al.,* 1987). The calls of females range from 0.03 to 3 kHz, with peak frequencies from 0.15 to 1 kHz; typical duration is 1.0 to 1.5 sec (Campbell *et al.,* 2002). Pups also produce bleating sounds. Individually distinct vocalizations exchanged between mothers and pups are thought to be the main modality by which reunion occurs when mothers return to crowded rookeries following foraging at sea (Mulsow and Reichmuth, 2008).

Mulsow and Reichmuth (2008) measured the unmasked airborne hearing sensitivity of one male Steller sea lion. The range of best hearing sensitivity was between 5 and 14 kHz. Maximum sensitivity was found at 10 kHz, where the subject had a mean threshold of 7 dB. The underwater hearing threshold of a male Steller sea lion was significantly different from that of a female. The peak sensitivity range for the male was from 1 to 16 kHz, with maximum sensitivity (77 dB re: 1μPa-m) at 1 kHz. The range of best hearing for the female was from 16 to above 25 kHz, with maximum sensitivity (73 dB re: 1μPa-m) at 25 kHz. However, because of the small number of animals tested, the findings could not be attributed to either individual differences in sensitivity or sexual dimorphism (Kastelein *et al.,* 2005).

California Sea Lion

Species Description—California sea lions are members of the Otariid family (eared seals). The species, *Zalophus californianus,* includes three subspecies: *Z. c. wollebaeki* (in the Galapagos Islands), *Z. c. japonicus* (in Japan, but now thought to be extinct), and *Z. c. californianus* (found from southern Mexico to southwestern Canada; referred to here as the California sea lion) (Carretta *et al.,* 2007). The California sea lion is sexually dimorphic. Males may reach 1,000 lb (454 kg) and 8 ft (2.4 m) in length; females grow to 300 lb (136 kg) and 6 ft (1.8 m) in length. Their color ranges from chocolate brown in males to a lighter, golden brown in females. At around five years of age, males develop a bony bump on top of the skull called a sagittal crest. The crest is visible in the dog-like profile of male sea lion heads, and hair around the crest gets lighter with age.

Status—The U.S. stock of California sea lions is estimated at 238,000 and the minimum population size of this stock is 141,842 individuals (Carretta *et al.,* 2007). These numbers are from counts during the 2001 breeding season of animals that were ashore at the four major rookeries in southern California and at haul-out sites north to the Oregon/California border. Sea lions that were at-sea or hauled-out at other locations were not counted (Carretta *et al.,* 2007). The stock has likely reached its carrying capacity and, even though current total human-caused mortality is unknown (due to a lack of observer coverage in the California set gillnet fishery that historically has been the largest source of human-caused mortalities), California sea lions are not considered a strategic stock under the MMPA because total human-caused mortality is still likely to be less than the potential biological removal (PBR). An estimated 3,000 to 5,000 California sea lions migrate to waters of Washington and British Columbia during the non-breeding season from September to May (Jeffries *et al.,* 2000). Peak numbers of up to 1,000 California sea lions occur in Puget Sound (including Hood Canal) during this time period (Jeffries *et al.,* 2000).

Distribution—The geographic distribution of California sea lions includes a breeding range from Baja California, Mexico to southern California. During the summer, California sea lions breed on islands from the Gulf of California to the Channel Islands and seldom travel more than about 31 mi (50 km) from the islands (Bonnell *et al.,* 1983). The primary rookeries are located on the California Channel Islands of San Miguel, San Nicolas, Santa Barbara, and San Clemente (Le Boeuf and Bonnell, 1980; Bonnell and Dailey, 1993). Their distribution shifts to the northwest in fall and to the southeast during winter and spring, probably in response to changes in prey availability (Bonnell and Ford, 1987).

The non-breeding distribution extends from Baja California north to Alaska for males, and encompasses the waters of California and Baja California for females (Reeves *et al.,* 2008; Maniscalco *et al.,* 2004). In the non-breeding season, an estimated 3,000–5,000 adult and sub-adult males migrate northward along the coast to central and northern California, Oregon, Washington, and Vancouver Island from September to May (Jeffries *et al.,* 2000) and return south the following spring (Mate, 1975; Bonnell *et al.,* 1983). Along their migration, they are occasionally sighted hundreds of miles offshore (Jefferson *et al.,* 1993). Females and juveniles tend to stay closer to the rookeries (Bonnell *et al.,* 1983).

California sea lions are present in Hood Canal during much of the year with the exception of mid-June through August, and occur regularly in the vicinity of the project site, as observed during Navy waterfront surveys conducted at NBKB from April 2008 through June 2010 (Navy, 2010). They are known to utilize man-made structures such as piers, jetties, offshore buoys, log booms, and oil platforms (Riedman, 1990), and are often seen rafted off of river mouths (Jeffries *et al.,* 2000). Although there are no regular California sea lion haul-outs known within the Hood Canal (Jeffries *et al.,* 2000), they are frequently observed hauled out at several opportune areas at NBKB (*e.g.,* submarines, floating security fence, barges). As many as 58 California sea lions have been observed hauled out together at NBKB (Agness and Tannenbaum, 2009a; Tannenbaum *et al.,* 2009a; Walters, 2009). California sea lions have also been observed swimming in the Hood Canal in the vicinity of the project area on several occasions and likely forage in both nearshore marine and inland marine deeper waters (DoN, 2001a).

Behavior and Ecology—California sea lions feed on a wide variety of prey, including many species of fish and squid (Everitt *et al.,* 1981; Roffe and Mate, 1984; Antonelis *et al.,* 1990; Lowry *et al.,* 1991). In the Puget Sound region, they feed primarily on fish such as Pacific hake (*Merluccius productus*), walleye pollock (*Theragra chalcogramma*), Pacific herring (*Clupea pallasii*), and spiny dogfish (*Squalus acanthias*) (Calambokidis and Baird, 1994). In some locations where salmon runs exist, California sea lions also feed on returning adult and out-migrating juvenile salmonids (London, 2006). Sexual maturity occurs at around four to five years of age for California sea lions (Heath, 2002). California sea lions are gregarious during the breeding season and social on land during other times.

Acoustics—On land, California sea lions make incessant, raucous barking sounds; these have most of their energy at less than 2 kHz (Schusterman *et al.,* 1967). Males vary both the number and rhythm of their barks depending on the social context; the barks appear to control the movements and other behavior patterns of nearby conspecifics (Schusterman, 1977). Females produce barks, squeals, belches, and growls in the frequency range of 0.25–5 kHz, while pups make bleating sounds at 0.25–6 kHz. California sea lions produce two types of underwater sounds: clicks (or short-duration sound pulses) and barks (Schusterman *et al.,* 1966, 1967; Schusterman and Baillet, 1969). All underwater sounds have most of their energy below 4 kHz (Schusterman *et al.,* 1967).

The range of maximal hearing sensitivity underwater is between 1–28 kHz (Schusterman *et al.,* 1972). Functional underwater high frequency hearing limits are between 35–40 kHz, with peak sensitivities from 15–30 kHz (Schusterman *et al.,* 1972). The California sea lion shows relatively poor hearing at frequencies below 1 kHz (Kastak and Schusterman, 1998). Peak hearing sensitivities in air are shifted to lower frequencies; the effective upper hearing limit is approximately 36 kHz (Schusterman, 1974). The best range of sound detection is from 2–16 kHz (Schusterman, 1974). Kastak and Schusterman (2002) determined that hearing sensitivity generally worsens with depth—hearing thresholds were lower in shallow water, except at the highest frequency tested (35 kHz), where this trend was reversed. Octave band sound levels of 65–70 dB above the animal's threshold produced an average temporary threshold shift (TTS; discussed later in ''Potential Effects of the Specified Activity on Marine Mammals'') of 4.9 dB in the California sea lion (Kastak *et al.,* 1999).

Harbor Seal

Species Description—Harbor seals, which are members of the Phocid family (true seals), inhabit coastal and estuarine waters and shoreline areas from Baja California, Mexico to western Alaska. For management purposes, differences in mean pupping date (*i.e.,* birthing) (Temte, 1986), movement patterns (Jeffries, 1985; Brown, 1988), pollutant loads (Calambokidis *et al.,* 1985) and fishery interactions have led to the recognition of three separate harbor seal stocks along the west coast of the continental U.S. (Boveng, 1988). The three distinct stocks are: (1) Inland waters of Washington (including Hood Canal, Puget Sound, and the Strait of Juan de Fuca out to Cape Flattery), (2) outer coast of Oregon and Washington, and (3) California (Carretta *et al.,* 2007). The inland waters of Washington stock is the only stock that is expected to occur within the project area.

The average weight for adult seals is about 180 lb (82 kg) and males are slightly larger than females. Male harbor seals weigh up to 245 lb (111 kg) and measure approximately 5 ft (1.5 m) in length. The basic color of harbor seals' coat is gray and mottled but highly variable, from dark with light color rings or spots to light with dark markings (NMFS, 2008c).

Status—Estimated population numbers for the inland waters of Washington, including the Hood Canal, Puget Sound, and the Strait of Juan de Fuca out to Cape Flattery, are 14,612 individuals (Carretta *et al.,* 2007). The minimum population is 12,844 individuals. The harbor seal is the only species of marine mammal that is consistently abundant and considered resident in the Hood Canal (Jeffries *et al.,* 2003). The population of harbor seals in Hood Canal is a closed population, meaning that they do not have much movement outside of Hood Canal (London, 2006). The abundance of harbor seals in Hood canal has stabilized, and the population may have reached its carrying capacity in the mid-1990s with an approximate abundance of 1,000 harbor seals (Jeffries *et al.,* 2003).

Harbor seals are not considered to be depleted under the MMPA or listed under the ESA. Human-caused mortality relative to PBR is unknown, but it is considered to be small relative to the stock size. Therefore, the Washington Inland Waters stock of harbor seals is not classified as a strategic stock.

Distribution—Harbor seals are coastal species, rarely found more than 12 mi (20 km) from shore, and frequently occupy bays, estuaries, and inlets (Baird 2001). Individual seals have been observed several miles upstream in coastal rivers. Ideal harbor seal habitat includes haul-out sites, shelter during the breeding periods, and sufficient food (Bjorge, 2002). Haul-out areas can include intertidal and subtidal rock outcrops, sandbars, sandy beaches, peat banks in salt marshes, and man-made structures such as log booms, docks, and recreational floats (Wilson, 1978; Prescott, 1982; Schneider and Payne, 1983; Gilber and Guldager, 1998; Jeffries *et al.,* 2000). Human disturbance can affect haul-out choice (Harris *et al.,* 2003).

Harbor seals occur throughout Hood Canal and are seen relatively commonly in the area. They are year-round, non-migratory residents, and pup (*i.e.,* give birth) in Hood Canal. Surveys in the Hood Canal from the mid-1970s to 2000 show a fairly stable population between 600–1,200 seals (Jeffries *et al.,* 2003). Harbor seals have been observed swimming in the waters along NBKB in every month of surveys conducted from 2007–2010 (Agness and Tannenbaum, 2009b; Tannenbaum *et al.,* 2009b). On the NBKB waterfront, harbor seals have not been observed hauling out in the intertidal zone, but have been observed hauled-out on man-made structures such as the floating security fence, buoys, barges, marine vessels, and logs (Agness and Tannebaum, 2009a; Tannenbaum *et al.,* 2009a). The main haul-out locations for harbor seals in Hood Canal are located on river delta and tidal exposed areas at Quilcene, Dosewallips, Duckabush, Hamma Hamma, and Skokomish River mouths (see Figure 4–1 of the Navy's application), with the closest haul-out area to the project area being ten miles (16 km) southwest of NBKB at Dosewallips River mouth, outside the potential area of effect for this project (London, 2006).

Behavior and Ecology—Harbor seals are typically seen in small groups resting on tidal reefs, boulders, mudflats, man-made structures, and sandbars. Harbor seals are opportunistic feeders that adjust their patterns to take advantage of locally and seasonally abundant prey (Payne and Selzer 1989; Baird 2001; Bjørge 2002). The harbor seal diet consists of fish and invertebrates (Bigg, 1981; Roffe and Mate, 1984; Orr *et al.,* 2004). Although harbor seals in the Pacific Northwest are common in inshore and estuarine waters, they primarily feed at sea (Orr *et al.,* 2004) during high tide. Researchers have found that they complete both shallow and deep dives during hunting depending on the availability of prey (Tollit *et al.,* 1997). Their diet in Puget Sound consists of many of the prey resources that are present in the nearshore and deeper waters of NBKB, including hake, herring and adult and out-migrating juvenile salmonids. Harbor seals in Hood Canal are known to feed on returning adult salmon, including ESA-threatened summer-run chum (*Oncorhynchus keta*). Over a 5-year study of harbor seal predation in the Hood Canal, the average percent escapement of summer-run chum consumed was eight percent (London, 2006).

Harbor seals mate at sea and females give birth during the spring and summer, although the pupping season varies by latitude. In coastal and inland regions of Washington, pups are born from April through January. Pups are generally born earlier in the coastal areas and later in the Puget Sound/Hood Canal region (Calambokidis and Jeffries, 1991; Jeffries *et al.,* 2000). Suckling harbor seal pups spend as much as forty percent of their time in the water (Bowen *et al.,* 1999).

Acoustics—In air, harbor seal males produce a variety of low-frequency (less than 4 kHz) vocalizations, including snorts, grunts, and growls. Male harbor seals produce communication sounds in the frequency range of 100–1,000 Hz (Richardson *et al.,* 1995). Pups make individually unique calls for mother recognition that contain multiple harmonics with main energy below 0.35 kHz (Bigg, 1981; Thomson and Richardson, 1995). Harbor seals hear nearly as well in air as underwater and had lower thresholds than California sea lions (Kastak and Schusterman, 1998). Kastak and Schusterman (1998) reported airborne low frequency (100 Hz) sound detection thresholds at 65.4 dB re 20 μPa for harbor seals. In air, they hear frequencies from 0.25–30 kHz and are most sensitive from 6–16 kHz (Richardson, 1995; Terhune and Turnbull, 1995; Wolski *et al.,* 2003).

Adult males also produce underwater sounds during the breeding season that typically range from 0.25–4 kHz (duration range: 0.1 s to multiple seconds; Hanggi and Schusterman 1994). Hanggi and Schusteman (1994) found that there is individual variation in the dominant frequency range of sounds between different males, and Van Parijs *et al.* (2003) reported oceanic, regional, population, and site-specific variation that could be vocal dialects. In water, they hear frequencies from 1–75 kHz (Southall *et al.,* 2007) and can detect sound levels as weak as 60–85 dB re 1 μPa within that band. They are most sensitive at frequencies below 50 kHz; above 60 kHz sensitivity rapidly decreases.

Killer Whale

Species Description—Killer whales are members of the Delphinid family and are the most widely distributed cetacean species in the world. Killer whales have a distinctive color pattern, with black dorsal and white ventral portions. They also have a conspicuous white patch above and behind the eye and a highly variable gray or white saddle area behind the dorsal fin. The species shows considerable sexual dimorphism. Adult males develop larger pectoral flippers, dorsal fins, tail flukes, and girths than females. Male adult killer whales can reach up to 32 ft (9.8 m) in length and weigh nearly 22,000 lb (10,000 kg); females reach 28 ft (8.5 m) in length and weigh up to 16,500 lb (7,500 kg).

Based on appearance, feeding habits, vocalizations, social structure, and distribution and movement patterns there are three types of populations of killer whales (Wiles, 2004; NMFS, 2005). The three distinct forms or types of killer whales recognized in the North Pacific Ocean are: (1) Resident, (2) Transient, and (3) Offshore. The resident and transient populations have been divided further into different subpopulations based mainly on genetic analyses and distribution; not enough is known about the offshore whales to divide them into subpopulations (Wiles, 2004). Only transient killer whales are known from the project area.

Transient killer whales occur throughout the eastern North Pacific, and have primarily been studied in coastal waters. Their geographical range overlaps that of the resident and offshore killer whales. The dorsal fin of transient whales tends to be more erect (straighter at the tip) than those of resident and offshore whales (Ford and Ellis, 1999; Ford *et al.,* 2000). Saddle patch pigmentation of transient killer whales is restricted to two patterns, and never has the large areas of black pigmentation intruding into the white of the saddle patch that is seen in resident and offshore types. Transient type whales are often found in long-term stable social units that tend to be smaller than resident social groups (*e.g.,* fewer than ten whales); these social units do not seem as permanent as matrilines are in resident type whales. Transient killer whales feed nearly exclusively on marine mammals (Ford and Ellis, 1999), whereas resident whales primarily eat fish. Offshore whales are presumed to feed primarily on fish, and have been documented feeding on sharks.

Within the transient type, association data (Ford *et al.,* 1994; Ford and Ellis, 1999; Matkin *et al.,* 1999), acoustic data (Saulitis, 1993; Ford and Ellis, 1999) and genetic data (Hoelzel *et al.,* 1998, 2002; Barrett-Lennard, 2000) confirms that three communities of transient whales exist and represent three discrete populations: (1) Gulf of Alaska, Aleutian Islands, and Bering Sea transients, (2) AT1 transients (Prince William Sound, AK; listed as depleted under the MMPA), and (3) West Coast transients. Among the genetically distinct assemblages of transient killer whales in the northeastern Pacific, only the West Coast transient stock, which occurs from southern California to southeastern Alaska, may occur in the project area.

Status—The West Coast transient stock is a trans-boundary stock, with minimum counts for the population of transient killer whales coming from various photographic datasets. Combining these counts of cataloged transient whales gives a minimum number of 354 individuals for the West Coast transient stock (Allen and Angliss, 2010). However, the number in Washington waters at any one time is probably fewer than twenty individuals (Wiles, 2004). The West Coast transient killer whale stock is not designated as depleted under the MMPA or listed under the ESA. The estimated annual level of human-caused mortality and serious injury does not exceed the PBR. Therefore, the West Coast Transient stock of killer whales is not classified as a strategic stock. Population trends and status of this stock relative to its Optimum Sustainable Population (OSP) level are currently unknown.

Distribution—The geographical range of transient killer whales includes the northeast Pacific, with preference for coastal waters of southern Alaska and British Columbia (Krahn *et al.,* 2002). Transient killer whales in the eastern North Pacific spend most of their time along the outer coast, but visit Hood Canal and the Puget Sound in search of harbor seals, sea lions, and other prey. Transient occurrence in inland waters appears to peak during August and September (Morton, 1990; Baird and Dill, 1995; Ford and Ellis, 1999) which is the peak time for harbor seal pupping, weaning, and post-weaning (Baird and Dill, 1995). In 2003 and 2005, small groups of transient killer whales (eleven and six individuals, respectively) visited Hood Canal to feed on harbor seals and remained in the area for significant periods of time (59 and 172 days, respectively) between the months of January and July.

Behavior and Ecology—Transient killer whales show greater variability in habitat use, with some groups spending most of their time foraging in shallow waters close to shore while others hunt almost entirely in open water (Felleman *et al.,* 1991; Baird and Dill, 1995; Matkin and Saulitis, 1997). Transient killer whales feed on marine mammals and some seabirds, but apparently no fish (Morton, 1990; Baird and Dill, 1996; Ford *et al.,* 1998; Ford and Ellis, 1999; Ford *et al.,* 2005). While present in Hood Canal in 2003 and 2005, transient killer whales preyed on harbor seals in the subtidal zone of the nearshore marine and inland marine deeper water habitats (London, 2006). Other observations of foraging transient killer whales indicate they prefer to forage on pinnipeds in shallow, protected waters (Heimlich-Boran, 1988; Saulitis *et al.,* 2000). Transient killer whales travel in small, matrilineal groups, but they typically contain fewer than ten animals and their social organization generally is more flexible than that of resident killer whales (Morton, 1990, Ford and Ellis, 1999). These differences in social organization probably relate to differences in foraging (Baird and Whitehead, 2000). There is no information on the reproductive behavior of killer whales in this area.

Acoustics—Killer whales produce a wide variety of clicks and whistles, but most of their sounds are pulsed, with frequencies ranging from 0.5–25 kHz (dominant frequency range: 1–6 kHz) (Thomson and Richardson, 1995; Richardson *et al.,* 1995). Source levels of echolocation signals range between 195–224 dB re 1 µPa-m peak-to-peak (p-p), dominant frequencies range from 20–60 kHz, with durations of about 0.1 s (Au *et al.,* 2004). Source levels associated with social sounds have been calculated to range between 131–168 dB re 1 µPa-m and vary with vocalization type (Veirs, 2004).

Both behavioral and auditory brainstem response techniques indicate killer whales can hear in a frequency range of 1–100 kHz and are most sensitive at 20 kHz. This is one of the lowest maximum-sensitivity frequencies known among toothed whales (Szymanski *et al.,* 1999).

Dall's Porpoise

Species Description—Dall's porpoises are members of the Phocoenid (porpoise) family and are common in the North Pacific Ocean. They can reach a maximum length of just under 8 ft (2.4 m) and weigh up to 480 lb (218 kg). Males are slightly larger and thicker than females, which reach lengths of just under 7 ft (2.1 m) long. The body of Dall's porpoises is a very dark gray or black in coloration with variable contrasting white thoracic panels and white 'frosting' on the dorsal fin and tail that distinguish them from other cetacean species. These markings and colorations vary with geographic region and life stage, with adults having more distinct patterns.

Based on NMFS stock assessment reports, Dall's porpoises within the Pacific U.S. Exclusive Economic Zone are divided into two discrete, noncontiguous areas: (1) waters off California, Oregon, and Washington, and (2) Alaskan waters (Carretta *et al.,* 2008). Only individuals from the CA/OR/WA stock may occur within the project area.

Status—The NMFS population estimate, recently updated in 2010 for the CA/OR/WA stock, is 42,000 (CV = 0.33) which is based on vessel line transect surveys by Barlow (2010) and Forney (2007). The minimum population is considered to be 32,106. Additional numbers of Dall's porpoises occur in the inland waters of Washington, but the most recent estimate was obtained in 1996 (900 animals; CV = 0.40; Calambokidis *et al.,* 1997) and is not included in the overall estimate of abundance for this stock due to the need for more up-to-date information. Dall's porpoise are not listed as depleted under the MMPA or listed under the ESA. The average annual human-caused mortality is estimated to be less than the PBR, and therefore the stock is not classified as a strategic stock under the MMPA. The status of Dall's porpoises in California, Oregon and Washington relative to OSP is not known, and there are insufficient data to evaluate potential trends in abundance.

Distribution—The Dall's porpoise is found from northern Baja California, Mexico, north to the northern Bering Sea and south to southern Japan (Jefferson *et al.,* 1993). The species is only common between 32–62 °N in the eastern North Pacific (Morejohn, 1979; Houck and Jefferson, 1999). North-south movements in California, Oregon, and Washington have been suggested. Dall's porpoises shift their distribution southward during cooler-water periods (Forney and Barlow, 1998). Norris and Prescott (1961) reported finding Dall's porpoises in southern California waters only in the winter, generally when the water temperature was less than 15 °C (59 °F). Seasonal movements have also been noted off Oregon and Washington, where higher densities of Dall's porpoises were sighted offshore in winter and spring and inshore in summer and fall (Green *et al.,* 1992).

In Washington, they are most abundant in offshore waters. They are year-round residents in Washington (Green *et al.,* 1992), but their distribution is highly variable between years, likely due to changes in oceanographic conditions (Forney and Barlow, 1998). Dall's porpoises are observed throughout the year in the Puget Sound north of Seattle (Osborne *et al.,* 1998) and are seen occasionally in southern Puget Sound. Dall's porpoises may also occasionally occur in Hood Canal (Jeffries 2006, personal communication). Nearshore habitats used by Dall's porpoises could include the marine habitats found in the inland marine waters of the Hood Canal. A Dall's porpoise was observed in the deeper water at NBKB in summer 2008 (Tannenbaum *et al.,* 2009a).

Behavior and Ecology—Dall's porpoises can be opportunistic feeders but primarily consume schooling forage fish. They are known to eat squid, crustaceans, and fishes such as blackbelly eelpout (*Lycodopsis pacifica*), herring, pollock, hake, and Pacific sandlance (*Ammodytes hexapterus*) (Walker *et al.,* 1998).

Groups of Dall's porpoises generally include fewer than ten individuals and are fluid, probably aggregating for feeding (Jefferson, 1990, 1991; Houck and Jefferson, 1999). Dall's porpoises become sexually mature at three and a half to eight years of age (Houck and Jefferson, 1999) and give birth to a single calf after ten to twelve months. Breeding and calving typically occurs in the spring and summer (Angell and Balcomb, 1982). In the North Pacific, there is a strong summer calving peak from early June through August (Ferrero and Walker, 1999), and a smaller peak in March (Jefferson, 1989). Resident Dall's porpoises breed in Puget Sound from August to September.

Acoustics—Only short duration pulsed sounds have been recorded for Dall's porpoises (Houck and Jefferson, 1999); this species apparently does not whistle often (Richardson *et al.,* 1995). Dall's porpoises produce short duration (50–1,500 µs), high-frequency, narrow band clicks, with peak energies between 120–160 kHz (Jefferson, 1988). There is no published data on the hearing abilities of this species.

Harbor Porpoise

Species Description—Harbor porpoises belong to the Phocoenid (porpoise) family and are found extensively along the Pacific U.S. coast. Harbor porpoises are small, with males reaching average lengths of approximately 5 ft (1.5 m); Females are slightly larger with an average length of 5.5 ft (1.7 m). The average adult harbor porpoise weighs between 135–170 lb (61–77 kg). Harbor porpoises have a dark grey coloration on their backs, with their belly and throats white. They have a dark grey chin patch and intermediate shades of grey along their sides.

Recent preliminary genetic analyses of samples ranging from Monterey, CA to Vancouver Island, BC indicate that there is small-scale subdivision within the U.S. portion of this range (Chivers *et al.,* 2002). Although geographic structure exists along an almost continuous distribution of harbor porpoises from California to Alaska, stock boundaries are difficult to draw because any rigid line is generally arbitrary from a biological perspective. Nevertheless, based on genetic data and density discontinuities identified from aerial surveys, NMFS identifies eight stocks in the Northeast Pacific Ocean. Pacific coast harbor porpoise stocks include: (1) Monterey Bay, (2) San Francisco-Russian River, (3) northern California/southern Oregon, (4) Oregon/Washington coastal, (5) inland Washington, (6) Southeast Alaska, (7) Gulf of Alaska, and (8) Bering Sea. Only individuals from the Washington Inland Waters stock may occur in the project area.

Status—Aerial surveys of the inland waters of Washington and southern British Columbia were conducted during August of 2002 and 2003 (J. Laake, unpubl. data). These aerial surveys included the Strait of Juan de Fuca, San Juan Islands, Gulf Islands, and Strait of Georgia, which includes waters inhabited by the Washington Inland Waters stock of harbor porpoises as well as harbor porpoises from British Columbia. An average of the 2002 and 2003 estimates of abundance in U.S. waters resulted in an uncorrected abundance of 3,123 (CV= 0.10) harbor porpoises in Washington inland waters (J. Laake, unpubl. data). When corrected for availability and perception bias, the estimated abundance for the Washington Inland Waters stock of harbor porpoise is 10,682 (CV = 0.38) animals (Carretta *et al.,* 2008). The minimum population estimate is 7,841. Harbor porpoise are not listed as depleted under the MMPA or listed under the ESA. Based on currently available data, the total level of human-caused mortality is not known to exceed the PBR. Therefore, the Washington Inland Waters harbor porpoise stock is not classified as strategic. The status of this stock relative to its OSP level and population trends is unknown. Although long-term harbor porpoise sightings in southern Puget Sound have declined since the 1940s, sightings have increased in Puget Sound and northern Hood Canal in recent years and are now considered to regularly occur year-round in these waters (Calambokidis 2010, pers. comm). This may represent a return to historical conditions, when harbor porpoises were considered one of the most common cetaceans in Puget Sound (Scheffer and Slipp 1948).

Distribution—Harbor porpoises are generally found in cool temperate to subarctic waters over the continental shelf in both the North Atlantic and North Pacific (Read 1999). This species is seldom found in waters warmer than 17 °C (63 °F; Read 1999) or south of Point Conception (Hubbs 1960; Barlow and Hanan 1995). Harbor porpoises can be found year-round primarily in the shallow coastal waters of harbors, bays, and river mouths (Green *et al.,* 1992). Along the Pacific coast, harbor porpoises occur from Monterey Bay, California to the Aleutian Islands and west to Japan (Reeves *et al.,* 2002). Harbor porpoises are known to occur in Puget Sound year round (Osmek *et al.,* 1996, 1998; Carretta *et al.,* 2007), and harbor porpoise observations in northern Hood Canal have increased in recent years (Calambokidis 2010, pers. comm.). Prior to recent construction projects conducted by the Navy at NBKB, harbor porpoises were considered as likely occurring only occasionally in the project area. A single harbor porpoise had been sighted in deeper water at NBKB during 2010 field observations (SAIC, 2010). However, while implementing monitoring plans for work conducted from July-October, 2011, the Navy recorded multiple sightings of harbor porpoise in the deeper waters of the project area. Following these sightings, the Navy conducted dedicated line transect surveys, recording multiple additional sightings of harbor porpoise, and have revised local density estimates accordingly. The current density estimates are based upon a small sample size of transect surveys, and may be further revised as more information becomes available from ongoing Navy survey efforts.

Behavior and Ecology—Harbor porpoises are non-social animals usually seen in small groups of two to five animals. Little is known about their social behavior. Harbor porpoises can be opportunistic foragers but primarily consume schooling forage fish (Osmek *et al.,* 1996; Bowen and Siniff, 1999; Reeves *et al.,* 2002). Along the coast of Washington, harbor porpoises primarily feed on herring, market squid (*Loligo opalescens*) and eulachon (*Thaleichthys pacificus*) (Gearin *et al.,* 1994). Females reach sexual maturity at three to four years of age and may give birth every year for several years in a row. Calves are born in late spring (Read, 1990; Read and Hohn, 1995). Dall's and harbor porpoises appear to hybridize relatively frequently in the Puget Sound area (Willis *et al.,* 2004).

Acoustics—Harbor porpoise vocalizations include clicks and pulses (Ketten, 1998), as well as whistle-like signals (Verboom and Kastelein 1995). The dominant frequency range is 110–150 kHz, with source levels of 135–177 dB re 1 µPa-m (Ketten 1998). Echolocation signals include one or two low-frequency components in the 1.4–2.5 kHz range (Verboom and Kastelein 1995).

A behavioral audiogram of a harbor porpoise indicated the range of best sensitivity is 8–32 kHz at levels between 45–50 dB re 1 µPa-m (Andersen 1970); however, auditory-evoked potential studies showed a much higher frequency of approximately 125–130 kHz (Bibikov 1992). The auditory-evoked potential method suggests that the harbor porpoise actually has two frequency ranges of best sensitivity. More recent psycho-acoustic studies found the range of best hearing to be 16–140 kHz, with a reduced sensitivity around 64 kHz (Kastelein *et al.,* 2002). Maximum sensitivity occurs between 100–140 kHz (Kastelein *et al.,* 2002).

Potential Effects of the Specified Activity on Marine Mammals

NMFS has determined that pile driving, as outlined in the project description, has the potential to result in behavioral harassment of Steller sea lions, California sea lions, harbor seals, harbor porpoises, Dall's porpoises, and killer whales that may be swimming, foraging, or resting in the project vicinity while pile driving is being conducted. Pile driving could potentially harass those pinnipeds that are in the water close to the project site, whether their heads are above or below the surface.

Marine Mammal Hearing

The primary effect on marine mammals anticipated from the specified activities would result from exposure of animals to underwater sound. Exposure to sound can affect marine mammal hearing. When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms derived using auditory evoked potential techniques, anatomical modeling, and other data, Southall *et al.* (2007) designate functional hearing groups for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- Low frequency cetaceans (thirteen species of mysticetes): Functional hearing is estimated to occur between approximately 7 Hz and 22 kHz;
- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and nineteen species of beaked and bottlenose whales): Functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;
- High frequency cetaceans (six species of true porpoises, four species of river dolphins, two members of the genus *Kogia,* and four dolphin species of the genus *Cephalorhynchus*): Functional hearing is estimated to occur between approximately 200 Hz and 180 kHz; and
- Pinnipeds in water: Functional hearing is estimated to occur between approximately 75 Hz and 75 kHz, with the greatest sensitivity between approximately 700 Hz and 20 kHz.

As mentioned previously in this document, three pinniped and three cetacean species are likely to occur in the proposed project area. Of the three cetacean species likely to occur in the project area, two are classified as high frequency cetaceans (Dall's and harbor porpoises) and one is classified as a mid-frequency cetacean (killer whales) (Southall *et al.,* 2007).

Underwater Sound Effects

Potential Effects of Pile Driving Sound—The effects of sounds from pile driving might result in one or more of the following: Temporary or permanent hearing impairment, non-auditory physical or physiological effects, behavioral disturbance, and masking (Richardson *et al.,* 1995; Gordon *et al.,* 2004; Nowacek *et al.,* 2007; Southall *et al.,* 2007). The effects of pile driving on marine mammals are dependent on several factors, including the size, type, and depth of the animal; the depth, intensity, and duration of the pile driving sound; the depth of the water column; the substrate of the habitat; the standoff distance between the pile and the animal; and the sound propagation properties of the environment. Impacts to marine mammals from pile driving activities are expected to result primarily from acoustic pathways. As such, the degree of effect is intrinsically related to the received level and duration of the sound exposure, which are in turn influenced by the distance between the animal and the source. The further away from the source, the less intense the exposure should be. The substrate and depth of the habitat affect the sound propagation properties of the environment. Shallow environments are typically more structurally complex, which leads to rapid sound attenuation. In addition, substrates that are soft (*e.g.,* sand) would absorb or attenuate the sound more readily than hard substrates (*e.g.,* rock) which may reflect the acoustic wave. Soft porous substrates would also likely require less time to drive the pile, and possibly less forceful equipment, which would ultimately decrease the intensity of the acoustic source.

In the absence of mitigation, impacts to marine species would be expected to result from physiological and behavioral responses to both the type and strength of the acoustic signature (Viada *et al.,* 2008). The type and severity of behavioral impacts are more difficult to define due to limited studies addressing the behavioral effects of impulsive sounds on marine mammals. Potential effects from impulsive sound sources can range in severity, ranging from effects such as behavioral disturbance, tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to mortality (Yelverton *et al.,* 1973; O'Keefe and Young, 1984; DoN, 2001b).

Hearing Impairment and Other Physical Effects—Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Kastak *et al.,* 1999; Schlundt *et al.,* 2000; Finneran *et al.,* 2002, 2005). TS can be permanent (PTS), in which case the loss of hearing sensitivity is not recoverable, or temporary (TTS), in which case the animal's hearing threshold would recover over time (Southall *et al.,* 2007). Marine mammals depend on acoustic cues for vital biological functions, (*e.g.,* orientation, communication, finding prey, avoiding predators); thus, TTS may result in reduced fitness in survival and reproduction, either permanently or temporarily. However, this depends on both the frequency and duration of TTS, as well as the biological context in which it occurs. TTS of limited duration, occurring in a frequency range that does not coincide with that used for recognition of important acoustic cues, would have little to no effect on an animal's fitness. Repeated sound exposure that leads to TTS could cause PTS. PTS, in the unlikely event that it occurred, would constitute injury, but TTS is not considered injury (Southall *et al.,* 2007). It is unlikely that the project would result in any cases of temporary or especially permanent hearing impairment or any significant non-auditory physical or physiological effects for reasons discussed later in this document. Some behavioral disturbance is expected, but it is likely that this would be localized and short-term because of the short project duration.

Several aspects of the planned monitoring and mitigation measures for this project (see the ''Proposed Mitigation'' and ''Proposed Monitoring and Reporting'' sections later in this document) are designed to detect marine mammals occurring near the pile driving to avoid exposing them to sound pulses that might, in theory, cause hearing impairment. In addition, many cetaceans are likely to show some avoidance of the area where received levels of pile driving sound are high enough that hearing impairment could potentially occur. In those cases, the avoidance responses of the animals themselves would reduce or (most likely) avoid any possibility of hearing impairment. Non-auditory physical effects may also occur in marine mammals exposed to strong underwater pulsed sound. It is especially unlikely that any effects of these types would occur during the present project given the brief duration of exposure for any given individual and the planned monitoring and mitigation measures. The following subsections discuss in somewhat more detail the possibilities of TTS, PTS, and non-auditory physical effects.

Temporary Threshold Shift—TTS is the mildest form of hearing impairment that can occur during exposure to a strong sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises, and a sound must be stronger in order to be heard. In terrestrial mammals, TTS can last from minutes or hours to days (in cases of strong TTS). For sound exposures at or somewhat above the TTS threshold, hearing sensitivity in both terrestrial and marine mammals recovers rapidly after exposure to the sound ends. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals, and none of the published data concern TTS elicited by exposure to multiple pulses of sound. Available data on TTS in marine mammals are summarized in Southall *et al.* (2007).

Given the available data, the received level of a single pulse (with no frequency weighting) might need to be approximately 186 dB re 1 μPa^2-s (*i.e.,* 186 dB sound exposure level [SEL] or approximately 221–226 dB pk-pk) in order to produce brief, mild TTS. Exposure to several strong pulses that each have received levels near 190 dB re 1 μPa rms (175–180 dB SEL) might result in cumulative exposure of approximately 186 dB SEL and thus slight TTS in a small odontocete, assuming the TTS threshold is (to a first approximation) a function of the total received pulse energy. Levels greater than or equal to 190 dB re 1 μPa rms are expected to be restricted to radii no more than 5 m (16 ft) from the pile driving. For an odontocete closer to the surface, the maximum radius with greater than or equal to 190 dB re 1 μPa rms would be smaller.

The above TTS information for odontocetes is derived from studies on the bottlenose dolphin (*Tursiops truncatus*) and beluga whale (*Delphinapterus leucas*). There is no published TTS information for other species of cetaceans. However, preliminary evidence from a harbor porpoise exposed to pulsed sound suggests that its TTS threshold may have been lower (Lucke *et al.,* 2009). To avoid the potential for injury, NMFS has determined that cetaceans should not be exposed to pulsed underwater sound at received levels exceeding 180 dB re 1 μPa rms. As summarized above, data that are now available imply that TTS is unlikely to occur unless odontocetes are exposed to pile driving pulses stronger than 180 dB re 1 μPa rms.

Permanent Threshold Shift—When PTS occurs, there is physical damage to the sound receptors in the ear. In severe cases, there can be total or partial deafness, while in other cases the animal has an impaired ability to hear sounds in specific frequency ranges (Kryter, 1985). There is no specific evidence that exposure to pulses of sound can cause PTS in any marine mammal. However, given the possibility that mammals close to pile driving activity might incur TTS, there has been further speculation about the possibility that some individuals occurring very close to pile driving might incur PTS. Single or occasional occurrences of mild TTS are not indicative of permanent auditory damage, but repeated or (in some cases) single exposures to a level well above that causing TTS onset might elicit PTS.

Relationships between TTS and PTS thresholds have not been studied in marine mammals but are assumed to be similar to those in humans and other terrestrial mammals. PTS might occur at a received sound level at least several decibels above that inducing mild TTS if the animal were exposed to strong sound pulses with rapid rise time. Based on data from terrestrial mammals, a precautionary assumption is that the PTS threshold for impulse sounds (such as pile driving pulses as received close to the source) is at least 6 dB higher than the TTS threshold on a peak-pressure basis and probably greater than 6 dB (Southall *et al.,* 2007). On an SEL basis, Southall *et al.* (2007) estimated that received levels would need to exceed the TTS threshold by at least 15 dB for there to be risk of PTS. Thus, for cetaceans, Southall *et al.* (2007) estimate that the PTS threshold might be an M-weighted SEL (for the sequence of received pulses) of approximately 198 dB re 1 μPa^2-s (15 dB higher than the TTS threshold for an impulse). Given the higher level of sound necessary to cause PTS as compared with TTS, it is considerably less likely that PTS could occur.

Non-auditory Physiological Effects—Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage (Cox *et al.,* 2006; Southall *et al.,* 2007). Studies examining such effects are limited. In general, little is known about the potential for pile driving to cause auditory impairment or other physical effects in marine mammals. Available data suggest that such effects, if they occur at all, would presumably be limited to short distances from the sound source and to activities that extend over a prolonged period. The available data do not allow identification of a specific exposure level above which non-auditory effects can be expected (Southall *et al.,* 2007) or any meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in those ways. Marine mammals that show behavioral avoidance of pile driving, including some odontocetes and some pinnipeds, are especially unlikely to incur auditory impairment or non-auditory physical effects.

Measured source levels from impact pile driving can be as high as 214 dB re 1 μPa at 1 m (3.3 ft). Although no marine mammals have been shown to experience TTS or PTS as a result of being exposed to pile driving activities, captive bottlenose dolphins and beluga whales exhibited changes in behavior when exposed to strong pulsed sounds (Finneran *et al.,* 2000, 2002, 2005). The animals tolerated high received levels of sound before exhibiting aversive behaviors. Experiments on a beluga whale showed that exposure to a single watergun impulse at a received level of 207 kPa (30 psi) p-p, which is equivalent to 228 dB p-p re 1 μPa, resulted in a 7 and 6 dB TTS in the beluga whale at 0.4 and 30 kHz, respectively. Thresholds returned to within 2 dB of the pre-exposure level within four minutes of the exposure (Finneran *et al.,* 2002). Although the source level of pile driving from one hammer strike is expected to be much lower than the single watergun impulse cited here, animals being exposed for a prolonged period to repeated hammer strikes could receive more sound exposure in terms of SEL than from the single watergun impulse (estimated at 188 dB re 1 μPa^2-s) in the aforementioned experiment (Finneran *et al.,* 2002). However, in order for marine mammals to experience TTS or PTS, the animals have to be close enough to be exposed to high intensity sound levels for a prolonged period of time. Based on the best scientific information available, these SPLs are far below the thresholds that could cause TTS or the onset of PTS.

Disturbance Reactions

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, and many other factors (Richardson *et al.,* 1995; Wartzok *et al.,* 2004; Southall *et al.,* 2007; Weilgart, 2007). Behavioral responses to sound are highly variable and context specific. For each potential behavioral change, the magnitude of the change ultimately determines the severity of the response. A number of factors may influence an animal's response to sound, including its previous experience, its auditory sensitivity, its biological and social status (including age and sex), and its behavioral state and activity at the time of exposure.

Habituation can occur when an animal's response to a stimulus wanes with repeated exposure, usually in the absence of unpleasant associated events (Wartzok *et al.,* 2003/04). Animals are most likely to habituate to sounds that are predictable and unvarying. The opposite process is sensitization, when an unpleasant experience leads to subsequent responses, often in the form of avoidance, at a lower level of exposure. Behavioral state may affect the type of response as well. For example, animals that are resting may show greater behavioral change in response to disturbing sound levels than animals that are highly motivated to remain in an area for feeding (Richardson *et al.,* 1995; NRC, 2003; Wartzok *et al.,* 2003/04).

Controlled experiments with captive marine mammals showed pronounced behavioral reactions, including avoidance of loud sound sources (Ridgway *et al.,* 1997; Finneran *et al.,* 2003). Observed responses of wild marine mammals to loud pulsed sound sources (typically seismic guns or acoustic harassment devices, but also including pile driving) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; Caltrans, 2001, 2006; see also Gordon *et al.,* 2004; Wartzok *et al.,* 2003/04; Nowacek *et al.,* 2007). Responses to continuous sound, such as vibratory pile installation, have not been documented as well as responses to pulsed sounds.

With both types of pile driving, it is likely that the onset of pile driving could result in temporary, short term changes in an animal's typical behavior and/or avoidance of the affected area. These behavioral changes may include (Richardson *et al.,* 1995): changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where sound sources are located; and/or flight responses (*e.g.,* pinnipeds flushing into water from haul-outs or rookeries). Pinnipeds may increase their haul-out time, possibly to avoid in-water disturbance (Caltrans 2001, 2006). Since pile driving would likely only occur for a few hours a day, over a short period of time, it is unlikely to result in permanent displacement. Any potential impacts from pile driving activities could be experienced by individual marine mammals, but would not be likely to cause population level impacts, or affect the long-term fitness of the species.

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification could be expected to be biologically significant if the change affects growth, survival, or reproduction. Significant behavioral modifications that could potentially lead to effects on growth, survival, or reproduction include:

- Drastic changes in diving/surfacing patterns (such as those thought to be causing beaked whale stranding due to exposure to military mid-frequency tactical sonar);
- Habitat abandonment due to loss of desirable acoustic environment; and
- Cessation of feeding or social interaction.

The onset of behavioral disturbance from anthropogenic sound depends on both external factors (characteristics of sound sources and their paths) and the specific characteristics of the receiving animals (hearing, motivation, experience, demography) and is difficult to predict (Southall *et al.,* 2007).

Auditory Masking

Natural and artificial sounds can disrupt behavior by masking, or interfering with, a marine mammal's ability to hear other sounds. Masking occurs when the receipt of a sound is interfered with by another coincident sound at similar frequencies and at similar or higher levels. Chronic exposure to excessive, though not high-intensity, sound could cause masking at particular frequencies for marine mammals that utilize sound for vital biological functions. Masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Therefore, under certain circumstances, marine mammals whose acoustical sensors or environment are being severely masked could also be impaired from maximizing their performance fitness in survival and reproduction. If the coincident (masking) sound were man-made, it could be potentially harassing if it disrupted hearing-related behavior. It is important to distinguish TTS and PTS, which persist after the sound exposure, from masking, which occurs during the sound exposure. Because masking (without resulting in TS) is not associated with abnormal physiological function, it is not considered a physiological effect, but rather a potential behavioral effect.

The frequency range of the potentially masking sound is important in determining any potential behavioral impacts. Because sound generated from in-water pile driving is mostly concentrated at low frequency ranges, it may have less effect on high frequency echolocation sounds made by porpoises. However, lower frequency man-made sounds are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey sound. It may also affect communication signals when they occur near the sound band and thus reduce the communication space of animals (*e.g.,* Clark *et al.,* 2009) and cause increased stress levels (*e.g.,* Foote *et al.,* 2004; Holt *et al.,* 2009).

Masking has the potential to impact species at population, community, or even ecosystem levels, as well as at individual levels. Masking affects both senders and receivers of the signals and can potentially have long-term chronic effects on marine mammal species and populations. Recent research suggests that low frequency ambient sound levels have increased by as much as 20 dB (more than three times in terms of SPL) in the world's ocean from pre-industrial periods, and that most of these increases are from distant shipping (Hildebrand 2009). All anthropogenic sound sources, such as those from vessel traffic, pile driving, and dredging activities, contribute to the elevated ambient sound levels, thus intensifying masking. However, the sum of sound from the proposed activities is confined in an area of inland waters (Hood Canal) that is bounded by landmass; therefore, the sound generated is not expected to contribute to increased ocean ambient sound.

The most intense underwater sounds in the proposed action are those produced by impact pile driving. Given that the energy distribution of pile driving covers a broad frequency spectrum, sound from these sources would likely be within the audible range of Steller sea lions, California sea lions, harbor seals, transient killer whales, harbor porpoises, and Dall's porpoises. Impact pile driving activity is relatively short-term, with rapid pulses occurring for approximately fifteen minutes per pile. The probability for impact pile driving resulting from this proposed action masking acoustic signals important to the behavior and survival of marine mammal species is likely to be negligible. Vibratory pile driving is also relatively short-term, with rapid oscillations occurring for approximately one and a half hours per pile. It is possible that vibratory pile driving resulting from this proposed action may mask acoustic signals important to the behavior and survival of marine mammal species, but the short-term duration and limited affected area would result in a negligible impact from masking. Any masking event that could possibly rise to Level B harassment under the MMPA would occur concurrently within the zones of behavioral harassment already estimated for vibratory and impact pile driving, and which have already been taken into account in the exposure analysis.

Airborne Sound Effects

Marine mammals that occur in the project area could be exposed to airborne sounds associated with pile driving that have the potential to cause harassment, depending on their distance from pile driving activities. Airborne pile driving sound would have less impact on cetaceans than pinnipeds because sound from atmospheric sources does not transmit well underwater (Richardson *et al.,* 1995); thus, airborne sound would only be an issue for hauled-out pinnipeds in the project area. Most likely, airborne sound would cause behavioral responses similar to those discussed above in relation to underwater sound. For instance, anthropogenic sound could cause hauled-out pinnipeds to exhibit changes in their normal behavior, such as reduction in vocalizations, or cause them to temporarily abandon their habitat and move further from the source. Studies by Blackwell *et al.* (2004) and Moulton *et al.* (2005) indicate a tolerance or lack of response to unweighted airborne sounds as high as 112 dB peak and 96 dB rms.

Anticipated Effects on Habitat

The proposed activities at NBKB would not result in permanent impacts to habitats used directly by marine mammals, such as haul-out sites, but may have potential short-term impacts to food sources such as forage fish and salmonids. There are no rookeries or major haul-out sites within 10 km (6.2 mi), foraging hotspots, or other ocean bottom structure of significant biological importance to marine mammals that may be present in the marine waters in the vicinity of the project area. Therefore, the main impact issue associated with the proposed activity would be temporarily elevated sound levels and the associated direct effects on marine mammals, as discussed previously in this document. The most likely impact to marine mammal habitat occurs from pile driving effects on likely marine mammal prey (*i.e.,* fish) near NBKB and minor impacts to the immediate substrate during installation and removal of piles during the wharf construction project.

Pile Driving Effects on Potential Prey (Fish)

Construction activities would produce both pulsed (*i.e.,* impact pile driving) and continuous (*i.e.,* vibratory pile driving) sounds. Fish react to sounds which are especially strong and/or intermittent low-frequency sounds. Short duration, sharp sounds can cause overt or subtle changes in fish behavior and local distribution. Hastings and Popper (2005, 2009) identified several studies that suggest fish may relocate to avoid certain areas of sound energy. Additional studies have documented effects of pile driving (or other types of continuous sounds) on fish, although several are based on studies in support of large, multiyear bridge construction projects (Scholik and Yan, 2001, 2002; Govoni *et al.,* 2003; Hawkins, 2005; Hastings, 1990, 2007; Popper *et al.,* 2006; Popper and Hastings, 2009). Sound pulses at received levels of 160 dB re 1 μPa may cause subtle changes in fish behavior. SPLs of 180 dB may cause noticeable changes in behavior (Chapman and Hawkins, 1969; Pearson *et al.,* 1992; Skalski *et al.,* 1992). SPLs of sufficient strength have been known to cause injury to fish and fish mortality (Caltrans, 2001; Longmuir and Lively, 2001). The most likely impact to fish from pile driving activities at the project area would be temporary behavioral avoidance of the area. The duration of fish avoidance of this area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. In general, impacts to marine mammal prey species are expected to be minor and temporary due to the short timeframe for the wharf construction project. However, adverse impacts may occur to a few species of rockfish (bocaccio [*Sebastes paucispinis*], yelloweye [*S. ruberrimus*] and canary [*S. pinniger*] rockfish) and salmon (chinook [*Oncorhynchus tshawytscha*] and summer run chum) which may still be present in the project area despite operating in a reduced work window in an attempt to avoid important fish spawning time periods. Impacts to these species could result from potential impacts to their eggs and larvae.

Pile Driving Effects on Potential Foraging Habitat

In addition, the area likely impacted by the wharf construction project is relatively small compared to the available habitat in the Hood Canal. Avoidance by potential prey (*i.e.,* fish) of the immediate area due to the temporary loss of this foraging habitat is also possible. The duration of fish avoidance of this area after pile driving stops is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. Any behavioral avoidance by fish of the disturbed area would still leave significantly large areas of fish and marine mammal foraging habitat in the Hood Canal and nearby vicinity.

Given the short daily duration of sound associated with individual pile driving events and the relatively small areas being affected, pile driving activities associated with the proposed action are not likely to have a permanent, adverse effect on any fish habitat, or populations of fish species. Therefore, pile driving is not likely to have a permanent, adverse effect on marine mammal foraging habitat at the project area.

Proposed Mitigation

In order to issue an incidental take authorization (ITA) under Section 101(a)(5)(D) of the MMPA, NMFS must, where applicable, set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for taking for certain subsistence uses (where relevant).

The modeling results for zones of influence (ZOIs; see ''Estimated Take by

Incidental Harassment'') were used to develop mitigation measures for pile driving activities at NBKB. The ZOIs effectively represent the mitigation zone that would be established around each pile to prevent Level A harassment to marine mammals. While the ZOIs vary between the different diameter piles and types of installation methods, the Navy is proposing to establish mitigation zones for the maximum zone of influence for all pile driving conducted in support of the wharf construction project. In addition to the measures described later in this section, the Navy would employ the following standard mitigation measures:

(a) Conduct briefings between construction supervisors and crews, marine mammal monitoring team, acoustical monitoring team, and Navy staff prior to the start of all pile driving activity, and when new personnel join the work, in order to explain responsibilities, communication procedures, marine mammal monitoring protocol, and operational procedures.

(b) Comply with applicable equipment sound standards of the U.S. Environmental Protection Agency and ensure that all construction equipment has sound control devices no less effective than those provided on the original equipment.

(c) For in-water heavy machinery work other than pile driving (using, *e.g.,* standard barges, tug boats, barge-mounted excavators, or clamshell equipment used to place or remove material), if a marine mammal comes within 10 m (33 ft), operations shall cease and vessels shall reduce speed to the minimum level required to maintain steerage and safe working conditions. This type of work could include the following activities: (1) Movement of the barge to the pile location; (2) positioning of the pile on the substrate via a crane (*i.e.,* stabbing the pile); (3) removal of the pile from the water column/substrate via a crane (*i.e.,* deadpull); or (4) the placement of sound attenuation devices around the piles. For these activities, monitoring would take place from 15 minutes prior to initiation until the action is complete.

Shutdown and Buffer Zone

The following measures would apply to the Navy's mitigation through shutdown and buffer zones:

(a) The Navy would implement a minimum shutdown zone of 25 m (82 ft) radius for cetaceans and 10 m for pinnipeds around all pile driving activity. Shutdown zones typically include all areas where the underwater SPLs are anticipated to equal or exceed the Level A (injury) harassment criteria for marine mammals (180-dB isopleth for cetaceans; 190-dB isopleth for pinnipeds). In this case, pile driving sounds are expected to attenuate below 180 dB at distances of 22 m (72 ft) or less and below 190 dB at distances of 5 m (16 ft) or less, but the minimum shutdown zones are intended to further avoid the risk of direct interaction between marine mammals and the equipment.

(b) The calculated zone encompassing the full 120-dB buffer zone for vibratory pile driving (an effective area of 41.4 km^2 when attenuation due to landmasses is accounted for) is so large as to make monitoring impracticable. As described previously, the buffer zone corresponding to the 160-dB harassment criterion for impact pile driving would always be subsumed by the larger zone associated with concurrently operating vibratory pile drivers. In order to conduct monitoring additional to the monitoring conducted in support of the shutdown zones, the Navy would establish an observation position within the Waterfront Restricted Area, maximally distant from the pile driving operations. Any marine mammal observations would be relayed to the observers monitoring the shutdown zones and would be recorded as Level B takes. The additional position would be able to monitor an effective area of at least 500 m distance from the pile driving activity, and any sighted animals would be recorded as takes. However, with such a large action area, it is impossible to guarantee that all animals would be observed or to make comprehensive observations of fine-scale behavioral reactions to sound.

(c) The shutdown and buffer zones would be monitored throughout the time required to drive a pile. If a marine mammal is observed within the buffer zone, a take would be recorded and behaviors documented. However, that pile segment would be completed without cessation, unless the animal approaches or enters the shutdown zone, at which point all pile driving activities would be halted.

(d) All buffer and shutdown zones would initially be based on the distances from the source that are predicted for each threshold level. However, in-situ acoustic monitoring would be utilized to determine the actual distances to these threshold zones, and the size of the shutdown and buffer zones would be adjusted accordingly based on received SPLs.

Visual Monitoring

Monitoring would be conducted for a minimum 10 m or 25 m shutdown zone (for pinnipeds and cetaceans, respectively) and an approximate 500 m (1,640 ft) buffer zone surrounding each pile for the presence of marine mammals before, during, and after pile driving activities. The buffer zone was set at the largest area practicable for the Navy to maintain a monitoring presence over the duration of the activity. Sightings occurring outside this area (within the predicted 41.4 km^2 buffer zone predicted for the 120-dB isopleths) would still be recorded and noted as a take, but detailed observations outside this zone would not be possible, and it would be impossible for the Navy to account for all individuals occurring in such a zone with any degree of certainty. Monitoring would take place from 15 minutes prior to initiation through 30 minutes post-completion of pile driving activities.

The following additional measures would apply to visual monitoring:

(a) Monitoring would be conducted by qualified observers. A trained observer would be placed from the best vantage point(s) practicable (*e.g.,* from a small boat, the pile driving barge, on shore, or any other suitable location) to monitor for marine mammals and implement shut-down or delay procedures when applicable by calling for the shut-down to the hammer operator.

(b) Prior to the start of pile driving activity, the shut-down zone would be monitored for 15 minutes to ensure that it is clear of marine mammals. Pile driving would only commence once observers have declared the shut-down zone clear of marine mammals; animals would be allowed to remain in the buffer zone (*i.e.,* must leave of their own volition) and their behavior would be monitored and documented.

(c) If a marine mammal approaches or enters the shut-down zone during the course of pile driving operations, pile driving would be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shut-down zone or 15 minutes have passed without re-detection of the animal.

Sound Attenuation Devices

Sound attenuation devices would be utilized during all impact pile driving operations. Impact pile driving is only expected to be required to proof, or drive the last 10–15 ft (3–4.6 m) of select piles. Past experience has shown that proofing is rarely required at the project location. The Navy plans to use a bubble curtain as mitigation for in-water sound during construction activities. Bubble curtains absorb sound, attenuate pressure waves, exclude marine life from work areas, and control the migration of debris, sediments and process fluids.

Acoustic Measurements

Acoustic measurements would be used to empirically verify the proposed shut-down and buffer zones. For further detail regarding the Navy's acoustic monitoring plan see ''Proposed Monitoring and Reporting''.

Timing Restrictions

The Navy has set timing restrictions for pile driving activities to avoid in-water work when ESA-listed fish populations are most likely to be present. The in-water work window for avoiding negative impacts to fish species is July 16–February 15. The initial months (July to September) of the timing window overlap with times when Steller sea lions are not expected to be present within the project area.

Soft Start

The use of a soft-start procedure is believed to provide additional protection to marine mammals by warning, or providing marine mammals a chance to leave the area prior to the hammer operating at full capacity. The wharf construction project would utilize soft-start techniques (ramp-up and dry fire) for impact and vibratory pile driving. The soft-start requires contractors to initiate sound from vibratory hammers for fifteen seconds at reduced energy followed by a 30-second waiting period. This procedure would be repeated two additional times. For impact driving, contractors would be required to provide an initial set of three strikes from the impact hammer at forty percent energy, followed by a 30-second waiting period, then two subsequent three strike sets.

Daylight Construction

Impact pile driving during the first half of the in-water work window (July 16 to September 15) would only occur between 2 hours after sunrise and 2 hours before sunset to protect breeding marbled murrelets. Vibratory pile driving and other construction activities occurring in the water between July 16 and September 15 could occur during daylight hours (sunrise to sunset). Between September 16 and February 15, construction activities occurring in the water would occur during daylight hours (sunrise to sunset).

Mitigation Effectiveness

It should be recognized that although marine mammals would be protected from Level A harassment by the utilization of a bubble curtain and protected species observers (PSOs) monitoring the near-field injury zones, mitigation may not be 100 percent effective at all times in locating marine mammals in the buffer zone. The efficacy of visual detection depends on several factors including the observer's ability to detect the animal, the environmental conditions (visibility and sea state), and monitoring platforms.

All observers utilized for mitigation activities would be experienced biologists with training in marine mammal detection and behavior. Due to their specialized training the Navy expects that visual mitigation would be highly effective. Trained observers have specific knowledge of marine mammal physiology, behavior, and life history, which may improve their ability to detect individuals or help determine if observed animals are exhibiting behavioral reactions to construction activities.

The Puget Sound region, including the Hood Canal, only infrequently experiences winds with velocities in excess of 25 kn (Morris *et al.,* 2008). The typically light winds afforded by the surrounding highlands coupled with the fetch-limited environment of the Hood Canal result in relatively calm wind and sea conditions throughout most of the year. The wharf construction project site has a maximum fetch of 8.4 mi (13.5 km) to the north, and 4.2 mi (6.8 km) to the south, resulting in maximum wave heights of from 2.85–5.1 ft (0.9–1.6 m) (Beaufort Sea State (BSS) between two and four), even in extreme conditions (30 kt winds) (CERC, 1984). Visual detection conditions are considered optimal in BSS conditions of three or less, which align with the conditions that should be expected for the wharf construction project at NBKB.

Habitat Mitigation

In addition to mitigation measures developed specifically for marine mammals and described previously, the following compensatory mitigation measures would be implemented to restore marine fish habitats, and by extension to indirectly benefit marine mammals in the project area. These measures were not developed in consultation with NMFS, but are described here due to their potential benefit for marine mammals.

Compensatory Mitigation—Compensatory Mitigation is the term given to projects or plans undertaken to offset unavoidable adverse environmental impacts which remain after all appropriate and practicable avoidance and minimization has been achieved. Compensatory Mitigation involves actions taken to offset unavoidable adverse impacts to wetlands, streams, and other aquatic resources. For impacts authorized under a Clean Water Act Section 404 permit, Compensatory Mitigation is not considered until after all appropriate and practicable steps have been taken to first avoid and then minimize adverse impacts to the aquatic ecosystem pursuant to 40 CFR part 230 (*i.e.,* the Clean Water Act Section 404(b)(1) Guidelines). Compensatory Mitigation is required for permits authorized by the Clean Water Act Section 404 and other Department of the Army permits.

The Compensatory Mitigation Rule establishes a hierarchy for Compensatory Mitigation:

- Mitigation Banks
- In-Lieu Fee (ILF) Programs
- Permittee-Responsible Mitigation

A preference for mitigation banks is established at present. However, there are no established mitigation banks or ILF programs for Kitsap County or the Hood Canal. Therefore, the Navy's preference for providing mitigation and complying with the Compensatory Mitigation Rule is through the development of an ILF Program. The goal of the ILF Program is to ensure no net loss of nearshore aquatic resource functions by in-kind mitigation within Kitsap County and/or Hood Canal. The Navy would partner with a qualified ILF sponsor that would be responsible for preparing all documentation associated with establishment of the program, including a prospectus, a credit/debit calculation tool or instrument, mitigation plans, and other appropriate documents. The ILF sponsor would be responsible for performing all of the required functions of the program including fiscal management; agreement(s) with entities that will purchase and hold mitigation sites in conservation status in perpetuity; reporting; and contracting for the design, construction, and monitoring for specific mitigation projects.

The Navy anticipates that the Kitsap County Nearshore Habitat Assessment and Restoration Prioritization Framework could provide an assessment tool to identify and prioritize mitigation sites. As the ILF program is developed for Kitsap County and/or Hood Canal, a more detailed credit/debit calculation tool or instrument would be developed. This information would be developed and reviewed in conjunction with the development of the ILF program. Mitigation can include protection, restoration, enhancement, and/or creation. The mitigation strategy selected will be based on an assessment of type and degree of disturbance at the landscape, drift cell, and nearshore assessment unit (NAU) scales.

Priority would be given to mitigation strategies that augment regional and local watershed plans and goals. Such strategies include, but are not limited to, protection and restoration of critical resource areas through acquisition or conservation easements, reconnecting pocket estuaries to tidal fluxes, shoreline rehabilitation, removal of fish migration barriers, stream restoration, and reforestation of watersheds and marine/freshwater riparian zones.

Alternative Mitigation Strategies—In the event that an ILF program is not established in Kitsap County in time for use as mitigation for the proposed action, other mitigation options will be considered. As an alternative to pursuing the development of an ILF program for Kitsap County/and or Hood Canal, the Navy is currently assessing nearshore permittee responsible mitigation opportunities within the Hood Canal and Puget Sound with state and local agencies and tribes. The Navy would identify appropriate in-kind mitigation sufficient in size to ensure no net loss of aquatic resource functions. Strategies to effect no net loss could include a combination of restoration, enhancement, creation, and preservation of nearshore habitats. Potential nearshore mitigation sites will take into consideration state and local watershed management plans, property ownership, tribal usual and accustomed areas, likelihood of success, ability to address multiple functions and services both among and within aquatic habitat types, and the ability to affect or improve regional aquatic resource conservation initiatives. As with the proposed development of an ILF program, these potential permittee-responsible mitigation projects would also be reviewed in accordance with the Compensatory Mitigation Rule and would be submitted for review and approval as part of the application process. In the event that the Navy selects a permittee-responsible mitigation as the Compensatory Mitigation strategy, a mitigation plan would be submitted to the U.S. Army Corps of Engineers.

NMFS has carefully evaluated the applicant's proposed mitigation measures and considered a range of other measures in the context of ensuring that NMFS prescribes the means of effecting the least practicable impact on the affected marine mammal species and stocks and their habitat. Our evaluation of potential measures included consideration of the following factors in relation to one another: (1) The manner in which, and the degree to which, the successful implementation of the measure is expected to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation, including consideration of personnel safety, and practicality of implementation.

Based on our evaluation of the applicant's proposed measures, as well as other measures considered by NMFS, NMFS has preliminarily determined that the proposed mitigation measures provide the means of effecting the least practicable impact on marine mammal species or stocks and their habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance.

Proposed Monitoring and Reporting

In order to issue an ITA for an activity, section 101(a)(5)(D) of the MMPA states that NMFS must, where applicable, set forth ''requirements pertaining to the monitoring and reporting of such taking''. The MMPA implementing regulations at 50 CFR 216.104(a)(13) indicate that requests for ITAs must include the suggested means of accomplishing the necessary monitoring and reporting that would result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present in the proposed action area.

Acoustic Measurements

Within the first 30 days of pile driving, the Navy would capture a representative acoustic sample of the major pile driving scenarios under the modeled conditions (impact hammer and vibratory driving, smaller [24-in to 36-in] and larger [48-in] piles, plumb and batter piles). All measurements would be made with the sound attenuation measures discussed previously in place. These acoustic measurements would determine the actual distances to the following isopleths: 190 dB re 1µPa rms, 180 dB re 1µPa rms, and 160 dB re 1µPa rms. The Navy would also conduct underwater acoustic monitoring for vibratory pile driving to determine the actual distance to the 120 dB re 1µPa rms isopleth for marine mammal behavioral harassment relative to background levels. Maximum sound pressure levels would also be documented. Airborne acoustic monitoring would be conducted during impact and vibratory pile driving to identify the actual distance to the 90 dB re 20µPa rms, and 100 dB re 20µPa rms airborne isopleths.

At a minimum, the methodology would include:

- For underwater recordings, a stationary hydrophone system with the ability to measure SPLs at mid-water depth and approximately 1 m from the bottom, (taking tidal changes into account) would be placed at a distance of 10 m from the source. The hydrophone would be deployed so as to maintain a constant distance of 10 m from the pile.
- For airborne recordings, reference recordings would be attempted at approximately 50 ft (15.2 m) from the source via a stationary hydrophone. However, other distances may be utilized to obtain better data if the pile driving signal cannot be isolated clearly due to other sound sources (*e.g.,* barges or generators).
- Each hydrophone (underwater) and microphone (airborne) would be calibrated prior to the start of the action and would be checked at the beginning of each day of monitoring activity. Other hydrophones and microphones would be placed at other distances and/or depths and moved as necessary to determine the distance to the thresholds for marine mammals (these include peak, rms, and SEL for underwater sound, and unweighted for airborne sound).
- Unweighted ambient conditions, both airborne and underwater, would be measured and recorded for 30 to 60 s each hour, every day for one week during the first 30 days of the construction period to determine background sound levels. These measurements are intended to capture ambient background sound during the timeframe of construction, but in the absence of pile driving sound. Ambient sound recordings would be edited for anomalous data to provide the best possible baseline condition for background sound. Recording would be made in the 10 Hz to 20 kHz range.
- Airborne levels would be recorded as an unweighted time series. The distance to marine mammal airborne sound disturbance thresholds would be determined.
- Sound levels associated with the soft-start techniques (on a representative subset of piles) would also be measured.
- Environmental data would be collected, such as wind speed and direction, wave height, precipitation, presence and location of other vessels, and types and locations of in-water construction activities, as well as other factors that could contribute to influencing the airborne and underwater sound levels (*e.g.,* aircraft, boats).

• The construction contractor would supply the Navy and other relevant monitoring personnel the substrate composition, hammer model and size, hammer energy settings and any changes to those settings during hammering of the piles being monitored, depth of the pile being driven, and blows per foot for the piles monitored.

• Post-analysis of underwater sound level signals would include the average rms value across all pile strikes per pile, the rise time, average duration of each pile strike, and number of strikes per pile, as well as a frequency spectrum with mitigation, between 10 and 20,000 Hz, for up to eight successive strikes with similar sound levels. Rms analyses would be completed for vibratory driving, including presentation of representative frequency spectra.

• Post–analysis of airborne sound would be presented in an unweighted format, and would include presentation of the average rms value across all pile strikes per pile, and the average rms value for vibratory driving. Frequency spectra would be provided from 10 to 20,000 Hz for up to eight successive strikes with similar sound levels, and would also be provided for representative vibratory driving.

Visual Marine Mammal Observations

The Navy would collect sighting data and behavioral responses to construction for marine mammal species observed in the region of activity during the period of activity. All observers would be trained in marine mammal identification and behaviors. NMFS requires that the observers have no other construction-related tasks while conducting monitoring.

Methods of Monitoring—The Navy would monitor the shutdown zone and buffer zone before, during, and after pile driving. There would, at all times, be at least one observer stationed at an appropriate vantage point to observe the shutdown zones associated with each operating hammer. There would also at all times be at least one vessel-based observer stationed within the WRA. In addition, at least one marine mammal observer would be stationed on a vessel conducting acoustic monitoring outside the WRA, for as long as such monitoring is conducted. The Navy estimates that representative acoustic sampling may occur in approximately 30 days. Based on NMFS requirements, the Marine Mammal Monitoring Plan would include the following procedures for pile driving:

(1) MMOs would be located at the best vantage point(s) in order to properly see the entire shutdown zone and as much of the buffer zone as possible. This may require the use of a small boat to monitor certain areas while also monitoring from one or more land based vantage points.

(2) During all observation periods, observers would use binoculars and the naked eye to search continuously for marine mammals.

(3) If the shut down or buffer zones are obscured by fog or poor lighting conditions, pile driving at that location would not be initiated until that zone is visible.

(4) The shut down and buffer zones around the pile would be monitored for the presence of marine mammals before, during, and after any pile driving or removal activity.

Pre-Activity Monitoring—The shutdown and buffer zones would be monitored for 15 minutes prior to initiating the soft start for pile driving. If marine mammal(s) are present within the shut down zone prior to pile driving, or during the soft start, the start of pile driving would be delayed until the animal(s) leave the shut down zone. Pile driving would resume only after the PSO has determined, through sighting or by waiting 15 minutes, that the animal(s) has moved outside the shutdown zone.

During Activity Monitoring—The shutdown and buffer zones would also be monitored throughout the time required to drive or remove a pile. If a marine mammal is observed entering the buffer zone, a take would be recorded and behaviors documented. However, that pile segment would be completed without cessation, unless the animal enters or approaches the shut down zone, at which point all pile driving activities would be halted. Pile driving can only resume once the animal has left the shutdown zone of its own volition or has not been re-sighted for a period of 15 minutes.

Post-Activity Monitoring—Monitoring of the shutdown and buffer zones would continue for 30 minutes following the completion of pile driving.

Individuals implementing the monitoring protocol would assess its effectiveness using an adaptive approach. Monitoring biologists would use their best professional judgment throughout implementation and would seek improvements to these methods when deemed appropriate. Any modifications to protocol would be coordinated between the Navy and NMFS.

Data Collection

NMFS requires that the PSOs use NMFS-approved sighting forms. In addition to the following requirements, the Navy would note in their behavioral observations whether an animal remains in the project area following a Level B taking (which would not require cessation of activity). This information would ideally make it possible to determine whether individuals are taken (within the same day) by one or more types of pile driving (*i.e.,* impact and vibratory). NMFS requires that, at a minimum, the following information be collected on the sighting forms:

(1) Date and time that pile driving begins or ends;

(2) Construction activities occurring during each observation period;

(3) Weather parameters identified in the acoustic monitoring (*e.g.,* percent cover, visibility);

(4) Water conditions (*e.g.,* sea state, tide state);

(5) Species, numbers, and, if possible, sex and age class of marine mammals;

(6) Marine mammal behavior patterns observed, including bearing and direction of travel, and if possible, the correlation to SPLs;

(7) Distance from pile driving activities to marine mammals and distance from the marine mammals to the observation point;

(8) Locations of all marine mammal observations; and

(9) Other human activity in the area.

Reporting

A draft report would be submitted to NMFS within 60 days of the completion of the first 30 days of acoustic measurements and marine mammal monitoring. The results would be summarized in graphical form and include summary statistics and time histories of impact sound values for each pile. The report would also provide descriptions of any problems encountered in deploying sound attenuating devices, any adverse responses to construction activities by marine mammals, and actions taken to solve these problems. A final report would be prepared and submitted to NMFS within 30 days following receipt of comments on the draft report from NMFS. Within 60 days of the end of the in-water work period, a draft comprehensive report on all marine mammal monitoring conducted under the proposed IHA would be submitted to NMFS. The report would include marine mammal observations pre-activity, during-activity, and post-activity during pile driving days. A final report would be prepared and submitted to NMFS within 30 days following receipt of comments on the draft report from NMFS. At a minimum, the report would include:

(1) Date and time of activity;

(2) Water and weather conditions (*e.g.,* sea state, tide state, percent cover, visibility);

(3) Physical characteristics of the bottom substrate where piles are driven;

(4) Description of the pile driving activity (*e.g.,* size and type of piles);

(5) A detailed description of the sound attenuation device, including design specifications;

(6) The impact or vibratory hammer force used to drive or extract the piles;

(7) A description of the monitoring equipment;

(8) The distance between hydrophone(s) and pile;

(9) The depth of the hydrophone(s);

(10) The depth of water in which the pile was driven;

(11) The depth into the substrate that the pile was driven;

(12) The ranges and means for peak, rms, and SELs for each pile;

(13) The results of the acoustic measurements, including the frequency spectrum, peak and rms SPLs, and single-strike and cumulative SEL with and without the attenuation system;

(14) The results of the airborne sound measurements (unweighted levels);

(15) A description of any observable marine mammal behavior in the immediate area and, if possible, the correlation to underwater sound levels occurring at that time;

(16) Actions performed to minimize impacts to marine mammals;

(17) Times when pile driving is stopped due to presence of marine mammals within shut down zones and time when pile driving resumes;

(18) Results, including the detectability of marine mammals, species and numbers observed, sighting rates and distances, behavioral reactions within and outside of shut down zones; and

(19) A refined take estimate based on the number of marine mammals observed in the shut down and buffer zones.

Estimated Take by Incidental Harassment

With respect to the activities described here, the MMPA defines ''harassment'' as:

> Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

All anticipated takes would be by Level B harassment, involving temporary changes in behavior. The proposed mitigation and monitoring measures are expected to minimize the possibility of injurious or lethal takes such that take by Level A harassment, serious injury or mortality is considered remote. However, as noted earlier, it is unlikely that injurious or lethal takes would occur even in the absence of the planned mitigation and monitoring measures.

If a marine mammal responds to an underwater sound by changing its behavior (*e.g.,* through relatively minor changes in locomotion direction/speed or vocalization behavior), the response may or may not constitute taking at the individual level, and is unlikely to affect the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on animals or on the stock or species could potentially be significant (Lusseau and Bejder, 2007; Weilgart, 2007). Given the many uncertainties in predicting the quantity and types of impacts of sound on marine mammals, it is common practice to estimate how many animals are likely to be present within a particular distance of a given activity, or exposed to a particular level of sound. This practice potentially overestimates the numbers of marine mammals taken. For example, during the past ten years, killer whales have been observed within the project area twice. On the basis of that information, an estimated amount of potential takes for killer whales is presented here. However, while a pod of killer whales could potentially visit again during the project timeframe, and thus be taken, it is more likely that they would not.

The proposed project area is not believed to be particularly important habitat for marine mammals, nor is it considered an area frequented by marine mammals, although harbor seals are year-round residents of Hood Canal and sea lions are known to haul-out on submarines and other man-made objects at the NBKB waterfront (although typically at a distance of a mile or greater from the project site). Therefore, behavioral disturbances that could result from anthropogenic sound associated with the proposed activities are expected to affect only a relatively small number of individual marine mammals, although those effects could be recurring over the life of the project if the same individuals remain in the project vicinity.

The Navy is requesting authorization for the potential taking of small numbers of Steller sea lions, California sea lions, harbor seals, transient killer whales, Dall's porpoises, and harbor porpoises in the Hood Canal that may result from pile driving during construction activities associated with the wharf construction project described previously in this document. The takes requested are expected to have no more than a minor effect on individual animals and no effect at the population level for these species. Any effects experienced by individual marine mammals are anticipated to be limited to short-term disturbance of normal behavior or temporary displacement of animals near the source of the sound.

Marine Mammal Densities

For all species, the best scientific information available was used to construct density estimates or estimate local abundance. Of available information deemed suitable for use, the data that produced the most conservative (*i.e.,* highest) density or abundance estimate for each species was used. For harbor seals, this involved published literature describing harbor seal research conducted in Washington and Oregon as well as more specific counts conducted in Hood Canal (Huber *et al.,* 2001; Jeffries *et al.,* 2003). Killer whales are known from two periods of occurrence (2003 and 2005) and are not known to preferentially use any specific portion of the Hood Canal. Therefore, density was calculated as the maximum number of individuals present at a given time during those occurrences (London, 2006), divided by the area of Hood Canal. The best information available for the remaining species in Hood Canal came from surveys conducted by the Navy at the NBKB waterfront or in the vicinity of the project area. These consist of three discrete sets of survey effort, and are described here in greater detail.

Beginning in April 2008, Navy personnel have recorded sightings of marine mammals occurring at known haul-outs along the NBKB waterfront, including docked submarines or other structures associated with NBKB docks and piers and the nearshore pontoons of the floating security fence. Sightings of marine mammals within the waters adjoining these locations were also recorded. Sightings were attempted whenever possible during a typical work week (*i.e.,* Monday through Friday), but inclement weather, holidays, or security constraints often precluded surveys. These sightings took place frequently (average fourteen per month) although without a formal survey protocol. During the surveys, staff visited each of the above-mentioned locations and recorded observations of marine mammals. Surveys were conducted using binoculars and the naked eye from shoreline locations or the piers/wharves themselves. Because these surveys consist of opportunistic sighting data from shore-based observers, largely of hauled-out animals, there is no associated survey area appropriate for use in calculating a density from the abundance data. Thus, NMFS has not used these data to derive a density but rather has used the absolute abundance to estimate take. Data were compiled for the period from April 2008 through June 2010 for analysis in this proposed IHA, and these data provided the basis for take estimation for Steller and California sea lions. Other information, including sightings data from other Navy survey efforts at NBKB, is available for these two species, but these data provide the most conservative (*i.e.,* highest) local abundance estimates (and thus the highest estimates of potential take).

Vessel-based marine wildlife surveys were conducted according to established survey protocols during July through September 2008 and November through May 2009–10 (Tannenbaum *et al.,* 2009, 2011). Eighteen complete surveys of the nearshore area resulted in observations of four marine mammal species (harbor seal, California sea lion, harbor porpoise, and Dall's porpoise). These surveys operated along pre-determined transects parallel to the shoreline from the nearshore out to approximately 1,800 ft (549 m) from shoreline, at a spacing of 100 yd (91 m), and covered the entire NBKB waterfront (approximately 3.9 km^2 per survey) at a speed of 5 kn or less. Two observers recorded sightings of marine mammals both in the water and hauled out, including date, time, species, number of individuals, age (juvenile, adult), behavior (swimming, diving, hauled out, avoidance dive), and haul-out location. Positions of marine mammals were obtained by recording distance and bearing to the animal with a rangefinder and compass, noting the concurrent location of the boat with GPS, and, subsequently, analyzing these data to produce coordinates of the locations of all animals detected. These surveys produced the information used to estimate take for Dall's porpoise, as well as for harbor porpoise under previous Navy actions at NBKB.

Recently, as part of the Test Pile Program, marine mammal monitoring was conducted on construction days for mitigation purposes. During those efforts, the Navy observed that harbor porpoises were more common in deeper waters of Hood Canal than the previously described, nearshore vessel-based surveys indicated. For that reason, the Navy conducted vessel-based line transect surveys in Hood Canal on days where no pile driving activities occurred in order to collect additional density data for species present in Hood Canal. These surveys were primarily conducted in September and detected three marine mammal species (harbor seal, California sea lion, and harbor porpoise), and included surveys conducted in both the main body of Hood Canal, near the project area, and baseline surveys conducted for comparison in Dabob Bay, an area of Hood Canal that is not affected by sound from Navy actions at the NBKB waterfront (see Figures 2–1 and 4–1 in the Navy's application). The surveys operated along pre-determined transects that followed a double saw-tooth pattern to achieve uniform coverage of the entire NBKB waterfront. The vessel traveled at a speed of approximately 5 kn when transiting along the transect lines. Two observers recorded sightings of marine mammals both in the water and hauled out, including the date, time, species, number of individuals, and behavior (swimming, diving, etc.). Positions of marine mammals were obtained by recording the distance and bearing to the animal(s), noting the concurrent location of the boat with GPS, and subsequently analyzing these data to produce coordinates of the locations of all animals detected. Sighting information for harbor porpoises was corrected for detectability (g(0) = 0.54; Barlow, 1988; Calambokidis *et al.,* 1993; Carretta *et al.,* 2001). Distance sampling methodologies were used to estimate densities of animals for the data. Due to the recent execution of these surveys, not all data have been processed. Due to the unexpected abundance of harbor porpoises encountered during the Test Pile Program, data for this species were processed first and are available for use in this proposed IHA. All other species data may be included in subsequent environmental compliance documents once all post-processing is complete, but preliminary analysis indicates that use of the previously described data would still provide the most conservative take estimates for the other species.

The cetaceans, as well as the harbor seal, appear to range throughout Hood Canal; therefore, the analysis in this proposed IHA assumes that harbor seal, transient killer whale, harbor porpoise, and Dall's porpoise are uniformly distributed in the project area. The remaining species that occur in the project area, Steller sea lion and California sea lion, do not appear to utilize most of Hood Canal. The sea lions appear to be attracted to the man-made haul-out opportunities along the NBKB waterfront while dispersing for foraging opportunities elsewhere in Hood Canal. California sea lions were not reported during aerial surveys of Hood Canal (Jeffries *et al.,* 2000), and Steller sea lions have only been documented at the NBKB waterfront.

Description of Take Calculation

The take calculations presented here rely on the best data currently available for marine mammal populations in the Hood Canal, as discussed in preceding sections. The formula was developed for calculating take due to pile driving activity and applied to each group-specific sound impact threshold. The formula is founded on the following assumptions:

(a) All pilings to be installed would have a sound disturbance distance equal to that of the piling that causes the greatest sound disturbance (*i.e.,* the piling furthest from shore);

(b) Mitigation measures (*e.g.,* sound attenuation system) would be utilized, as discussed previously;

(c) All marine mammal individuals potentially available are assumed to be present within the relevant area, and thus incidentally taken; and,

(d) An individual can only be taken once during a 24-h period.

The calculation for marine mammal takes is estimated by:

Take estimate = (n * ZOI) * days of total activity

Where:

n = density estimate used for each species/season

ZOI = sound threshold zone of influence (ZOI) impact area; the area encompassed by all locations where the SPLs equal or exceed the threshold being evaluated

n * ZOI produces an estimate of the abundance of animals that could be present in the area for exposure, and is rounded to the nearest whole number before multiplying by days of total activity.

The ZOI impact area is the estimated range of impact to the sound criteria. The distances (actual) specified in Table 5 were used to calculate ZOI around each pile. All impact pile driving take calculations were based on the estimated threshold ranges using a bubble curtain with 10 dB attenuation as a mitigation measure (see ''Underwater Sound from Piledriving''). The ZOI impact area took into consideration the possible affected area of the Hood Canal from the pile driving site furthest from shore with attenuation due to land shadowing from bends in the canal. Because of the close proximity of some of the piles to the shore, the narrowness of the canal at the project area, and the maximum fetch, the ZOIs for each threshold are not necessarily spherical and may be truncated.

For sea lions, as described previously, the surveys offering the most conservative estimates of abundance do not have a defined survey area and so are not suitable for deriving a density construct. Instead, abundance is estimated on the basis of previously described opportunistic sighting information at the NBKB waterfront, and it is assumed that the total amount of animals known from NBKB haul-outs would be 'available' to be taken in a given pile driving day. Thus, for these two species, take is estimated by multiplying abundance by days of activity.

While pile driving can occur any day throughout the in-water work window, and the analysis is conducted on a per day basis, only a fraction of that time is actually spent pile driving. On days when pile driving occurs, it could take place for thirty minutes, or up to several hours. For each pile installed, vibratory pile driving is expected to be no more than one hour. The impact driving portion of the project is anticipated to take approximately fifteen minutes per pile (for proofing). Based on the proposed action, the total pile driving time from vibratory pile driving during installation would be a maximum of 195 days (approximately the number of days available during the in-water work window, when considering contractor work schedule). During installation, there is the potential for the contractor to need to utilize an impact hammer to proof a select number of piles, although past repairs on the existing pier have never required the use of an impact pile driver.

The exposure assessment methodology is an estimate of the numbers of individuals exposed to the effects of pile driving activities exceeding NMFS-established thresholds. Of note in these exposure estimates, mitigation methods other than the use of a sound attenuation device (*i.e.,* visual monitoring and the use of shutdown zones) were not quantified within the assessment and successful implementation of this mitigation is not reflected in exposure estimates. Results from acoustic impact exposure assessments should be regarded as conservative estimates.

California Sea Lion

California sea lions are present in Hood Canal during much of the year with the exception of mid-June through August. California sea lions occur regularly in the vicinity of the project site from September through mid-June, as determined by Navy waterfront surveys conducted from April 2008 through June 2010 (Navy 2010; Table 8). With regard to the range of this species in Hood Canal and the project area, it is assumed on the basis of waterfront observations (Agness and Tannenbaum, 2009; Tannenbaum *et al.,* 2009, 2011) that the opportunity to haul out on submarines docked at Delta Pier is a primary attractant for California sea lions in Hood Canal, as they have rarely been reported, either hauled out or swimming, elsewhere in Hood Canal (Jeffries 2007, personal communication). Abundance is calculated as the monthly average of the maximum number observed in a given month, as opposed to the overall average (Table 8). For example, in the month of May, the maximum number of animals observed on any one day was 25 in 2008, 33 in 2009, and 17 in 2010, providing a monthly average of the maximum daily number observed of 25. This provides a conservative overall daily abundance of 26.2 for the in-water work window, as compared with an actual per survey abundance of 11.4 during the same period.

In previous IHAs issued to the Navy for work at NBKB, NMFS has calculated a density for California sea lions on the basis of the maximum daily average number of animals for the period of activity and the total project area (defined as 41.4 km^2). This approach was determined to be the most appropriate method of deriving a local density for the species (see, *e.g.,* 76 FR 6406). The method produced a similar estimate of take as would be produced through the use of abundance information and days of activity, because the density was based on the same area as the larger ZOI associated with the 120-dB harassment zone (*i.e.,* 41.4 km^2), described previously, but also allowed for calculation of take estimate for different areas, as would be encompassed by the 160-dB underwater harassment zone associated with impact driving or harassment zones associated with airborne sound. However, because the vibratory and impact pile drivers would be operating simultaneously under the currently proposed action, the 160-dB harassment zone associated with the impact driver would be at all times subsumed by the 120-dB harassment zone associated with the vibratory driver. In addition, because California sea lions are known to haul-out only in the vicinity of Delta Pier, over one mile south of the project area, they would not be subject to airborne sound that would constitute harassment (*i.e.,* within approximately 350 m of an impact-driven pile). As such, NMFS has determined that it is appropriate to discard the previously used density construct in favor of simple abundance. This methodology conservatively uses the maximum abundance (rather than mean) and assumes that all individuals would be taken on any given day of activity. NMFS feels that this provides a conservative estimate of the number of individuals that may be incidentally taken by the Navy's proposed action while avoiding the need to construct a density estimate from survey data with no defined survey area. As described previously, sighting information from other Navy survey effort that is more appropriate for estimating density (*i.e.,* with defined survey area) would produce a less conservative (*i.e.,* lower) estimate of take.

TABLE 8—CALIFORNIA SEA LION SIGHTING INFORMATION FROM NBKB, APRIL 2008–JUNE 2010

Month	Number of surveys	Number of surveys with animals present	Frequency of presence [1]	Abundance [2]
January	25	15	0.60	24.0
February	28	24	0.86	31.0
March	28	26	0.93	38.5
April	38	27	0.71	36.3
May	44	34	0.77	25.0
June	44	7	0.16	5.3
July	31	0	0	0
August	29	1	0.03	0.5
September	26	9	0.35	22.0

TABLE 8—CALIFORNIA SEA LION SIGHTING INFORMATION FROM NBKB, APRIL 2008–JUNE 2010—Continued

Month	Number of surveys	Number of surveys with animals present	Frequency of presence [1]	Abundance [2]
October	26	22	0.85	45.5
November	22	22	1	54.0
December	24	14	0.58	32.5
Total or average (in-water work season only)	211	107	0.53	26.2

Totals (number of surveys) and averages (frequency and abundance) presented for in-water work season (July–February) only. Information from March–June presented for reference.

[1] Frequency is the number of surveys with California sea lions present/number of surveys conducted.

[2] Abundance is calculated as the monthly average of the maximum daily number observed in a given month.

The largest observed number of California sea lions hauled out along the NBKB waterfront was 58 in a November survey. During the in-water construction period (mid-July to mid-February) the largest daily attendance average for each month ranged from 24 individuals to 54 individuals. The likelihood of California sea lions being present at NBKB is greatest from October through May, when the frequency of attendance in surveys was at least 0.58. Attendance along the NBKB waterfront in November surveys (2008–09) was 100 percent. Additionally, five navigational buoys near the entrance to Hood Canal were documented as potential haul-outs, each capable of supporting three adult California sea lions (Jeffries *et al.,* 2000). Breeding rookeries are in California; therefore, pups are not expected to be present in Hood Canal (NMFS 2008b). Female California sea lions are rarely observed north of the California/Oregon border; therefore, only adult and sub-adult males are expected to be exposed to project impacts. Table 10 depicts the estimated number of behavioral harassments.

Steller Sea Lion

Steller sea lions were first documented at the NBKB waterfront in November 2008, while hauled out on submarines at Delta Pier (Bhuthimethee, 2008, pers. comm.; Navy, 2010) and have been periodically observed since that time. Based on waterfront observations, Steller sea lions appear to use available haul-outs (typically in the vicinity of Delta Pier, approximately one mile south of the project area) and habitat similarly to California sea lions, although in lesser numbers. On occasions when Steller sea lions are observed, they typically occur in mixed groups with California sea lions also present, allowing observers to confirm their identifications based on discrepancies in size and other physical characteristics.

Vessel-based survey effort in NBKB nearshore waters have not detected any Steller sea lions (Agness and Tannenbaum, 2009; Tannenbaum *et al.,* 2009, 2011). Opportunistic sightings data provided by Navy personnel since April 2008 have continued to document sightings of Steller sea lions at Delta Pier from November through April (Table 9). Steller sea lions have only been observed hauled out on submarines docked at Delta Pier. Delta Pier and other docks at NBKB are not accessible to pinnipeds due to the height above water, although the smaller California sea lions and harbor seals are able to haul out on pontoons that support the floating security barrier. One to two animals are typically seen hauled out with California sea lions; the maximum Steller sea lion group size seen at any given time was six individuals in November 2009.

TABLE 9—STELLER SEA LION SIGHTING INFORMATION FROM NBKB, APRIL 2008–JUNE 2010

Month	Number of surveys	Number of surveys with animals present	Frequency of presence [1]	Abundance [2]
January	25	4	0.16	1.0
February	28	1	0.04	0.5
March	28	4	0.14	1.0
April	38	5	0.13	1.3
May	44	0	0	0
June	44	0	0	0
July	31	0	0	0
August	29	0	0	0
September	26	0	0	0
October	26	0	0	[3] 1.3
November	22	3	0.14	5.0
December	24	5	0.21	1.5
Total or average (in-water work season only)	211	13	0.07	1.2

Totals (number of surveys) and averages (frequency and abundance) presented for in-water work season (July–February) only. Information from March–June presented for reference.

[1] Frequency is the number of surveys with Steller sea lions present/number of surveys conducted.

[2] Abundance is calculated as the monthly average of the maximum daily number observed in a given month.

[3] Abundance updated to include observations made in October 2011 during Navy's Test Pile Program. All other information reflects only data from April 2008–June 2010.

Their frequency of occurrence by month has not exceeded 0.21 (in December 2009), *i.e.,* they were present in only 21 percent of surveys that month. The time period from November through April coincides with the time when Steller sea lions are frequently observed in Puget Sound. Only adult and sub-adult males are likely to be present in the project area during this time; female Steller sea lions have not been observed in the project area. Since there are no known breeding rookeries in the vicinity of the project site, Steller sea lion pups are not expected to be present. By May, most Steller sea lions have left inland waters and returned to their rookeries to mate. Although sub-adult individuals (immature or pre-breeding animals) will occasionally remain in Puget Sound over the summer, observational data (Table 9) have indicated that Steller sea lions are present only from November through April and not during the summer months. However, recent observational data available from the Navy's Test Pile Program noted the presence of Steller sea lions at NBKB in October for the first time. Up to four individuals were sighted either hauled out at the submarines docked at Delta Pier or swimming in the waters just adjacent to those haul-outs.

Local abundance information, rather than density, was used in estimating take for Steller sea lions. Please see the discussion provided previously for California sea lions. Steller sea lions are known only from haul-outs over one mile from the project area, and would not be subject to harassment from airborne sound. Table 10 depicts the number of estimated behavioral harassments.

Harbor Seal

Harbor seals are the most abundant marine mammal in Hood Canal, where they can occur anywhere in Hood Canal waters year-round. The Navy detected harbor seals during marine mammal boat surveys of the waterfront area from July to September 2008 (Tannenbaum *et al.,* 2009) and November to May 2010 (Tannenbaum *et al.,* 2011), as described previously. Harbor seals were sighted during every survey and were found in all marine habitats including nearshore waters and deeper water, and hauled out on manmade objects such as piers and buoys. During most of the year, all age and sex classes (except newborn pups) could occur in the project area throughout the period of construction activity. Since there are no known pupping sites in the vicinity of the project area, harbor seal neonates are not expected to be present during pile driving. Otherwise, during most of the year, all age and sex classes could occur in the project area throughout the period of construction activity. Harbor seal numbers increase from January through April and then decrease from May through August as the harbor seals move to adjacent bays on the outer coast of Washington for the pupping season. From April through mid-July, female harbor seals haul out on the outer coast of Washington at pupping sites to give birth. The main haul-out locations for harbor seals in Hood Canal are located on river delta and tidal exposed areas at Quilcene, Dosewallips, Duckabush, Hamma Hamma, and Skokomish River mouths, with the closest haul-out area to the project area being 10 mi (16 km) southwest of NBKB at Dosewallips River mouth (London, 2006). Please see Figure 4–1 of the Navy's application for a map of haul-out locations in relation to the project area.

Jeffries *et al.* (2003) conducted aerial surveys of the harbor seal population in Hood Canal in 1999 for the Washington Department of Fish and Wildlife and reported 711 harbor seals hauled out. The authors adjusted this abundance with a correction factor of 1.53 to account for seals in the water, which were not counted, and estimated that there were 1,088 harbor seals in Hood Canal. The correction factor (1.53) was based on the proportion of time seals spend on land versus in the water over the course of a day, and was derived by dividing one by the percentage of time harbor seals spent on land. These data came from tags (VHF transmitters) applied to harbor seals at six areas (Grays Harbor, Tillamook Bay, Umpqua River, Gertrude Island, Protection/Smith Islands, and Boundary Bay, BC) within two different harbor seal stocks (the coastal stock and the inland waters of WA stock) over four survey years. The Hood Canal population is part of the inland waters stock, and while not specifically sampled, Jeffries *et al.* (2003) found the VHF data to be broadly applicable to the entire stock. The tagging research in 1991 and 1992 conducted by Huber *et al.* (2001) and Jeffries *et al.* (2003) used the same methods for the 1999 and 2000 survey years. These surveys indicated that approximately 35 percent of harbor seals are in the water versus hauled out on a daily basis (Huber *et al.,* 2001; Jeffries *et al.,* 2003). Exposures were calculated using a density derived from the number of harbor seals that are present in the water at any one time (35 percent of 1,088, or approximately 381 individuals), divided by the area of the Hood Canal (291 km^2 [112 mi^2]) and the formula presented previously.

NMFS recognizes that over the course of the day, while the proportion of animals in the water may not vary significantly, different individuals may enter and exit the water. However, fine-scale data on harbor seal movements within the project area on time durations of less than a day are not available. Previous monitoring experience from Navy actions conducted from July-October 2011 in the same project area has indicated that this density provides an appropriate estimate of potential exposures. Data from those monitoring efforts are currently in post-processing and are not available in report form at this time. However, the density of harbor seals calculated in this manner (1.3 animals/km^2) is corroborated by results of the Navy's vessel-based marine mammal surveys at NBKB in 2008 and 2009–10, in which an average of five individual harbor seals per survey was observed in the 3.9 km^2 survey area (density = 1.3 animals/km^2) (Tannenbaum *et al.,* 2009, 2011).

The Navy's waterfront surveys have found that it is extremely rare for harbor seals to haul out in the vicinity of the project area, although it has been known to occur. Therefore, in order to estimate potential incidental take of harbor seals by airborne sound, NMFS has considered that the entire in-water density, as described previously, could potentially be available to be taken by airborne sound. This calculation, using the density estimate as described above and the maximum area estimated to be ensonified to 90 dB by airborne sound (0.41 km^2), results in a prediction that 0.5 seals could be exposed per day. When rounded up to the nearest whole number, this gives the result that up to one seal could haul-out within the 90-dB in-air harassment zone per day of pile driving. NMFS feels that this is extremely unlikely, based on past observations of the frequency with which harbor seals haul-out on the floating security fence near the project area, but that this is nevertheless an appropriate precautionary approach. Table 10 depicts the number of estimated behavioral harassments.

Killer Whales

Transient killer whales are uncommon visitors to Hood Canal. Transients may be present in the Hood Canal anytime during the year and traverse as far as the project site. Resident killer whales have not been observed in Hood Canal, but transient pods (six to eleven individuals per event) were observed in Hood Canal for lengthy periods of time (59–172 days) in 2003 (January–March) and 2005 (February–June), feeding on harbor seals (London 2006).

These whales used the entire expanse of Hood Canal for feeding. Subsequent aerial surveys suggest that there has not been a sharp decline in the local seal population from these sustained feeding events (London 2006). Based on this data, the density for transient killer whales in the Hood Canal for January to June is 0.038/km^2 (eleven individuals divided by the area of the Hood Canal [291 km^2]). Because the timeframe of known transient killer whale occurrence in Hood Canal only partially overlaps the construction period (January to mid-February), the days of total activity (or days of potential exposure) portion of the formula presented previously is reduced to 45 for killer whales. Table 10 depicts the number of estimated behavioral harassments.

Dall's Porpoise

Dall's porpoises may be present in the Hood Canal year-round and could occur as far as the project site. Their use of inland Washington waters, however, is mostly limited to the Strait of Juan de Fuca. The Navy conducted vessel-based surveys of the waterfront area in 2008–10 (Tannenbaum *et al.,* 2009, 2011). During one of the surveys a Dall's porpoise was sighted in August in the deeper waters off Carlson Spit.

In the absence of an abundance estimate for the entire Hood Canal, a density was derived from the waterfront survey by the number of individuals seen divided by total number of kilometers of survey effort (18 surveys with approximately 3.9 km^2 [1.5 mi^2] of effort each), assuming strip transect surveys. In absence of any other survey data for the Hood Canal, this density is assumed to be throughout the project area. Exposures were calculated using the formula presented previously. Table 10 depicts the number of estimated behavioral harassments.

Harbor Porpoise

Harbor porpoises may be present in the Hood Canal year-round; their presence had previously been considered rare. During waterfront surveys of NBKB nearshore waters from 2008–10 only one harbor porpoise had been seen in 18 surveys of 3.9 km^2 each. However, during monitoring of recent Navy actions at NBKB (test pile program and EHW–1 pile replacement) several sightings indicated that their presence may be more frequent in deeper waters of Hood Canal than had been believed on the basis of existing survey data and anecdotal evidence. Subsequently, the Navy conducted dedicated vessel-based line transect surveys on days when no pile driving occurred (due to security, weather, etc.), described previously in this document, with regular observations of harbor porpoise groups. Sightings in the deeper waters of Hood Canal ranged up to 11 individuals, with an average of approximately six animals sighted per survey day (Navy, in prep.).

Sightings of harbor porpoises during these surveys were used to generate a density for Hood Canal. Based on guidance from other line transect surveys conducted for harbor porpoises using similar monitoring parameters (*e.g.,* boat speed, number of observers) (Barlow, 1988; Calambokidis *et al.,* 1993; Caretta *et al.,* 2001), the Navy determined the effective strip width for the surveys to be one kilometer, or a perpendicular distance of 500 m from the transect to the left or right of the vessel. The effective strip width was set at the distance at which the detection probability for harbor porpoises was equivalent to one, which assumes that all individuals on a transect are detected. Only sightings occurring within the effective strip width were used in the density calculation. By multiplying the trackline length of the surveys by the effective strip width, the total area surveyed during the surveys was 259.01 km^2. Thirty-five individual harbor porpoises were sighted within this area, resulting in a density of 0.135 animals per km^2. To account for availability bias, or the animals which are unavailable to be detected because they are submerged, the Navy utilized a g(0) value of 0.54, derived from other similar line transect surveys (Barlow, 1988; Calambokidis *et al.,* 1993; Carretta *et al.,* 2001). This resulted in a density of 0.250 harbor porpoises per km^2. For comparison, 274.27 km^2 of trackline survey effort in nearby Dabob Bay produced a corrected density estimate of 0.203 harbor porpoises per km^2. Exposures were calculated using the formula described previously. Table 10 depicts the number of estimated behavioral harassments.

Potential takes could occur if individuals of these species move through the area on foraging trips when pile driving is occurring. Individuals that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, individuals may move away from the sound source and be temporarily displaced from the areas of pile driving. Potential takes by disturbance would likely have a negligible short-term effect on individuals and not result in population-level impacts.

TABLE 10—NUMBER OF POTENTIAL INCIDENTAL TAKES OF MARINE MAMMALS WITHIN VARIOUS ACOUSTIC THRESHOLD ZONES

Species	Density/Abundance	Underwater		Airborne	Total proposed authorized takes
		Impact injury threshold [1]	Vibratory disturbance threshold (120 dB)	Impact disturbance threshold [3]	
California sea lion [2]	[4] 26.2	0	5,070	0	5,070
Steller sea lion	[4] 1.2	0	195	0	195
Harbor seal	1.31	0	10,530	195	10,725
Killer whale	0.038	0	90	N/A	90
Dall's porpoise	0.014	0	195	N/A	195
Harbor porpoise	0.250	0	1,950	N/A	1,950
Total		0	18,330	195	18,225

[1] Acoustic injury threshold for impact pile driving is 190 dB for pinnipeds and 180 dB for cetaceans.

[2] The 160-dB acoustic harassment zone associated with impact pile driving would always be subsumed by the 120-dB harassment zone produced by vibratory driving. Therefore, takes are not calculated separately for the two zones.

[3] Acoustic disturbance threshold is 100 dB for sea lions and 90 dB for harbor seals. NMFS does not believe that sea lions would be available for airborne acoustic harassment because they are known to haul-out only at locations well outside the zone in which airborne acoustic harassment could occur.

[4] Figures presented are abundance numbers, not density, and are calculated as the average of average daily maximum numbers per month. Abundance numbers are rounded to the nearest whole number for take estimation.

Negligible Impact and Small Numbers Analysis and Preliminary Determination

NMFS has defined ''negligible impact'' in 50 CFR 216.103 as ''* * * an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.'' In making a negligible impact determination, NMFS considers a variety of factors, including but not limited to: (1) The number of anticipated mortalities; (2) the number and nature of anticipated injuries; (3) the number, nature, intensity, and duration of Level B harassment; and (4) the context in which the take occurs.

Pile driving activities associated with the wharf construction project, as outlined previously, have the potential to disturb or displace marine mammals. Specifically, the proposed activities may result in take, in the form of Level B harassment (behavioral disturbance) only, from airborne or underwater sounds generated from pile driving. No mortality, serious injury, or Level A harassment is anticipated given the methods of installation and measures designed to minimize the possibility of injury to marine mammals and Level B harassment would be reduced to the level of least practicable adverse impact. Specifically, vibratory hammers, which do not have significant potential to cause injury to marine mammals due to the relatively low source levels (less than 190 dB), would be the primary method of installation. Also, no impact pile driving would occur without the use of a sound attenuation system (*e.g.,* bubble curtain), and pile driving would either not start or be halted if marine mammals approach the shut-down zone (described previously in this document). The pile driving activities analyzed here are similar to other nearby construction activities within the Hood Canal, including two recent projects conducted by the Navy at the same location (test pile project and EHW–1 pile replacement project) as well as work conducted in 2005 for the Hood Canal Bridge (SR–104) by the Washington Department of Transportation, which have taken place with no reported injuries or mortality to marine mammals.

The proposed numbers of authorized take for Steller and California sea lions and for Dall's porpoises would be considered small relative to the relevant stocks or populations (each less than two percent) even if each estimated taking occurred to a new individual—an extremely unlikely scenario. The proposed numbers of authorized take for harbor seals, transient killer whales, and harbor porpoises are somewhat higher relative to the total stocks. However, these numbers represent the instances of take, not the number of individuals taken. That is, it is likely that a relatively small subset of Hood Canal harbor seals, which is itself a small subset of the regional stock, would be harassed by project activities. While the available information and formula estimate that as many as 10,725 exposures of harbor seals to stimuli constituting Level B harassment could occur, that number represents some portion of the approximately 1,088 harbor seals resident in Hood Canal (approximately seven percent of the regional stock) that could potentially be exposed to sound produced by pile driving activities on multiple days during the project. No rookeries are present in the project area, there are no haul-outs other than those provided opportunistically by man-made objects, and the project area is not known to provide foraging habitat of any special importance. Repeated exposures of individuals to levels of sound that may cause Level B harassment are unlikely to result in hearing impairment or to significantly disrupt foraging behavior. Thus, even repeated Level B harassment of some small subset of the overall stock is unlikely to result in any significant realized decrease in viability for Hood Canal harbor seals, and thus would not result in any adverse impact to the stock as a whole. Similarly, for killer whales, the estimated number of takes represents a single group of eleven whales that could potentially be exposed to sound on multiple days, if present. In fact, if a group of transient killer whales was present in the Hood Canal during the project (which is in itself unlikely, as such groups have appeared only twice since 2003), such a group would be able to simply leave the project area and forage elsewhere in Hood Canal or Puget Sound if the acoustic behavioral harassment caused by the project disturbed the group to a sufficient degree. However, it is difficult to quantify such a group's willingness to remain in the presence of behavioral harassment or, alternatively, to depart the project area. As such, NMFS proposes to authorize the take presented in Table 10, which represents the take of a single pod (approximately 11) that might be taken repeatedly over multiple days if they stayed in the area. The possible repeated exposure of a small group of individuals to levels associated with Level B harassment in this area is expected to have a negligible impact on the stock.

For harbor porpoises, the situation relative to the regional stock (where estimated take is approximately eighteen percent) is less clear as little is known about their use of Hood Canal. Sightings information from opportunistic waterfront surveys as well as designed surveys of nearshore waters had previously indicated that harbor porpoises rarely occurred in NBKB waters. In addition, although no systematic survey work for harbor porpoises has occurred in Hood Canal, anecdotal evidence and expert opinion received through personal communication had confirmed that harbor porpoises were expected to occur infrequently and in low numbers in the project area. Recent Navy surveys, described previously in this document, have indicated that harbor porpoises are present in greater numbers than had been believed. It is unclear from the limited information available what relationship this occurrence, recorded only during September–October, 2011, may hold to the regional stock or whether similar usage of Hood Canal may be expected to recur throughout the project timeframe. Nevertheless, the estimated take of harbor porpoises is likely an overestimate (as it is based on information that may not hold true throughout the project timeframe) and should be considered to present a negligible impact on the stock. Harbor porpoise sightings to date have occurred only at significant distance from the project area (both inside and outside of the predicted 120–dB zone).

NMFS has preliminarily determined that the impact of the previously described wharf construction project may result, at worst, in a temporary modification in behavior (Level B harassment) of small numbers of marine mammals. No mortality or injuries are anticipated as a result of the specified activity, and none are proposed to be authorized. Additionally, animals in the area are not expected to incur hearing impairment (*i.e.,* TTS or PTS) or non-auditory physiological effects. For pinnipeds, the absence of any major rookeries and only a few isolated and opportunistic haul-out areas near or adjacent to the project site means that potential takes by disturbance would have an insignificant short-term effect on individuals and would not result in population-level impacts. Similarly, for cetacean species the absence of any known regular occurrence adjacent to the project site means that potential takes by disturbance would have an insignificant short-term effect on individuals and would not result in population-level impacts. Due to the nature, degree, and context of behavioral harassment anticipated, the activity is not expected to impact rates of recruitment or survival.

For reasons stated previously in this document, the negligible impact determination is also supported by the likelihood that, given sufficient ''notice'' through mitigation measures including soft start, marine mammals are expected to move away from a sound source that is annoying prior to its becoming potentially injurious, and the likelihood that marine mammal detection ability by trained observers is high under the environmental conditions described for Hood Canal, enabling the implementation of shut-downs to avoid injury, serious injury, or mortality. As a result, no take by injury or death is anticipated, and the potential for temporary or permanent hearing impairment is very low and would be avoided through the incorporation of the proposed mitigation measures.

While the number of marine mammals potentially incidentally harassed would depend on the distribution and abundance of marine mammals in the vicinity of the survey activity, the number of potential harassment takings is estimated to be small relative to regional stock or population number, and has been mitigated to the lowest level practicable through incorporation of the proposed mitigation and monitoring measures mentioned previously in this document. This activity is expected to result in a negligible impact on the affected species or stocks. The Eastern DPS of the Steller sea lion is listed as threatened under the ESA; no other species for which take authorization is requested are either ESA-listed or considered depleted under the MMPA.

Based on the analysis contained herein of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the mitigation and monitoring measures, NMFS preliminarily finds that the proposed wharf construction project would result in the incidental take of small numbers of marine mammal, by Level B harassment only, and that the total taking from the activity would have a negligible impact on the affected species or stocks.

Impact on Availability of Affected Species or Stock for Taking for Subsistence Uses

No tribal subsistence hunts are held in the vicinity of the project area; thus, temporary behavioral impacts to individual animals would not affect any subsistence activity. Further, no population or stock level impacts to marine mammals are anticipated or authorized. As a result, no impacts to the availability of the species or stock to the Pacific Northwest treaty tribes are expected as a result of the proposed activities. Therefore, no relevant subsistence uses of marine mammals are implicated by this action.

Endangered Species Act (ESA)

There is one ESA-listed marine mammal species with known occurrence in the project area: The Eastern DPS of the Steller sea lion, listed as threatened. Because of the potential presence of Steller sea lions, the Navy engaged in a formal consultation with the NMFS Northwest Regional Office under Section 7 of the ESA. The Biological Opinion associated with that consultation concluded that the proposed action is not likely to jeopardize the continued existence of the Steller sea lion. The Steller sea lion does not have critical habitat in the action area.

National Environmental Policy Act (NEPA)

The Navy has prepared a preliminary final EIS. NMFS, which is a cooperating agency in the preparation of that document, will review it and the public comments received and subsequently either adopt it or prepare its own NEPA document before making a determination on the issuance of an IHA. The Navy EIS is available for public review at *www.nbkeis.com.*

Proposed Authorization

As a result of these preliminary determinations, NMFS proposes to authorize the take of marine mammals incidental to the Navy's wharf construction project, provided the previously mentioned mitigation, monitoring, and reporting requirements are incorporated.

Dated: December 14, 2011.

James H. Lecky

Director, Office of Protected Resources, National Marine Fisheries Service.

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