Environmental Assessment
FOR
ISSUANCE OF AN INCIDENTAL HARASSMENT AUTHORIZATION FOR THE EXPLORATORIUM RELOCATION PROJECT IN SAN FRANCISCO, CA

October 2010

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Abstract: The National Marine Fisheries Service (NMFS) proposes to issue an Incidental Harassment Authorization (IHA) to the Exploratorium for the incidental taking of small numbers of marine mammals in the wild, pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1361 *et seq*.). The IHA would be valid for 1 year from the date of issuance and would authorize the take, by Level B harassment, of marine mammals incidental to pile driving associated with the Exploratorium Relocation Project in San Francisco, California.

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CHAPTER 1 PURPOSE OF AND NEED FOR ACTION

1.1 DESCRIPTION OF ACTION

On April 28, 2010, the National Marine Fisheries Service (NMFS), Permits, Education, and Conservation Division received a request from the Exploratorium to take[1], by Level B harassment[2] only, small numbers of marine mammals incidental to pile driving associated with the Exploratorium Relocation Project in San Francisco, CA. After receipt of supplemental information, the application was determined complete on June 1, 2010. As such, NMFS proposes to issue an Incidental Harassment Authorization (IHA) pursuant to Section 101(a)(5)(A) and (D) of the Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1371 *et seq*.), and the regulations governing the taking and importing of marine mammals (50 CFR Part 216).

1.1.1 Purpose and Need

The purpose and need of the action is to ensure compliance with the MMPA and its implementing regulations for the activities associated with the Exploratorium relocation project. The MMPA prohibits takes of all marine mammals in the U.S. (including territorial seas) with a few exceptions. Sections 101(a)(5)(A) and (D) of the MMPA direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) if certain findings are made and regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may be granted for up to 5 years 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 certain subsistence uses, and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such taking 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.”

NMFS’ decision of whether or not to issue the Exploratorium an incidental take authorization is a major Federal action that requires an analysis of its effect on the human environment pursuant to the National Environmental Policy Act (NEPA). This Environmental Assessment (EA) contains that analysis and is intended to support NMFS’ issuance of an IHA

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1 Under the MMPA, “take” is defined as to "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." [16 U.S.C. 1362(18)(A)].

2 “Harass” is defined by regulation (50 CFR §216.3) 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 a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but does not have the potential to injure a marine mammal or marine mammal stock in the wild (Level B harassment)."

authorizing the incidental take of small numbers of marine mammals associated with the Exploratorium relocation project.

1.1.2 Objectives of the Exploratorium Relocation Project

As described in the application, the fundamental objective of the project is to construct a new home for the Exploratorium – an internationally recognized museum that provides education on science, nature, art, human perception, and technology. The relocation of the Exploratorium would provide centralized space to accommodate substantial growth in its exhibit, education, and research programs, as well as administrative space and functions.

1.2 SCOPING SUMMARY

The purpose of scoping is to identify the issues to be addressed and any potentially significant environmental issues related to the proposed action, as well as identify and eliminate from detailed study the environmental issues that are not significant or that have been covered by review in prior NEPA analyses. An additional purpose of the scoping process is to identify the concerns of the affected public and Federal agencies, states, and Indian tribes. While the Council on Environmental Quality's (CEQ) regulations and NOAA Administrative Order 216-6, implementing the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 *et seq*.), do not require that a draft EA be made available for public comment as part of the scoping process, NMFS utilizes the IHA review process to the maximum extent practical to inform the public of environmental issues and information related to the proposed action being analyzed in the EA and to obtain public comment for consideration prior to making final determinations regarding the significance of environmental impacts.

Under 50 CFR 216.104(b) of NMFS' implementing regulations for the MMPA, NMFS must, after deeming the application adequate and complete, publish in the *Federal Register* a notice of proposed IHA or receipt of a request for the implementation or re-implementation of regulations governing the incidental taking. Information gathered during the associated comment period is considered by NMFS in ensuring adequacy of preliminary determinations and proposed mitigation measures for IHAs. In accordance, a notice of receipt of application and proposed issuance of an IHA were published in the *Federal Register* on July 22, 2010 (75 FR 42691) and was made available for public review and comment for 30 days. Comments received on the proposed IHA were also used to develop the scope of this EA.

1.3 APPLICABLE LAWS AND NECESSARY FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

This section summarizes Federal, state, and local permits, licenses, approvals, and consultation requirements necessary to implement the proposed action, as well as who is responsible for obtaining them. Even when it is the applicant's responsibility to obtain such permissions, NMFS is obligated under NEPA to ascertain whether the applicant is seeking other Federal, state, or local approvals for their action.

1.3.1 National Environmental Policy Act (NEPA)

NEPA was enacted in 1969 and its environmental review requirements set forth in Section 102(C) are applicable to all "major" Federal actions with the potential to result in significant effects on the quality of the human environment. A major Federal action is an activity that is fully or partially funded, regulated, conducted, or approved by a Federal agency. NMFS issuance of incidental take authorizations represents approval and regulation of activities. While NEPA does not dictate substantive requirements for permits, licenses, etc., it requires consideration of environmental issues in Federal agency planning and decision making. The procedural provisions outlining Federal agency responsibilities under NEPA are provided in CEQ's implementing regulations (40 CFR Parts 1500-1508).

NOAA has, through NOAA Administrative Order (NAO) 216-6, established agency procedures for complying with NEPA and the implementing regulations issued by CEQ. NAO 216-6 specifies that issuance of incidental take authorizations under the MMPA and ESA is among a category of actions that are generally exempted (categorically excluded) from further environmental review if they are tiered to a pre-existing programmatic environmental review, except under extraordinary circumstances. When a proposed action that would otherwise be categorically excluded is the subject of public controversy based on potential environmental consequences, has uncertain environmental impacts or unknown risks, establishes a precedent or decision in principle about future proposals, may result in cumulatively significant impacts, or may have an adverse effect upon endangered or threatened species or their habitats, preparation of an EA or EIS is required. NMFS has not prepared a programmatic NEPA analysis covering the proposed IHA. Since issuance of the IHA has the potential to adversely affect species protected under the MMPA, NMFS has decided to prepare an EA to evaluate the context and intensity of such impacts to determine whether or not they have the potential to be significant. This EA is prepared in accordance with NEPA, its implementing regulations, and NOAA 216-6.

1.3.2 Endangered Species Act (ESA)

Section 7 of the ESA requires consultation with the appropriate federal agency (either NMFS or the U.S. Fish and Wildlife Service) for federal actions that "may affect" a listed species or adversely modify critical habitat. NMFS' issuance of an authorization affecting ESA-listed species or designated critical habitat, directly or indirectly, is a federal action subject to these Section 7 consultation requirements. Section 7 requires federal agencies to use their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered and threatened species. NMFS is further required to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any threatened or endangered species or result in destruction or adverse modification of habitat for such species. Regulations specify the procedural requirements for these consultations (50 Part CFR 402).

1.3.3 Marine Mammal Protection Act (MMPA)

The MMPA prohibits takes of all marine mammals in the U.S. (including territorial seas) with a few exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 *et seq*.)

direct the Secretary of Commerce (Secretary) to allow, upon request, the incidental, but not intentional, taking of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) if certain findings are made and regulations are issued or, if the taking is limited to harassment, notice of a proposed authorization is provided to the public for review.

Authorization for incidental takings may 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 certain subsistence uses, and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such taking 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."

Under the MMPA, harassment is defined as any act of pursuit, torment, or annoyance which has the potential to: (i) injure a marine mammal or marine mammal stock in the wild (Level A harassment); or (ii) 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). An IHA may be issued, except for activities that have the potential to result in serious injury or mortality (i.e., it may only authorize Level A and B harassment), for a period of no more than 1 year, following a 30-day public review period. Alternatively, regulations may be granted for a period of 5 years and may include takes by serious injury and mortality. Upon rulemaking (i.e., defining regulations), Letters of Authorization (LOAs) will be issued each year to the authorization holder. For both an IHA and regulations, authorization shall be granted if the Secretary finds that the taking will have a negligible impact on a species or stock, and that the IHA or regulations are prescribed setting forth the permissible methods of taking, the means of effecting the least practicable adverse impact, and requirements pertaining to monitoring and reporting. For authorizations associated with activities that could impact marine mammals in Arctic waters (i.e., waters north of 60ºN), the action agency must also consider means of effecting the least practicable impact on the availability of the species for subsistence uses.

1.3.4 Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)

Under the MSFCMA, Congress defined Essential Fish Habitat (EFH) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The EFH provisions of the MSFCMA offer resource managers means to accomplish the goal of giving heightened consideration to fish habitat in resource management. NMFS Office of Protected Resources is required to consult with NMFS Office of Habitat Conservation for any action it authorizes (e.g., research permits), funds, or undertakes, or proposes to authorize, fund, or undertake that may adversely affect EFH. This includes renewals, reviews, or substantial revisions of actions.

1.3.5 Coastal Zone Management Act

Congress enacted the Coastal Zone Management Act (CZMA) (16 U.S.C. 1451 *et seq*.) to protect the coastal environment from growing demands associated with residential, recreational, commercial, and industrial uses (e.g., state and federal offshore oil and gas development). Those coastal states with an approved Coastal Zone Management Plan, which defines permissible land and water use within the state's coastal zone[3], can review federal actions, licenses, or permits for "federal consistency." Federal consistency is the requirement that those federal permits and licenses likely to affect any land/water use or natural resources of the coastal zone be consistent with the Program's enforceable policies. NMFS consults with states on issuance of permits for activities that fall within the state's Coastal Zone Management Plan.

[3] A state's coastal zone extends 3 miles seaward, and inland as far as necessary to protect the coast.

CHAPTER 2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the range of potential actions (alternatives) determined reasonable with respect to achieving the stated purpose and need for the proposed action, as well as alternatives eliminated from detailed study. This chapter also summarizes the expected outputs and any related mitigation of each alternative. One alternative is the "No Action" alternative where the proposed permit would not be issued. The No Action alternative is the baseline for the rest of the analyses. The Proposed Action alternative represents the activity proposed in the submitted application for a permit, with standard permit terms and conditions specified by NMFS.

2.1 ALTERNATIVE 1 – NO ACTION

Under the No Action alternative, NMFS would not issue an IHA to the Exploratorium authorizing the take of small numbers of marine mammals incidental to the specified activity. The Exploratorium would still be authorized to conduct the activity, as allowed for under their Section 404 Army Corps of Engineers permit; however, mitigation measures would not be implemented and illegal take of marine mammals could occur.

2.2 ALTERNATIVE 2 – PROPOSED ACTION (Issuance of an IHA with Proposed Conditions)

Under the Proposed Action alternative, an IHA would be issued for takes of small numbers of marine mammals incidental to specified activities as proposed by the applicant, with the mitigation, monitoring, and reporting conditions contained within the Exploratorium's application and NMFS' proposed IHA *Federal Register* notice. The primary distinction between the proposed action and no action alternatives, thus, is the proposed action's requirement to implement mitigation and monitoring measures to minimize adverse impacts to marine mammals.

2.2.1 Action Area

After 38 years in the Palace of Fine Arts, the Exploratorium has outgrown its current location; therefore, the Exploratorium proposes to relocate from 3601 Lyon Street, San Francisco to Piers 15 and 17, along the Embarcadero of San Francisco's waterfront. The Exploratorium relocation project would create a new home for the Exploratorium and provide ample space to accommodate growth in its exhibit, education, and research programs, as well as space for administrative activities and functions in a single facility. Piers 15 and 17 are located in the northeast quadrant of San Francisco and are bounded by the Embarcadero to the west and by the San Francisco Bay to the east, north, and south. Pier 9 lies south and Pier 19 lies north of the project site. Pile driving would take place along the length of the piers, 244 meters into the Bay.

2.2.2 Specified Activity

The Exploratorium relocation project is scheduled to commence as early as September 2010 and construction would continue throughout a 26-month period. However, only pile driving has the potential to result in marine mammal take and this activity is expected to be complete by the spring of 2011. Activities would include the installation, repair, and removal of piles at Pier 15, removal of wharf decking between Piers 15 and 17, and expansion of the southern portion of Pier 15. The Exploratorium proposes to install up to 69 new steel piles and repair, extend, and remove up to 2,289 existing piles by hydraulic or hand-held cutting tools. Pile driving results in elevated noise levels; therefore, this activity may impact marine mammals in the vicinity of the operation pile driver.

Installation of the piles would primarily be accomplished using a vibratory hammer; however, an impact hammer may be necessary for the large diameter 72-inch piles. The entire construction project is expected to take 26 months to complete; however, pile driving is expected to take 6 months over an 8-month time span (September-November and February-April). Pile driving would occur intermittently, Mondays through Fridays, during this window of time. Between two and five steel piles (average of three piles) would be installed daily, depending on their size and the amount of time necessary to install them. Each pile would take approximately 30 minutes to install followed by at least a 1-hour break, the minimum amount of time needed to reset the hammer and next pile. In total, the Exploratorium anticipates conducting 28 hours of pile driving, with 15 hours needed to install 72-inch piles, 5 hours spent on 20-inch piles, and 8 hours spent on 24-inch piles.

All piles would be installed with an ICE 14122 (or similar) vibratory hammer; however, it may be necessary to seat a pile using an impact hammer. Based on the ground sediments and the depth of pile driving needed, the use of an impact hammer is not anticipated for the smaller 20-inch and 24-inch piles, but may be needed for the larger diameter 72-inch piles. Should an impact hammer be necessary, the Exploratorium would use a steam- or diesel-powered hammer delivering between 80,000 and 110,000 ft-lbs per blow. For 20, 24, and 72-inch piles, the amount of strikes per pile would be limited to 120, 25, and 5, respectively. Sound attenuation devices (e.g., wood block, bubble curtain) would be used during any impact hammering; however, no mitigation is required for vibratory pile driving because received levels would not reach 180 dB or above.

During the San Francisco-Oakland Bay Bridge Project (SFOBB), the California Department of Transportation (Caltrans), measured vibratory driving sound levels from various pile types, sizes, and locations around San Francisco Bay (Caltrans, 2007). Because no pile driving noise data specific to the Exploratorium project exists, NMFS has determined that hydroacoustic data from the Caltrans SFOBB project are appropriate to use to estimate sound levels from the specified activity. For background, sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water, and is generally characterized by several variables. Frequency describes the sound's pitch and is measured in hertz (Hz) or kilohertz (kHz), while sound level describes the sound's loudness and is measured in decibels (dB). Sound level increases or decreases exponentially with each dB of change. For example, 10 dB yields a sound level 10 times more intense than 1 dB, while a 20 dB level

equates to 100 times more intense, and a 30 dB level is 1,000 times more intense. Sound levels are compared to a reference sound pressure (micro-Pascal) to identify the medium. For air and water, these reference pressures are "re: 20 μPa" and "re: 1 μPa," respectively. Sound levels in this document are referenced to 1 μPa, unless otherwise noted.

In 2007, Caltrans released a report summarizing typical and maximum sound pressure levels (SPLs) measured during vibratory pile driving in San Francisco Bay (Table 2). In summary, sound pressure levels (SPLs) measured 5 m from the hammer were below 180 dB root mean square (rms) values. Most of the energy during vibratory pile driving was below 600 Hz. NMFS notes that the vibratory hammers Caltrans used to install the 72-inch pile were the King Kong and Super Kong Driver (Model 600). The hammer the Exploratorium proposes to use is 40% of the energy of the King Kong hammer; therefore, source levels would be lower for the relocation project as hammer noise levels are proportional to blow energy. Vibratory pile driving measurements taken by Caltrans approximately 11-13 kilometers (km) northeast of the Exploratorium in similar depth water indicate that peak sound pressures drop off at a rate of about 7 dB per doubling of distance. For comparison, spherical spreading (20 log R) is characterized by a drop-off rate of 6 dB per doubling of distance. Therefore, it is anticipated that noise from pile driving will dissipate very quickly around the Exploratorium.

Table 2. Measured sound pressure levels during vibratory pile driving in San Francisco Bay (Caltrans, 2007).

Pile Type/Size	Relative Water Depth	SPL at 10 m (RMS)
72-inch steel pile	5 meters	Average = 170 dB Loudest = 180 dB
34-inch steel pile	5 meters	Average = 170 dB Loudest = 175 dB
24-inch steel pile	5 meters	Average = 160 dB Loudest = 165 dB
12-inch steel pile	5 meters	Average = 155 dB

Caltrans also conducted hydroacoustic surveys within San Francisco Bay during impact pile driving of similar size piles proposed for use by the Exploratorium (Table 3). Bubble curtains can provide between 5-20 dB reduction in source level; however, this is highly directional and a function of current and device effectiveness (Caltrans, 2009). Therefore, distances to the Level A and Level B harassment isopleths are based on estimated, unattenuated source levels. These distances are likely an overestimate of sound levels produced by pile driving using a bubble curtain or wood cap. The Level B harassment isopleth is estimated to reach 1,900 m into the Bay from any direction of the pile hammer. This is the same distance established by NMFS and Caltrans to determine Level B harassment during vibratory pile driving for the SFOBB project, and is based on a received level of 120 dB.

Table 3. Measured unattenuated sound pressure levels in the near field (10 m) during impact pile driving in San Francisco Bay (Caltrans, 2009).

Pile Type/Size	Relative Water Depth	SPL at 10 m (RMS)
96- inch steel pile	10 meters	205 dB
60-inch steel pile	<5 meters	195 dB
36-inch steel pile	<5 meters	190 dB
24-inch steel pile	5 meters	190 dB
14-inch steel pile	15 meters	184 dB

In addition to pile driving, the Exploratorium would repair or remove existing piles and remove existing wharf decking. Existing concrete piles would be removed by cutting them with a hydraulic shear. The shear operates like a knife gate, with hydraulic rams pushing a shear plate through the piling. The cutting shear would be suspended from a crane on deck. In-water noise from this work would be negligible. Pile repair would include installing a fiberglass shell around damaged piles and filling the shell with concrete. The work would be completed by divers using hand tools and would not involve loud noise. Furthermore, there are no marine mammal haul out sites at Piers 15 and 17 and deck height in the area is at elevations generally too high to facilitate marine mammal haul out. As such, deck removal and expansion would occur outside of marine mammal habitat. Therefore, removal and expansion of the existing pier decking would not likely result in harassment of marine mammals. Finally, there would be two to ten barges or floats at any given time in the water to support construction activities; however, these would be concentrated in the direct vicinity of Piers 15/17. Because pile repair, pile removal, and use of barges does not release loud sounds into the environment, marine mammal harassment from these activities is not anticipated.

2.2.3 Mitigation Measures

In order to issue an IHA under Section 101(a)(5)(D) of the MMPA, NMFS must set forth the permissible methods of taking pursuant to such activity, and other means of effecting the least practicable adverse 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.

The Exploratorium had no prior experience with MMPA compliance and therefore, sought NMFS' assistance in developing the appropriate mitigation and monitoring measures, including harassment zone distances, in order to ensure their project resulted in the least practicable adverse impacts to marine mammals. NMFS and the Exploratorium worked closely to develop these measures and as a result, these measures were included in the Exploratorium's application. The following mitigation measures are designed to ensure the least practicable adverse impact on marine mammals:

(1) Limited Use of an Impact Hammer

All piles would be installed using a vibratory pile driver unless sufficient depth cannot be reached, at which point an impact hammer may be used. In the event that an impact hammer is

necessary, a bubble curtain, wood block, or both would be used as an attenuation device to reduce hydroacoustic sound levels to avoid the potential for injury and reduce disturbance. With the use of these devices, hydroacoustic source levels are anticipated to be less than those presented in Table 3 above. Based on Caltrans (2007), source levels using sound attenuation devices would likely be between 164 and 179 dB RMS during impact hammering. In addition, impact hammering would not occur between June 1 and November 30 to prevent injury to listed salmonids.

(2) Establishment of a Safety Zone

During all in-water impact pile driving, the Exploratorium would establish a preliminary marine mammal safety zone of 500 m around each pile before pile driving commences. This safety zone is based on estimated unattenuated source levels and therefore is considered conservative. No safety zone for vibratory pile driving is necessary as source levels will not exceed the Level A harassment threshold.

(3) Pile Driving Shut Down and Delay Procedures

If a protected species observer (PSO) sees a marine mammal within or approaching the safety zone prior to the start of impact pile driving, the PSO would notify the Resident Engineer (or other authorized individual) who would then be required to delay pile driving until the marine mammal has moved outside of the safety zone or if the animal has not been resighted within 15 minutes. If a marine mammal is sighted within or on a path toward the safety zone during impact pile driving, pile driving would cease until that animal has cleared and is on a path away from the safety zone or 15 minutes has lapsed since the last sighting. Hydroacoustic monitoring would be conducted for the first two piles of each size that are driven with an impact hammer. After the data is analyzed, if empirical data shows that sound levels do not reach or exceed 190 dB (Level A harassment), then the impact pile driving shut down and delay procedures could be waived. In addition, if a marine mammal not authorized to be taken under the IHA (e.g., humpback whale) is observed within the Level B harassment zone (1,900 m), all pile driving would be delayed.

(4) Soft-Start Procedures

A “soft-start” technique would be used at the beginning of each pile installation to allow any marine mammal that may be in the immediate area to leave before the pile hammer reaches full energy. For vibratory pile driving, the soft-start procedures requires contractors to initiate noise from the vibratory hammer for 15 seconds at 40-60% reduced energy followed by a 1-minute waiting period. The procedure would be repeated two additional times before full energy is achieved. For impact hammering, contractors would be required to provide an intitial set of three strikes from the impact hammer at 40% energy, followed by a 1-minute waiting period, then two subsequent three-strike sets. The soft-start procedure would be conducted prior to driving each pile if impact or vibratory hammering ceases for more than 30 minutes.

2.2.4 Monitoring Measures

In order to issue an IHA for an activity, Section 101(a)(5)(D) of the MMPA states that NMFS must 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 IHAs must include the suggested means of accomplishing the necessary monitoring and reporting that will 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.

(1) Protected Species Observers

The Exploratorium would designate at least one biologically-trained, on-site individual, approved in advance by NMFS, to monitor the area for marine mammals 30 minutes before, during, and 30 minutes after all impact pile driving activities and call for shut down if any marine mammal is observed within or approaching the designated Level A harassment zone (preliminarily set at 500 m).

In addition, at least one NMFS-approved PSO would conduct behavioral monitoring in and around the Exploratorium at least two days per week for the duration of the project to estimate take and evaluate the behavioral impacts that vibratory pile driving has on marine mammals out to the Level B harassment isopleth (1,900 m).

(2) Herring Spawning Season

The herring spawning season occurs from December 1 through February 28 and is monitored by the California Department of Fish and Game (CDFG). The Exploratorium's action area is closed to all in-water work (including, but not limited to, pile driving) during this season. Therefore, NMFS does not authorize the Exploratorium to take any marine mammals from December 1 through February 28.

(3) Equipment

PSOs would be provided with the equipment necessary to effectively monitor for marine mammals (e.g., high-quality binoculars, compass, and range-finder) in order to determine if animals have entered into the harassment isopleths and to record species, behaviors, and responses to pile driving.

(4) Reporting

PSOs would be required to submit a report to NMFS within 120 days of expiration of the IHA or completion of pile driving, whichever comes first. The report would include data from marine mammal sightings (e.g., species, group size, behavior), any observed reactions to construction, distance to operating pile hammer, and construction activities occurring at time of sighting.

2.2.5 Other Alternatives Considered but Eliminated

The Exploratorium worked closely with NMFS and the Southwest Regional Office to develop the above mitigation and monitoring measures needed to ensure their project resulted in

the least practicable adverse impacts to marine mammals. Pinnipeds are located within San Francisco Bay yearround; therefore, no temporal scheduling of the specified activity would aid in reducing impacts to marine mammals. Because of these factors, no other alternatives are provided or analyzed.

CHAPTER 3 AFFECTED ENVIRONMENT

This chapter presents baseline information necessary for consideration of the alternatives, and describes the resources that would be affected by the alternatives, as well as environmental components that would affect the alternatives if they were to be implemented. The effects of the alternatives on the environment are discussed in Chapter 4.

3.1 SOCIAL AND ECONOMIC ENVIRONMENT

Economic and social factors are listed in the definition of effects in the NEPA regulations. However, the definition of human environment states that "economic and social effects are not intended by themselves to require preparation of an EIS." An EA must include a discussion of a proposed action's economic and social effects when these effects are related to the natural or physical environment.

The Exploratorium relocation project would provide a larger and better-equipped science, nature, art, human perception, and technology museum to be used for public education and outreach. Currently, Pier 15 is used as a tugboat docking facility and both piers have storage sheds and vacant space. The repair and expansion of the piers would not have any negative economic or social impact as the piers are not used to facilitate economic growth (e.g., not a shipping port). Social impacts would be beneficial as more visitors would be able to access and enjoy the museum.

NMFS's proposed action is to issue an IHA authorizing harassment of marine mammals within the action area. This part of San Francisco Bay is industrialized and does not support any marine mammal related businesses (e.g., whale or seal watching industry). There are no subsistence uses of marine mammals within the action area.

3.2 PHYSICAL ENVIRONMENT

The Exploratorium's project site is located on the western, central banks of San Franciso Bay. San Francisco Bay abuts the Sacramento-San Joaquin Delta, a system that drains 40% of California's landmass. Together, the Bay and Delta make up one of the largest estuarine systems on the continent. This intertidal landscape measures up to 19 km wide and up to 97 km long and is made up of numerous habitats, from deep channels to shallow marshes. Although the Bay has undergone extensive industrialization – losing 95% of its wetlands since 1850 – the estuary remains an important environment for healthy marine mammal populations year round. At least 35 marine mammal species can be found off the coast of California; however, few venture into the Bay and only Pacific harbor seals and California sea lions inhabit the southern portion of the Bay regularly. Gray whales are sighted in the Bay during their yearly migration, though most sightings tend to occur in the central Bay. Harbor porpoises, too, are not common to the area, but can be found in small pods of two or three animals on occasion. Humpback whales, while sometimes present in the central Bay, are rare in the south and are not expected to be present within the action area.

Waters adjacent to the Exploratorium relocation project site experience high traffic for tugboat activities, other large marine shipping, and cruise vessels. The area between the project site and Angel Island is the primary route for shipping traffic into and out of ports, including the Port of San Francisco and the Port of Oakland. Residents and visitors to the Bay area also utilize this water body as a recreational boating resource.

3.2.1 Essential Fish Habitat (EFH)

Essential Fish Habitat (EFH) means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, "waters" include aquatic areas that are used by fish and their associated physical, chemical, and biological properties and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' entire life cycle.

EFH has been designated for many of the fish species within the action area. Details of the designations and descriptions of the habitats are available in the Pacific Fishery Management Plans. Activities that have been shown to affect EFH include disturbance or destruction of habitat from stationary fishing gear, dredging and filling, agricultural and urban runoff, direct discharge, and the introduction of exotic species.

3.2.2 Designated Critical Habitat

The ESA mandates the Federal government to designate "critical habitat" for every listed species except in limited circumstances. Critical habitat is an areadeemed essential to the conservation of a species listed under the ESA.

No marine mammal critical habitat has been designated within the action area; however, critical habitat has been established within San Francisco Bay for the southern stock of green sturgeon (*Acipenser medirostris*) (50 CFR Part 226.219), central California coast steelhead (*Oncorhynchus mykiss*) (50 CFR Part 226.211), and Sacramento River winter-run chinook salmon (*O. tshawytscha*) (50 CFR Part 226.204).

3.3 BIOLOGICAL ENVIRONMENT

San Francisco Bay is a habitat for numerous coastal and marine species, including birds, fish, and marine mammals, that are protected by a variety of environmental regulations. Caltrans' 2009 EA for the San Francisco-Oakland Bay Bridge Project identifies and describes a variety of biologically important and protected species inhabiting the action area. NMFS' action of issuing an IHA would allow for the harassment of marine mammals and therefore is the focus of this section.

Marine mammals with confirmed occurrences in San Francisco Bay are the Pacific harbor seal, California sea lion, harbor porpoise, gray whale, humpback whale, and sea otter.

However, humpback whales are extremely rare in San Francisco Bay and are unlikely to be present in the project vicinity during pile driving. Sea otters are managed by the U.S. Fish and Wildlife Service and NMFS does not authorize take of this species. Therefore, these two species will not be considered further in this analysis and no take authorization is requested or proposed for this action.

3.3.1 Pacific Harbor Seals

Pacific harbor seals are found in the coastal and estuarine waters off Baja, California, north to British Columbia, west through the Gulf of Alaska, and in the Bering Sea. The most recent harbor seal counts estimate the California stock of Pacific harbor seals at 34,233 individuals. The population appears to be stabilizing at what may be their carrying capacity and human-caused mortality is declining (NMFS, 2005). The California stock of Pacific harbor seals is not listed under the ESA nor considered strategic under the MMPA.

In California, approximately 400-500 harbor seal haul out sites are widely distributed along the mainland and offshore islands, including intertidal sandbars, rocky shores, and beaches. The north side of Yerba Buena Island is the closest haul out area to the relocation project, approximately 3 km from Piers 15 and 17. Although harbor seals use this haul out year-round, Yerba Buena Island is not considered a pupping site. In California, breeding occurs from March to May and pupping between April and May, depending on local populations. Harbor seals around the new Exploratorium site would likely be transiting or opportunistically foraging. Herring spawning events, which have historically occured between December and February, could result in harbor seals congregating and approaching the action area sporadically in an unpredictable manner (pers. comm., M. DeAngelis to M. Magliocca).

Pinnipeds produce a wide range of social signals, most occurring at relatively low frequencies (Southall et al., 2007), suggesting that hearing is keenest at these frequencies. Pinnipeds communicate acoustically both on land and in the water, but have different hearing capabilities dependent upon the medium (air or water). Based on numerous studies, as summarized in Southall et al. (2007), pinnipeds are more sensitive to a broader range of sound frequencies underwater than in air. Underwater, pinnipeds can hear frequencies from 75 Hz to 75 kHz. In air, the lower limit remains at 75 Hz, but the highest audible frequencies are only around 30 kHz (Southall et al., 2007).

3.3.2 California Sea Lions

California sea lions are found throughout the Eastern North Pacific Ocean in shallow coastal and estuarine waters, ranging from Central Mexico to British Columbia, Canada. Their primary breeding range extends from Central Mexico to the Channel Islands in Southern California. The abundance of the U.S. stock is estimated to be 238,000 sea lions (NMFS, 2007). This stock is approaching carrying capacity and is reaching “optimum sustainable population” limits, as defined by the MMPA. California sea lions are not listed under the ESA nor considered strategic under the MMPA.

Sandy beaches are preferred habitat for haul out sites, but marina docks, jetties, and buoys are often used in California for resting, breeding, and molting. In San Francisco Bay, sea lions haul out on floating docks (e.g., Pier 39 around Fishermen's Wharf) and on buoys throughout the Bay. Breeding season begins in May and lasts until August, with most pups born by July. While onshore, California sea lions often form groups of several hundred animals. No sea lion haul outs are located around the Exploratorium. Sea lions within this area may be transiting or opportunistically foraging.

Like Pacific harbor seals, California sea lions are pinnipeds that hear best at low frequencies. Underwater, pinnipeds can hear frequencies from 75 Hz to 75 kHz. In air, the lower limit remains at 75 Hz, but the highest audible frequencies are only around 30 kHz (Southall et al., 2007).

3.3.3 Harbor Porpoises

Harbor porpoises have a wide and discontinuous range that includes the North Atlantic and North Pacific. In the Eastern North Pacific, harbor porpoises are found in coastal and inland waters from Point Conception, California to Alaska. Harbor porpoises in U.S. waters are divided into ten stocks, based on genetics, movement patterns, and management. Any harbor porpoises encountered during the Exploratorium relocation project would likely be part of the San Francisco-Russian River stock which has an estimated abundance of 9,189 animals. Abundance of the San Francisco-Russian River stock appeared to be stable or declining between 1988 and 1991 and has steadily increased since 1993, although this increase is not statistically significant. Harbor porpoises are not commonly sighted in San Francisco Bay, but have been observed traveling in small pods of two or three animals on occasion (pers. comm., M. DeAngelis to M. Magliocca). Harbor porpoises in California are not listed under the ESA nor considered strategic under the MMPA.

Cetaceans are divided into three functional hearing groups: low-frequency, mid-frequency, and high-frequency. Harbor porpoises are considered high-frequency cetaceans and their estimated auditory bandwidth (lower to upper frequency hearing cut-off) ranges from 200 Hz to 180 kHz.

3.3.4 Gray Whales

Gray whales are large mysticetes, or baleen whales, found mainly in shallow coastal waters of the North Pacific Ocean. Two isolated geographic distributions of gray whales exist: the Eastern North Pacific stock and the Western North Pacific stock. The Eastern North Pacific stock migrates as far south as Baja, California for breeding and calving in the winter and as far north as the Bering and Chukchi Seas for summer feeding. During migration, gray whales will occasionally enter rivers and bays, including San Francisco Bay, along the coast, but in very low numbers. The most recent 2008 stock assessment report estimated the Eastern North Pacific stock to be approximately 18,813 individuals with an increasing population trend over the past several decades. Gray whales were delisted from the ESA in 1994 and are not considered strategic under the MMPA.

Gray whales, like other baleen whales, are in the low-frequency hearing group. There are no empirical data on gray whale hearing; however, Wartzok and Ketten (1999) suggest that mysticete hearing is most sensitive at the same frequencies at which they vocalize. Underwater sounds produced by gray whales range from 20 Hz to 20 kHz (Richardson et al., 1995).

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

This chapter represents the scientific and analytic basis for comparison of the direct, indirect, and cumulative effects of the alternatives. Regulations for implementing the provisions of NEPA require consideration of both the context and intensity of a proposed action (40 CFR Parts 1500-1508).

4.1 EFFECTS OF ALTERNATIVE 1: No Action

Under the No Action alternative, NMFS would deny the Exploratorium an authorization to harass marine mammals incidental to pile driving during the Exploratorium relocation project. To avoid violation of the MMPA if no IHA is issued, the Exploratorium would have to shut down all pile driving operations whenever a marine mammal is sighted within the Level B harassment zones during impact and vibratory pile driving. These zones have been modeled to extend 100 m and 1,900 m from the pile, respectively.

4.2 EFFECTS OF ALTERNATIVE 2: Issue IHA with Proposed Conditions

This section describes potential impacts to the human environment from issuance of MMPA authorizations allowing the harassment of marine mammals incidental the Exploratorium relocation project.

4.2.1 Effects to the Social and Economic Environment

The proposed action is NMFS' issuance of an IHA to the Exploratorium authorizing the harassment of marine mammals incidental to the pile driving associated with the Exploratorium's relocation project. As described in Chapter 3, there is no commercial, recreational, or subsistence use of marine mammals within the action area. Therefore, the proposed action is not anticipated to effect the social and economic environment.

4.2.2 Effects on the Physical Environment

The issuance of an IHA authorizing harassment to marine mammals would not affect the physical environment. The Exploratorium is authorized to conduct the relocation project under a Corps permit. NMFS' authorization solely authorizes marine mammal harassment. With respect to marine mammal habitat, see section 4.3.4 below.

4.2.3 Effects on Marine Mammals

Pile driving at the Exploratorium's new location may temporarily impact marine mammals within the action area due to elevated in-water noise levels. NMFS has prepared, supplemented, or adopted numerous EAs leading to Findings of No Significant Impact (FONSIs) for pile driving activities in general, including ones for larger Caltrans projects which involved pile driving large piles in adjacent sections of the Bay. The analysis of pile driving impacts to

marine mammals and their environment under NEPA have been conducted to facilitate issuance of other IHAs. Examples of such EAs include:

1. *Environmental Assessment on the Authorization for the Harassment of Marine Mammals Incidental to the Seismic Retrofit of the Richmond-San Rafael Bridge, San Francisco Bay, CA Under Section 101(a)(5) of the Marine Mammal Protection Act* (1997);

2. *Environmental Assessment on the Authorization for the Harassment of Marine Mammals Incidental to Construction of the East Span of The San Francisco-Oakland Bridge Under Section 101(a)(5) of the Marine Mammal Protection Act* (2003); and

3. *Environmental Assessment on the Authorization for the Harassment of Marine Mammals Incidental to Retrofitting Three Bridges at Humbolt Bay in Humbolt County, CA by the California Department of Transportation Under Section 101(a)(5) of the Marine Mammal Protection Act* (2005).

Marine mammals are continually exposed to many sources of sound. Naturally occurring sounds such as lightning, rain, sub-sea earthquakes, and biological sounds (e.g., snapping shrimp, whale songs) are ubiquitous throughout the world's oceans. Marine mammals produce sounds in various contexts and use sound for various biological functions including, but not limited to: (1) social interactions; (2) foraging; (3) orientation; and (4) predator detection. Interference with producing or receiving these sounds may result in adverse impacts. In this EA, all sound pressure levels are referenced to 1 microPascal (re: 1 µPa) unless otherwise noted. Impacts from noise exposure are expected to be both auditory and behavioral, as described in the below sections. No pinniped haul outs would be affected, as the closest haul out is approximately 3 kms away; therefore, in-air noise is not a concern.

Auditory Impacts

In mammals, high-intensity sound may rupture the eardrum, damage the small bones in the middle ear, or over-stimulate the electromechanical hair cells that convert the fluid motions caused by sound into neural impulses that are sent to the brain. Lower level exposures may cause a loss of hearing sensitivity, termed a threshold shift (TS) (Miller, 1974). Incidence of TS may be either permanent, referred to as permanent threshold shift (PTS), or temporary, referred to as temporary threshold shift (TTS).

PTS consists of non-recoverable physical damage to the sound receptors in the ear, which can include total or partial deafness, or an impaired ability to hear sounds in specific frequency ranges; PTS is considered Level A harassment. TTS is recoverable and is considered to result from temporary, non-injurious impacts to hearing-related tissues; TTS is considered Level B harassment. There are no empirical data for onset of PTS in any marine mammal; therefore, PTS-onset must be estimated from TTS-onset measurements and from the rate of TTS growth with increasing exposure levels above the level eliciting TTS-onset. PTS is presumed to be likely if the hearing threshold is reduced by $\geq$ 40 dB (i.e., 40 dB of TTS). Due to proposed mitigation measures and source levels, NMFS does not expect that marine mammals would be exposed to levels that could elicit PTS; therefore, it will not be discussed further.

TTS is the mildest form of hearing impairment that can occur during exposure to a loud sound (Kryter, 1985). While experiencing TTS, the hearing threshold rises and a sound must be louder in order to be heard. TTS can last from minutes or hours to, in cases of strong TTS, days. For sound exposures at or somewhat above the TTS-onset threshold, hearing sensitivity recovers rapidly following exposure. Few data on sound levels and durations necessary to elicit mild TTS have been obtained for marine mammals. Southall et al. (2007) considers a 6 dB TTS (i.e., baseline thresholds are elevated by 6 dB) sufficient to be recognized as an unequivocal deviation and thus a sufficient definition of TTS-onset. Because it is non-injurious, NMFS considers TTS as Level B harassment that is mediated by physiological effects on the auditory system; however, NMFS does not consider TTS-onset to be the lowest level at which Level B harassment may occur.

The amplitude, duration, frequency, temporal pattern, and energy distribution of a sound exposure all affect the amount of associated TS and the frequency range in which it occurs. As amplitude and duration of sound exposure increase, generally, so does the amount of TS and recovery time. Human non-impulsive noise exposure guidelines are based on exposures of equal energy (the same SEL) producing equal amounts of hearing impairment regardless of how the sound energy is distributed in time (NIOSH, 1998). Until recently, previous marine mammal TTS studies have also generally supported this equal energy relationship (Southall et al., 2007). Three newer studies, two by Mooney et al. (2009a, 2009b) on a single bottlenose dolphin either exposed to playbacks of Navy MFAS (mid-frequency active sonar) or octave-band noise (4–8 kHz) and one by Kastak et al. (2007) on a single California sea lion exposed to airborne octave-band noise (centered at 2.5 kHz), concluded that for all noise exposure situations the equal energy relationship may not be the best indicator to predict TTS onset levels. Generally, with sound exposures of equal energy, those that were quieter (lower sound pressure level [SPL]) with longer duration were found to induce TTS onset more than those of louder (higher SPL) and shorter duration. For intermittent sounds, less TS will occur than from a continuous exposure with the same energy (some recovery will occur between exposures) (Kryter et al., 1966). Additionally, though TTS is temporary, very prolonged exposure to sound strong enough to elicit TTS, or shorter-term exposure to sound levels well above the TTS threshold, can cause PTS, at least in terrestrial mammals (Kryter, 1985). However, these studies highlight the inherent complexity of predicting TTS-onset in marine mammals, as well as the importance of considering exposure duration when assessing potential impacts.

Sound exposure that elicit TTS in pinnipeds underwater have been measured in harbor seals, California sea lions, and the northern elephant seal. As described in Southall (2007), Kastak and Schusterman (1996) reported a TTS of approximately 8 dB (measured underwater at 100 Hz) in a harbor seal following exposure to broadband airborn noise from nearby construction. Kastak et al. (1999) measured TTS of approximately 4-5 dB in all the aforementioned species of pinnipeds following 20-22 minutes of expsore to underwater 100 Hz to 2 kHz octave band noise (OBN). Subsequently, Kastak et al. (2005) made TTS measurements on the same subjects using 2.5 kHz OBN using higher sensation levels and longer durations. Cumulatively, these tests indicate that the harbor seal experienced a 6 dB TTS when exposed to 25 minutes of OBN with an SPL of 152 dB re 1 microPa. The California sea lion experienced TTS-onset at 174 dB re 1 microPa. No TTS data are available for harbor porpoise.

As described above, it is difficult to predict if TTS in marine mammals could occur; however, received levels and duration of sound exposure can help determine TTS potential. The Exploratorium has indicated that piles would be primarily, if not always, driven with a vibratory hammer. The Exploratorium has reserved the right to use an impact hammer should substrate resistence occur; however, this would likely not be the case. Vibratory source levels are expected to range from 155 dB to a maximum of 180 dB and impact hammering would utilize sound attenuation devices designed to reduce sound levels (SLs) below NMFS' Level A harassment threshold (however, the effectiveness of sound attenutation devices very; therefore, the Exploratorium has proposed a 500-m shut down zone). With respect to duration, vibratory pile driving would be conducted up to five days per week for 6-8 months; however, pile driving would occur intermittently. Each pile would take approximately 30 minutes to install, followed by at least a 1-hr break with 2-5 piles being installed each day. Given that pinnipeds move freely around the Bay and are not likely to remain in any given area for a long period of time and porpoises are highly mobile, duration of exposure to pile driving sounds is expected to be short (on the order of minutes). Therefore, NMFS has preliminarily determined that the potential for TTS is limited, though possible.

Behavioral Impacts

Type and significance of marine mammal reactions to noise are likely to be dependent on a variety of factors including, but not limited to, the behavioral state (e.g., feeding, traveling, etc.) of the animal at the time it receives the stimulus, frequency of the sound, distance from the source, and the level of the sound relative to ambient conditions (Southall et al., 2007). Vibratory pile driving emits low-frequency broadband noise, all of which may be detectable by marine mammals within the action area. However, lower frequency hearing animals such as pinnipeds and gray whales are likely to be able to hear the sound better and farther away than the harbor porpoise, who has a hearing range of 200 Hz-180 kHz (Southall et al., 2007), as most of the energy during vibratory pile driving is expected to be below 600 Hz (Illinworth & Rodkin, 2007). In addition, San Francisco Bay is highly industrialized and masking of the pile driver by other vessels and anthropogenic noise within the action area, especially in the nearby shipping channel, may also make construction sounds difficult to hear at greater distances. Seals would likely also exhibit tolerance or habituation (as described in Richardson et al., 1995) to pile driving due to the amount of anthropogenic use within the action area and San Francisco Bay as a whole.

There are limited data available on the effects of non-pulse noise (e.g., vibratory pile driving) on pinnipeds in-water; however, field and captive studies to date collectively suggest that pinnipeds do not strongly react to exposures of 90-140 dB re 1 µPa; no data exist from exposures at higher levels. Jacobs and Terhune (2002) observed wild harbor seal reactions to high-frequency acoustic harassment devices (ADH) around nine sites. Seals came within 44 m of the active ADH and failed to demonstrate any behavioral response when received SPLs were estimated at 120-130 dB. In a captive study (Kastelein, 2006), a group of seals were collectively subjected to non-pulse sounds of 8-16 kHz from an underwater data collection and communication network (ACME). Exposures of 80-107 dB did not induce strong behavioral responses; however, a single observation of 100-110 dB indicated an avoidance response. The

seals returned to baseline conditions shortly following exposure. Southall et al. (2007) notes contextual differences between these two studies; the captive animals were not reinforced with food for remaining in the noise fields, whereas free-ranging subjects may have been more tolerant of exposures because of motivation to return to a safe location or approach enclosures holding prey items. While most of the pile driving for the Exploratorium relocation project would be vibratory, a small portion of piles may be driven using an impact hammer (pulse noise). Southall et al. (2007) reviewed relevant data from studies involving pinnipeds exposed to pulse noise and concluded that exposures of 150-180 dB (approximate source level range for vibratory pile driving) generally have limited potential to induce avoidance behavior.

Pacific harbor seal and California sea lion pupping season is outside of the temporal pile driving schedule; therefore, no impacts to reproduction are anticipated. It is expected that marine mammals exposed to pile driving noise would be using the adjacent waters around the Exploratorium's project site for foraging or as a daily migration route between foraging grounds and haul out locations. Harbor porpoises also may use the adjacent waters for foraging and may pass through the area during pile driving. Gray whales are not expected to forage in the activity area, but may display behavioral changes in response to noise if they enter San Francisco Bay and transit or linger around the action area during their migration south in the fall and north in the spring.

Any impacts to marine mammal behavior are expected to be temporary. First, animals may avoid the area around the hammer; thereby reducing exposure. Second, pile driving would not occur continuously throughout the day. As described above, the vibratory hammer would only operate for about 30 minutes followed by at least a 1-hr break. Two to five pilings are anticipated to be driven per day, resulting in a total of 1-2.5 hrs of pile driving within any given 24-hr period. Limiting pile driving to less than 3 hrs per day would allow for minimal disruption of foraging or dispersal throughout the habitat. Any disturbance to marine mammals would likely be in the form of temporary avoidance or alteration of opportunistic foraging behavior near the pile driving location. In addition, because pile driving is anticipated to be accomplished using only a vibratory hammer, marine mammal injury or mortality is not anticipated. If an impact hammer proves necessary, PSOs would be on watch to implement pile driver shut down, a mitigation measure designed to prevent animals from being exposed to injurious sound levels. Finally, pupping season does not occur within the scheduled pile driving timeframe; therefore, no impact to survival of pups, and reproduction in general, is anticipated. For these reasons, any changes to marine mammal behavior are expected to be temporary and result in negligible impact to affected species and stocks.

Estimated Take by Harassment

NMFS typically proposes threshold sound levels to establish appropriate mitigation. Current NMFS practice regarding exposure of marine mammals to anthropogenic noise is that in order to avoid injury of marine mammals (e.g., PTS), cetaceans and pinnipeds should not be exposed to impulsive sounds of 180 and 190 dB RMS or above, respectively. This level is considered precautionary as it is likely that more intense sounds would be required before injury actually occurs (Southall et al., 2007). Potential for 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 non-pulse noise (e.g., vibratory pile driving), but below the aforementioned injury thresholds. NMFS is currently revisiting its harassment threshold levels to better reflect the available scientific data.

Based on consultation with the NMFS Southwest Regional Office and review of Caltrans monitoring reports for pile driving activities in San Francisco Bay, the Exploratorium requested a total take, by Level B harassment, of two Pacific harbor seals, one California sea lion, and one gray whale per day of pile driving. Upon further consultation with NMFS, the Exploratorium is also requesting take, by Level B harassment, of harbor porpoise, due to the recorded, albeit infrequent, sightings of harbor porpoises within San Francisco Bay.

The Exploratorium estimates an average of three piles would be driven in a single day. Given 69 piles in total, pile driving would occur for 23 days over the duration of the project. Therefore, NMFS is proposing to authorize annual take of 46 Pacific harbor seals and 23 California sea lions incidental to the Exploratorium's pile driving activities. Due to the infrequent, but potential presence of harbor porpoise and gray whales in the area, NMFS is also proposing to authorize the take of 28 harbor porpoise and five gray whales, annually, based on consultation with the NMFS Southwest Regional Office, NMFS. These numbers indicate the maximum number of animals expected to occur within the Level B harassment isopleth (1,900 m). This is the same distance established by NMFS and Caltrans to determine Level B harassment during vibratory pile driving for the SFOBB project, and is based on a received level of 120 dB. Estimated distances to NMFS current threshold sound levels from pile driving during the Exploratorium's relocation project are presented in Table 4. These estimates are based on the worst case scenario of driving the 72-inch steel piles, but would be carried over for all pile driving. Note that despite short distances to the Level A harassment isopleths, the Exploratorium has proposed to implement a preliminary 500-m marine mammal safety zone until empirical pile driving measurements can be made and distances to this threshold isopleths can be verified. Estimated and proposed level of take of each species is less than 1% of the affected stock population and therefore is considered small.

Table 4. Modeled underwater distances to NMFS' marine mammal harassment threshold levels, based on empirical measurements taken by Caltrans.

	Level A (190/180 dB)	Level B harassment (160 dB)	Level B harassment (120 dB)
Impact hammering	20 m (w/o sound attenuation device)	100 m	n/a
Vibratory hammering	n/a	n/a	1900 m

4.2.4 Effects on Marine Mammal Habitat

On May 28, 2010, the NMFS Southwest Regional Office concluded informal Section 7 and Essential Fish Habitat (EFH) consultation, under the ESA and Magnuson Stevens Fishery Conservation and Management Act (MSFCMA), respectively, with the U.S. Army Corps of Engineers (Corps) on issuance of a Corps permit to the Exploratorium. In summary, NMFS

Southwest Regional Office found that the proposed construction activities may affect ESA-listed fish by generating increased levels of turbidity and sound; however, these impacts are expected to be minor, localized, and short term. As such, NMFS Southwest Regional Office concurred with the Corps determination that impacts from the Exploratorium's project would not result in adverse impacts to ESA-listed fish or their critical habitat. NMFS Southwest Regional Office also determined that the proposed project would adversely affect EFH for various federally-managed species within the Pacific Groundfish, Coastal Pelagic, and Pacific Salmonid Fishery Management Plans; however, they also determined that the proposed action contains adequate measures to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH.

Marine mammals and fish may occupy the same habitat. Pile driving noise would result in degradation of in-water habitat; however, this impact would be short-term and localized. Installation of new piles would be permanent; however, overall site conditions are anticipated to be substantively unchanged from existing conditions for marine mammals following project implementation. Therefore, following results of consultation under the ESA and MSFCMA, NMFS has preliminarily determined impacts to marine mammal habitat are negligible.

4.3 SUMMARY OF COMPLIANCE WITH APPLICABLE LAWS, NECESSARY FEDERAL PERMITS, LICENSES, AND ENTITLEMENTS

As summarized below, NMFS has determined that the proposed activity is consistent with the purposes, policies, and applicable requirements of the NEPA, ESA, MMPA, MSFCMA, and NMFS regulations. NMFS' issuance of the permit would be consistent with the MMPA and ESA.

4.3.1 National Environmental Policy Act

In compliance with the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq*.), NMFS has prepared this EA analyzing the effects of the proposed action (i.e., issuance of an IHA) on the human environment. Based on the analyses in the EA, NMFS has not identified any significant impacts on the human environment resulting from issuance of the IHA. The EA will serve as the basis for preparing a Finding of No Significant Impact and not publishing a Notice of Intent to prepare an Environmental Impact Statement.

4.3.2 Endangered Species Act

No ESA listed marine mammals occur within the action area; therefore, NMFS' Office of Protected Resources did not request Section 7 consultation under the ESA for issuance of the IHA. The NMFS Southwest Regional Office did conclude informal Section 7 and Essential Fish Habitat (EFH) consultation with the Corps for fish species. In summary, NMFS Southwest Regional Office found that the proposed construction activities may affect ESA-listed fish by generating increased levels of turbidity and sound; however, these impacts are expected to be minor, localized, and short-term. As such, NMFS Southwest Regional Office concurred with the Corps determination that impacts from the Exploratorium's project would not result in adverse impacts to ESA-listed fish or their critical habitat.

4.3.3 Marine Mammal Protection Act

The Exploratorium submitted an IHA application consistent with applicable issuance criteria in the MMPA and NMFS implementing regulations. The views and opinions of scientists or other persons or organizations knowledgeable of the marine mammals that are the subject of the application or of other matters germane to the application were considered, and support NMFS's determinations regarding the application. In summary, NMFS has determined that the proposed action will result in short-term behavioral changes to marine mammals in-water (e.g., avoidance, change in behavioral patterns at time of exposure) in response to pile driving during the Exploratorium's relocation project. Hence, the Exploratorium's specified activities will result in the incidental take of small numbers of marine mammals, by Level B harassment only, and the total taking will have a negligible impact on the affected species or stocks.

Any incidental take authorization issued by NMFS would contain standard terms and conditions stipulated in the MMPA and NMFS' regulations. As required by the MMPA, the authorization would specify: (1) the effective date of the authorization; (2) the number and kinds (species and stock) of marine mammals that may be taken; (3) the manner in which they may be taken; (4) appropriate mitigation measures designed to minimize impacts to affected marine mammals; and (5) a monitoring plan designed to detect impacts or lack thereof.

4.3.4 Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)

NMFS Southwest Regional Office determined that the proposed project would adversely affect EFH for various federally-managed species within the Pacific Groundfish, Coastal Pelagic, and Pacific Salmonid Fishery Management Plans; however, they also determined that issuance of an IHA is not expected to cause substantial damage to designated EFH because adequate measures are proposed to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH.

4.4 MITIGATION AND MONITORING MEASURES

As required under the MMPA, NMFS considered mitigation to effect the least practicable adverse impact on marine mammals and developed a series of mitigation measures, as well as monitoring and reporting procedures, that would be required as part of its incidental harassment authorization. NMFS assisted with the development of the Exploratorium's proposed measures identified in the IHA application in preparation of the proposed IHA and considered comments received during the public comment period. NMFS has determined that the Exploratorium's proposed mitigation and monitoring measures are adequate to ensure neglibile impact on affected marine mammal species and stocks and effect the least practicable adverse impact. The mitigation measures described in Chapter 2 were designed to eliminate the potential for injury and mortality and minimize harassment. Monitoring measures also described in Chapter 2 are designed to ensure that the Exploratorium is effectively detecting animals and implementing the required mitigation measures.

4.5 CUMULATIVE EFFECTS

Cumulative effects are defined as those that result from incremental impacts of a proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions that take place over a period of time.

The Bay provides recreational, commercial, and industrial resources for the residents of California and is therefore heavily subjected to anthropogenic disturbance. These include recreational and commercial vessel traffic, vehicular traffic over bridges, and coastal construction and development. As described in Richardson et al. (1995), marine mammals are likely habituated and tolerant to a certain degree of anthropogenic disturbance, including noise. The Exploratorium relocation project is not likely to add an increment of disturbance which would cumulatively, when combined with other actions, result in significant adverse impacts to marine mammals.

4.5.1 Current Projects in Action Area

Issuance of an IHA to the Exploratorium is not related to other actions with individually insignificant, but cumulatively significant impacts. Currently, Caltrans holds three IHAs for multiple projects (Dumbarton Bridge and Antioch Bridge retrofits and construction of the San Francisco-Oakland Bay Bridge) authorizing the harassment of the same populations of Pacific harbor seals, California sea lions, harbor porpoises, and gray whales from pile driving in San Francisco Bay. While some individual pinnipeds may frequent multiple project sites, the distance between the Exploratorium relocation project and the closest project site is approximately 4 kms. The other two projects are located in the southern portion of the Bay. Considering this distance and the fact that a maximum of only 3 hrs of pile driving would occur daily at the Exploratorium site, any temporary harassment from exposure to either project is not anticipated to result in significant cumulative impacts.

4.5.2 Reasonably Foreseeable Future Actions (RFFAs)

There are currently no reasonably foreseeable projects planned for this portion of the San Francisco Bay under NMFS authority that are not currently ongoing (e.g., Caltrans activities). Any future authorizations will have to undergo the same permitting process and will take the Exploratorium relocation project into consideration when addressing cumulative effects. Should NMFS receive an application from applicants requesting authorization to take marine mammals incidental to specified activities in the action area, NMFS would also consider cumulative impacts to the affected species or stock, as required under NEPA.

CHAPTER 5 List of Preparers and Agencies Consulted

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LITERATURE CITED

Caltrans. 2009. Initial Study with Mitigated Negative Declaration (CEQA) and Environmental Assessment (NEPA) with Findings of No Significant Impact (FONSI). District 4. 79 pp.

Illinworth & Rodkin. 2007. Compendium of pile driving sound data. Prepared for the California Department of Transportation (Caltrans). 129 pp.

Jacobs, S. R. and J. M. Terhune. 2002. The effectiveness of acoustic harassment devices in the Bay of Fundy, Canada: seal reactions and a noise exposure model. Aquatic Mammals 28:147-158.

Kastak, D. and Schusterman, R.J. 1996. Temporary threshold shift in a harbor seal, *Phoca vitulina*. J. Acoust. Soc. Am. 106:1905-1908.

Kastak, D., R.J. Schusterman, B.L. Southall, and C.J. Reichmuth. 1999. Underwater temporary threshold shift induced by octave-band noise in three species of pinniped. J. Acoust. Soc. Am. 106:1142-1148.

Kastak, D., B.L. Southall, R.J. Schusterman, and C.R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. J. Acoust. Soc. Am. 118:3154-3163.

Kastak, D., C. Reichmuth, et al. 2007. Onset, growth, and recovery of in-air temporary threshold shift in a California sea lion (Zalophus californianus). J. Acoust. Soc. Am. 122(5):2916-2924.

Kastelein, R., S. van der Huel, W. Verboom, R. Triesscheijn, N. Jennings. 2006. The influence of underwater data transmission sounds on the displacement behaviour of captive harbour seals (*Phoca vitulina*). Mar Environ Res. 61(1):19-39.

Kryter, K. D. 1985. The effects of noise on man. 2nd edition. Orlando: Academic Press Inc., Publishers. 688 pp.

Kryter, K.D., W.D. Ward, J.D. Miller, and D.H. Eldredge. 1966. Hazardous exposure to intermittent and steady-state noise. J. Acoust. Soc. Am. 39(3):451-464.

National Marine Fisheries Service (NMFS). 2007. California sea lion (*Zalophus californianus californianus*) stock assessment report. 8 pp.

National Marine Fisheries Service (NMFS). 2005. Harbor seal (*Phoca vitulina richardsi*) stock assessment report. 7 pp.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. San Diego: Academic Press. 576 pp.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene, C.R. Jr., Kastak, D., Ketten, D.K., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and

Tyack, P.L. 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Special Issue of Aquatic Mammals 33(4):412-522.

Wartzok, D. and D.R. Ketten. 1999. Marine Mammal Sensory Systems. p.117-175 In J. Reynolds and S.A. Rommel (eds). Biology of Marine Mammals. Smithsonian Institute Press, Washington D.C. 578 pp.