DRAFT ENVIRONMENTAL ASSESSMENT

TEST PILE PROGRAM NBK BANGOR WATERFRONT
NAVAL BASE KITSAP BANGOR
SILVERDALE, WA

November 1, 2010

Abstract

This Environmental Assessment identifies and evaluates the potential effects of installing and removing 29 test and reaction piles at Naval Base Kitsap Bangor. The purpose and need for this activity is to acquire accurate geotechnical and sound propagation data to validate design concepts, construction methods, and environmental analyses for the proposed second Explosive Handling Wharf and other future projects at the Naval Base Kitsap Bangor waterfront.

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Department of the Navy

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EXECUTIVE SUMMARY

The Navy proposes to conduct a Test Pile Program to acquire accurate geotechnical and sound propagation data to validate design concepts, construction methods, and environmental analyses for future projects at the Naval Base Kitsap (NBK) Bangor waterfront.

The need for the proposed action is to obtain the most accurate geotechnical information to validate the design for the proposed second Explosive Handling Wharf (EHW-2) and to obtain sound propagation data to identify possible effects on the species and habitat within the project area. Sound propagation data will also be used to form the mitigation strategy for the construction of the proposed EHW-2. Information obtained as part of the Test Pile Program will also be valuable for the design of future waterfront facilities upgrades at NBK Bangor.

Two Alternatives have been evaluated in this Environmental Assessment (EA): 1) to conduct the Test Pile Program in the same location as the proposed EHW-2 along the NBK Bangor waterfront; 2) No Action. The Preferred Alternative, to conduct the Test Pile Program along the NBK Bangor waterfront, would include installing and removing 29 test and reaction piles (from 30" to 60" in diameter) into the substrate in the location of the proposed EHW-2. During pile driving 18 piles will be installed with a vibratory hammer and then "proofed" with an impact hammer. After the initial 18 test piles are installed, three lateral load tests will be performed. The lateral load tests will require re-installing two of the 60 inch piles and one 48 inch pile. Additionally, two tension load tests will also be performed. This will require installing four reaction piles for each of the two tension load tests. The lateral load test in combination with the tension load test will result in the installation of an additional 11 piles. The Navy expects that some of the initial test piles will be pulled and reused as part of the 11 additional piles. The length of the piles will range from approximately 100 feet to 197 feet.

Under the No Action Alternative the Test Pile Program would not be conducted. Geotechnical and sound propagation data would not be gathered to validate the design concepts, construction methods, and environmental analysis.

The anticipated impacts of the Action Alternative are primarily noise- related resulting from pile driving. The analysis in the EA indicated these impacts would be short term in nature (40 days). The ambient noise and underwater sound associated with pile driving could have an effect on wildlife (fish, birds, marine mammals, federally listed species, and benthic invertebrates) associated with Hood Canal. As such, this EA analyzed the impacts to these species as well as marine vegetation and essential fish habitat. This EA concludes the impacts associated with pile driving are minor and temporary and result in no significant impacts to marine vegetation or benthic invertebrates. Foraging fish species occurring along Hood Canal in the vicinity of the proposed action may be affected but are not likely to be adversely affected by the proposed action when the mitigation measures described in this EA are utilized. The North American green sturgeon and the Pacific eulachon will not be affected by the proposed action. Pacific Sound Chinook salmon, Hood Canal Summer-run chum salmon, rockfish, and the Puget Sound steelhead are likely to be adversely affected by the proposed action. Essential fish habitat occurring along Hood Canal in the vicinity of the proposed action may be affected but is not likely to be adversely affected by the proposed action. Due to the adverse affect to the salmonid fish species there is the potential for a may affect, not likely to adversely affect for the Southern Resident killer whales and Steller sea lions. These species would not directly be affected by the

Test Pile Program but the affect to its prey species could create an indirect affect for the whale and sea lion. Other marine mammals occurring in the vicinity of the Test Pile Program are not likely to be adversely affected by pile driving. As with fish, mitigation measures will be utilized to reduce the adverse impacts to marine mammals. The Test Pile Program is not anticipated to have an impact to birds with the exception of the marbled murrelet. Marbled murrelets may be affected, likely to be adversely affected by pile driving. Mitigation measures will be utilized to reduce the adverse impacts to marbled murrelets. In accordance with the Navy's National Environmental Policy Act (NEPA) policies, all applicable consultations will be obtained as part of this EA.

Recent and proposed projects on NBK Bangor and other projects in northern Hood Canal were examined to determine possible cumulative impacts. Analysis in this document indicates that no significant cumulative impacts are anticipated for reasons of geographical distance, the relative scale of projects, and the nature and magnitude of specific impacts.

As detailed in Table ES.1, the Test Pile Program would not result in significant impacts to the human environment.

TABLE ES.1 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES BY RESOURCE

Resource	Action Alternative	No-Action Alternative
Bathymetry	The Test Pile Program is short-term in duration and any impacts to bathymetry would be inconsequential. The proposed action would not result in significant impacts to bathymetry.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to bathymetry.
Geology and Sediments	The Test Pile Program would have no impact on subsurface slope stability nor is it likely to cause chemical constituents to violate SQS. The Test Pile Program would not result in significant impacts to geology and sediments.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to geology and sediments.
Water Resources	The Test Pile Program would not alter temperature or salinity in the project area. DO concentrations would not decrease as a result of pile installation and removal. Pile driving would not result in long term impacts to turbidity. The Test Pile Program would not violate WQS. The Test Pile Program would not result in significant impacts to water resources.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to water resources.
Air Quality	The Test Pile Program would not exceed PSCAA thresholds or greenhouse gas reporting thresholds. The Test Pile Program would not result in significant impacts to air quality.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to air quality.
Ambient Noise	The Test Pile Program is short-term and would not result in impacts to sensitive receptors. The Test Pile Program would not result in significant impacts to ambient noise.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to ambient noise.
Marine Vegetation	The Test Pile Program would not result in long term impacts to marine vegetations. Indirect impacts to marine vegetation could occur but these impacts would be temporary and marine vegetation would be expected to recover. The Test Pile Program would not result in significant impacts to marine vegetation.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to marine vegetation.

TABLE ES.1 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES BY RESOURCE (continued)

Resource	Action Alternative	No-Action Alternative
Benthic Invertebrates	The Test Pile Program would result in a temporary loss of benthic habitat and direct mortality of less motile species. Benthic invertebrates would likely recover from the impacts of pile driving. The Test Pile Program would not result in significant impacts to benthic invertebrates.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to bentic invertebrates.
Fish	The Test Pile Program would not affect the North American Green Sturgeon and the Pacific eulachon. Foraging fish are not likely to be adversely affected by the pile driving activities. The Test Pile Program is determined to have a may affect, not likely to adversely affect for the bull trout. The Test Pile Program is determined to have a may affect, likely to adversely for the Pacific Sound Chinook salmon, the Hood Canal Summer-run chum, the Puget Sound Steelhead and the rockfish. The Test Pile Program will not adversely affect essential fish habitat. The Test Pile Program would not result in significant impacts to fish.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to fish.
Marine Mammals	The Test Pile Program may affect, not likely to adversely affect Stellar sea lions and Southern Resident killer whales due to the indirect impact of the adverse effect on salmonid fish species. No marine mammals would be exposed to sound levels resulting in injury or mortality during pile driving activities. The Test Pile Program would result in negligible impacts to the population, stock or species level. The Test Pile Program would not result in significant impacts to marine mammals.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to marine mammals.
Birds	The Test Pile Program is determined to have a may affect, likely to adversely affect for the marbled	The Test Pile Program would not be conducted. There would be no change in existing conditions and

TABLE ES.1 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES BY RESOURCE (continued)

Resource	Action Alternative	No-Action Alternative
	murrelet. There would be no adverse effect on migratory birds or special status birds. The Test Pile Program would not result in significant impacts to birds.	no impacts to birds.
Tribal Resources	Tribal consultations are ongoing.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to tribal resources.
Environmental Health and Safety	The Test Pile Program is not expected to result in any impacts related to public environmental health and safety. Construction activities are not likely to release hazardous materials to the environment. The Test Pile Program would not result in significant impacts to environmental health and safety.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to environmetnal health and safety.

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LIST OF ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
° W	West
μg/kg	micrograms per kilogram
μg/m^3	micrograms per cubic meter
μPa-m	Micro Pascals per meter
AAQS	Ambient Air Quality Standards
AQI	Air Quality Index
BA	Biological Assessment
BMPs	Best Management Practices
BOD	Biochemical oxygen demand
BRAC	Base Realignment and Closure
BSS	Beaufort Sea State
CA	California
CAA	Clean Air Act
CATEX	Categorical Exclusion
CDP	Census Designated Place
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CISS	Cast in Steel Shells
CKSD	Central Kitsap School District
CNO	Chief of Naval Operations
CO	Carbon Monoxide
CSL	Clean-up Screening Levels
CV	Coefficient of Variation
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
dB	decibel

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

dBA	A-weighted decibel
dBPEAK	Peak decibels
dBRMS	Decibel root mean square
DNR	Department of Natural Resources
DO	Dissolved Oxygen
DoD	Department of Defense
DoN	Department of the Navy
DPS	Distinct population segment
dw	Dry weight
EA	Environmental Assessment
EAC	Early Action Compact
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EHW	Explosives Handling Wharf
EHW-1	Explosive Handling Wharf #1
EHW-2	Explosive Handling Wharf #2
EIS	Environmental Impact Statement
EO	Executive Order
EOD	Explosive Ordnance Disposal
EQ	Extraordinary Quality
ESA	Endangered Species Act
ESS	Electronic Security Systems
ESU	Evolutionarily significant unit
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FICON	Federal Interagency Committee on Noise
FONSI	Finding of No Significant Impact
ft	feet
GPS	Global Positioning System

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

HAP	Hazardous air pollutant
HCCC	Hood Canal Coordinating Council
HCDOP	Hood Canal Dissolved Oxygen Program
hp	Horse power
HPAH	Higher Molecular Polycyclic Aromatic Hydrocarbons
Hz	hertz
IHA	Incidental Harassment Authorization
INRMP	Integrated Natural Resources Management Plan
KB	Keyport/Bangor
kHz	Kilohertz
Kg	Kilograms
km	Kilometers
Lbs	Pounds
LPAH	Lower Molecular Polycyclic Aromatic Hydrocarbons
M	Meter
MBTA	Migratory Bird Treaty Act
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MHHW	Mean higher high water
Mi	mile
mL	milliliters
MLLW	Mean Lower Low Water
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MPN	Most Probable Number
MSFCMA	Magnuson-Stevens Fisheries Conservation and Management Act

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

MSL	Mean Sea Level
N/A	Not applicable
NAAQS	National Ambient Air Quality Standards
NAVBASE	Naval Base
NAVRESREDCOM	Naval Reserve Readiness Command Region
NEPA	National Environmental Policy Act
NBK	Naval Base Kitsap
ND	Not detected
NH_4	Ammonium
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO_2	nitrite
NO_3	nitrate
NO_x	nitrous oxides
NPDES	National Pollutant Discharge Elimination System
NSWCCD	Navy Surface Warfare Center Carderock Division
NTU	Nephelometric Turbidity Units
OA	Operational Area
OR	Oregon
Pa	Pascal
PAH	Polycyclic aromatic hydrocarbon
PBDE	Polybrominated diphenyl ether
PCB	Polychlorinated biphenyl
PDA	Pile Dynamic Analyzer
PFMC	Pacific Fishery Management Council
PM	Particulate matter
PM_{10}	particulate matter smaller than 10 microns
$PM_{2.5}$	particulate matter smaller than 2.5 microns
PO_4	Phosphate

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PPT	Parts per thousand
PSAMP	Puget Sound Ambient Monitoring Program
PSCAA	Puget Sound Clean Air Agency
PSU	Practical Salinity Units
PTS	Permanent Threshold Shift
RCW	Revised Code of Washington
RMS	Root Mean Square
SARA	Species at Risk Act
SAS	Sound Attenuation System
SEL	Sound Exposure Level
SFOBB	San Francisco-Oakland Bay Bridge
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SISS	Swimmer Inderdiction Security System
SMS	Sediment Management Standards
SO_2	sulfur dioxide
SPLs	Sound Pressure Levels
SRKW	Southern Resident Killer Whale
SSP	Navy Strategic Systems Programs
sq ft	square feet
SQS	Sediment Quality Standards
SUBASE	Submarine Base
SUBDEVRON	Submarine development Squadron
SWFPAC	Strategic Weapons Facilities Pacific
TBD	To be determined
TL	Transmission Loss
TOC	Total Organic Carbon
TP#	Test Pile Number
TPF	Test Pile Floating concept

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

TPT	Test Pile Trestle
TRIDENT	Trident Fleet Ballistic Missile
TROC	Thorndyke Resources Operation Complex
TS	Threshold Shift
TSS	Total suspended solids
TTS	Temporary Threshold Shift
U&A	Usual and Accustomed fishing area
U.S.	United States
USACE	U.S. Army Corps of Engineers
USCB	U.S. Census Bureau
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WA	Washington
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington State Department of Ecology
WDOH	Washington Department of Health
WRCC	Western Regional Climate Center
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries
ZOI	Zone of Influence

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1 PROPOSED ACTION, PURPOSE AND NEED

1.1 INTRODUCTION

Naval Base Kitsap (NBK) Bangor, Washington is located on Hood Canal approximately 20 miles west of Seattle, Washington (Figure 1–1). NBK Bangor provides berthing and support services to United States (U.S.) Navy submarines and other fleet assets. The entirety of NBK Bangor, including the land areas and adjacent water areas in Hood Canal, is restricted from general public access.

1.2 PROPOSED ACTION

As part of the U.S. Navy's sea-based strategic deterrence mission, the Navy Strategic Systems Programs (SSP) directs research, development, manufacturing, test, evaluation, and operational support of the TRIDENT Fleet Ballistic Missile (TRIDENT) program. The proposed action (also called the Test Pile Program) is to install and remove 29 test and reaction piles, conduct testing on select piles, and measure in-water noise propagation during pile installation and removal. Geotechnical and sound data collected during pile installation and removal will be integrated into the design, construction, and environmental planning for the Navy's proposed second Explosives Handling Wharf (EHW-2). The Navy proposes to install the test piles in the location planned for EHW-2 (south of the existing Explosives Handling Wharf [EHW-1]); however, other future projects can also benefit from the geotechnical and sound propagation data gathered from driving the test piles.

The Navy proposes to install 29 test and reaction piles at NBK Bangor, WA to gather geotechnical and sound data to validate the design concepts and construction methods for the proposed EHW-2 and future projects at the Bangor waterfront. The Test Pile Program will involve installing 18 steel piles, ranging in size from 30 inches in diameter to 60 inches in diameter, at predetermined locations within the proposed footprint of EHW-2. Eleven additional piles will be installed to perform lateral load and tension load tests on the original 18 test piles. The pile lengths will range from 100 feet to 197 feet. See Table 2-1 for more information. All piles will be driven to an initial embedment depth with a vibratory hammer. The 18 test piles will require the use of an impact hammer to be driven the remaining 10-15 feet (approximate) and for proofing. Noise attenuation measures will be used during all impact hammer operations and some vibratory hammer operations. The proposed action would also include the removal of all test piles and occur over 40 work days between 16 July and 31 October 2011. Hydroacoustic monitoring will be accomplished to assess effectiveness of noise attenuation measures. The presence of marine mammals and marbled murrelets will also be monitored during pile installation and removal.

1.3 STUDY AREA DESCRIPTION

NBK Bangor is located on Hood Canal and utilizes various piers and docks. The proposed location for the Test Pile Program, also referred to in this document as the project area, is immediately south of EHW-1. Two restricted areas are associated with NBK Bangor, Naval Restricted Areas 1 and 2 (33 CFR 334.1220). Naval Restricted Area 1 covers the area to the north and south along Hood Canal encompassing the NBK Bangor waterfront. The regulations associated with Naval Restricted Area 1 state that no person or vessel shall enter this area

Figure 1-1 Vicinity Map

without permission from the Commander, Naval Submarine Base Bangor or his/her authorized representative. Naval Restricted Area 2 encompasses the waters of Hood Canal within a circle of 1,000 yards (3,000 ft) diameter centered at the north end of NBK Bangor and partially overlapping Naval Restricted Area 1.

The regulations associated with Naval Restricted Area 2 state that navigation will be permitted within that portion of this circular area not lying within Area No. 1 at all times except when magnetic silencing operations are in progress. Figure 1-2 depicts a plan view of the study area location and Figure 1-3 indicates the restricted areas associated with NBK Bangor.

The non-tidal submerged lands adjacent to NBK Bangor are state lands under the jurisdiction of the Department of Natural Resources (DNR). Nevertheless, the United States Navy retains a navigational servitude in all navigable waters regardless of the ownership of submerged lands. Thus, the United States may take actions concerning navigation over any navigable channel such as Hood Canal, to include affecting the submerged lands beneath the water column. At NBK Bangor, the restricted areas governing access to the waters immediately adjacent to the base are a valid exercise of the navigational servitude, as would be the construction of any facility relating to navigation, such as EHW-1 and the proposed EHW-2.

NBK Bangor is surrounded by private residences along its north and south borders. The closest off-base residences are approximately 1.5 miles north of the project area. The project area is also within the Usual and Accustomed (U&A) fishing area of five Native American Tribes. The tribes include: Skokomish Tribe; Lower Elwha Klallam Tribe, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and the Suquamish Tribe.

1.4 PURPOSE AND NEED

The purpose of the Test Pile Program is to acquire accurate geotechnical and sound propagation data to validate design concepts, construction methods, and environmental analyses for the proposed EHW-2 and future projects at the NBK Bangor waterfront.

The need for the Test Pile Program is to obtain the most accurate geotechnical data to validate the proposed EHW-2 design and to obtain sound propagation data to identify possible effects on the species and habitat within the project area. Sound propagation data will also be used to form the mitigation strategy for the construction of the proposed EHW-2. Information obtained as part of the Test Pile Program will also be valuable for the design of future waterfront facilities upgrades at NBK Bangor.

1.5 ENVIRONMENTAL REVIEW PROCESS

1.5.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 requires the consideration of potential environmental consequences of federal actions. Regulations for federal agency implementation of the Act were established by the President's Council on Environmental Quality (CEQ). Under NEPA, federal agencies must prepare an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) for any major federal action, except those actions that are determined to be "categorically excluded" from further analysis.

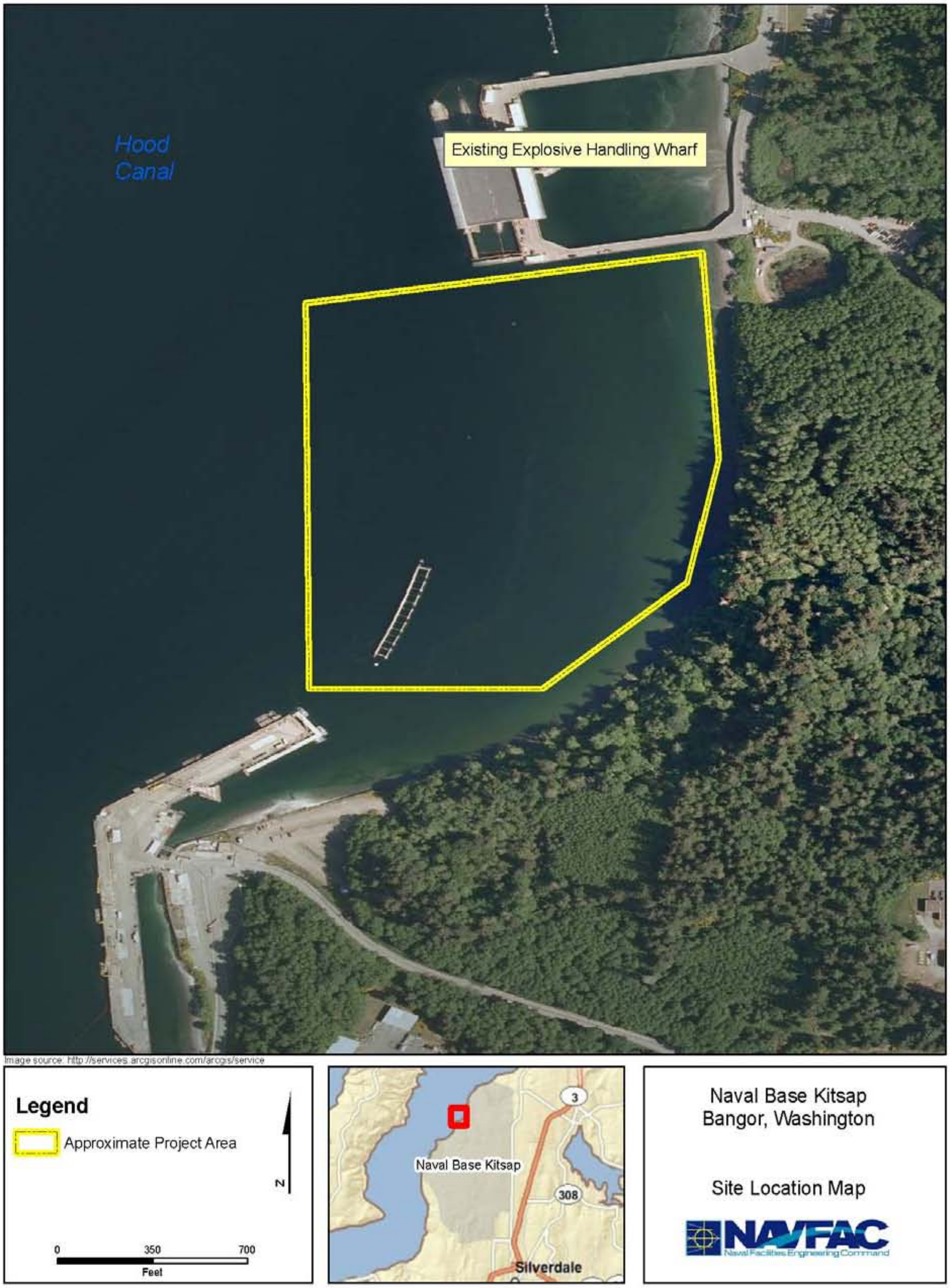

Figure 1-2 Study Area

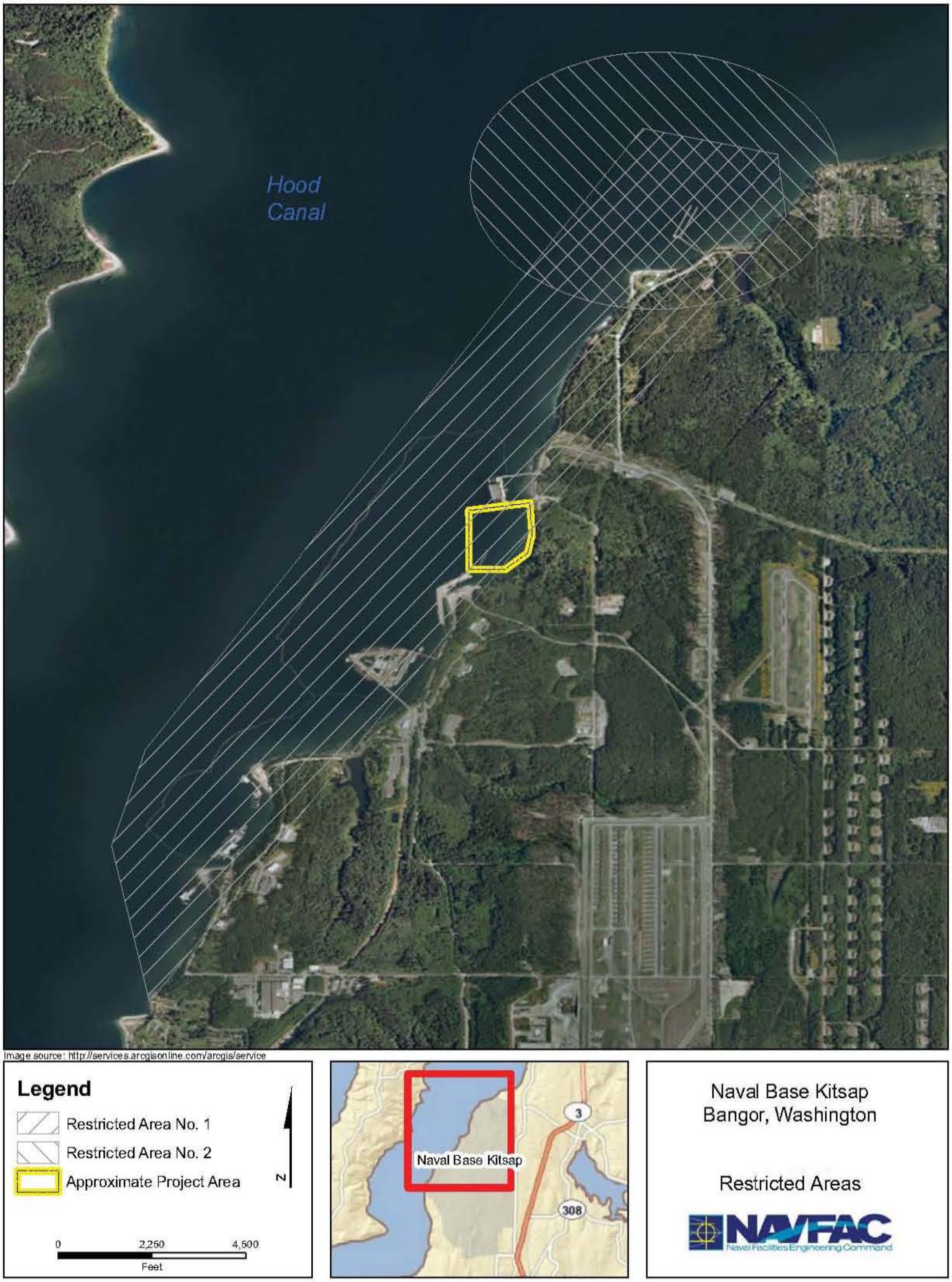

Figure 1-3 NBK Bangor Restricted Areas

An EA is a concise public document that provides sufficient analysis for determining whether the potential environmental impacts of a proposed action are significant, resulting in the preparation of an EIS, or not significant, resulting in the preparation of a Finding of No Significant Impact (FONSI). An EIS is prepared for those federal actions that may significantly affect the quality of the human environment. Thus, if the Navy were to determine that the proposed action would have a significant impact on the quality of the human environment, an EIS would be prepared. An EA should include: brief discussions of the purpose and need for the proposal, the proposed action, the alternatives, the affected environment, the environmental impacts of the proposed action and alternatives, a listing of agencies and persons consulted and a discussion of the cumulative impacts associated with the alternatives.
This EA will be reviewed by the lead agency, the Navy, who will make a determination regarding the proposed action and whether a FONSI or an EIS is appropriate. Should the Navy conclude that a FONSI is appropriate; a FONSI that summarizes the issues presented in this EA would be prepared. The FONSI would be signed by the Navy and a notice of availability would be published in local newspapers in Kitsap County, WA.

The Navy has prepared this EA in accordance with applicable federal and state regulations and instructions, as well as with other applicable laws, rules and policies. These include, but are not limited to the following:

- NEPA as amended by Public Law 94-52, July 3, 1975 (42 U.S.C. 4321 *et seq.*), which requires environmental analysis for major federal actions significantly affecting the quality of the environment.
- Council on Environmental Quality (CEQ) regulations, as contained in 40 CFR Parts 1500 to 1508, which direct federal agencies on how to implement the provisions of NEPA.
- Navy Regulations for Implementing NEPA 32 CFR 775.
- OPNAVINST 5090.1C.

1.5.2 Agency Coordination and Permit Requirements

In addition to NEPA, other laws, regulations, permits, and licenses may be applicable to the proposed action including the following:

- Permit from the U.S. Army Corps of Engineers (USACE), Seattle District in accordance with Section 10 of the Rivers and Harbors Appropriation Act of 1899.
- Federal Coastal Consistency Determination concurrence by the State of Washington Department of Ecology, Coastal Zone Management Program in accordance with the Coastal Zone Management Act (CZMA).
- Section 106 consultation with the Washington State Historic Preservation Officer (SHPO).
- Government to government consultations with federally recognized American Indian Tribes.

- Coordination on Endangered Species Act (ESA) with the U.S. Fish and Wildlife Service (USFWS) and coordination on Migratory Bird Treaty Act (MBTA) with USFWS.

- Consultation with the National Marine Fisheries Service (NMFS) on the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), and Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA)

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2 DISCUSSION OF ALTERNATIVES

NEPA's implementing regulations (*e.g.*, 40 CFR 1502.14) provide guidance on the consideration of alternatives to a federally proposed action and require rigorous exploration and objective evaluation of reasonable alternatives. Each of the alternatives must be feasible and reasonably foreseeable in accordance with the CEQ regulations (40 CFR 1500-1508). This chapter provides a description of the alternatives analyzed in this EA.

2.1 SITE SELECTION

The site selection process for this EA is based on the proposed location for the construction of EHW-2. The Test Pile Program must occur within the proposed EHW-2 footprint. Although the locations of the proposed EHW-2 piles within the footprint have the potential to change from the proposed action, the data collected from the Test Pile Program will validate the design concepts and construction methods for the proposed EHW-2. Therefore, the location of the Test Pile Program must coincide with the proposed location of EHW-2 to ensure the most accurate and representative geotechnical and sound data is collected.

2.2 ALTERNATIVES

As required by NEPA, all reasonable alternatives must be considered. However, only those alternatives determined to be reasonable relative to their ability to fulfill the purpose and need for the proposed action will be analyzed in the EA. Reasonable alternatives include those that are practical and feasible. The Action Alternative was developed giving due consideration to the purpose and need. This EA analyzes a No Action Alternative and one Action Alternative to achieve the proposed action.

2.2.1 No Action Alternative

Under the No Action Alternative, the Test Pile Program will not be conducted. The geotechnical and sound data resulting from the test pile installation will not be collected and therefore will not be available to validate the design concepts and construction methods for the proposed EHW-2. The No-Action Alternative would not meet the purpose of and need for the proposed action but represents the baseline condition against which potential consequences of the proposed action can be compared. As required by CEQ guidelines, the No-Action Alternative is carried forward for analysis in this EA.

2.2.2 Action Alternative

Under the Action Alternative, 29 test piles will be installed in Hood Canal and subsequently removed between 16 July and 31 October 2011. These test piles will be situated throughout the footprint of a future EHW-2, which is currently under development. The installation of the test piles will involve driving 18 steel pipe piles ranging in size from 30 inches to 60 inches in diameter into the substrate. Additionally, three lateral load tests will be performed. The lateral load test involves measurements of lateral displacement versus the load for the piles[1]. The lateral load tests will require re-installing two of the 60-inch piles and one 48-inch pile.

[1] The lateral load test is accomplished by installing two like sized piles to the design penetration depth below the mudline, then pulling the piles towards each other while plotting the deflection for a given load. This test helps to better define lateral load resistance performance and lateral stiffness.

Two tension load tests will also be performed. The tension load test measures the vertical capacity of a pile[2]. The tension load tests will require installing four reaction piles for each of the two tension load tests. The lateral load test in combination with the tension load test will result in the installation of an additional 11 piles. The Navy expects that some of the initial test piles will be pulled and reused as part of the 11 additional piles. The length of the piles will range from approximately 100 feet to 197 feet. Table 2.1 provides an implementation plan for the Test Pile Program. Figure 2-1 provides a diagram of the lateral load test, the tension load test.

All of the test piles will be installed by a vibratory hammer to their initial embedment depths. The 18 test piles would require the use of an impact hammer to drive the piles the remaining 10-15 feet into the substrate. While driving the piles with the impact hammer the piles will be "proofed[3]" as well. The impact hammer will perform a few blows to warm up the hammer and a number of blows to verify capacity. A Pile Dynamic Analyzer (PDA) will be utilized to confirm capacity. As a contingency, any piles that cannot be driven to the desired depth using a vibratory hammer would be installed using an impact hammer. This contingency has been accounted for in the modeling analysis. For each pile installed, the actual driving time is expected to be no more than one hour for the vibratory portion of the project. The impact driving portion of the project is anticipated to take approximately 15 minutes per pile with less than 100 blows per day anticipated. It is estimated that test pile installation could occur at a rate of up to four piles per day maximum, but more likely a rate of two piles per day should be expected. The piles will be extracted using the vibratory hammer. Extraction is anticipated to take approximately 30 minutes per pile. A 108 day authorization window (16 July - 31 October) was requested to take into account delays that could occur due to the permitting process, materials availability, and inclement weather that may preclude construction

The contractor is expected to mobilize two floating barges, one large barge up to 80' wide x 300' long and one medium sized barge approximately 60' wide x 150' long, for the Test Pile Program. These barges will be moved into location with a 44' tug boat. The two barges will share the work load, with the smaller barge working the inboard trestle test piles and the larger barge working the outboard test piles. The smaller barge will likely be on site for approximately two weeks of pile driving while the larger barge will be on site for the full duration of the program which is expected to be approximately 40 days. Only one pile driving rig will be operated at any one time, The 40 work day duration of the program includes the time for the initial pile installations, time for performing the loading test, and time to remove all of the test piles and demobilize. All test piles will be removed as part of the project. Figure 2-2 shows in detail the location of 18 test piles.

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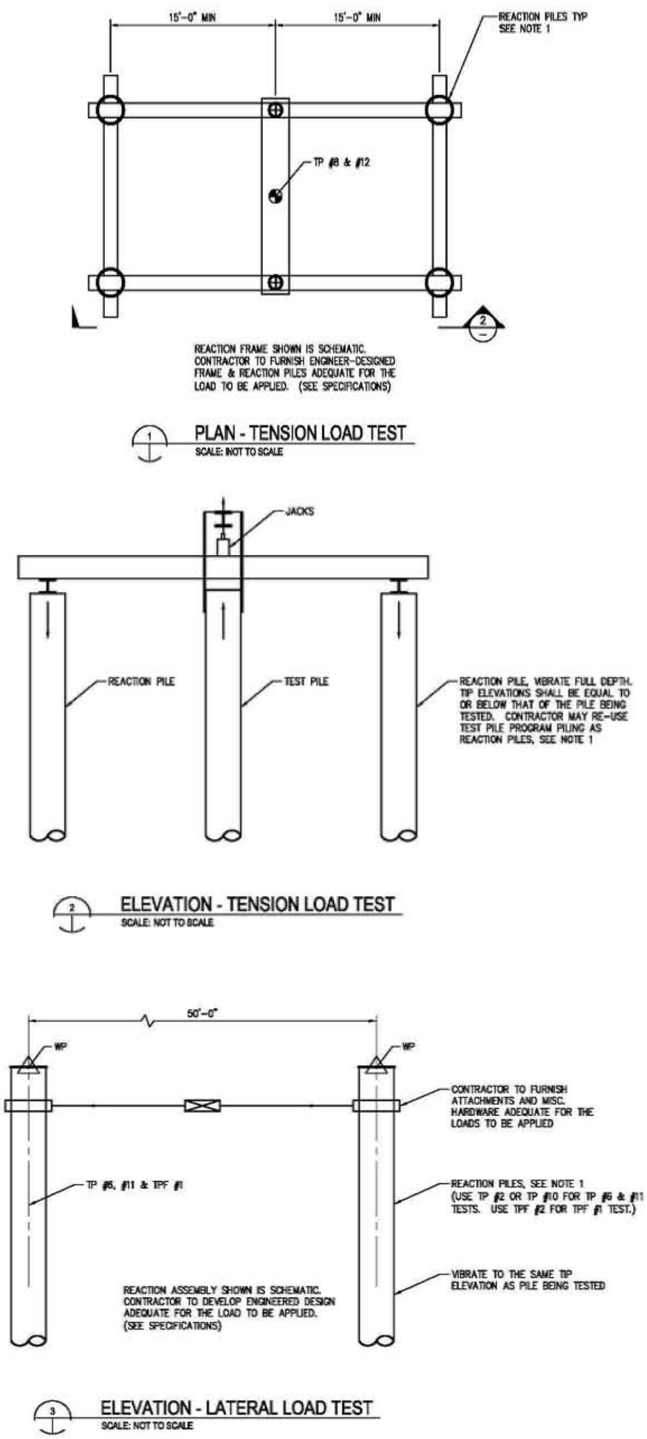
[2] The tension load test is accomplished by installing a pile to the design penetration depth below the mudline. Four temporary piles will then be installed around the pile to provide a foundation for a jacking frame. The frame will be constructed to allow for jacking against the four piles in compression while pulling up on the test pile in tension. The load versus displacement information is then recorded.

[3] "Proofing" is driving the test pile the last few feet into the substrate to determine the capacity of the pile. The capacity during proofing is established by measuring the resistance of the pile to a hammer that has a piston with a known weight and stroke (distance the hammer rises and falls) so that the energy on top of the pile can be calculated. The blow count in "blows per inch" is measured to verify resistance, and pile compression capacities are calculated using a known formula.

TABLE 2.1 TEST PILE PROGRAM IMPLEMENTATION PLAN

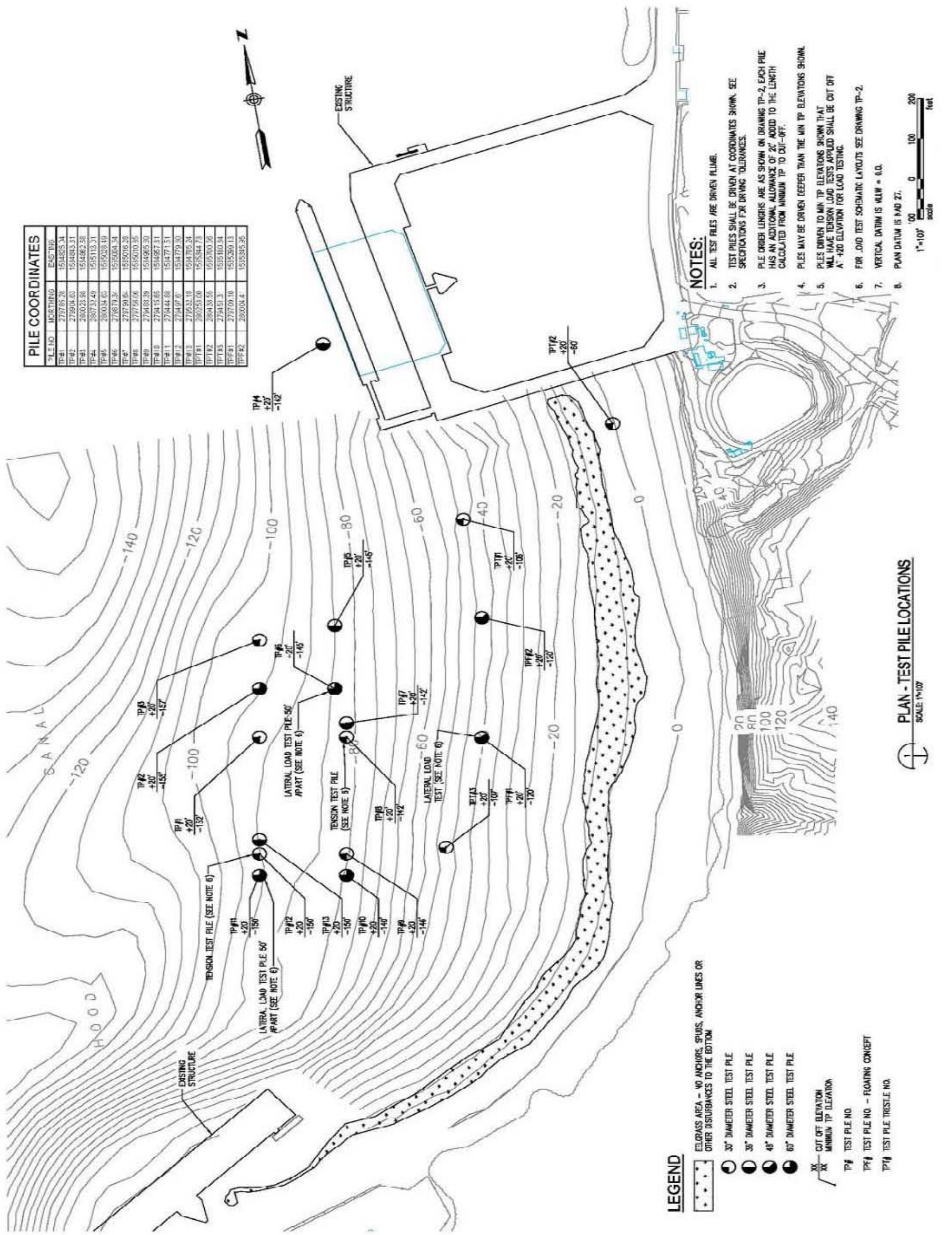
Test Pile NO	Suggested Driving Sequence	Pile Type	Driving Shoes/End Hardening	Vibrate & Impact	Lateral Load Test	Tension Load Test	Load to be Applied
TP#1	11	30'Ø x ¾"T x 192'L		X			
TP#2	12	60'Ø x 1"T x 195'L	Reinforced Tip *1	X			
TP#3	13	30'Ø x ¾"T x 197'L	Cutting Shoe *2	X			
TP#4	1	36'Ø x ¾"T x 182'L	Cutting Shoe *2	X			
TP#5	2	36'Ø x ¾"T x 185'L	Cutting Shoe *2	X			
TP#6	3	60'Ø x 1"T x 185'L	Reinforced Tip *1	X	X		TBD
TP#7	4	36'Ø x ¾"T x 182'L		X			
TP#8	5	30'Ø x ¾"T x 182'L		X		X	TBD
TP#9	6	30'Ø x ¾"T x 180'L	Cutting Shoe *2	X			
TP#10	7	60'Ø x 1"T x 180'L		X			
TP#11	8	60"Ø x 1"T x 190"L		X	X		TBD
TP#12	9	30'Ø x ¾"T x 190'L		X		X	TBD
TP#13	10	36'Ø x ¾"T x 190'L		X			
TPT#1	2	30'Ø x ¾"T x 138'L	Cutting Shoe *2	X			
TPT#2	1	30'Ø x ¾"T x 100'L	Cutting Shoe *2	X			
TPT#3	3	30'Ø x ¾"T x 147'L		X			
TPF#1	2	48'Ø x 1"T x 160'L	Cutting Shoe *2	X	X		TBD
TPF#2	1	48'Ø x 1"T x 160'L	Stinger *3	X			

*1 – Welded end hardening using 90 ksi weld material
*2 – Inside edge cutting shoe
*3 - 'H' pile stinger
TP# - Test Pile Number (See figure 2-2 for locations)
TPT - Test Pile Trestle
TPF - Test Pile Floating concept
Ø – Diameter of the test piles
L – Length = Mudline + 60' Embedment + 20 MLLW cut off + 20" Driving Allowance
T – Wall thickness
TBD – To Be Determined



Source: Berger ABAM

Figure 2-1 Lateral Load and Tension Load Tests



Source: Berger ABAM

Figure 2-2 Test Pile Locations (Action Alternative)

Additional piles used for lateral load test and tension load tests are not shown in this figure, but would occur in the same general vicinity as the 18 pile locations shown.

Sound attenuation measures will be used during all impact hammer operations and some vibratory hammer operations. The Navy will monitor hydroacoustic levels, as well as the presence and behavior of marine mammals and marbled murrelets during pile installation and removal. The piles will be removed at or before the completion of the Test Pile Program because they could pose a potential navigation risk if left in place. The test piles would not be incorporated into the proposed EHW-2 because exact pile locations for the proposed structure are not yet determined. A 108 day authorization window (16 July - 31 October) was requested to take into account delays that could occur due to the permitting process, materials availability, and inclement weather that may preclude construction.

2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

The development process for this EA considered other alternatives to the Test Pile Program. Five alternatives were considered, but eliminated from further consideration due to location, feasibility, operational and other impacts. A summary of each of the alternatives eliminated from further consideration is discussed below.

2.3.1 Alternate Pile Locations within the Study Area

The Test Pile Program will provide geotechnical and sound propagation data for the proposed EHW-2 as well as future projects along the NBK Bangor waterfront. Test piles should be installed at locations as close as practicable to the proposed footprint. The environmental impacts associated with minor changes in location of the Test Pile Program would not be significantly altered if the installation of the test pile occurs in an alternate location within the proposed Test Pile Program project area.

2.3.2 Lesser Number of Piles

The number of piles proposed in the Test Pile Program has been reduced to the minimum number required to gather accurate data to support the proposed EHW-2 project. Piles will be placed to optimize the data collection area and capabilities without compromising the integrity of the data.

2.3.3 Alternate Test Project Location

The Test Pile Program is designed to gather geotechnical and sound propagation data to validate waterfront renovations at Bangor, in particular the design for the proposed EHW-2 being planned at NBK Bangor, WA. If the location of the Test Pile Program was altered, the results would not provide site-specific data needed for design of the proposed EHW-2. The installation and removal of test piles for this purpose must be performed in the location which is anticipated for the construction of the proposed EHW-2 to ensure the data collection effort for the proposed EHW-2 project is successful.

2.3.4 Alternate Pile Installation Methodology

Two alternative methods of pile installation that might be accomplished using non-vibratory and non-impact hammer methods of pile installation were considered during the planning phase of the EA.

The first consists of drilling a hole to a required depth (i.e., tip elevation) and then inserting the pile in the hole. This approach would result in very low capacities and is impractical, if not impossible, in deep water. This approach was quickly abandoned as being non-feasible.

A second approach would be to install conventional drilled shafts offshore. For larger diameter shafts, the likely method of installation would consist of advancing large diameter steel casing to the predetermined required tip elevation. For the size of shafts being considered for the project (60-inch diameter), this would likely be accomplished using “hydraulic oscillator hydraulic rotator casing” methods. This type of construction consists of a machine that can “push” a casing into the ground while, at the same time, rotate it back and forth to provide a cutting action. The soil inside the advancing casing is then removed from the interior of the casing as the casing is advanced. This method of construction is difficult, if not impossible, to complete in deep water. Additionally, this particular method, even if feasible, would be prohibitively expensive. Accordingly, this alternative was not considered further.

2.3.5 Geotechnical Modeling

Geotechnical modeling can be used to assist in the design of piers, wharfs and other in-water structures. However, geotechnical modeling is based on assumptions. In order to formulate these assumptions, real data must be gathered. There is insufficient data on sediment conditions in the project area to accurately perform geotechnical modeling. Therefore, it is essential to gather data by performing the Test Pile Program to ensure the validity of the proposed EHW-2 design.

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3 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes existing environmental conditions for resources potentially affected by the Action Alternative. This chapter also identifies and assesses the environmental consequences of the Action Alternative. The affected environment and environmental consequences are described and analyzed according to categories of resources. The categories of resources addressed in this EA are listed in Table 3-1.

Several resources areas have been eliminated from further discussion as it was concluded that these resources areas would not be impacted by the Test Pile Program described under the Action Alternative. The resources excluded from the analysis and the reasons for excluding these resources are discussed below.

- Visual Resources – Visual resources are the natural and manmade features that give a particular environment its aesthetic qualities. In developed areas, the natural landscape is more likely to provide a background for more obvious manmade features. The size, forms, materials, and functions of buildings, structures, roadways, and infrastructure will generally define the visual character of the built environment. These features form the overall impression that an observer receives of an area or its landscape character. Attributes used to describe the visual resource value of an area include landscape character, perceived aesthetic value, and uniqueness. The Test Pile Program is proposed to occur within the waters of Hood Canal off the NBK Bangor waterfront. The proposed action is temporary, only lasting 40 days. All 29 piles will be removed at or before the conclusion of the Test Pile Program. Therefore, no impact to visual resources will occur due to the temporary nature of the program.

- Cultural Resources – The Navy performed an assessment in preparation for consultation with the State of Washington Department of Archaeology and Historic Preservation for the proposed EHW-2 project. Consultation with the SHPO as required by Section 106 of the National Historic Preservation Act (NHPA) has been accomplished as part of the NEPA process for this EA. The SHPO, in a letter dated June 28, 2010, concurred with the Navy's finding of "no historic properties affected" for the Test Pile Program (Appendix D).

- Recreational and Commercial Fishing - Recreational and commercial fishing does not occur in the proposed Test Pile Program project area at the NBK Bangor waterfront. This area is restricted from access by the general public per 33 CFR 334.1220. Therefore the activities described under the Action Alternative would not have an impact on recreational and commercial fishing.

- Socioeconomics, Environmental Justice and the Protection of Children – The Test Pile Program is proposed to occur at the NBK Bangor waterfront. Local contractors and equipment would be utilized to conduct the Test Pile Program, though this project is short in duration and no significant impacts to the local economy would result. EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, requires each federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental impacts of its programs, policies, and activities on minority and low-income populations. EO 13045, *Environmental Health Risks and Safety Risk to Children* requires each federal agency to "…make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children and shall...ensure that its policies, programs, activities, and standards address disproportionate risks to children…." As stated above this area is restricted from access by the general public. As a result, impacts to minority and low income populations and children are not anticipated to occur. Therefore the activities described under the Action Alternative would not have an impact on socioeconomics, Environmental Justice or the Protection of Children.

TABLE 3.1 RESOURCE AREAS AND CHAPTER LOCATIONS

Resource	Section	Resource	Section
Bathymetry	3.1	Marine Invertebrates	3.7
Geology and Sediments	3.2	Fish	3.8
Water Resources	3.3	Marine Mammals	3.9
Air Quality	3.4	Birds	3.10
Ambient Noise	3.5	Tribal Fisheries/Access	3.11
Marine Vegetation	3.6	Environmental Health and Safety	3.12

3.1 BATHYMETRY

3.1.1 Affected Environment

Puget Sound is a glacially carved fjord with five major basins. Hood Canal is the westernmost basin and has a total length of approximately 62 miles (100 km) and a maximum depth of nearly 626 feet (200 m) (Kellogg, 2004). The basin is relatively straight for the majority of its length, with the exception of Dabob Bay, a major embayment. The major components of Hood Canal are the entrance, Dabob Bay, the central region, and The Great Bend at the southern end (Gustafson et al., 2000) (Figure 3-1). Over most of its length Hood Canal varies in width from 1.0 to 2.5 miles (2 km to 4 km) (Kellogg, 2004).

A shallow sill extends across the short axis of the canal south of Hood Canal Floating Bridge and the northern end of NBK Bangor in the vicinity of South Point and Thorndyke Bay. It is approximately 25 miles (40 km) long and lies at a depth of approximately 130 feet (40 m). Southward of the sill the bottom on the western side drops off steeply, while the eastern side slopes more gently downward (Figure 3-2). The main thalweg[4] and current runs along the west side of the channel, forming a hanging valley[5] at the sill crest (Gregg and Pratt, 2010). The sill limits exchanges of dense water between the deeper southern reach and Admiralty Inlet, the channel linking Puget Sound to the North Pacific Ocean via the Strait of Juan de Fuca (Gregg and Pratt, 2010). South of the sill, the bottom along the thalweg is extremely rough, varying by + 80 feet (25 m) over 0.6 miles (1 km) or less (Gregg and Pratt, 2010).

The sill, canal cross-sectional area and bathymetric irregularities exert a controlling affect on tidal currents, flow stratification, tidal energy and exchange of dissolved oxygen (Gregg and Pratt, 2010; Kellogg, 2004; Gustafson et al., 2000). However, an accurate description of the hydraulic properties of Hood Canal is hindered by its complex geometry and bathymetry (Gregg and Pratt, 2010).

3.1.2 Environmental Consequences

3.1.2.1 No Action Alternative

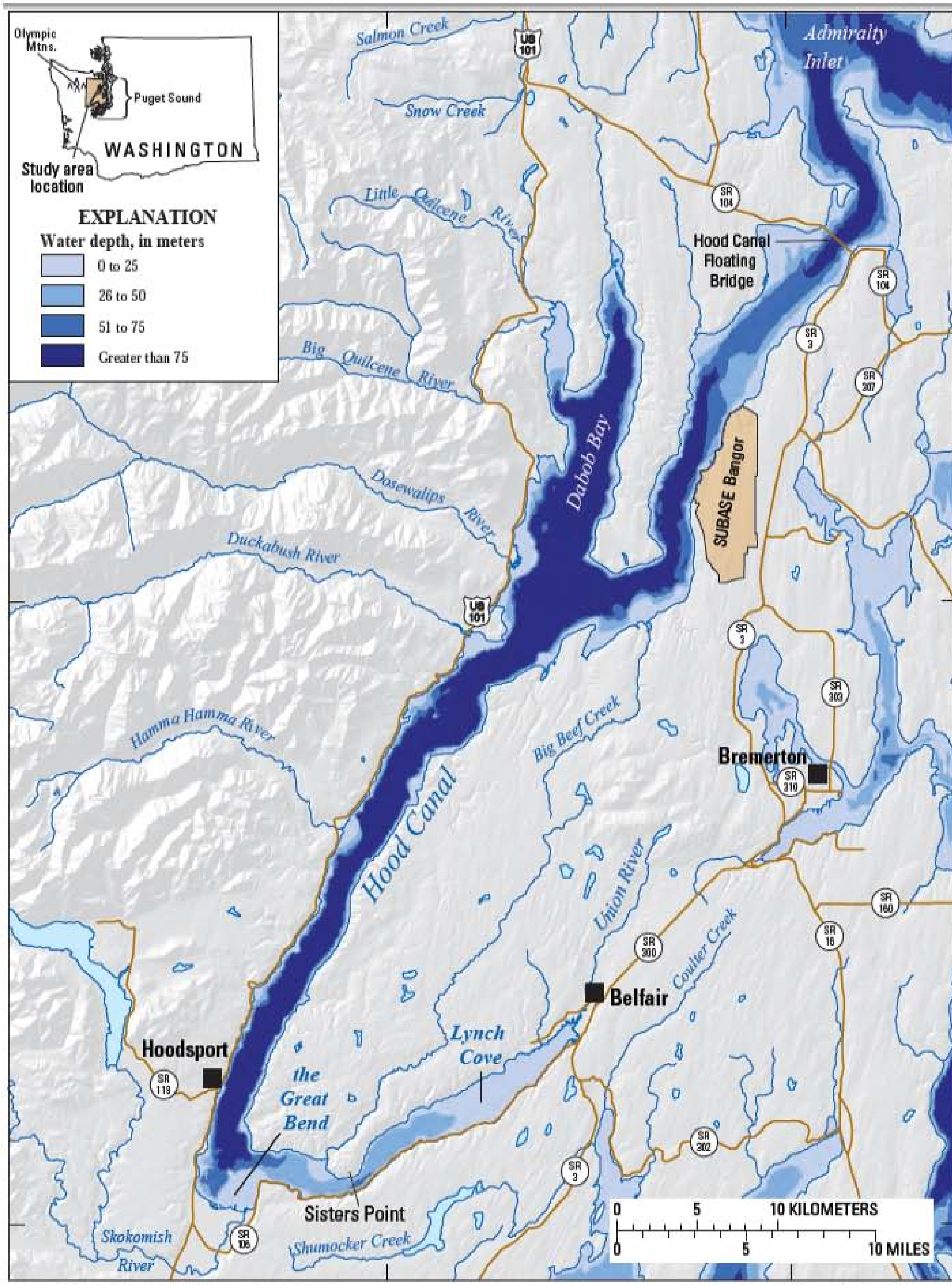
Under the No Action Alternative the Test Pile Program would not be conducted. Baseline bathymetric conditions would remain unchanged. Therefore, there would be no significant impacts to bathymetry from implementation of the No Action Alternative.

3.1.2.2 Action Alternative

The proposed action is to drive 29 test and reaction piles at NBK Bangor supported by two barges, spuds and anchors. All work is temporary and the equipment and test piles will be demobilized and removed after 40 days.

Changes to the bathymetry from these activities will be inconsequential. The greatest localized change would likely occur from anchor or spud placement during pile driving. However, after a full seasonal cycle of storm and wind events, and daily and seasonal tide cycles, the seafloor topography should return to its original condition within 6 to 12 months of demobilization. Therefore, the Action Alternative would not result in a significant impact to bathymetry.

[4] A thalweg is the line defining a channel’s maximum depth, and is also usually the line of a current’s fastest flow.
[5] A former tributary glacier valley that is incised into the upper part of a U-shaped glacier valley, higher than the floor of the main valley (USGS, 2010).



Base from U.S. Geological Survey digital data, 1983, 1:100,000
Universal Transverse Mercator projection, Zone 10
North American Datum of 1983 (NAD 83)

Base map is derived from a 10-meter DEM image modified to highlight north-south glacial lineations.

Source: Gustafson et al., 2000

Figure 3-1 Hood Canal Water Depths

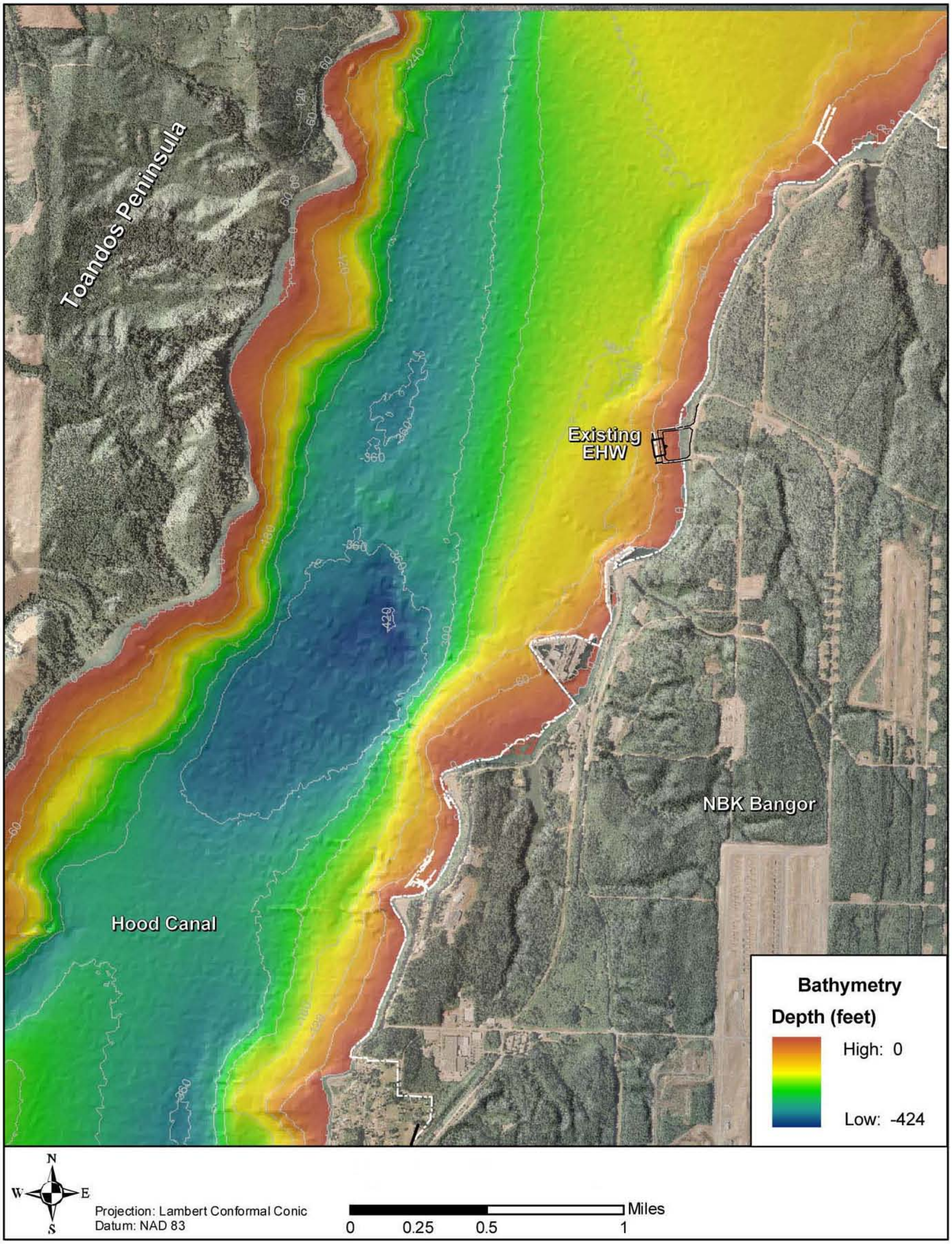


Figure 3-2 NBK Bangor Waterfront Bathymetry

3.2 GEOLOGY AND SEDIMENTS

3.2.1 Affected Environment

3.2.1.1 Regulatory Overview

The Washington State Sediment Management Standards (SMS) (WAC 173-204) provides the framework for the long-term management of marine sediment quality. The purpose of the SMS is to reduce and ultimately eliminate adverse biological impacts and threats to human health from sediment contamination. The SMS establishes standards for the quality of sediments as the basis for management and reduction of pollutant discharges by providing a management and decision-making process for contaminated sediments.

The marine Sediment Quality Standards (SQS) established by the SMS include numeric criteria using bulk contaminant concentrations and biological impacts criteria based on sediment bioassays that define the lower limit of sediment quality expected to cause no adverse impacts to biological resources in Puget Sound. The SMS Cleanup Screening Levels (CSL) consist of numeric chemical concentration and biological impacts criteria that represent cleanup thresholds. Bulk sediment concentrations between the SQS and CSL values require further investigation to determine whether actual adverse impacts exist at the site due to contaminated sediments.

3.2.1.2 Geology

Hood Canal basin is a glacially carved fjord with steep flanks rising abruptly to elevations of more than 200 feet (60 m) above mean sea level (MSL). Farther inland on the Kitsap Peninsula, slopes are moderate and many upland areas are nearly flat. The NBK Bangor waterfront geomorphology is typical of shorelines around Hood Canal and the Puget Sound. Steep bluffs rising several hundred feet above sea level and merging into uplands with a gentler slope is indicative of this area. Maximum elevations at NBK Bangor are nearly 500 feet (152 m) MSL (USGS, 2002; 2003). The advance and retreat of glaciers resulting from periodic episodes of glaciation have shaped the underlying geologic conditions of the surrounding area. Successive layers of sediments alternating between dense till layers and other fine- and coarse-grained layers of sediments are found throughout the area. Glacial deposits in the project area are more than 1,200 feet (365 m) thick and are underlain by bedrock.

3.2.1.3 Sediments

Sources of sediment along the east shore of Hood Canal primarily results from natural erosion of bluffs (by wind or wave action). This is because no rivers or large watersheds feed into Hood Canal along the east shore. However, numerous small drainages along the waterfront do feed Hood Canal thus contributing as a secondary source of sedimentation. Littoral drift or shore drift is the primary mechanism for sediment transport from eroding bluffs. Drift results primarily from the oblique approach of wind-generated waves and can therefore change in response to short-term (daily, weekly, or seasonal) shifts in wind direction. Over the long term, however, many shorelines exhibit a single direction of net shore drift, determined through geomorphologic analysis of beach sediment patterns and of coastal landforms (WDOE, 2009a). A net northerly shore drift occurs at the NBK Bangor waterfront (WDOE, 1991).

Sediment transport and deposition can become altered by constructed features (e.g., wharves, piers, dolphins, floats, ramps, and groins) by decreasing water velocity, resulting in sedimentation along one side of an obstruction. Offshore structures that alter wave energy (such as breakwaters, floats, and moored vessels) reduce erosion along the shore and allow drift sediment to accumulate. Piers and groins can create a change in the distribution of sediments resulting in patches of coarse-grained sediment adjacent to patches of fine-grained sediment as well as sediment depleted beaches on the opposite side of the obstruction. As natural wave and current action gradually move fine sediment from intertidal elevations to subtidal elevations, the upper intertidal substrate gradually coarsens and its slope steepens without new sources of sediment to replace the finer material (Downing, 1983).

The proposed study area contains a relatively consistent subsurface matrix series. The ground surface elevation in the vicinity of the Test Pile Program ranges from +26 feet (8 m) Mean Lower Low Water (MLLW) at the onshore area to approximately -90 feet (27.43 m) MLLW at the western project area edge; with a 10 to 16 percent slope toward the west. Previous borings conducted by Hart Crowser (Geotechnical Data Report Draft P-990 EHW-2 May 4, 2010) demonstrate a subsurface profile that generally consists of recent soil deposits underlain by older glacial deposits. Recent deposits comprised of soft silt and loose sand downslope within the site area to medium dense silty sand with variable amounts of shell and gravel upslope towards the shoreline. Older underlying glacial deposits consist of dense to very dense sand and gravel with variable silt content and interspersed layers of hard silt and clay.

Physical and Chemical Properties of Sediments

Hammermeister and Hafner (2009) described marine sediments as composed of gravelly sands with some cobbles in the intertidal zone, transitioning to silty sands in the subtidal zone. The presence of glacial till approximately six feet (two meters) below mud line in the intertidal zone, increasing to over 10 feet (3 m) in the subtidal zone was found in subsurface coring studies performed in 1994 (URS, 1994). The composition of sediment samples from the project area ranged from 65 to 100 percent for sand, less than one to seven percent for gravel, two to 32 percent silt, and two to 11 percent clay. Table 3.2 provides a detailed description of the physical and chemical characteristics of the surface sediments at the proposed Test Pile Program location.

Sediment parameters (such as Total Organic Carbon (TOC), metals, and organic contaminants) were used to characterize sediment quality. TOC, which provides a measure of how much organic matter occurs in sediments, was less than 1 percent at the project area (see Table 3.2). A range of 0.5 to 3 percent is typical for Puget Sound marine sediments, particularly those in the main basin and in the central portions of urban bays (PSWQAT and PSEP, 1997). Total sulfide concentrations range from not detected (ND) (i.e., below detection limit of 0.4 milligrams per kilogram [mg/kg]) to 82.6 mg/kg (see Table 3.2). Ammonia concentrations range from 1.3 to 6.2 mg/kg (see Table 3.2). There are no SQS for TOC, sulfides or ammonia concentrations.

Metals

The concentrations of metals in sediments at the project area seen in Table 3.2 are based on sampling conducted by Hammermeister and Hafner (2009). These concentrations are comparable to background levels for Puget Sound and below sediment quality guidelines (e.g., SQS values and CSL values). For example, cadmium concentrations ranged from less than 0.1 to 0.3 mg/kg, which were below the standards of 5.1 and 6.7 mg/kg for SQS and CSL, respectively.

TABLE 3.2 PHYSICAL AND CHEMICAL CHARACTERISTICS OF SURFACE SEDIMENTS AT THE TEST PILE PROGRAM SITE

PARAMETER	SEDIMENT QUALITY STANDARDS (SQS)	CLEANUP SCREENING LEVELS (CSL)	NEW EHW SITE[1] (MINIMUM – MAXIMUM VALUES)
Conventionals			
Total Organic Carbon (TOC) (%)	–	–	0.2 – 0.9
Total Volatile Solids (%)	–	–	1.4 – 3.4
Total Solids (%)	–	–	57.8 – 75.7
Ammonia (mg-N/kg)	–	–	1.3 – 6.2
Total Sulfides (mg/kg)	–	–	ND – 82.6
Grain Size			
Percent Gravel (>2.0mm)	–	–	<0.1 – 6.9
Percent Sand (<2.0mm – 0.06mm)	–	–	64.6 – 100
Percent Silt (0.06mm – 0.004mm)	–	–	2.0 – 32.1
Percent Fines (<0.06mm)	–	–	4.6 – 41.2
Percent Clay (<0.004mm)	–	–	2.3 – 11.3
Metals (mg/kg)			
Antimony	–	–	<0.1
Arsenic	57	93	1.1 – 3.5
Cadmium	5.1	6.7	<0.1 – 0.3
Chromium	260	270	13.4 – 26.6
Copper	390	390	5.8 – 21.6
Lead	450	530	2.2 – 6.5
Mercury	0.41	0.59	ND – <0.1
Nickel	–	–	13.2 – 28.2
Selenium	–	–	ND – 0.4
Silver	6.1	6.1	<0.1
Zinc	410	960	21.8 – 47.2
Butyltins (µg/kg)			
Di-n-butyltin	–	–	ND – 13.0
Tri-n-butyltin	–	–	ND – 7.5
Tetra-n-butyltin	–	–	ND
n-butyltin	–	–	ND – 0.9
Low Molecular Polycyclic Aromatic Hydrocarbons (LPAH) (mg/kg TOC)			
Naphthalene	99	170	ND
Acenaphthylene	66	66	ND
Acenaphthene	16	57	ND – 1.5
Fluorene	23	79	ND – 1.4
Phenanthrene	100	480	1.0 – 10.0
Anthracene	220	1200	ND – 1.4
2-Methylnaphthalene	38	64	ND
Total LPAH[2]	370	780	0.7 – 14.3

TABLE 3.2 PHYSICAL AND CHEMICAL CHARACTERISTICS OF SURFACE SEDIMENTS AT THE TEST PILE PROGRAM SITE (continued)

PARAMETER	SEDIMENT QUALITY STANDARDS (SQS)	CLEANUP SCREENING LEVELS (CSL)	TEST PILE PROGRAM PROJECT AREA [1](MINIMUM – MAXIMUM VALUES)
High Molecular Polycyclic Aromatic Hydrocarbons (HPAH) (mg/kg TOC)			
Fluoranthene	160	1200	1.1 – 10.0
Pyrene	1000	1400	1.0 – 9.6
Benz(a)anthracene	110	270	ND – 3.7
Chrysene	110	460	ND – 8.2
Benzofluoranthenes[3]	230	450	ND – 6.7
Benzo(a)pyrene	99	210	ND – 3.1
Indeno(1,2,3-cd)pyrene	34	88	ND – 2.3
Dibenz(a,h)anthracene	12	33	ND
Benzo(g,h,i)perylene	31	78	ND – 2.3
Total HPAH[4]	960	5300	2.2 – 48.8
Chlorinated Aromatics (mg/kg TOC)			
1,3-Dichlorobenzene	—	—	ND
1,2-Dichlorobenzene	2.3	2.3	ND
1,4-Dichlorobenzene	3.1	9	ND
1,2,4-Trichlorobenzene	0.81	1.8	ND
Hexachlorobenzene	0.38	2.3	ND
Phthalate Esters (mg/kg TOC)			
Dimethylphthalate	53	53	ND
Diethylphthalate	61	110	ND – 5.7
Di-n-Butylphthalate	220	1700	3.5 – 26.1
Butylbenzylphthalate	4.9	64	ND – 2.1
bis(2-Ethylhexyl)phthalate	47	78	ND – 8.3
Di-n-Octylphthalate	58	4500	ND
Phenols (µg/kg dw)			
Phenol	420	1200	14.0 – 53.0
2-Methylphenol	63	63	ND
4-Methylphenol	670	670	ND – 23.0
2,4-Dimethylphenol	29	29	ND
Pentachlorophenol	360	690	ND
Misc. Extractables (mg/kg TOC)			
Benzyl Alcohol	57	73	ND
Benzoic Acid	650	650	ND
Dibenzofuran	15	58	ND – 10.4
Hexachloroethane	—	—	ND
Hexachlorobutadiene	3.9	6.2	ND
N-Nitrosodiphenylamine	28	130	ND

TABLE 3.2 PHYSICAL AND CHEMICAL CHARACTERISTICS OF SURFACE SEDIMENTS AT THE TEST PILE PROGRAM SITE (continued)

PARAMETER	SEDIMENT QUALITY STANDARDS (SQS)	CLEANUP SCREENING LEVELS (CSL)	TEST PILE PROGRAM PROJECT AREA [1](MINIMUM – MAXIMUM VALUES)
Hexachloroethane	—	—	ND
Hexachlorobutadiene	3.9	6.2	ND
N-Nitrosodiphenylamine	28	130	ND
Pesticides and PCBs (mg/kg TOC)			
Total DDT[5]	—	—	ND
Aldrin	—	—	ND
alpha-Chlordane	—	—	ND
Dieldrin	—	—	ND
Heptachlor	—	—	ND
gamma-BHC (Lindane)	—	—	ND
Total PCBs[6]	12	65	ND

Source: SQS and CSL from WAC 173-204-320(b), EHW sample data are from Hammermeister and Hafner (2009).
__ = No sediment quality standard or screening levels exist; dw = dry weight; ND = not detected; PCB = polychlorinated biphenyl; TOC = total organic carbon; mg/kg = milligrams per kilogram; µg/kg = micrograms per kilogram.

1 Samples taken at depths from 0–10 cm. Values represent the ranges for samples from 13 locations near the proposed EHW project area.
2 Sum of LPAH results for naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, and anthracene. LPAH does not include 2-methylnaphthalene.
3 Sum of benzo(b)fluoranthene and benzo(k)fluoranthene.
4 Sum of HPAH results for fluoranthene, pyrene, benz(a)anthracene, chrysene, total benzofluoranthenes, benzo(a)pyrene, indeneo(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene, and benzo(g,h,i)perylene
5 Sum of 4,4'-DDD, 4-4'-DDE, and 4-4'-DDT
6 Sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260

Organic Contaminants

Organotin (butyltin) compounds in marine sediments primarily result from residues from anti-fouling paints applied to vessel hulls (Danish EPA, 1999). The Organotin Anti-Fouling Paint Control Act banned the use of organotins in anti-fouling paints for ships less than 25 meters (82 feet) in length and non-aluminum hulls in 1988. Organotin concentrations within the sediments at the proposed EHW-2 project area contain tri-n-butyltin concentrations up to 7.5 micrograms per kilogram (µg/kg) or 870 µg/kg TOC (see Table 3.2). Although sediment quality standards for organotins do not currently exist, Garono and Robinson (2002) proposed a threshold value of 6,000 µg/kg TOC for tributyltin in sediments as protective of juvenile salmonids. Thus, concentrations in sediments near the project area are below this threshold.

Concentrations of individual polycyclic aromatic hydrocarbon (PAH) compounds in sediments near the project area varied from ND to 10 mg/kg TOC (see Table 3.2). Concentrations of individual PAH compounds, as well as the summed concentrations (i.e., total LPAHs and total higher molecular polycyclic aromatic hydrocarbons [HPAHs]) were below the corresponding SQS and CSL values.

Concentrations of other classes of organic contaminants, such as chlorinated aromatics, phthalate esters, phenols, and other miscellaneous extractable compounds, typically were at or below the analytical detection limits and consistently below the SQS and CSL values.

3.2.2 Environmental Consequences

3.2.2.1 No Action Alternative

Under the No Action Alternative, the Test Pile Program would not be conducted. Baseline conditions for geology and sediments would remain unchanged. Therefore, there would be no significant impacts to geology and sediments from implementation of the No Action Alternative.

3.2.2.2 Action Alternative

Under the proposed action, very low amounts of sediment will be disturbed and subsequently suspended in the water column. The use of the vibratory hammer and impact hammer could cause the very fine soft sandy silt layers located above the hard glacial deposits to be susceptible to liquefaction and subsequent contraction. As a result, the sediments would quickly settle back to the bottom of the project area or be carried out with tidal flow. Such suspension will be localized to the immediate area of the pile being driven and removed. The underlying glacial materials, although a coarse and cohesion-less granular material, will tend to collapse in on itself when drilled and removed (Hart Crowser, 2010). This action would have no effect on the subsurface slope stability within the project area.

Construction activities would not result in the discharge of wastes containing metals or otherwise alter the concentrations of trace metals in bottom sediments. Nor would construction activities result in the discharge of high levels of contaminants or otherwise alter the concentrations of organic contaminants in bottom sediments. However, because the magnitude of metal and organic compound concentrations in sediment can vary as a function of grain size (higher concentrations typically are associated with fine-grained sediments due to higher interior surface areas), small changes to grain size associated with construction-related disturbances to bottom sediments could result in minor changes in metal and organic compound concentrations. This would mainly occur in the removal of the test piles. These changes would not likely cause chemical constituents to violate SQS due the small scale of temporary operations and the general lack of sediment contaminants in the project area. Therefore, the Action Alternative would not result in a significant impact to geology or sediments.

3.3 WATER RESOURCES

3.3.1 Affected Environment

3.3.1.1 Regulatory Overview

Water quality describes the chemical and physical composition of water as affected by natural conditions and human activities. The Clean Water Act (CWA) (33 USC §1251), established the basic structure for regulating discharges of pollutants into waters of the United States. The CWA contains the requirements to set water quality standards (WQS) for all contaminants in surface waters. The U.S. Environmental Protection Agency (USEPA) is the designated regulatory authority to implement pollution control programs and other requirements of the CWA. However, USEPA has delegated regulatory authority for the CWA to Washington State Department of Ecology (WDOE) for the implementation of pollution control programs as well as other CWA requirements.

The Rivers and Harbors Act regulates development and use of the nation's navigable waterways. 33 USC 401 §10 of the Act prohibits unauthorized obstruction or alteration of navigable waters and vests the USACE with authority to regulate discharges of fill and other materials into such waters.

3.3.1.2 Water Quality

EHW-1 is located along the northern stretch of Hood Canal on the NBK Bangor waterfront. Hood Canal was designated as an Extraordinary Quality (EQ) water body by the WDOE. Because of this designation, WDOE requires any federal, state, local, and/or private action to maintain the standards shown in Table 3.3.

The area surrounding EHW-1 was sampled for water quality parameters (temperature, salinity, dissolved oxygen [DO], and turbidity) in 2005 and 2006 (Phillips et al., 2008). The sampling locations (Figure 3-3) compared a series of shallow, nearshore locations with deeper, offshore locations. These same sites were sampled again in 2007 and 2008 (Phillips et al., 2009). Water quality sampling in the proposed project area did not measure for nutrients, pH, or fecal coliform levels. Existing conditions for those parameters are based on information collected as part of regional monitoring programs, such as the WDOE’s Marine Water Quality Monitoring Program (WDOE, 2005).

Temperature

The temperature of marine surface waters designated as extraordinary quality should average less than 13.0°C (55ºF), or 0.3°C (0.5ºF) above natural levels (WAC, 173-201A). Monthly mean surface water temperatures along the NBK Bangor waterfront are summarized in Table 3.4. Temperatures for the nearshore locations (water depth ranging from 1 to 60 m) met extraordinary quality standards during the winter months (January to May 2006) and excellent quality standards during the summer months (July to September 2005 and June 2006). Nearshore areas are susceptible to greater temperature variations due to seasonal fluxes in solar radiation input. Water temperatures at the offshore locations (water depths ranging from 20 to 60 meters) met extraordinary quality standards in July 2005, September 2005, and March through May 2006 and excellent quality standards during late summer (August) (Phillips et. al., 2008). Though still in

Figure 3-3 Water Quality Monitoring Stations for 2005

TABLE 3.3 MARINE WATER QUALITY CRITERIA

WATER QUALITY CLASSIFICATION	WATER QUALITY CRITERIA			
Aquatic Life	**Temperature**[1]	**Dissolved Oxygen**[2]	**Turbidity**[3]	**pH**
Extraordinary Quality	13°C (55°F)	7.0 mg/L	+5 NTU or +10%[4]	7.0 – 8.5[6]
Excellent Quality	16°C (61°F)	6.0 mg/L	+5 NTU or +10%[4]	7.0 – 8.5[7]
Good Quality	19°C (66°F)	5.0 mg/L	+10 NTU or +20%[5]	7.0 – 8.5[7]
Fair Quality	22°C (72°F)	4.0 mg/L	+10 NTU or +20%[5]	6.5 – 9.0[7]
	COLIFORM BACTERIA			
Shellfish Harvesting	Geometric mean not to exceed 14 MPN/100 mL fecal coliforms[8]			
Recreation				
Primary Contact	Geometric mean not to exceed 14 MPN/100 mL fecal coliforms[8]			
Secondary Contact	Geometric mean not to exceed 70 MPN/100 mL enterococci[9]			

Source: WAC 173-201A as amended in November 2006.

1 One-day maximum (degrees Celsius [°C]). Temperature measurements should be taken to represent the dominant aquatic habitat of the monitoring site. Measurements should not be taken at the water's edge, the surface, or shallow stagnant backwater areas.

2 One-day minimum (milligrams per liter [mg/L]). When DO is lower than the criteria or within 0.2 mg/L, then human actions considered cumulatively may not cause the DO to decrease more than 0.2 mg/L. DO measurements should be taken to represent the dominant aquatic habitat of the monitoring site. Measurements should not be taken at the water's edge, the surface, or shallow stagnant backwater areas.

3 Measured in Nephelometric Turbidity Units (NTU); point of compliance for non-flowing marine waters — turbidity not to exceed criteria at a radius of 150 feet from activity causing the exceedance.

4 5 NTU over background when the background is 50 NTU or less; or 10 percent increase in turbidity when background turbidity is more than 50 NTU.

5 10 NTU over background when the background is 50 NTU or less; or 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

6 Human-caused variation within range must be less than 0.2 units.

7 Human-caused variation within range must be less than 0.5 units.

8 No more than 10 percent of all samples used to calculate geometric mean may exceed 43 most probable number (MPN)/100 milliliters (mL); when averaging data, it is preferable to average by season and include five or more data collection events per period.

9 No more than 10 percent of all samples used to calculate geometric mean may exceed 208 MPN/100 mL; when averaging data, it is preferable to average by season and include five or more data collection events per period.

draft form, additional survey data from 2007 and 2008 using methodology of Phillips et al. (2008) show water temperatures met extraordinary quality standards during the winter and extraordinary to excellent quality standards in the spring (Phillips et al., 2009).

Salinity

Between June 2005 and July 2006, surface water salinity levels along the NBK Bangor waterfront ranged from 26 to 35 practical salinity units (PSU) (Phillips et al. 2009). Salinity measurements with depth reflected a stratified water column, with less saline surface water overlying cooler saline water at depth. The transition between the lower salinity surface waters and higher salinity subsurface waters occurred at a depth of about 33 feet (Phillips et al. 2009).

The lowest surface water salinity (26.7 PSU) was measured in January 2006 when input from fresh water may have been high due to winter storms and runoff. The range of salinity along the NBK Bangor waterfront is typical for marine waters in Puget Sound (Newton et al. 1998, 2002).

Dissolved Oxygen (DO)

Per the state's water quality classification, concentrations of DO in extraordinary quality marine surface waters, such as Hood Canal, should exceed 7.0 mg/L, allowing for only 0.2 mg/L reductions in the natural condition by human-caused activities (WAC, 173-201A). State guidelines [WAC 173-201A 200(1)(d)(i)] specify that "when a water body's DO is lower than the criteria in Table 200(1)(d) (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, the human action considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L." Data from WDOE's Marine Water Quality Monitoring Program for 1998 to 2000 and Hood Canal Dissolved Oxygen Program (HCDOP) for 2002 to 2004 show that Hood Canal is particularly susceptible to low DO levels (Newton et al., 2002; HCDOP, 2005).

The nearshore sampling locations adjacent to the project area indicate that DO levels routinely meet the WDOE standards (Table 3.3). Off-shore waters of Hood Canal sampled in the location of the project area periodically do not meet the state WQS set forth by the Washington State Water Pollution Control Act (Revised Code of Washington [RCW] 90.48). Moreover, waters of Hood Canal located approximately 0.5 miles north of the NBK Bangor base boundary also do not meet the state water quality standards and are on the 303(d) list (WDOE's list of impaired waterways) requiring the development of a cleanup plan.

Scientists have proposed the following possible causes for the lower DO concentrations in Hood Canal: (1) changes in production or input of organic matter, due to naturally better growth conditions, such as increased sunlight (or other climate factors), increased nutrient availability, or human loading of nutrients or organic material; (2) changes in ocean properties, such as seawater density that affects flushing of the canal's waters, oxygen concentration, or nutrients in the incoming ocean water; (3) changes in river input or timing from natural causes (e.g., drought) or from human actions (e.g., diversion) that affect both flushing and mixing in the canal; and (4) changes in weather conditions, such as wind direction and speed, which affect the flushing and/or oxygen concentration distribution. There is supporting evidence for all of these hypotheses (HCDOP, 2009).

Although DO is low in much of Hood Canal, this problem is less pronounced in northern Hood Canal, the location of NBK Bangor, than elsewhere in the canal. At NBK Bangor, DO routinely meets standards in nearshore waters including the project area (Table 3.5). Additional survey work was undertaken following the methodology of Phillips et al. (2008), during 2007 and 2008. Minimum DO concentrations in 2007 met the extraordinary water quality standard of 7.0 mg/L for all surveys, but one. The DO minimum for 8–9 March 2007, was 3.9 mg/L at BS06, or below fair quality. All other beach locations on this date ranged between 5.0 mg/L and 7.7 mg/L, or good to extraordinary quality (Phillips et al., 2009).

TABLE 3.4 MONTHLY MEAN SURFACE WATER TEMPERATURES (°C/°F)

SAMPLING MONTH (2005, 2006)[1]	NEARSHORE		OFFSHORE	
	TEMPERATURE	RATING	TEMPERATURE	RATING
July 2005	14.3°C (57.8°F)	Excellent	11.6°C (52.9°F)	Extraordinary
August 2005	13.8°C (56.8°F)	Excellent	13.5°C (56.3°F)	Excellent
September 2005	14.9°C (58.8°F)	Excellent	11.6°C (52.9°F)	Extraordinary
January 2006	8.2°C (46.8°F)	Extraordinary	---	---
February 2006	8.1°C (46.6°F)	Extraordinary	---	---
March 2006	8.5°C (47.3°F)	Extraordinary	8.3°C (46.9°F)	Extraordinary
April 2006	9.6°C (49.3°F)	Extraordinary	9.3°C (48.7°F)	Extraordinary
May 2006	10.9°C (51.6°F)	Extraordinary	11.0°C (51.8°F)	Extraordinary
June 2006	13.2°C (55.8°F)	Excellent	---	---

Source: Phillips et al., 2008.
Data are from 13 nearshore and 4 offshore stations along the NBK Bangor waterfront. Those stations near the project area are shown in Figure 3–3.
--- No data were collected at this depth during this sampling month.

TABLE 3.5 MONTHLY MEAN DISSOLVED OXYGEN (mg/L)

SAMPLING MONTH (2005, 2006)	NEARSHORE		OFFSHORE	
	DO	RATING	DO (MG/L)	RATING
July 2005	8.4	Extraordinary	5.8	Good
August 2005	7.1	Extraordinary	6.9	Excellent
September 2005	8.5	Extraordinary	4.9	Fair
January 2006	9.3	Extraordinary	---	---
February 2006	8.9	Extraordinary	---	---
March 2006	9.7	Extraordinary	8.2	Extraordinary
April 2006	9.8	Extraordinary	8.1	Extraordinary
May 2006	9.1	Extraordinary	9.0	Extraordinary
June 2006	9.8	Extraordinary	---	---

Source: Phillips et al., 2008.
Data are from 11 nearshore and 4 offshore stations along the NBK Bangor waterfront. Those stations near the project area are shown in Figure 3–3.
--- No water quality data were collected at this depth during this sampling month

Turbidity

Turbidity is a measure of the amount of light scatter related to total suspended solids (TSS) in the water column and is measured in Nephelometric Turbidity Units (NTUs). Sources of turbidity in Hood Canal waters may include plankton, organic detritus from streams and other storm or wastewater sources, fine suspended sediment particulates (silts and clays), and re-suspended bottom sediments and organic particulates. Suspended particles in the water have the ability to absorb heat in the sunlight, which then raises water temperature and reduces light available for photosynthesis.

Washington State-designated extraordinary quality marine surface waters should have an average turbidity reading of less than 5 NTUs (WAC, 173-201A). For good and fair quality use categories, maximum one-day turbidity increases cannot exceed 10 NTU above background when the background is below 50 NTU. Turbidity measurements were collected along the NBK Bangor waterfront, including the vicinity of the proposed EHW-2 project area, from July 2005 through May 2006, except for October to December 2005 (Phillips et al., 2008). These mean monthly turbidity measurements for both nearshore and offshore waters ranged from 0.7 to 3 NTU and were consistently within the Washington State standards for extraordinary water quality.

Additional survey work was undertaken following the methodology of Phillips et al. (2008), during 2007 and 2008. Although analysis is still in draft, preliminary data indicate that water quality parameters were similar to those in earlier years of survey work. Water temperatures met extraordinary quality standards during the winter and extraordinary to excellent quality standards in the spring. Minimum DO concentrations in 2007 met the extraordinary water quality standard of 7.0 mg/L for all surveys, but one. The DO minimum for March 8–9, 2007, was 3.9 mg/L at BS06, or below fair quality. All other beach locations on this date ranged between 5.0 mg/L and 7.7 mg/L, or good to extraordinary quality. All turbidity measurements fell within acceptable ranges. Initial assessments report that, with the exception of one sample with below fair DO levels, water quality parameters meet good to extraordinary standards for aquatic uses (Phillips et al., 2009).

Fecal Coliform

Fecal coliform covers two bacteria groups (coliforms and fecal streptococci) that are commonly found in animal and human feces and are used as indicators of possible sewage contamination in marine waters (USEPA, 1997). Although the fecal indicator bacteria typically are not harmful to humans, they indicate the possible presence of pathogenic bacteria, viruses, and protozoa that also live in animal and human digestive systems. Therefore, their presence in marine waters at elevated levels may indicate the presence of pathogenic microorganisms that pose a health risk.

The Washington Department of Health (WDOH) Office of Food Safety and Shellfish Programs conducts annual fecal coliform bacteria monitoring in Hood Canal including stations near the NBK Bangor waterfront. The standard for approved shellfish growing waters is a fecal coliform geometric mean not greater than 14 most probable number (MPN)/100 mL and an estimate of the 90th percentile not greater than 43 MPN/100 mL (see Table 3.3). When this standard is met, the water is considered safe for shellfish harvesting and for water contact use by humans (also referred to as primary human contact). The most recent data from August 2002 through November 2007 covering six monitoring stations in Hood Canal near the NBK Bangor waterfront (WDOH, 2008) showed an average geometric mean of 3.1 MPN/100 mL and an estimated 90th percentile of 11.8 MPN/100 mL. These values are within the shellfish harvesting and recreation standard for fecal coliform.

WDOH summarizes the annual fecal coliform bacteria monitoring results in Hood Canal and the rest of Puget Sound in the form of an index rating system ranging from bad to good, where lower numbers indicate lower fecal coliform. In 2005, the fecal pollution index for Hood Canal was 1.09, which corresponds to a WDOH "good" rating (low bacterial levels) for most of the survey sites (WDOH, 2006). The fecal pollution index for the area near the proposed EHW-2 project area was 1.0, which was also a good rating.

While WDOH uses a rolling average of about 30 samples to calculate the 90th percentile for classification of shellfish growing areas, the WDOE water quality criteria uses no more than one year of data to determine compliance with WAC 173-201A if enough data points are available to reasonably represent seasonal variation. However, WDOE's assessment policy allows for bridging data over several years to determine a geometric mean when doing so does not mask periods of non-compliance with the standards. The closest sampling stations to the project area (85 and 86) meet the WDOE standard.

pH

The term pH is a measure of alkalinity or acidity and affects many chemical and biological processes in water. For example, low pH can allow toxic elements and compounds to become mobile and available for uptake by aquatic plants and animals, which can produce conditions toxic to aquatic life, particularly to juvenile organisms. Washington State-designated extraordinary quality marine surface waters should have a pH reading between 7.0 and 8.5 (WAC, 173-201A). WDOE's Marine Water Monitoring Program monitors pH in Hood Canal marine waters in the vicinity of the NBK Bangor waterfront. The measured pH levels from the 2005 monitoring year ranged from 3.6 to 8.4, and all but 5 of the 45 data values were within extraordinary quality standards (WDOE, 2005).

Nutrients

Nutrients (particularly nitrogen-based compounds), sunlight, and a stratified water column play important roles in algae productivity in Hood Canal. High algae productivity (e.g., algal blooms) is believed to be a contributing factor to low DO conditions in Hood Canal, due to algae die off and decomposition (HCDOP, 2005). Nitrogen enters the canal from the ocean, rivers, and atmosphere. However, as more nitrogen enters Hood Canal through uncontrolled sources (e.g., runoff, fertilizer use, leaking septic systems), algae growth is stimulated, which can then reduce oxygen levels when the algae dies and decomposes in the late summer and early fall (HCDOP, 2005).

WDOE's Marine Water Monitoring Program monitors nutrients in Hood Canal marine waters in the vicinity of the NBK Bangor waterfront (WDOE, 2005a). Concentrations of nitrate and phosphate during the 2005 monitoring year ranged from 0.02 to 2 mg/L and from 0.04 to 0.4 mg/L, respectively. Specific water quality standards for nutrients are not established, but the ranges observed in Hood Canal near the project area are typical for marine waters in Puget Sound (Newton et al., 1998; 2002).

Overall, water quality along the NBK Bangor shoreline is good by most measures and for the most part meets applicable standards. Exceptions for the 2005-2006 sampling year were limited to dissolved oxygen offshore below the extraordinary WQS over the summer months.

3.3.1.3 Coastal Zone Management

A Coastal Consistency Determination, which includes an assessment of coastal zone resources and compliance with the Coastal Zone Management Act (CZMA) was made by researching the relevant portions of pertinent federal, state and local laws and regulations. Only the Action Alternative was assessed for its applicability and consistency with Washington's Coastal Zone Management Program. In accordance with the Coastal Zone Management Act, the

Navy will be submitting a statement and supporting documentation to Washington indicating that the proposed action is consistent to the maximum extent practicable with Washington's coastal zone enforceable policies. The federal consistency determination can be found in Appendix A.

3.3.2 Environmental Consequences

3.3.2.1 No Action Alternative

Under the No Action Alternative, the Test Pile Program would not occur. The baseline conditions would remain unchanged. Therefore, there would be no significant impacts to water resources from implementation of the No Action Alternative.

3.3.2.2 Action Alternative

The proposed action would not require dredging or placement of fill. The test piles are not considered fill material. There would also be no direct discharges of waste to the marine environment. Construction-related impacts to water quality would be limited to short term, temporary and localized changes associated with re-suspension of bottom sediments from pile installation and barge and tug operations, such as anchoring and propeller wash, as well as accidental losses or spills of construction materials or fuel into Hood Canal. These changes would be spatially limited to the construction corridor, including areas potentially impacted by anchor drag and areas immediately adjacent to the testing sites that could be impacted by plumes of re-suspended bottom sediments that are not expected to violate applicable state or federal water quality standards.

During pile driving of the 29 test piles described in the proposed action, best management practices (BMPs) would be used to prevent all deleterious materials from entering the water. NBK Bangor has an approved Spill Management Plan (DoN, 2006a) and a regional Integrated Spill Contingency Plan (DoN, 2010) is in place. As a result, accidental spills or discharges of deleterious materials would not be expected to adversely impact marine water quality at the project area.

The proposed action would not impact water temperature or salinity because test pile activities would not discharge wastewaters. In the absence of project related discharges, the proposed action would not alter water temperature, or salinity in Hood Canal.

The proposed action would not discharge any wastes containing materials with an oxygen demand into Hood Canal. However, pile installation would re-suspend bottom sediments, which may contain chemically reduced organic materials. Subsequent oxidation of sulfides, reduced iron, and organic matter associated with the suspended sediments would consume some DO in the water column. The amount of oxygen consumed would depend on the magnitude of the oxygen demand associated with suspended sediments (Jabusch et al., 2008). The impacts of sediment re-suspension from pile installation and removal on DO concentrations would be minimal.

Additionally, the Navy plans to use a Gunderboom Sound Attenuation System (SAS™) as mitigation for in-water sound during construction activities. The Gunderboom SAS™ is a multipurpose enclosure that absorbs sound, attenuates pressure waves, excludes marine life from work areas, and controls the migration of debris, sediments and process fluids. The Gunderboom SAS™ is comprised of a water-permeable double layer of polypropylene/polyester fabric. Compressed air is released at the bottom of the fabric and moves up to the top of the fabric inflating the fabric and creating a wall. A traditional bubble curtain/wall will be used as a backup mitigation if the Navy cannot obtain the Gunderboom SAS™ or if it does not achieve the proposed noise attenuation. Use of a bubble curtain/wall would increase DO concentrations in marine waters at the project area by (1) increasing the rate of vertical mixing of site waters and (2) promoting dissolution of air bubbles, thereby increasing oxygen saturation levels. The impacts to DO from use of a bubble curtain would be relatively greater than those associated with sediment resuspension, and a net increase in DO levels would be expected. DO concentrations at the project area would not be altered. Construction activities would not result in decreases in DO concentrations, cause changes that would violate water quality standards, or exacerbate low DO concentrations that occur seasonally in Hood Canal waters.

Installation of piles would re-suspend bottom sediments within the immediate construction area, resulting in short-term and localized increases in suspended sediment concentrations that, in turn, would cause increases in turbidity levels. The suspended sediment/turbidity plumes would be generated periodically, in relation to the level of in-water construction activities.

The amount of bottom sediments that would be re-suspended into the water column during pile placement, and the duration and spatial extent of the resulting suspended sediment/turbidity plume, would reflect the composition of the sediments. In general, coarse-grained sediments (e.g., sands and gravels) that occur in the nearshore environment of the project area are more resistant to resuspension and have a higher settling speed than fine-grained sediments in deeper, offshore portions of the project area. Higher settling rates would result in a shorter water column residence time and a smaller horizontal displacement by local currents (Herbich and Brahme, 1991; LaSalle et al., 1991; Herbich, 2000).

Construction activities would not result in persistent increases in turbidity levels or cause changes that would violate water quality standards because processes that generate suspended sediments, which result in turbid conditions, would be short-term and localized and suspended sediments would disperse and/or settle rapidly.

The proposed action would not result in the discharge of wastes containing nutrients nor would this action impact fecal indicator bacteria or pH levels in the project area. Stormwater discharges would be controlled in accordance with a stormwater discharge permit and stormwater pollution prevention plan, thus this action would not violate water quality standards. Therefore, there would be no significant impacts to water resources from implementation of the Action Alternative.

3.4 AIR QUALITY

This section discusses air quality in the vicinity of the proposed action as well as anticipated impacts which could occur as a result of implementing the Action Alternative. The No Action Alternative would not be anticipated to result in any change in emissions since no new activities would occur. However, the Action Alternative would be anticipated to result in a change in air emissions; therefore, only potential impacts associated with its implementation are discussed.

3.4.1 Affected Environment

3.4.1.1 Regulatory Overview

The Clean Air Act (CAA) of 1970, 42 U.S.C. 7401, et seq., amended in 1977 and 1990 is the primary federal statue governing air quality. Under authority of the CAA, the USEPA sets the maximum acceptable concentration levels for specific pollutants that may impact the health and welfare of the public. With USEPA oversight, states may set concentration levels for additional pollutants not regulated by the USEPA. The State of Washington administers the provisions of the majority of the CAA.

The CAA prohibits federal agencies from engaging in, supporting, providing financial assistance for licensing, permitting, or approving any activity that does not conform to an applicable State Implementation Plan (SIP). Federal agencies must determine that a federal action conforms to the SIP before proceeding with the action.

In Washington, the Washington Department of Ecology (WDOE) administers the State's CAA and implements its regulations (RCW Chapter 70.94 and Washington Administrative Code [WAC] 173-400). The WDOE has, in turn, delegated the responsibility of regulating stationary emission sources to local air agencies. In Kitsap County, the WDOE has delegated this responsibility to the Puget Sound Clean Air Agency (PSCAA) which serves as the local air agency. In areas that exceed the National Ambient Air Quality Standards (NAAQS), the CAA requires preparation of a SIP. The SIP details how the State will attain the standards within mandated time frames. Both the federal CAA and the State CAA identify emission reduction goals and compliance dates based upon the severity of the NAAQS violation within a region. PSCAA has developed rules which regulate stationary sources of air pollution in Kitsap County (PSCAA, 2009).

Seven pollutants are commonly found in the air. These "criteria pollutants" are particularly common in developed countries such as the U.S. and include the following:

- particulate matter 10 microns in size, or PM_{10}
- particulate matter 2.5 microns in size, or $PM_{2.5}$
- ground-level ozone
- carbon monoxide
- sulfur oxides

- nitrogen oxides
- lead

3.4.1.2 Attainment, Air Emissions and Air Quality Index

The NAAQS, discussed above, include primary and secondary standards. The primary standards are limits set to protect human health. The secondary standards set limits intended to protect public welfare, including environmental and property damage (USEPA, 2009). A geographic area with air quality that meets the primary standard, since its air is as clean as or cleaner than the standard, is called an "attainment" area. USEPA designates areas that do not meet the primary standard as “nonattainment” areas. Areas that were previously designated non-attainment, but are now in attainment, are designated as maintenance areas. The primary and secondary standards are listed in Table 3-6.

Kitsap County is presently in attainment of all NAAQS. The regulatory requirements for proposed emission sources in attainment areas are typically less rigorous than they are in nonattainment and maintenance areas.

In 1999, the PSCAA adopted a local health goal for a daily average of particulate matter never to exceed 25 $\mu g/m^3$. All four counties monitored by the PSCAA exceeded this health goal (but did not violate CAA standards) during the winter of 2007 (PSCAA, 2008).

The USEPA has developed a nationwide reporting index for the criteria pollutants, known as the Air Quality Index (AQI) based on a 500-point scale for five major pollutants: CO, NO_x, SO_x, O_3, and particulate matter. The highest pollutant value determines the daily ranking. For example, if CO is 152 and other pollutants are below 60, then the AQI for that day is 152. The index is broken down as follows: (1) 0–50 good, (2) 51–100 moderate, (3) 101–150 unhealthy for sensitive groups, (4) 151–200 unhealthy, (5) 201–300 very unhealthy, and (6) 301–500 hazardous (PSCAA, 2008).

Within the vicinity of the proposed action, the AQI indicated that air quality was good for most of 2007 (PSCAA, 2008). Approximately 88 percent of the year air quality was rated as good, and for 12 percent of the year it was rated as moderate. The highest AQI for Kitsap County in 2007 was 92; thus, there was no occurrence of the AQI within the range of unhealthy for sensitive groups.

The PSCAA maintains a network of monitoring stations across Washington, with three stations in Kitsap County. These stations are located in Silverdale, Poulsbo, and Bremerton. PSCAA only monitors particulate matter in the county because there are so few point sources of air pollutants. This includes PM_{10} and $PM_{2.5}$, which is used as a measure of regional visibility. For the majority of 2007, visibility was rated as good. A few moderate visibility days occurred in February, May, July, September, November, and December. Average visibility for the Puget Sound area has steadily increased over the last decade, with year-to-year variability caused by weather conditions (PSCAA, 2008).

TABLE 3.6 NATIONAL AND WASHINGTON STATE AMBIENT AIR QUALITY STANDARDS

Air Pollutant	Averaging Time	Washington/PSCAA AAQS ([a,b])	NAAQS	
			Primary[c]	Secondary[d]
Carbon Monoxide (CO)	8-Hour 1-Hour	9 ppm 35 ppm	9 ppm 35 ppm	- -
Nitrogen Dioxide (NO_x)	Annual 1-Hour	0.053 ppm -	0.053 ppm 0.1 ppm	0.053 ppm -
Sulfur Dioxide (SO_x)	Annual 24-Hour 3-Hour 1-Hour[e] 1-Hour[f]	0.02 ppm 0.10 ppm - 0.25 ppm 0.40 ppm	0.03 ppm 0.14 ppm - - -	- - 0.5 ppm - -
Total Suspended Particles	Annual 24-Hour	60 µg/m^3 150 µg/m^3	- -	- -
Particulate Matter (PM_{10})[g]	Annual 24-Hour	50 µg/m^3 150 µg/m^3	- 150 µg/m^3	- 150 µg/m^3
Particulate Matter ($PM_{2.5}$)[h]	Annual 24-Hour	15 µg/m^3 35 µg/m^3	15 µg/m^3 35 µg/m^3	15 µg/m^3 35 µg/m^3
Ozone (O_3)	1-Hour 8-Hour[i]	0.12 ppm 0.075 ppm	0.12 ppm 0.075 ppm	0.12 ppm 0.075 ppm
Lead and Lead Compounds	Calendar Quarter Rolling 3-Month[j]	1.5 µg/m^3 0.15 µg/m^3	1.5 µg/m^3 0.15 µg/m^3	1.5 µg/m^3 0.15 µg/m^3

Sources: USEPA, 2009; WAC 173-470; WAC 173-474; WAC 173-475.

a. The NAAQS and Washington State standards are based on standard temperature and pressure of 25ºC and 760 millimeters of mercury, respectively. Units of measurement are ppm and micrograms per cubic meter (µg/m3).

b. National and Washington State standards, other than those based on annual or quarterly arithmetic mean, are not to be exceeded more than once per year.

c. National Primary Standards: The levels of air quality necessary to protect the public health with an adequate margin of safety. Each state must attain the primary standards no later than 3 years after the SIP is approved by the USEPA.

d. National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each state must attain the secondary standards within a reasonable time after the state implementation plan is approved by the USEPA.

e. Not to be exceeded more than twice in seven consecutive days.

f. Not to be exceeded more than once per year throughout the state of Washington and never to be exceeded within the PSCAA region.

g. PM10 is particulate matter smaller than 10 microns. The 3-year average of the 99th percentile (based on the number of samples taken of the daily concentrations) must not exceed the standard.

h. PM2.5 is particulate matter smaller than 2.5 microns. The 3-year annual average of the daily concentrations must not exceed the standard.

i. The 3-year average of the 4th highest daily maximum 8-hour average concentration must not exceed the standard. As of June 21 15, 2005, USEPA revoked the 1-hour ozone standard in all areas except the 8-hour ozone nonattainment Early Action Compact (EAC) Areas, none of which occur in the Puget Sound area.

j. Final rule on rolling 3-month average for lead was signed October 15, 2008

3.4.1.3 Greenhouse Gases

While not regulated by PSCAA like other conventional air pollutants, greenhouse gases are reportable in certain scenarios to USEPA. Greenhouse gases include: carbon dioxide (CO_2), methane (CH_4), nitrous oxides (N_2O), and fluorinated gases such as Chlorofluorocarbons: compounds consisting of chlorine, fluorine, and carbon and Hydrochlorofluorocarbons: compounds consisting of hydrogen and sulfur hexafluoride (SF_6)(USEPA, 2010a).

3.4.2 Environmental Consequences

The evaluation of impacts to air quality considers whether conditions resulting from the project during construction and operation violate federal, state, or local air pollution standards and regulations. Applicable air pollution standards and regulations that are the basis for determinations of environmental consequences are discussed in Section 3.4.1. The amount of emissions is anticipated to be below the threshold required to conduct a conformity analysis, therefore a conformity analysis was not conducted as part of this EA.

3.4.2.1 No Action Alternative

Under the No Action Alternative the Test Pile Program would not be conducted. Baseline air quality conditions would remain unchanged. Therefore, there would be no significant impacts to air quality from implementation of the No Action Alternative.

3.4.2.2 Action Alternative

Air emissions were calculated using methodology prescribed in the most recent edition of the USEPA's AP-42 document (USEPA, 1996). Emissions were only calculated for NAAQS and greenhouse gas pollutants (specifically CO_2) with known emissions factors. The No Action Alternative would not involve any activities which would result in emissions, therefore calculations were not performed and additional analysis was not carried forward. However, because activities associated with the Action Alternative would be anticipated, these potential emissions were calculated. The contractor will be held to opacity regulations (PSCAA Regulation 1, Section 9.03). As such, the contractor's equipment must not exceed 20 percent opacity. Table 3.7 depicts the anticipated emissions under the Action Alternative for pollutants which had emissions factors in the AP-42 (USEPA, 1996). All calculations and assumptions associated with the calculations are included in Appendix B.

The following assumptions were made in calculating total potential emissions:

- One hour would be required to install each piling.
- A vibratory hammer would be used for the first 60 minutes of the hour for installation.
- An impact hammer would be used for the last 15 minutes of installation.
- Thirty minutes would be required to remove each piling.
- Only the vibratory hammer would be used to remove each piling.

- Both the vibratory hammer and pile driver would utilize 600 horse power (hp) diesel engines.

- One tugboat with a 600 hp diesel engine would operate at 100% of capacity 100% of the time during pile installation and removal.

- Fugitive dust and smoke emissions associated with pile driving are negligible.

TABLE 3.7 POTENTIAL EMISSIONS ANTICIPATED ASSOCIATED WITH THE ACTION ALTERNATIVE

Air Pollutant	Emissions (lbs)		Emissions (tons)	
NO_x	1888	lbs.	0.94	tons
CO	407	lbs.	0.20	tons
SO_x	125	lbs.	0.06	tons
PM_{10}	134	lbs.	0.06	tons
CO_2	70,035	lbs.	35.02	tons
SUM	**72,589**	**lbs.**	**36.29**	**tons**

As illustrated in the above table, the potential air emissions associated with the Action Alternative would not be anticipated to exceed any of the above PSCAA thresholds or greenhouse gas reporting thresholds established by USEPA. In addition, the activities proposed would be anticipated to be minimal and temporary in nature and no permanent emissions would be anticipated. Additionally, reasonable precautions would be implemented to minimize fugitive dust and smoke emissions from pile driving and no temporary construction permit from PSCAA would be required. Therefore, in accordance with NEPA, no significant impacts would be anticipated as a result of implementation of the Action Alternative.

3.5 AMBIENT NOISE

3.5.1 Affected Environment

3.5.1.1 Regulatory Overview

Occupational Safety and Health Programs for Federal Employees

Executive Order (EO) 12196, *Occupational Safety and Health Programs for Federal Employees*, directs federal agencies to furnish places and conditions of employment free from recognized hazards causing, or likely to cause, death or serious physical harm, and to ensure prompt abatement of unsafe or unhealthy working conditions.

Navy Regulations

Navy regulations regarding noise are found in the 2001 Navy Occupational Safety and Health Program Manual (Chief of Naval Operations Instruction [OPNAVINST] 5100-19D), which is directed at preventing occupational hearing loss and assuring auditory fitness for all Navy personnel. The Navy's Occupational Exposure Level over an 8-hour time-weighted average in any 24-hour period is 84 decibel (dB) in the A-weighting scale (dBA). The decibel is a unit of measure based on a logarithmic scale for sound levels. dBA is a weighted measure of sound levels corresponding to the frequency range humans hear. When noise exposures are likely to exceed 84 dBA, hearing-protective devices are required.

State of Washington Regulations

Maximum allowable noise levels, at the state level, are established by the Washington Administrative Code (WAC) Chapter 173-60. This code establishes zones, or environmental designations, of Class A, B, or C based on land-use characteristics for the purposes of noise abatement (see Table 3.8). This regulation applies to noise created on the base that may propagate into adjacent non-Navy properties. The NBK Bangor waterfront is considered a Class C zone, along with other industrial areas. Class B zones include commercial and recreational areas and residential areas are considered Class A zones.

TABLE 3.8 WASHINGTON MAXIMUM PERMISABLE ENVIRONMENTAL NOISE LEVELS (dBA)

NOISE SOURCE	RECEIVING PROPERTY		
	A – RESIDENTIAL (DAY/NIGHT)	B – COMMERCIAL	C – INDUSTRIAL
A – Residential	55/45	57	60
B – Commercial	57/47	60	65
C – Industrial	60/50	65	70

Source: WAC 197-60-040.

Washington noise regulations (WAC 173-60-040) limit the noise levels from a Class C noise source that affect a Class A receiving property to 60 dBA (daytime) and 50 dBA (nighttime). Nighttime hours under the WAC are considered 10:00 p.m. to 7:00 a.m. However, the state noise rules allow these levels to be exceeded for up to 15 dBA for certain brief periods without violating the limits. In addition, certain activities are exempt from these noise limitations:

- Sounds created by motor vehicles on public roads are exempt at all times, except for individual vehicle noise, which must meet noise performance standards set by WAC 173-60-050.
- Sounds created by motor vehicles off public roads, except when such sounds are received in residential areas.
- Sounds originating from temporary construction activities during all hours when received by industrial or commercial zones and during daytime hours when received in residential zones.
- Sounds caused by natural phenomena and unamplified human voices.

3.5.1.2 Sound Environment

The Federal Interagency Committee on Noise (FICON) (1992) defines noise as unwanted sound. More specifically, FICON defines noise as any sound that is undesirable because it interferes with communication, is intense enough to damage hearing, or is otherwise annoying. Human response to sound can vary depending on several factors including the type and characteristics of the noise source, distance between the noise source and the receptor, sensitivity of the receptor, and time of day.

Due to wide variations in sound levels, measurements are in dB, which is a unit of measure based on a logarithmic scale (e.g., a 10 dB increase corresponds to a 100-percent increase in perceived sound). Noise impacts to humans are commonly assessed by quantifying sound levels. As a result, sound levels are weighted (A-weighted) to correspond to the same frequency range that humans hear (approximately 20 Hz to 20 kHz). To make comparisons between sound levels, dB sound levels are always referenced to a standard intensity at a standard distance from the source. Humans, under most conditions, can detect changes in noise in 5 dB increments (USEPA, 1974). In many cases, sound levels are not corrected for standard distance and reflect levels as measured at the receiver's location.

Ambient noise levels are made up of natural and manmade sounds. Natural sound sources include the wind, rain, thunder, water movement such as surf, and wildlife. Sound levels from these sources are typically low, but can be pronounced during violent weather events. Sounds from natural sources are not considered undesirable. Ambient background noise in urbanized areas typically varies from 60 to 70 dBA, but can be higher; suburban neighborhoods experience ambient noise levels of approximately 45 to 50 dBA (USEPA, 1974).

The sound environment at NBK Bangor is influenced by several factors. The natural environment such as wind and surf produce some of the existing ambient noise. However, the primary sound environment is influenced by military activities such as waterfront operations, movement of people and military vehicles at the base, and the various industrial activities that occur at the shoreline facilities. Consequently, human activity is responsible for the majority of the daily ambient noise at NBK Bangor. Noise levels at NBK Bangor vary based on location but are estimated to average around 65 dBA in the residential and office park areas, with traffic noise ranging from 60 to 80 dBA during daytime hours (Cavanaugh and Tocci, 1998). The highest levels of noise are produced along the waterfront and at the ordnance handling areas where estimated noise levels range from 70 to 90 dBA and may peak at 99 dBA for short durations. These higher noise 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/military activities.

Maximum noise levels produced by common construction equipment, including trucks, cranes, compressors, generators, pumps, and other equipment that might typically be employed along NBK Bangor's industrial waterfront and ordnance handling areas (WSDOT, 2010). The maximum noise levels may be as high as 99 dBA, presuming multiple sources of noise may be present at one time. This estimate assumes that an increase of 3 dB can occur when two similar sources combine together (WSDOT, 2010). These maximum noise levels are intermittent in nature, and not present at all times.

A noise-sensitive receptor is defined as a location or facility where people involved in indoor or outdoor activities may be subject to stress or considerable interference from noise. Such locations or facilities often include residential dwellings, hospitals, nursing homes, educational facilities, and libraries. Sensitive noise receptors may also include supporting habitat for certain wildlife species or noise-sensitive cultural practices.

The nearest sensitive noise receptors include a great blue heron nesting area near one of the EHW-1 towers, and another nesting area located near Hunter's Marsh. A probable osprey nest sighted in 1990 is located approximately 1 mile northeast of the proposed Test Pile Program project area on the southeast end of Cattail Lake. Other sensitive noise receptors include residences located just north of the NBK Bangor northern property boundary, approximately 1.5 miles from the proposed Test Pile Program site, and a bald eagle nesting territory in the same vicinity. Another bald eagle nesting area is located across Hood Canal. Section 3.10.2.2.1 provides an analysis for the impacts to the bird species listed above.

3.5.2 Environmental Consequences

3.5.2.1 No Action Alternative

Under the No Action Alternative, the Test Pile Program would not be conducted. Baseline conditions would remain unchanged. Therefore, there would be no significant impacts to ambient noise from implementation of the No Action Alternative.

3.5.2.2 Action Alternative

This EA considers the intensity and the duration of noise that would be generated by the proposed action and whether this noise would be harmful to humans or disrupt human activities when evaluating ambient noise impacts. The proposed action is to drive and remove 29 test and reaction piles in Hood Canal along the NBK Bangor waterfront. Pile driving noise would be generated during regular work hours (two hours post sunrise through two hours prior to sunset) between July 16 and February 15.

The Test Pile Program would result in a temporary increase in noise in the vicinity of the project area. The closest residence is a small rural population approximately 1.5 miles to the north of NBK Bangor. The impact pile driver would be estimated to produce a maximum peak level of 105 dBA re 20μPa at a distance of 50 feet from the pile (WSDOT, 2010a). The vibratory hammer would be estimated to produce noise levels of 95 dBA re 20μPa at 50 feet (WSDOT, 2010a). Other construction activities or equipment such as cranes, generators, and any other necessary equipment would also generate noise; however, this noise would be much lower in level compared to noise produced by the impact hammer (Table 3.9). In the absence of pile driving noise, the maximum construction noise from equipment such as the crane, generator, etc. running simultaneously would be less than that of the vibratory pile driver (WSDOT, 2008).

WSDOT (2008) indicates that construction noise behaves as a point-source, propagating in a spherical manner, with a 6 dB decrease in sound pressure level per doubling of distance[6]. Two specific noise conditions exist at the proposed Test Pile Program project area, namely propagation over water across and along Hood Canal, and propagation over heavily vegetated terrain on the east side of Hood Canal. In relation to propagation over water, WSDOT (2008) considers this a "hard-site" condition; thus, no additional noise reduction factors apply. However, in the second condition two noise reduction factors apply for the topography of the proposed Test Pile Program site. The first condition is a 1.5 dB reduction per doubling of distance in "soft-site" conditions, wherein normal, unpacked earth is the predominant soil condition. The second factor is a reduction of 10 dB for interposing dense vegetation (e.g., trees and brush) between the noise source and potential receptors (WSDOT, 2008).

Noise associated with the impact hammer is expected to attenuate to 61 dBA at 1.5 miles (2,414 m) and 60 dBA at 1.68 miles (2,710 m). Noise associated with the vibratory hammer is expected to attenuate to 60 dBA at .53 miles (860 m). These estimates assume a free flowing medium (e.g. over water) without obstructions. Trees and other vegetation obstruct sound transmission and can create a 10 dBA reduction in sound. The estimates provided in this analysis do not account for the 10 dBA reduction in sound associated with vegetation and other structures obstructing sound transmission. Thus, the actual sound received by the residence 1.5 miles north of NBK Bangor would likely be less than 60 dBA.

The Test Pile Program would be a temporary action occurring over a 40 day period. The impact hammer and the vibratory driver would be used intermittently throughout the 40 day period and would produce sound levels at or below 60 dBA around the nearest residence 1.5 miles from NBK Bangor. Therefore, no significant impacts to ambient noise will result from the implementation of the Action Alternative.

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[6] RL = SL-TL

Where: RL is the Received Level of sound, SL is the Source Level of sound and TL is the Transmission Loss. TL=20logR (R is the distance from the source).

RL=210-20log10(meters)	RL= 210-20log20(meters)
RL = 210-20	RL=210-26
RL=190dB	RL=184

**A doubling in distance from 10 meters to 20 meters results in a 6dB reduction in the sound pressure.

TABLE 3.9 MAXIMUM NOISE LEVELS AT 50 FEET FOR COMMON CONSTRUCTION EQUIPMENT

Equipment Type	Maximum Noise Level
Impact pile driver	105
Vibratory pile driver	95
Scraper	90
Backhoe	90
Crane	81
Pumps	81
Generator	81
Front loader	79
Air Compressor	78

Source: WSDOT, 2008
Maximum Sound Pressure Levels in dBA re 20µPa (A-weighted)

3.6 MARINE VEGETATION

3.6.1 Affected Environment

The waterfront of NBK Bangor has recently been extensively surveyed for eelgrass and macroalgae (Morris et al., 2009). Marine vegetation at NBK Bangor consists of floating, attached, and drift intertidal and subtidal species including brown algae, red algae, green algae and eelgrass (Table 3.10). Each group is discussed more specifically below.

3.6.1.1 Macroalgae

At NBK Bangor, brown algae are found in a variety of forms, including encrusting varieties on rocks and filamentous types. Several leafy brown algae species (e.g., Egregia) are present in the project area. Rock weed (*Fucus* spp.) is common, attached to rocks and cobble in the intertidal barnacle zone (see Table 3.10). Sargassum, a non-native species, and non-canopy kelp are also found at NBK Bangor and are described in more detail below.

Red algae of the genera Endocladia*, Mastocarpus, Ceramium, Porphyra*, and *Gracilaria* are present in the project area in the intertidal zones (Pentec, 2003) (Figure 3–4). During the 2007 survey, red algae (primarily *Gracilaria*) were more abundant at water depths between 10 feet (3 m) and 25 feet (8 m) below MLLW. Red algae (*Endocladia, Mastocarpus, Ceramium, Porphyra*, and *Gracilaria* spp.) are also found in the cobble and gravel upper intertidal and the subtidal zones.

Among the green algae, sea lettuce *Ulva* sp. is the predominant species found. It is found mainly in sheltered or partially exposed lower-intertidal and nearshore marine habitats from 2 feet (.6 m) above MLLW to 20 feet (6 m) below MLLW (Morris et al., 2009). In the project area, boulders in the nearshore area are typically encrusted with sea lettuce (Pentec, 2003). Sea lettuce has a high nutrient value which, when it dies and decomposes, provides an important source of marine nitrogen, as detritus, that supports eelgrass growth (Kirby, 2001).

3.6.1.2 Sargassum

Sargassum (*Sargassum muticum*), native to the Sea of Japan, was first documented in Washington State waters in the 1950s and was likely introduced when Pacific oysters were planted in the early 1900s. The complex branching of Sargassum provides habitat for invertebrates such as amphipods; however, where Sargassum overlaps with native marine vegetation, it outcompetes them (Critchey et al., 1997). Further, Sargassum has been suggested to negatively affect water movement, light penetration, sediment accumulation, and DO concentrations at night (Williams et al., 2001). Two large beds of Sargassum occur within NBK Bangor between Delta Pier and Carlson Spit. Other pockets of Sargassum are small and isolated. However, no Sargassum occurs in the project area (Morris et al., 2009).

3.6.1.3 Eelgrass

Eelgrass (*Zostera marina*) is prevalent in low-energy areas, occurring in the lower intertidal and shallow subtidal photic zones with abundant organic matter and nutrients (Johnson and O'Neil, 2001). Eelgrass beds offer habitat to many fish and shellfish species by providing vital three-dimensional structure (Nightingale and Simenstad, 2001a). They are important in maintaining migratory corridors and as foraging areas for juvenile salmonids, other fish and invertebrates

TABLE 3.10 MARINE VEGETATION CLASSIFIED AS PERCENT OF LINEAR SHORELINE

Zone	Vegetation Type	NBK Waterfront (%)[1]
Upper Intertidal	**Brown Algae**[2] (*Fucus*-Barnacle Assemblage)	
	Present	60.4
	Absent	39.6
Upper Intertidal; Lower-Intertidal	**Red Algae** (*Gracilaria*)	
	Present	76.8
	Absent	23.2
Upper Intertidal; Lower-Intertidal; Nearshore Marine (subtidal photic zone)	**Mixed Red Algae**[2] (*Ceramium, Endocladia, Gracilaria, Mastocarpus papillata, Mazzaella, Porphyra*, unidentified filamentous red algae)	
	Present	Interspersed
	Absent	100
Lower-Intertidal; Nearshore Marine (subtidal photic zone)	**Green Algae** (*Ulva spp.*)	
	Present	97.4
	Absent	2.6
Lower-Intertidal; Nearshore Marine (subtidal photic zone)	**Brown Algae** (*Sargassum, Desmarestia, Pilayella*)	
	Present	15.9
	Absent	0
Lower-Intertidal; Nearshore Marine (subtidal photic zone)	**Eelgrass** (*Zostera marina, Z. japonica*)	
	Present	81.9
	Absent	18.1
Nearshore Marine (subtidal photic zone)	**Non-Floating Kelp** (*Laminaria*)	
	Present	75.8
	Absent	24.2

Sources: WDNR, 2006; Morris et al., 2009.

1 Percent represented by proportionate amount in sampled area.

2 Macroalgae coverage data obtained by SAIC in 2007 were concentrated in the lower intertidal and shallow (less than 70 feet) zones along the NBK Bangor shoreline. *Fucus* distribution and density based upon the Washington State Shorezone Inventory (WDNR, 2006). Mixed red algae distribution from WDNR, 2006.

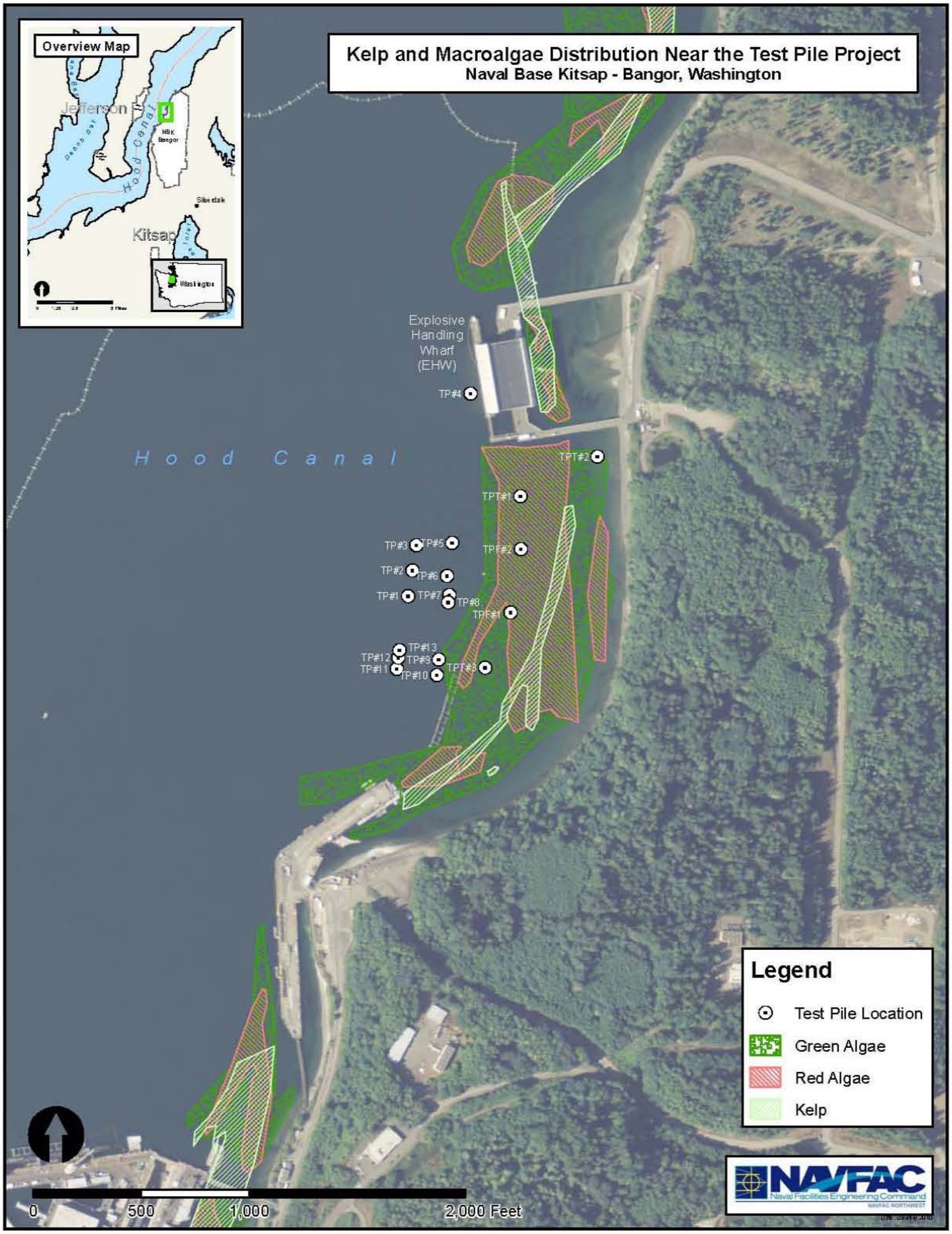


Figure 3-4 Kelp and Macroalgae Distribution in the Project Area

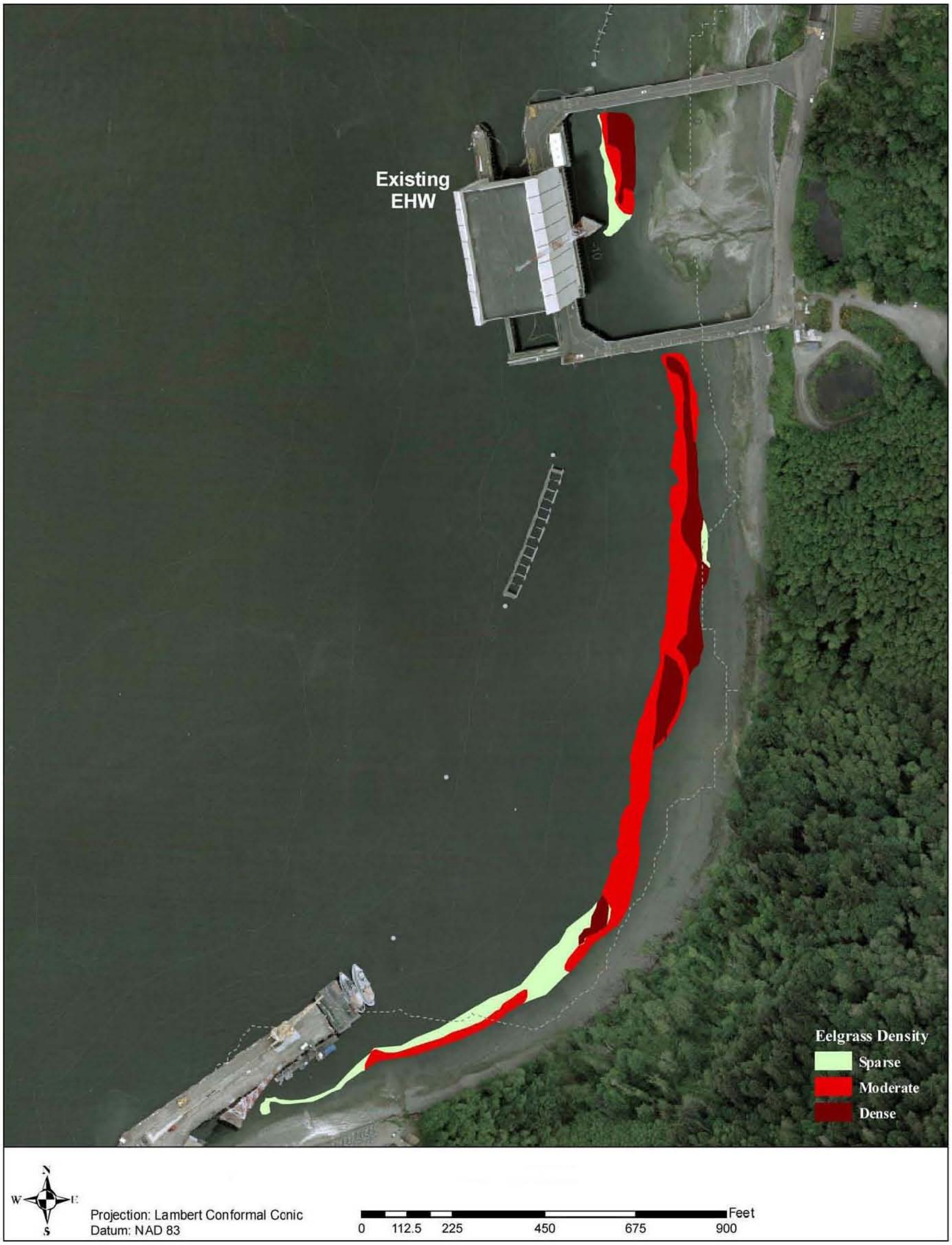


Figure 3-5 Eelgrass Distribution in the Project Area

(Simenstad and Cordell, 2000). Within the project area, the native *Z. marina* is the dominant species occurring in a narrow depth band roughly parallel to shore from 2 feet (.6 m) below to 20 feet (6 m) below MLLW (Garono and Robinson, 2002; Morris et al., 2009) (Figure 3–5). In addition, non-native eelgrass, Z. japonica, also occurs in small patches between 2 feet (.6m) above and below MLLW.

3.6.1.4 Non-Floating Kelp

Non-floating, or Understory kelp (*Laminaria* sp.), provide a large source of photosynthesized nutrients to the seafloor (from fragmentation and decomposition) and important multi-species vertical habitat in the subtidal zone (Mumford, 2007). A narrow band of understory kelp occurs in the project area approximately 330 feet (101 m) to the south of EHW-1 (Figure 3–4). The band is approximately 1,600 feet (488 m) long and covers 2.3 acres (Morris et al., 2009). No canopy-forming attached kelp beds (e.g., bull kelp) occur in the project area (Morris et al., 2009).

3.6.2 Environmental Consequences

3.6.2.1 No Action Alternative

Under the No Action Alternative the Test Pile Program will not be conducted. Baseline conditions, as described above, for marine vegetation would remain unchanged. Therefore, there would be no impacts to marine vegetation from implementation of the No Action Alternative.

3.6.2.2 Action Alternative

The installation of the test piles will involve driving 18 steel pipe piles ranging in size from 30 inches to 60 inches in diameter into the substrate. Additionally, lateral load and tension load tests will be performed which will require driving 11 additional piles. A conservative estimate of total bottom disturbance from the barge anchors, spuds, and test piles is approximately 6,970 ft^2 (647 m^2).

Marine surveys at NBK Bangor have shown that eelgrass is only present in water down to 20 feet (6 m) MLLW which is well above the location of all but one test pile, With the exception of test pile #2, all other test piles will be in water deeper than 40 feet (12m). In addition, test pile #2 is in water shallower than the band of eelgrass currently present at NBK Bangor, thus eelgrass will not be directly impacted. Although kelp is present along the Bangor waterfront, the location of the test piles will not impact kelp. Red and green algae are present at the test pile locations, but in low densities due to the inherent light limitation at the deepwater depths of the majority of the test piles, limiting potential impacts.

The barge anchors, spuds, and test piles would result in indirect impacts on marine vegetation within the Test Pile Program project area. Indirect impacts to marine vegetation are likely to result from turbidity caused by driving and removing barge anchors, spuds, and the test piles. The area within a 150-foot (46 m) radius of the pile driving footprint could have higher levels of turbidity. The temporary increase in turbidity is expected to decrease the light available for marine vegetation. However, these impacts would be minor and temporary in nature. Disturbed sediments would be dissipated by the strong tidal currents in the area and any disturbed marine vegetation would be expected to recover within a relatively short period of time. Therefore, the Action Alternative would have no significant impacts on the marine vegetation.

3.7 BENTHIC INVERTEBRATES

3.7.1 Affected Environment

Benthic invertebrates are comprised of bottom dwelling animals that live burrowing or buried in the soft sediments (infauna) and those that live attached to hard bottom substrates (epifauna). Four major groups (Phylum) are found in Hood Canal and in the project area: 1) marine worms (Annelids); 2) snails and bivalves (Molluscs); 3) crabs and other crustaceans (Arthropods); and, 4) seastars and sea urchins (Echinoderms).

The types and numbers of benthic organisms are closely linked to sediment grain size (gravel, sand, silt, clay, etc.), levels of DO and the amount of total organic carbon (TOC). The organic carbon content is itself strongly correlated with sediment grain size being higher in more fine-grained sediments than coarser ones.

Hood Canal has been divided into nine biotic subregions based on soft-bottom benthic community structure, dominant taxa, percent fines (i.e., the percent of silt or clay material), percent TOC, and depth (WDOE, 2007). NBK Bangor and the project area specifically, are within the north Hood Canal biotic subregion.

Sediments at the northern end of Hood Canal are primarily composed of relatively coarse sands near the entrance, on the sill, and in the shallows along the shorelines of both the main axis of the canal and the adjoining bays. Sediments south of the sill, down the central axis of the canal, at the greatest depths, and in portions of the terminal inlets are primarily finer-grained silts and clays. The composition of sediment samples from the project area ranged from 65 to 100 percent for sand, less than one to seven percent for gravel, two to 32 percent for silt, and two to 11 percent for clay (Hammermeister and Hafner, 2009).

A recent survey of four different areas along the NBK Bangor waterfront found consistently greater benthic community development in the subtidal zone compared to the intertidal zone and variable community development within and among survey areas (Weston, 2006). A mean total of two to 12 species with a mean total abundance of three to 67 individuals per square foot (0.10 m^2) was observed in the intertidal zone. Subtidal values varied from a mean total of 36 to 77 species and a mean total abundance of 301 to 736 individuals per square foot (0.10 m^2). Table 3.11 provides a list of some of the benthic invertebrates and shellfish occurring at NBK Bangor. The soft-bottom benthic community within the project area is dominated by marine worms, crustaceans, and molluscs across the tide zone, although in the intertidal zone other organisms also may be numerically abundant (Weston, 2006; WDOE, 2007).

Molluscs

Molluscs occurring within the project area include two major classes: gastropods (slugs and snails) and bivalves (having two-part shells, such as clams, oysters, and mussels). In contrast to mussels and oysters, which attach to hard substrate, clams live partially buried in the substrate and gastropods live on the substrate surface.

TABLE 3.11 BENTHIC INVERTEBRATES AT THE NBK BANGOR WATERFRONT

Phylum	Major Taxa of Phyla	Genera or Species	Typical Location	Common Name or Description
Mollusca	***Gastropod***	*Alvania compacta*	Sand, silt, clay or mixed substrate, vegetated shallow subtidal	Snail
		Lirularia acuticostata	Mixed substrate, intertidal-subtidal	Sharp-keeled lirularia, a snail,
	Bivalves	*Macoma* sp.	Mixed substrate, intertidal-subtidal	Clam
		Nutricola spp.	Sandy subtidal	Clam
		Saxidomus giganteus	Sandy subtidal	Butter Clam
		Panopea abrupta	Sandy intertidal-subtidal	Geoduck clam
		Rochefortia tumida	Sandy intertidal-subtidal	Robust mysella
		Axinopsida serricata	Sandy or mixed substrate with organic enrichment subtidal	Silky axinopsid
		Protothaca staminea	Sandy intertidal-subtidal	Native littleneck clam
		Tellina carpenteri	Sandy or mixed sand/silt intertidal-subtidal	Clam
		Parvilucina tenuisculpta	Sandy, silty, clay or mixed substrate in shallow subtidal	Fine-lined lucine
		Protothaca staminea	Sandy intertidal-subtidal	Rough-sided littleneck clam
		Mytilus spp.	Intertidal-subtidal, hard substrates	Blue mussel
		Pododesmus macroschisma	Hard substrates	Jingle shell
		Hinnites giganteus	Rocky substrates subtidal, rarely intertidal under boulders	Giant rock scallop
		Crassostrea gigas	Rocky substrates	Pacific oyster
		Ostrea lurida	Rocky substrates	Olympia oyster
Crustaceans	***Ostracod***	*Euphilomedes carcharodonta*	All soft substrates	Seed-shrimp
	Tanaid	*Leptochelia dubia*	Mixed substrate, vegetated habitat, manmade structures	Tanaid
	Barnacles	*Balanus* sp.	Rocky, manmade structures	Barnacle
	Amphipods	*Protomedeia* sp.	All soft substrates	Gammarid
		Aoroides spp.	Detritus, sand, vegetated habitats	Corophiid

TABLE 3.11 BENTHIC INVERTEBRATES AT THE NBK BANGOR WATERFRONT (continued)

PHYLUM	MAJOR TAXA OF PHYLA	GENERA OR SPECIES	TYPICAL LOCATION	COMMON NAME OR DESCRIPTION
		Rhepoxynius boreovariatus	Sandy subtidal	Gammarid
		Corophium and *Monocorophium* spp.	Sandy subtidal, manmade structures	Corophiid
	Crabs	*Pinnixa occidentalis*	Sand/silt/clay subtidal	Pea crab
		Hemigrapsus oregonsis	Quiet water, rocky habitats, gravel	Green Shore crab
		Pagurus granosimanus	Mixed substrate, eelgrass, subtidal	Hermit crab
		Pugettia spp.	Sand/silt/clay subtidal, eelgrass	Kelp crab
		Cancer gracilis	Intertidal and subtidal, eelgrass	Graceful crab
		Cancer magister	Intertidal and subtidal, eelgrass	Dungeness crab
		Cancer oregonensis	Rocky and manmade structures, intertidal-subtidal	Oregon Cancer crab
		Cancer productus	Sandy, protected rocky areas, eelgrass, intertidal-subtidal	Red Rock crab
		Carcinus maenas	Intertidal, mixed substrates	European green crab
		Telmessus cheiragonus	Eelgrass, kelp, sargassum	Helmet crab
		Pagurus granosimanus	Mixed substrate, eelgrass, subtidal	Hermit crab
	Shrimps	*Crangon* sp.	Shallow waters, sandy substrates	True shrimps
		Pandalus sp.	Mixed sand substrate intertidal and shallow subtidal	Spot shrimp
		Neotrypaea sp.	Mixed sand substrate intertidal and shallow subtidal	Ghost shrimp
Annelida	***Polychaetes***	*Platynereis bicanaliculata*	Mixed substrates, manmade structures, eelgrass	Nereidae
		Podarkeopsis glabra	Soft substrates	Hesionidae
		Pectinaria californiensis	Sandy, low intertidal and subtidal	Cone worm
		Owenia collaris	Sandy, intertidal-subtidal	Oweniidae
		Euclymeninae	Mixed substrates, subtidal	Maldanidae
Echinoderma	***Echinoderms***	*Pisaster brevispinus*	Subtidal eelgrass	Pink sea star
		Pisaster ochraceus	Lower intertidal, hard	Purple star

TABLE 3.11 BENTHIC INVERTEBRATES AT THE NBK BANGOR WATERFRONT (continued)

PHYLUM	MAJOR TAXA OF PHYLA	GENERA OR SPECIES	TYPICAL LOCATION	COMMON NAME OR DESCRIPTION
			structures	
		Amphiodia urtica/periercta	Subtidal silty mud	Burrowing brittle star
		Pycnopedia helianthoides	Lower intertidal to subtidal soft substrates	Sunflower star
		Dendraster excentricus	Flat, sandy subtidal	Sand dollar
		Strongylocentrotus droebachiensis	Intertidal to subtidal soft substrates	Green sea urchin
Chordata	***Tunicates***	*Corella willmeriana*	Subtidal to deepwater	Transparent tunicate
		Distaplia occidentalis	Intertidal to subtidal	Mushroom compound tunicate

Sources: Abbott and Reish, 1980; Barnard et al., 1980; Lee and Miller, 1980; Kozloff, 1983; URS, 1994; WDOE, 1998; Pentec, 2003; Weston, 2006.

The gastropod snail *Alvania compacta* was a numerical dominant of shallow subtidal waters within the project area (Weston, 2006); it is commonly found in mixed sediments including fine gravels (Kozloff, 1983). Other snails are associated with eelgrass beds, and limpets occur intertidally on hard substrates such as docks, cobble, and rocks.

A variety of bivalves occur within the project area, ranging from intertidal to subtidal depths (see Table 3.11). Common intertidal species include Macoma clams, rough-sided littleneck clams, and robust mysella. The most abundant species in subtidal waters include silky axinopsid, various dwarf venus clams, fine-lined lucine, and robust mysella (Weston, 2006). Robust mysella live in semi-permanent burrows and can be an indicator of a more stable habitat (Ockelmann and Muus, 1978). Common species on hard substrates include multiple blue mussel species, jingle shell, rock scallop, Olympia oyster, and Pacific oyster (DoN, 2001a; WDFW, 2007a). An approximately 15-foot oyster bed is located off the southwestern corner of EHW-1 (Figure 3-6). Bivalve siphons were detected throughout the project area during a 2007 survey in a wide range of depths. Siphon characteristics indicated these were geoducks. These organisms tended to be more concentrated in the silty sand substrate present below 25 feet (8 m) water depth.

Arthropods

Arthropods (crustaceans) are associated with all soft-bottom and hard substrate habitats and also occur in the water column. The most abundant species in the 2005 benthic sediment sampling along the NBK Bangor waterfront was the seed-shrimp (Weston, 2006). Seed-shrimp are minute

Figure 3-6 Oyster Densities Near the Project Area

crustaceans that are protected by a bivalve-like shell and typically feed on detritus in the subtidal nearshore marine habitats. Seed-shrimp comprised almost 30 percent of the individual organisms in the sandy deltaic subtidal zones along the waterfront (Weston, 2006). Larger crabs and shrimps, which are mobile and evasive during sampling, are not well quantified near the project area. Several species have been commonly observed (Weston, 2006).

Dungeness crabs range from intertidal to subtidal depths in sandy habitats and may use eelgrass beds as nursery areas (LFR, 2004). Hermit crabs, cancer crabs, kelp crabs, and shore crabs occur in rocky and/or vegetated habitats. European green crab and helmet crab also have been reported (DoN, 2001a).

Annelids

Polychaetes, a type of marine worm, are a major component of the benthic community and occupy intertidal and subtidal soft- and hard-bottom habitats (Weston, 2006). Sessile polychaetes are often tube-building while other species may be active burrowers (Kozloff,1983). Polychaetes are typically more abundant in the nearshore subtidal zone than in the intertidal zone (Weston, 2006; WDOE, 2007). Several species of polychaetes live among fouling organisms on manmade structures. Suspension-deposit spionids, herbivorous nereids, predatory syllids, and scale worms were found during rapid assessment of several marinas in Puget Sound (Cohen et al., 1998).

Echinoderms

Echinoderms contributed up to 6 percent to the abundance of benthic organisms occurring in soft-substrate benthic sediment sampling conducted in 2005 along the waterfront but only 2 percent, at most, to the abundance of benthic organisms within the project area (Weston, 2006). These species included brittle stars and green sea urchins (DoN, 1988; Weston, 2006). However, sea stars have also been observed at many locations along the waterfront (DoN, 1988). Purple stars are found primarily in the lower-intertidal zone on pilings where they feed on mussels. Pink sea stars are often found in subtidal eelgrass beds (Pentec, 2003).

The red sea urchin has not been documented near the project area but typically lives in rocky areas, which have not been extensively surveyed at the waterfront. Red urchin habitat ranges from protected shallow subtidal to inland marine deeper water nearshore marine habitats.

3.7.2 Environmental Consequences

3.7.2.1 No Action Alternative

Under the No Action Alternative the Test Pile Program would not be conducted. Baseline conditions, as described above, for marine invertebrates would remain unchanged. Therefore, there would be no significant impacts to benthic invertebrates from implementation of the No Action Alternative.

3.7.2.2 Action Alternative

The installation of the test piles will involve driving 18 steel pipe piles ranging in size from 30 inches to 60 inches in diameter into the substrate. Additionally, lateral load and tension load tests will be performed which will require driving 11 additional piles. A conservative estimate of total bottom disturbance from the barge anchors, spuds, and test piles is approximately 6,970 ft^2 (647 m^2).

Mean density estimates of benthic organisms in the project area are in the range of 830 individuals/ft^2 (0.10 m^2) (Barry A. Vittor & Associates, Inc., 2001). The barge anchors, spuds, and test piles would result in a temporary loss of benthic habitat, as well as direct mortality of less motile benthic organisms. Indirect impacts to habitat and benthic organisms are likely to result from turbidity caused by driving and removing barge anchors, spuds, and the test piles. The area within a 150-foot radius of the pile driving footprint could have higher levels of turbidity. Disturbed sediments would eventually redeposit upon the existing benthic community. Suspension and surface deposit feeders would be the most susceptible to burial. However, these impacts are minor and temporary in nature. Benthic organisms, particularly annelids, are very resilient to habitat disturbance and are likely to recover to pre-disturbance levels within 2 years (CH2M Hill, 1995; Parametrix, 1994; 1999; Anchor Environmental, 2002; Romberg, 2005). Therefore, the Action Alternative would have no significant impacts on benthic invertebrates.

3.8 FISH

There are nine species of fish that have been listed as threatened or endangered under the ESA that occur near the Test Pile Program project area in Puget Sound, Washington (Table 3.12). These species as well as other important fishes that inhabit waters around the Test Pile Program project area are discussed below more specifically in section 3.8.1 Affected Environment.

Seven species of Pacific salmonids occur in the Puget Sound area. These include Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), chum salmon (*O. keta*), steelhead trout (*O. mykiss*), cutthroat trout (*O. clarki*), and bull trout (*Confluentus salvelinus*). Four of these seven species (Chinook salmon, chum salmon, steelhead trout, and bull trout) have populations that have been listed as threatened under the ESA within the vicinity of Hood Canal. Neither pink salmon or cutthroat trout have been listed under ESA; coho salmon have one evolutionary significant unit (ESU) listed as endangered, three ESUs as threatened, and one ESU listed as a species of concern, but none of the coho salmon ESUs utilize Hood Canal. An ESU is a population or group of populations of Pacific salmon that represents an important component of the evolutionary legacy of the species as a result of being substantially reproductively isolated from other conspecific populations.

Salmonids use Hood Canal as a passageway between spawning streams flowing into the canal and marine rearing areas in Puget Sound, the Strait of Juan de Fuca, and the North Pacific Ocean. Hood Canal also provides important estuarine and nearshore rearing and refuge habitat for juvenile salmonids (Bhuthimethee et al., 2009). There are two small estuaries at NBK Bangor: Devil's Hole and Cattail Lake. Both outflows create small deltas seaward of their entry into Hood Canal. In the summer months, the outflows contribute nutrient-rich freshwater that is warmer than the surrounding saltwater (Phillips et al., 2008). In both Devil's Hole and Cattail Lake outflows, the shallow deltas support dense marine vegetation and benthic invertebrate communities, which provide food and refuge for juvenile salmonids (Phillips et al., 2008).

Rockfish are another important group of fish that occur in the project waters. This diverse group is made up of mostly bottom dwelling fish of the genus *Sebastes* especially prevalent in the North Pacific Ocean (Love et al., 2002). Three of the five Puget Sound rockfish species are federally listed under the ESA. Bocaccio (*Sebastes paucispinis*) is the only one of the three listed as endangered, while canary rockfish (*S. pinniger*) and yelloweye rockfish (*S. ruberrimus*) are listed as threatened (75 FR 22276).

As in most fish with pelagic larvae, current patterns play a large role in the recruitment and distribution of rockfish larvae within and between basins (Palsson et al., 2008). As summarized by Drake et al. (2008), onshore currents, eddies, upwelling shadows, and other localized circulation patterns create conditions that retain larvae rather than disperse them. The shallow sill (~50 meters deep) at the mouth of Hood Canal further limits the circulation and exchange of water between this basin and the Strait of Juan de Fuca and central Puget Sound (Babson et al., 2006). Thus, Puget Sound basins, including Hood Canal, have greater retention of, and reliance upon, intra-basin rockfish larvae for recruitment than coastal systems (Drake et al., 2008).

TABLE 3.12 ENDANGERED SPECIES ACT-LISTED FISH HISTORICALLY SIGHTED IN HOOD CANAL IN THE VICINITY OF NBK BANGOR

Species	ESA-Listed Status	Relative Occurrence in Hood Canal, Washington	Season(s) of Occurrence
Chinook salmon *Oncorhynchus tshawytscha* Puget Sound ESU	Threatened	Common	Juveniles - May to Jul; Adults - Aug to Oct
Chum salmon *Oncorhynchus keta* Hood Canal Summer-run ESU	Threatened	Common	Juveniles - Jan to Apr; Adults - Aug to Oct
Steelhead trout *Oncorhynchus mykiss* Puget Sound DPS	Threatened	Common	Year-round
Bull Trout *Salvelinus confluentus* All U.S. stocks	Threatened	Rare to occasional use	Unknown
Bocaccio *Sebastes paucispinis* Puget Sound/Georgia Basin DPS	Endangered	Rare to occasional use	Year-round
Canary rockfish *Sebastes pinniger* Puget Sound/Georgia Basin DPS	Threatened	Rare to occasional use	Year-round
Yelloweye rockfish *Sebastes ruberrimus* Puget Sound/Georgia Basin DPS	Threatened	Rare to occasional use	Year-round
Green sturgeon *Acipenser medirostris* Southern DPS	Threatened	Rare to occasional use	Year-round
Pacific Eulachon/Smelt *Thaleichthys pacificus* Southern DPS	Threatened	Rare to occasional use	Year-round

In addition to salmonids and rockfish, Puget Sound provides habitat for at least 44 other fish species including, herring, smelt, sand lance, perch, gunnel, pipefish, stickleback, tubesnout and flatfish, as well as two additional ESA-listed species, the southern distinct population segment (DPS) of the North American green sturgeon (*Acipenser medirostris*) and the southern DPS of Pacific eulachon (*Thaleichthys pacificus*) (SAIC, 2006; Bhuthimethee et al., 2009). A DPS represents a population or group of populations that is isolated from other populations of the same species and significant in relation to the entire species. In contrast to salmonids which exclusively use freshwater for spawning, these fish species may use areas of Puget Sound shoreline for spawning. Additional important forage species include, Pacific herring (*Clupea pallasii*), surf smelt (*Hypomesus pretiosus*), and sand lance (*Ammodytes hexapterus*), which represent the three most important forage fish species in the area (Penttila, 1997; Stout et al., 2001). They serve as a key prey source for salmonids, rockfish and other predatory fishes in the area, as well as birds and marine mammals (Salo, 1991; Love et al., 2002).

3.8.1 Affected Environment

3.8.1.1 Regulatory Overview

Endangered Species Act (ESA)

Federally threatened and endangered species are those listed for protection under the Federal Endangered Species Act (ESA) (16 U.S.C. 1536), administered by the USFWS. The USFWS also list federal species of concern. Federal species of concern is an informal term that indicates species might be in need of conservation actions. Federal species of concern do not receive legal protection and this term does not imply the species will eventually be proposed for listing (USFWS, 2008b).

Under NEPA the impacts of a proposed action to threatened and endangered species must be considered. The ESA of 1973 established protection over and conservation of threatened and endangered species and the ecosystems upon which they depend. An “endangered” species is a species that is in danger of extinction throughout all or a significant portion of its native habitat, while a “threatened” species is one that is likely to become endangered within the foreseeable future throughout all or in a significant portion of its native habitat.

The USFWS and the National Marine Fisheries Service (NMFS) jointly administer the ESA and are also responsible for the listing of species (i.e., the labeling of a species as either threatened or endangered). The USFWS has primary management responsibility for management of terrestrial and freshwater species, while the NMFS has primary responsibility for marine species and anadromous fish species (species that migrate from saltwater to freshwater to spawn). The ESA allows the designation of geographic areas as critical habitat for threatened or endangered species.

Magnuson-Stevens Fishery Conservation and Management Act

The Fishery Conservation and Management Act of 1976 later changed to the Magnuson Fishery Conservation and Management Act in 1980 established a 200 nautical mile (nm) fishery conservation zone in U.S. waters and a regional network of Fishery Management Councils. The Fishery Management Councils are composed of federal and state officials, including the USFWS, which oversee fishing activities within the fishery management zone. In 1996, the Magnuson Fishery Conservation and Management Act was reauthorized and amended as the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), known more popularly as the Sustainable Fisheries Act. The MSFCMA mandated numerous changes to the existing legislation designed to prevent overfishing, rebuild depleted fish stocks, minimize bycatch, enhance research, improve monitoring, and protect fish habitat.

One of the most significant mandates in the MSFCMA is the essential fish habitat (EFH) provision, which provides the means to conserve fish habitat. The EFH mandate requires that the regional Fishery Management Councils, through federal Fishery Management Plans (FMP), describe and identify EFH for each federally managed species, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitats. Congress defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 USC 1802[10]). The term "fish" is defined in the MSFCMA as "finfish, mollusks, crustaceans, and all other forms of marine animals and plant life other than marine mammals and birds." The regulations for implementing EFH clarify that "waters" include all aquatic areas and their biological, chemical, and physical properties, while "substrate" includes the associated biological communities that make these areas suitable fish habitats (CFR 50:600.10). Habitats used at any time during a species' life cycle (i.e., during at least one of its life stages) must be accounted for when describing and identifying EFH. In addition to EFH designations, areas called habitat areas of particular concern (HAPC), which are a subset of designated EFH that is especially important ecologically to a species/life stage and/or is vulnerable to degradation, are also to be designated to provide additional focus for conservation efforts (50 CFR 600.805-600.815). Categorization as HAPC does not confer additional protection or restriction to designated areas.

Authority to implement the MSFCMA is given to the Secretary of Commerce through NMFS. The MSFCMA requires that EFH be identified and described for each federally managed species. The NMFS and regional Fishery Management Councils determine the species distributions by life stage and characterize associated habitats, including HAPC. The MSFCMA requires federal agencies to consult with the NMFS on activities that may adversely affect EFH, or when the NMFS independently learns of a federal activity that may adversely affect EFH. The MSFCMA defines an adverse effect as "any impact which reduces quality and/or quantity of EFH [and] may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species' fecundity), site-specific or habitat wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR 600.810).

3.8.1.2 ESA-Listed Fish

Puget Sound Chinook Salmon

Status and Management

The Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) ESU was listed as federally threatened under the ESA in 1999 (64 FR 14308), with the threatened listing reaffirmed in 2005 (70 FR 37160). The Puget Sound Chinook salmon ESU includes all naturally spawned populations from all rivers and streams flowing into Puget Sound. Average adult Chinook escapement (number of fish surviving to reach spawning grounds or hatcheries) in recent years is relatively low, particularly for the mid-Hood Canal stock, for which average escapements were typically below the low escapement threshold of 400 Chinook fish (WDFW, 2002). Reduced viability and listing of these specific stocks were attributed to habitat loss and degradation, hatcheries, and harvest management issues. Additionally, DO levels in Hood Canal are at a historic low, which is a concern and future threat to recovery of Hood Canal stocks of this and all other Hood Canal salmonid ESUs (70 FR 76445). Chinook salmon are managed as an ESA-listed species by NMFS and as a fishery by the Pacific Fishery Management Council (PFMC) through the Pacific Coast Salmon Fishery Management Plan (PFMC, 2003).

Critical Habitat

Critical habitat was initially designated for Puget Sound Chinook on February 16, 2000 (65 FR 7764) and was revised on September 2, 2005 (70 FR 52630) (Figure 3-7). Critical habitat consists of the water, substrate, and the adjacent riparian zone of accessible estuarine and riverine reaches and extends to a depth of 30 meters MLLW. Although critical habitat for Puget Sound Chinook salmon occurs within the project area along portions of the shorelines in Hood Canal both north and south of the project area, NBK Bangor is excluded from this designation by federal law as the base maintains an active Integrated Natural Resource Management Plan (INRMP) (70 FR 52630).

Distribution, Behavior, and Ecology

Chinook salmon are one of the least abundant salmonids occurring along the NBK Bangor shoreline (Figure 3-8). Past and recent surveys have found that Chinook salmon migrating from southern Hood Canal streams and hatcheries occur most frequently along the NBK Bangor waterfront from late May to early July (Schreiner et al., 1977; Prinslow et al., 1980; Bax, 1983; Salo, 1991; SAIC, 2006; Bhuthimethee et al., 2009).

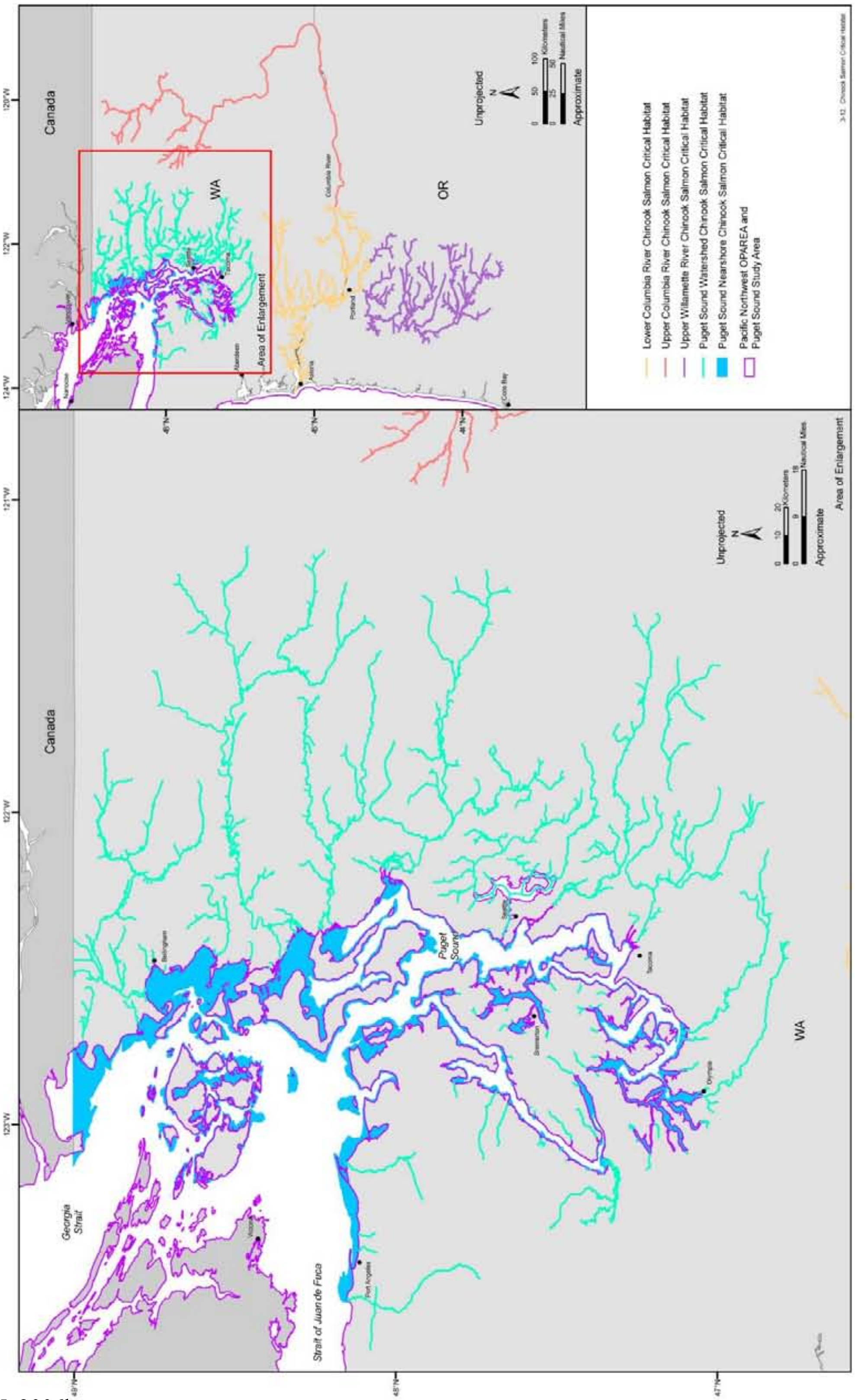
Emergent Chinook fry, like fry of other Pacific salmonids, depend on shaded, nearshore habitat, with slow-moving currents, where they forage on drift organisms, including insects and zooplankton (Healey, 1991). Smolts (juveniles that have transitioned from fresh water to salt water) usually migrate to estuarine areas within the first year, approximately three months after emergence from spawning gravel (in general, April through July with population variability).

The peak out-migration timing of juvenile Puget Sound Chinook along the NBK Bangor shoreline, and within the greater Hood Canal region, occurs from May to early July. During spawning season, adult Chinook salmon enter Hood Canal waters from August to October to begin spawning in their natal streams in September with peak spawning occurring in October. Table 3.13 provides a compilation of information regarding the in-migration and spawn timing of adult Puget Sound Chinook past NBK Bangor, and within the greater Hood Canal region.

TABLE 3.13 SPAWNING PERIOD TIMING AND PEAK PRESENCE OF ADULT HOOD CANAL STOCKS OF PUGET SOUND CHINOOK

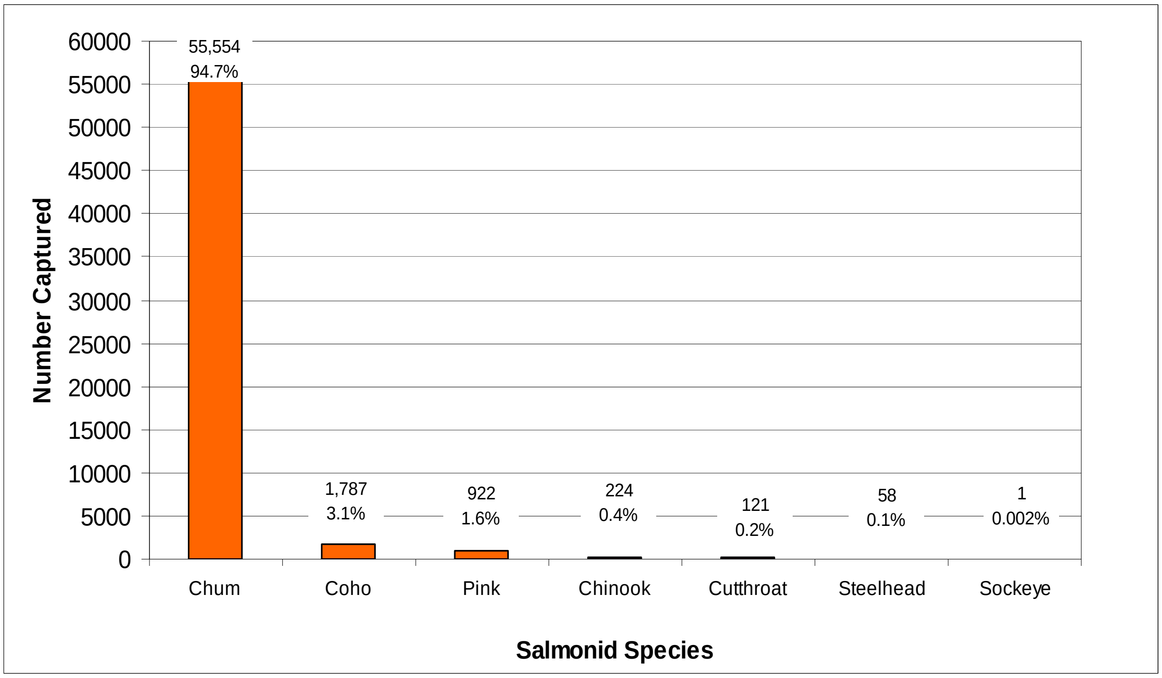
STOCK	TIME PERIOD DETECTED IN HOOD CANAL	SPAWN TIME PERIOD	SPAWN PEAK
Skokomish	Late August to October	Mid September to October	Mid October
Mid-Hood Canal	Mid August to late October	Early September to late October	October

Source: Healey, 1991.



Source: DoN, 2006b.

Figure 3-7 Critical habitat designated for Chinook salmon in Puget Sound



Source: SAIC, 2006; Bhuthimethee et al., 2009.

Figure 3-8 Salmonids, in order of abundance, captured during 2005–2008 Bangor beach seine survey

Hood Canal Summer-run Chum Salmon

Status and Management

Hood Canal summer-run chum salmon (*Oncorhynchus keta*) ESU was federally listed as threatened under the ESA in 1999, and the threatened listing was reaffirmed in 2005 (70 FR 37160). The NMFS recovery plan for Hood Canal summer-run chum was adopted 24 May 2007 (72 FR 29121). Hood Canal summer-run chum ESU includes all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries. The only active fish hatchery that currently provides summer-run chum salmon to Hood Canal is the Quilcene National Fish Hatchery.

Historically, there were 16 stocks within Hood Canal summer-run chum ESU, eight of which are still in existence (six in Hood Canal and two in eastern Strait of Juan de Fuca), with the remaining eight being extinct (71 FR 47180). Supplementation programs are currently ongoing at three of the extinct stock locations (two in Hood Canal) to effectively reintroduce the summer-run chum back to their historic range, and these stocks are recognized as part of the ESU (HCCC 2005). Reduced viability, lower survival, and listing of extant stocks of summer-run chum and recent stock extinctions in Hood Canal are attributed to the combined impacts of three primary factors: (1) habitat loss and degradation, (2) climate change, and (3) increased fishery harvest rates (HCCC, 2005). An additional factor cited was impacts associated with the releases of hatchery salmonids (WDFW and PNPTT, 2000; HCCC, 2005), which compete with naturally spawning stocks for food and other resources.

Critical Habitat

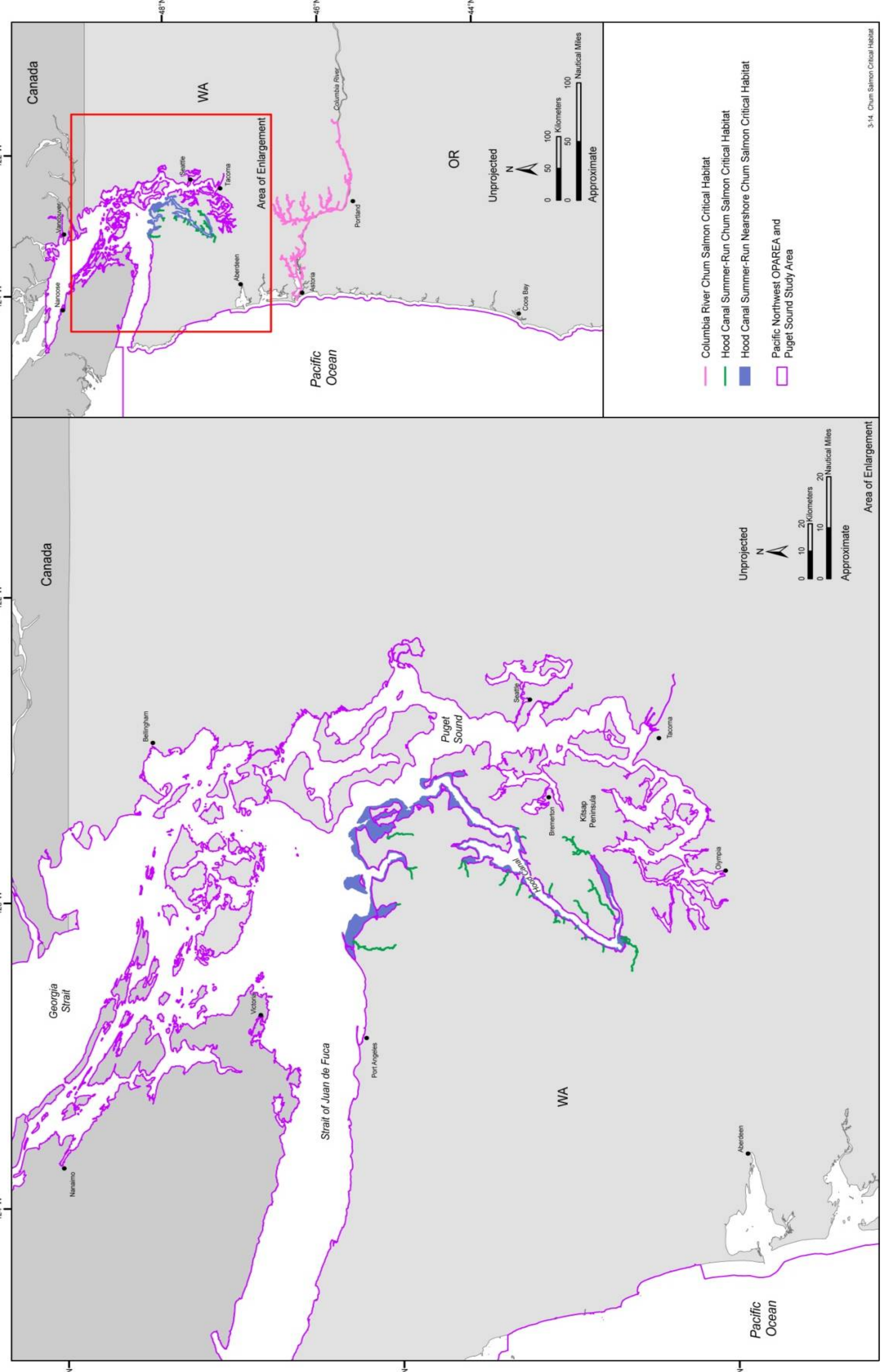
Critical habitat was designated for Hood Canal summer-run chum ESU on September 2, 2005 (70 FR 52630) (Figure 3-9). Critical Habitat extends from extreme high tide to a depth of 30 m relative to MLLW, i.e. habitat typically within the photic zone that is important for rearing, migrating, and maturing salmon and their prey (primary constituent elements). Although critical habitat for Hood Canal summer-run chum salmon occurs within the project area along portions of the shorelines in Hood Canal both north and south of the project area, NBK Bangor is excluded from this designation by federal law as the base maintains an active INRMP (70 FR 52630).

Distribution, Behavior, and Ecology

Hood Canal summer-run chum migrate through the intertidal and nearshore waters of NBK Bangor; however, spawning populations have not been found in base streams (DoN, 2001a). Most summer chum juveniles originate from streams on the western shore of Hood Canal and cross Hood Canal following surface freshwater flows from the tip of Toandos Peninsula to the NBK Bangor waterfront (Salo et al., 1980). Surveys conducted along the shoreline of NBK Bangor in 2005 through 2008 found large numbers of chum salmon along the Bangor shoreline (Figure 3-8); however, these chum were identified as part of the fall-run chum population rather than the summer-run.

During out-migration, fry move within the nearshore corridor and into and out of sub-estuaries with the tides, most likely in search of food resources (Hirschi et al., 2003). At a migration rate of 7 kilometers (4.4 miles) per day, the majority of chum emigrants from southern Hood Canal exit the canal to the north 14 days after their initial emergence in seawater (WDFW and PNPTT, 2000). Juvenile summer-run chum are expected to occur near the proposed site from late January through early April, with a peak in late March (Prinslow et al., 1980; Salo et al., 1980; Bax, 1983; WDFW and PNPTT, 2000; SAIC, 2006; Bhuthimethee et al., 2009).

Approximately one month separates peak spawn timing of the early (summer) and later (fall) runs of chum salmon in Hood Canal (Johnson et al., 1997). Summer-run chum are, in part, distinguished from fall chum populations by their exclusive use of nearshore marine habitat early in the run period (early August to October). Summer-run chum adults return to Hood Canal from as early as August and September through the first week in October (WDF et al., 1993; WDFW and PNPTT, 2000) (Table 3.14).



Source: DoN, 2006b.

Figure 3-9 Critical habitat designated for Hood Canal summer-run chum salmon in Puget Sound

TABLE 3.14 SPAWNING PERIOD, PEAK, AND 90 PERCENT SPAWN TIMING OF ADULT STOCKS OF HOOD CANAL SUMMER-RUN CHUM

Stock	Time Period Detected in Hood Canal [1]	Spawn Time Period and Peak	Date at which 90 Percent of Spawning is Complete
Big/Little Quilcene	Early September to Mid-October	Mid-September to Mid-October	10/1 - 10/5
Lilliwaup Creek	Early September to Mid-October	Mid-September to Mid-October	10/10
Hamma Hamma	Early September to Mid-October	Mid-September to Mid-October	10/8 - 10/10
Duckabush	Early September to Mid-October	Mid-September to Mid-October	10/11
Dosewallips	Early September to Mid-October	Mid-September to Mid-October	10/9
Union	Mid-August to Early October	Early September to Early October	9/29 - 9/30

Source: WDFW, 2002; WDFW and PNPTT, 2000

1. Range of timing estimates from PNPTT and WDFW, in Appendix Report 1.2 (WDFW and PNPTT, 2000).

Puget Sound Steelhead

Status and Management

The Puget Sound steelhead (*Oncorhynchus mykiss)* was listed in May 2007 under the ESA as a threatened DPS (72 FR 26722). Stocks of the Puget Sound steelhead DPS are mainly winter-run, although a few small stocks of summer-run steelhead also occur (71 FR 15666). Eight stocks of winter-run and three stocks of summer-run Puget Sound steelhead occur in Hood Canal (WDFW, 2002). Some stocks of Puget Sound steelhead in Hood Canal (i.e., hatchery supplementation or hatchery releases to non-native streams) may not be considered part of the DPS (71 FR 15668).

Critical Habitat

Critical habitat for Puget Sound steelhead is currently under development.

Distribution, Behavior, and Ecology

Steelhead exhibit the most complex life history of any species of Pacific salmonid. Steelhead can be freshwater residents (referred to as rainbow trout) or anadromous (referred to as steelhead), and, under some circumstances, they can yield offspring of the alternate life history form (72 FR 26722). Anadromous forms can spend up to seven years in fresh water prior to smoltification and then spend up to three years in salt water prior to migrating back to their natal streams to spawn (Busby et al., 1996). In addition, steelhead may spawn more than once during their life span, whereas other Pacific salmon species generally spawn once and die.

Steelhead do not occur in large numbers along the NBK Bangor shoreline (Figure 3-8). Recently, the juvenile steelhead captured in 2005 through 2008 beach seine surveys were one of the least abundant of the salmonids captured along the NBK Bangor waterfront, accounting for less than one percent of the salmonid catch (SAIC, 2006; Bhuthimethee et al., 2009). Steelhead occur most frequently in the late spring and early summer months.

Winter-run

Limited information is available regarding the timing of juvenile out-migration for winter-run steelhead in Hood Canal. The Washington Department of Fish and Wildlife (WDFW) suggests that juvenile out-migration of steelhead stocks in Hood Canal occurs from March through June, with peak out-migration during April and May (Johnson, 2006, personal communication).

Most stocks of winter-run steelhead in Hood Canal (Skokomish, Hamma Hamma, Duckabush, Quilcene/Dabob Bay, and Dosewallips) spawn from mid-February to early June (WDFW, 2002). Information published to date indicates adult spawn timing occurs from mid-February to early June (NMFS, 2005a; Hard et al., 2007) (Table 3.15).

Summer-run

Information regarding the timing of juvenile out-migration for summer-run steelhead in Hood Canal is not currently available. Spawn timing of summer-run steelhead in Hood Canal is not fully understood; however, spawning is believed to occur from February through April (WDFW 2002).

TABLE 3.15 MIGRATION, SPAWNING PERIOD, AND PEAK WINTER-RUN STOCKS OF PUGET SOUND STEELHEAD

STOCK	TIME PERIOD DETECTED IN HOOD CANAL [1]	SPAWN TIME PERIOD [2]	PEAK SPAWNING
Tahuya winter-run	January through June	Early March to early June	May
Skokomish winter-run	January through mid-July	Mid-February to mid-June	May
Dewatto winter-run	January through June	Mid-February to early June	May
Union winter-run	Not identified	Mid-February to early June	Unknown
Hamma Hamma winter-run	Not identified	Mid-February to early June	Unknown
Duckabush winter-run	Not identified	Mid-February to early June	Unknown
Quilcene/Dabob Bay winter-run	Not identified	Mid-February to early June	Unknown
Dosewallips winter-run	Not identified	Mid-February to early June	Unknown

Source: Busby et al., 1996; WDFW, 2002.
1. Time period detected in Hood Canal, reported in Busby et al. (1996).
2. Spawning time reported in WDFW (2002).

Bull Trout

Status and Management

Currently, all populations of bull trout in the lower 48 states are listed as threatened under the ESA. Bull trout are in the char subgroup of salmonids and have both resident and migratory life histories (64 FR 58910). The Coastal-Puget Sound bull trout DPS reportedly contains the only occurrence of anadromous bull trout in the contiguous United States (64 FR 58912); Hood Canal is one of five geographically distinct regions within this DPS. All Hood Canal bull trout originate in the Skokomish River (WDFW, 2004).

In May 2004, the USFWS released the Draft Recovery Plan for the Coastal-Puget Sound DPS of bull trout. The Test Pile Program project area is located within the Olympic Peninsula Management Unit which includes six core areas important for recovery. A "core area" represents a combination of both suitable habitat as well as a demographically dependent grouping of one or more local populations. Specifically, core areas consist of core habitat that could supply all the necessary elements for every life stage of bull trout (e.g., spawning, rearing, migration, overwintering, foraging) and have one or more populations of bull trout.

Critical Habitat

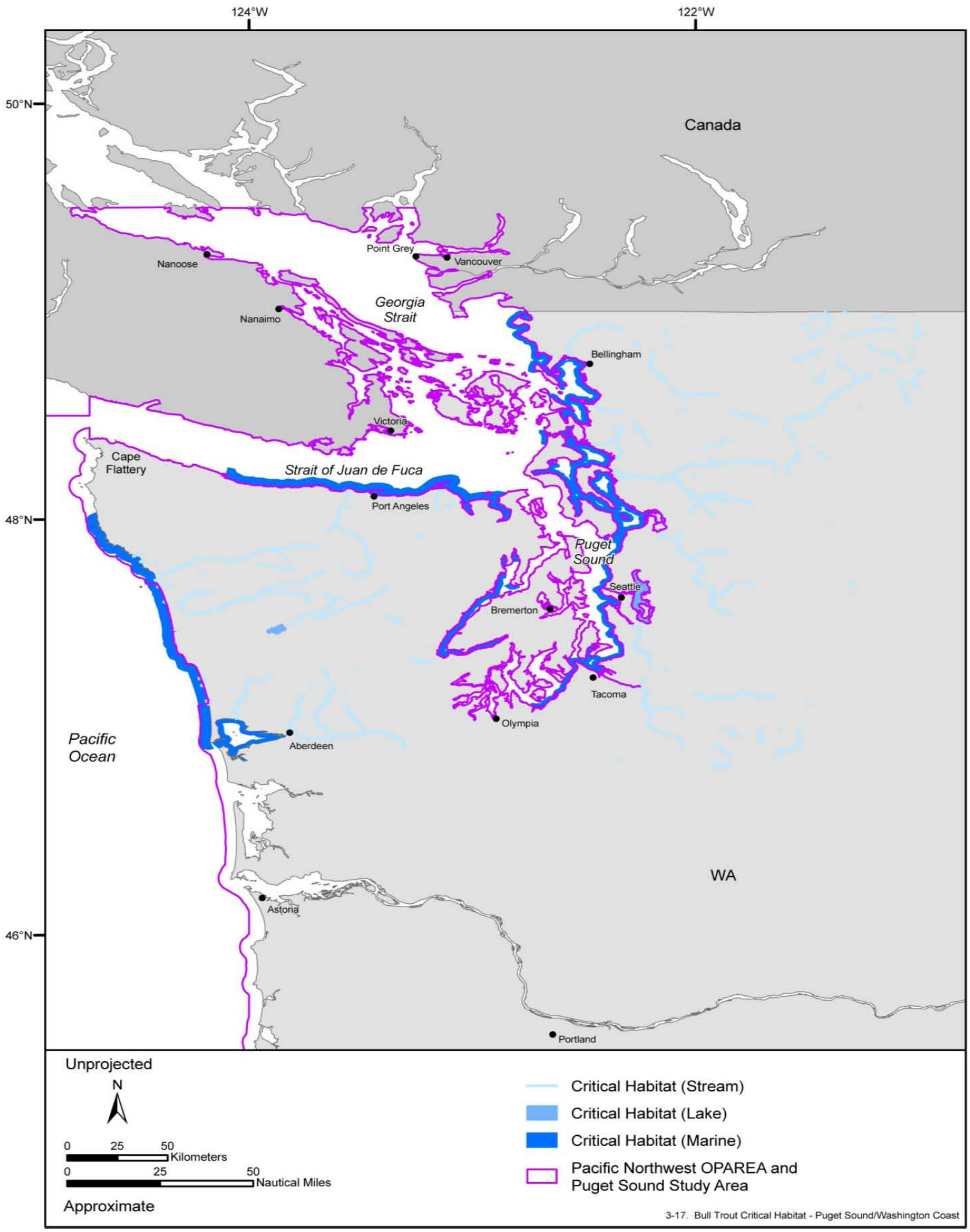
Critical habitat was designated for bull trout on September 26, 2005 (70 FR 56212). The geographic boundaries of this designation do not overlap with the project area (Figure 3-10). Therefore, there is no designated critical habitat in the project area. On January 14, 2010, the USFWS proposed to revise the critical habitat for bull trout (75 FR 2270). As part of this revision, additional nearshore areas of Hood Canal south of the project area would be included as critical habitat (75 FR 2314). There is no overlap between the project area and the existing designated critical habitat and the proposed critical habitat.

Distribution, Behavior, and Ecology

Bull trout within the Olympic Peninsula Management Unit exhibit all known migratory life history forms of this species, including fluvial (fish that migrate from tributaries to larger rivers to mature), adfluvial (fish that migrate from tributaries to lakes or reservoirs to mature), and anadromous (fish that migrate to the ocean to grow and live as an adult and return to freshwater to spawn). Additional bull trout surveys may document resident life forms (non-migratory fish, living in tributaries for their entire lives) as well, which are not yet documented on the Olympic Peninsula.

Bull trout are known to occur within many of the drainages within the greater Puget Sound area including the Skokomish River in Hood Canal, but are not known to occur in any tributary systems at NBK Bangor (Adolfson, 2005). Bull trout require snow-fed glacial streams and since there are none on the Kitsap Peninsula they would not be expected in any streams at NBK Bangor or in any other streams on the Kitsap Peninsula. Therefore their occurrence in the study area is limited to the marine waters.

The Skokomish River basin (located at the extreme south end of Hood Canal) is made up of three distinct bull trout stocks. Very little information exists regarding the life history of this stock, as well as no harvest, escapement, or run-size data (SAIC, 2001). Bull trout prey upon



Source: Don, 2006b.

Figure 3-10 Critical habitat designated for bull trout Puget Sound

sand lance, surf smelt, and herring, as well as other species. Sand lance are known to spawn at and near Floral Point, so it is possible that a foraging bull trout may be present along the nearshore areas of NBK Bangor to take advantage of this food source. Due to the distance between Floral Point and the Skokomish River (over 64 kilometers [40 miles]), bull trout occurrence at NBK Bangor and within the project area is anticipated to be occasional and rare, if it occurs at all (DoN, 2004; DoN, 2005).

Bull trout in the Skokomish River system are believed to spawn from mid-September to December (WDFW, 2004). Although Hood Canal bull trout likely migrate through the NBK Bangor waterfront, neither historic nor recent juvenile fish surveys (using beach and lampara seines and tow nets) have captured bull trout (Schreiner et al., 1977; Salo et al., 1980; Bax, 1983; SAIC, 2006; Bhuthimethee et al., 2009). For the species as a whole, emergence of fry generally occurs from early April to May (64 FR 59810). Not enough is known to specify the duration of juvenile out-migration specifically for Hood Canal (WDFW, 2004).

Bocaccio Rockfish

Status and Management

The Puget Sound/Georgia Basin bocaccio DPS was listed as endangered throughout all of their range on April 28, 2010 (75 FR 22276). The designation area of Puget Sound/Georgia Basin encompasses the inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia.

Critical Habitat

Critical habitat has not been designated for this species.

Distribution, Behavior, and Ecology

Bocaccio (*Sebastes paucispinis*) range from Punta Blanca, Baja California, to the Gulf of Alaska, Alaska (Love et al. 2002). They are believed to have commonly occurred along steep walls in most of Puget Sound prior to fishery exploitations, although they are currently very rare in these Puget Sound habitats (Love et al. 2002). Little is known about the habitat requirements of most rockfishes despite the years of research already performed. Even less is known about bocaccio in Puget Sound (Drake et al. 2008; Palsson et al. 2009). Much of the information presented below on bocaccio life history and habitat use is derived from other areas where bocaccio occur.

Adult bocaccio inhabit waters from approximately 40 - 1,570 ft, but are most common at depths of 160-820 ft (i.e., greater than the project depth). Although bocaccio are typically associated with hard substrate, they may wander into mud flats presumably because they can be located as much as 98 ft off the bottom.

General life history information for Bocaccio is provided in Table 3.16. Bocaccio mature at 4 years of age with 100 percent maturity occurring at 22 inches (3 years) for males and 24 inches (8 years) for females (Wyllie Echeverria 1987). Bocaccio can live up to 50 years, growing to 91 cm in size (Palsson et al. 2009). Young bocaccio are preyed upon by least terns, lingcod, other rockfish, Chinook salmon, and harbor seals (Love et al. 2002).

TABLE 3.16 GENERAL LIFE HISTORY OF BOCACCIO OF THE NORTHEAST PACIFIC OCEAN

	Larvae	Pelagic Juvenile	Settling Juvenile to Sub-adult	Mature Adult
Age	0	~1 month	3.5–5.5 months	3–4 years
Size (inches)	0.16–0.2	0.6–1.2	1.5	24
Habitat	pelagic	near water surface; associated with drifting kelp	shallow, over algae covered rocks or sand areas with eelgrass or drift algae; move to deeper water as they age; juvenile seen recruiting to oil platforms in central and southern California	deep water (typically seen at 165–825 feet but as deep as 1,578 feet), over high relief boulder fields and rocks; can be found 100+ feet over substrata; sometimes in caves and crevices
Time period	Dec–April		Feb–Aug, peak May–July	
Diet	microplankton	opportunistic feeder: fish larvae, zooplankton	opportunistic feeder: fish larvae, zooplankton	rockfishes, hake sablefish, northern anchovies, lanternfish, and squid

Source: Phillips, 1964; Matarese et al., 1989; Love et al., 2002.

Bocaccio release larvae in January, continuing through April off the coast of Washington. Larval and pelagic juvenile bocaccio drift into the nearshore, near the water surface, associated with drifting kelp mats (Love et al. 2002).

The young bocaccio settle the nearshore environment at 3 – 4 months of age (~1.5 inches in size), where the species prefer shallow waters over algae-covered rocks, or in sandy areas where eelgrass beds or drift algae are present (Love et al. 1991; Love et al. 2002). As juveniles, bocaccio rockfish inhabit relatively shallow water, compared to adults, and are often found in large schools (Eschemeyer et al. 1983).

As bocaccio grow older, they move into deeper waters with adults found over high relief boulder fields and rocks. They can occur well off the bottom (over 100 feet above the substrata) or as deep as 900 feet (Love et al. 2002).

Larval fish feed upon microplankton, but juveniles are more opportunistic feeders (e.g,. fish larvae, copepods, krill) (Love et al. 2002; Phillips 1964; Sumida and Moser 1984). Larger juveniles and adults feed upon other rockfishes, hake, sablefish, northern anchovies, lanternfish, and squid (Phillips 1964; Eschemeyer et al. 1983; Sumida and Moser 1984).

Adult bocaccio are piscivorous, whereas juveniles consume smaller fishes and zooplankton. In Puget Sound, most bocaccio are reportedly found near Point Defiance and Tacoma Narrows. Bocaccio have always been rare in northern Puget Sound. An approximate estimate of bocaccio abundance in Puget Sound Proper (Whidbey Island and south, including the project area) was only 100 individuals during the 1980s (74 FR 18516).

Bocaccio have never been observed during WDFW bottom trawl, video, or dive surveys in Puget Sound (Moulton and Miller 1987; Palsson et al. 2009). However, Palsson et al. (2009) investigated historic fish catch records and reported only two known instances of bocaccio captures in Hood Canal. Note that recreational fishing records reflect observed frequencies, not observed densities. Although there have been no confirmed observations of bocaccio in Puget Sound for approximately seven years (74 FR 18516), Drake et al. (2008) concluded that it is likely that bocaccio occur in low abundances. As a result, bocaccio have the potential to occur within the action area.

Canary Rockfish

Status and Management

On April 28, 2010 the Puget Sound/Georgia Basin canary rockfish DPS was listed as threatened under the ESA (75 FR 22276) throughout all of their range. This designation encompasses the inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia.

Critical Habitat

Critical habitat has not been designated for this species.

Distribution, Behavior, and Ecology

Canary rockfish (*Sebastes pinniger*) range from Punta Blanca, Baja California, to the Shelikof Strait of Alaska, and are abundant from British Columbia to central California. Canary rockfish were once considered fairly common in the greater Puget Sound area (Holmberg et al., 1967; Kincaid, 1919); these deepwater species most likely occur in north and south basins to South Sound (Palsson et al. 2009) however, little is known about their habitat requirements and occurrence in the waters in the project area vicinity (Drake et al., 2008; Palsson et al., 2008). Much of the information presented below on canary rockfish life history and habitat use is derived from research from other areas where canary rockfish are more abundant.

Adult canary rockfish can life to be 84 years old and have been measured at 76 cm in size (Palsson et al 2009). Canary rockfish have been recorded to reach maturity at 7 to 9 years old (16 to 18 inches) in females and 7 to 12 years (16 inches) in males (Palsson et al. 2009; Love et al. 2002).

General life history information for canary rockfish is provided in Table 3.17. Adults release larvae (0.1 to 0.2 inch) between September and March with peaks in December and January off

TABLE 3.17 GENERAL LIFE HISTORY OF CANARY ROCKFISH OF THE NORTHEAST PACIFIC OCEAN

	LARVAE	PELAGIC JUVENILE	SETTLING JUVENILE TO SUB-ADULT	MATURE ADULT
Age	0	1–3 month	3–4 month	7–9 years (female), 7–12 years (male) in Oregon
Size (inches)	0.1–0.2	0.5–0.8		16–20 (female), 16–17 (male)
Habitat	upper 330 feet of water column, pelagic	upper 330 feet of water column, associated with drifting kelp	intertidal tide pools and kelp beds, move to deeper water as they age	deep water (typically 264–660 feet), aggregate around pinnacles and high-relief rock with substantial current, sometimes over flat rock and mixed mud-boulder habitat near the ocean bottom
Time period	Nov–Feb, peak in Jan–Feb		April-July	
Diet	microplankton	opportunistic feeder: fish larvae, zooplankton	opportunistic feeder with open water or benthic prey: fish larvae, copepod, amphipod, krill egg and larvae	krill, gelatinous zooplankton, shortbelly rockfish, anchovy, lanternfish, and sanddab

Source: Phillips, 1964; Matarese et al., 1989; and Love et al., 2002.

the Oregon and Washington coasts (Wyllie Echeverria 1987). Larvae and pelagic juveniles (0.5 to 0.8 inch) are found in the upper 330 feet of the water column from January until about March when they start to move into intertidal areas (tide pools, rocky reefs, kelp beds, cobble areas), although some juveniles remain pelagic in much deeper water until July (Love et al. 2002). Juveniles may occupy rock-sand interfaces near 50-65 ft during the day, then move to sandy areas at night.

Diets of juveniles consist of open water and benthic prey, including copepods, amphipods, and krill eggs and larvae. Juvenile canary rockfish emerge to become long and thin-bodied with large heads, growing into adult fish that are primarily orange on a white background (Phillips 1964; Love et al. 2002).

Adults and sub-adults feed on krill, gelatinous zooplankton, small lanternfishes, anchovies, sanddabs, and adult shortbelly rockfish (Phillips 1964). Some juvenile canary rockfish predators include marine birds and mammals, lingcod, other rockfish, Chinook salmon, and other fishes (Love et al. 2002).

Adult canary rockfish typically inhabit waters from 160-820 ft, but some may occur at 1,400 ft (i.e., greater than the project depth). Larger fish tend to occur in deeper water. Although canary rockfish are sedentary, some have been reported to migrate 435 miles over several years.

Canary rockfish were once considered fairly common in the greater Puget Sound area. An approximate estimate of canary rockfish abundance in Puget Sound Proper was only 300 individuals during the 1980s (74 FR 18516). Drake et al. (2008) concluded that canary rockfish occur in low and decreasing abundances in Puget Sound. Therefore, canary rockfish have the potential to occur within the action area.

Yelloweye Rockfish

Status and Management

The Puget Sound/Georgia Basin yelloweye rockfish DPS has been listed as threatened under the ESA (75 FR 22276) throughout all of their range on April 28, 2010. The designation area of Puget Sound/Georgia Basin encompasses the inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia.

Critical Habitat

Critical habitat has not been designated for this species.

Distribution, Behavior, and Ecology

Yelloweye rockfish are found from Ensenada, Baja California, to the Aleutian Islands in Alaska. They are abundant from southeast Alaska to central California. Yelloweye rockfish are more common in northern Puget Sound compared with southern Puget Sound presumably because more rocky habitat is available in northern Puget Sound. An approximate estimate of yelloweye rockfish abundance in Puget Sound Proper was only 1,200 individuals during the 1980s (74 FR 18516). Hood Canal has the greatest frequency of yelloweye rockfish observed in both trawl and scuba surveys conducted by WDFW (Palsson et al. 2009).

Yelloweye rockfish is a deep-water species that is relatively sedentary living in association with high relief rocky habitats and often near steep slopes (Palsson et al 2009; Love et al. 2002; Wang 2005). Yelloweyes move into deeper water as they grow into adults, continuing to associate with caves and crevices and spending large amounts of time lying on the substratum, sometimes at the base of rocky pinnacles and boulder fields (Love et al. 2002).

General life history information for yelloweye rockfish is provided in Table 3.18. Yelloweye become mature at 19-22 years of age, growing up to 91 cm in size. The mean maximum age is 118 years of age (Palsson et al. 2009). Yelloweye release larvae from April to September with a hiatus in June and July (Palsson et al. 2009), Larvae and juveniles remain pelagic for up to 2 months, settling to shallow, high relief zones, crevices, and sponge gardens (Love et al. 2002).

Yelloweye larvae and juveniles are opportunistic feeders, preying upon fish larvae, copepods, amphipods, krill eggs, and larvae. Adult diets consist of rockfishes, herring, sand lance, flatfishes, shrimps, crabs, and lingcod eggs (Love et al. 2002). In South Sound, yelloweye rockfish are known to feed on fish, especially walleye pollock (*Theragra chalcogramma*), cottids, poachers, and Pacific cod (*Gadus macrocephalus*) (Washington et al. 1978).

Adult yelloweye rockfish inhabit waters from 80-1,560 ft, but they are most common at depths of 300-590 ft (i.e., greater than the project depth). They are typically solitary, but sometimes form aggregations near rocky substrate. Juveniles occur in shallower waters compared with larger adults. Approximately 50% of the fish reach maturity at age-6 (~16 inches). Their home range is typically relatively small, but adult rockfish have the potential to move long distances.

TABLE 3.18 GENERAL LIFE HISTORY OF YELLOW EYE ROCKFISH OF THE NORTHEAST PACIFIC OCEAN

	LARVAE	PELAGIC JUVENILE	SETTLING JUVENILE TO SUB-ADULT	MATURE ADULT
Age	0	1–2 month	2 month	19–22 years
Size (inch)	0.16–0.2	0.2–1	1	18–18.4 (female), 18–21.6 (male)
Habitat	> 48 feet; pelagic	> 48 feet; pelagic	shallow, high relief zones, crevices, and sponge gardens; move to deeper water as they mature	deep water (typically seen at 300–600 feet, but as deep as 1,800 feet), associated with caves and crevices, lying on the substratum; sometimes at the base of rocky pinnacles and boulder fields; all life stages seen around oil platforms in southern California
Time period	Apr–Aug, peak around May–Jun		about 2 months after release	
Diet	microplankton	opportunistic feeder: fish larvae, zooplankton	opportunistic feeder: fish larvae, copepods, amphipods, krill egg and larvae	rockfish, herring, sand lance, flatfish, shrimp, crab, and lingcod egg

Source: Matarese et al., 1989; Love et al., 2002.

Green Sturgeon

Status and Management

The southern DPS of green sturgeon (*Acipenser medirostris*) was listed as threatened on April 7, 2006 (71 FR 17757).

Critical Habitat

On October 9, 2009 NMFS designated critical habitat for the green sturgeon (74 FR 52300). There is no critical habitat established within the vicinity of Hood Canal or NBK Bangor for green sturgeon.

Distribution, Behavior, and Ecology

Green sturgeon are the most broadly distributed, wide-ranging, and most marine-oriented species of the sturgeon family. The green sturgeon is anadromous and it ranges from Baja California to at least Alaska in marine waters, and is observed in bays and estuaries up and down the west coast of North America (Moyle et al., 1995). The actual historical and current distribution of where this species spawns is unclear because green sturgeon make non-spawning movements into coastal lagoons and bays in the late summer to fall, and because their original spawning distribution may have been reduced due to harvest and other anthropogenic effects (Adams et al., in press). Green sturgeon spawn in the Rogue River, Klamath River Basin, the Sacramento River, and possibly in a few other tributaries along the west coast. Green sturgeon are not known to spawn in Washington rivers but they may occur in Puget Sound and its estuaries (Abrams et al., 2007). A number of green sturgeon were found stranded in mudflat pools of Port Susan as the tide receded in spring 2009.

Green sturgeon congregate in coastal bays and estuaries in late summer and early fall, with particularly large concentrations in the Columbia River Estuary, Willapa Bay, and Grays Harbor. Sturgeon live near bottom substrate where they consume benthic prey, including shrimp, mollusks, amphipods, and small fishes (Moyle et al., 1992). In Puget Sound, sturgeon likely use Admiralty Inlet as a migration corridor as they move to and from Puget Sound estuaries. Low harvests of green sturgeon in Puget Sound suggest they are less abundant there compared with coastal estuaries and are not likely to occur in the project area.

Pacific Eulachon/Smelt

Status and Management

In March 2010, NMFS listed the southern DPS of Pacific eulachon (*Thaleichthys pacificus*) as threatened (75 FR 13012). Most spawning runs within the eulachon range have declined in the past 20 years, especially since the mid-1990s (74 FR 10857). The primary factor responsible for the decline of the southern DPS is climate change and its effects on ocean conditions and freshwater hydrology and other environmental factors. Directed commercial fishing for eulachon was identified as a low to moderate threat, whereas bycatch in other commercial fisheries (e.g., shrimp) was a moderate threat to the species. Dams and water diversions are considered moderate threats as well. Although eulachon catch harvests have been limited in response to population declines, these existing regulatory mechanisms may be inadequate to recover stocks (74 FR 10857).

Critical Habitat

Critical habitat has not been designated for this species.

Distribution, Behavior, and Ecology

Eulachon are anadromous fish, spawning in freshwater systems and spending their juvenile and adult lives in marine waters. Eulachon are important ecologically, providing a food source for a wide variety of organisms such as birds, marine mammals, and fish in both marine and freshwater ecosystems (WDFW, 2001).

Although eulachon range from northern California to western Alaska, the southern DPS of eulachon consists of populations spawning in rivers south of the Nass River in British Columbia, Canada, to, and including, the Mad River in California (74 FR 10857). The major production areas include the Columbia and Fraser Rivers and may have historically included the Klamath River. Historically, the Columbia River supported approximately 50 percent of the total population abundance. However, commercial harvests of eulachon in the Columbia River declined from approximately 500 metric tons during 1915-1992 to less than 5 metric tons in 2005-2008. The Fraser River population also declined sharply. Canada is presently reviewing the status of eulachon in British Columbia to determine whether it deserves protection under its Species at Rick Act (SARA).

Eulachon occur infrequently in coastal rivers and tributaries to Puget Sound, Washington. Eulachon presence in Hood Canal is rare. NMFS (2010) reported no historical catch records of eulachon in Hood Canal however; very low numbers of eulachon were caught in the NBK Bangor shoreline surveys from 2005 through 2008.

Eulachon typically spend 3-5 years in nearshore marine waters up to 300 meters (1,000 feet) in depth, except for the brief spawning runs into their natal (birth) streams from late winter through early summer. Eulachon adults return to freshwater to spawn at 3 to 5 years of age and most eulachon die after spawning, but eulachon can spawn repeatedly (WDFW, 2001).

3.8.1.3 Non-ESA Listed Fish

Pacific Herring

Pacific herring (*Clupea pallasii*) are small schooling fish distributed along the Pacific coast from Baja California, Mexico, to the Bering Sea and northeast to the Beaufort Sea, Alaska. Adult herring feed primarily on planktonic crustaceans, and juveniles demonstrate a preference for crab and shrimp larvae. Herring are also an important food resource for other species in Puget Sound waters. The majority of herring spawning in Washington State waters occurs annually from late January through early April (Bargmann, 1998). Herring deposit their transparent eggs on intertidal and shallow subtidal eelgrass and marine algae. Although large spawning areas are found elsewhere in Hood Canal (Stick and Lindquist, 2009), there are no documented herring spawning grounds at NBK Bangor. Based on recent surveys, Pacific herring have been detected in small numbers during late winter months and larger numbers in early summer months at NBK Bangor (SAIC, 2006; Bhuthimethee et al., 2009). During the 2005 and 2006 beach seine surveys, Pacific herring represented 73 percent of all forage fish captured (SAIC, 2006). However, no herring were captured near the project area.

Surf Smelt

Surf smelt (*Hypomesus pretiosus*) are small schooling fish distributed along the Pacific coast from Long Beach, California, to Chignik Lagoon, Alaska and are most abundant at NBK Bangor in late spring through summer (SAIC, 2006; Bhuthimethee et al., 2009). During the 2005 through 2006 beach seine surveys, surf smelt were second in abundance for all forage fish captured (20 percent of the forage fish catch) (SAIC, 2006). Adult surf smelt feed primarily on planktonic organisms and have shown a preference for euphausiids (krill). As with herring, these fish are an important component in Puget Sound, both as a food resource in the marine food web and as part of the commercial fishing industry. In surveys conducted from May 1996 through

June 1997, Penttila (1997) found no surf smelt spawning grounds at NBK Bangor, however, juvenile surf smelt have been found to rear in nearshore waters (Bargmann, 1998) and were detected along the shoreline near the Test Pile Program project area from January through the mid-summer months (SAIC, 2006; Bhuthimethee et al., 2009). Although previous surveys have not indicated the presence of spawning grounds near the Test Pile Program project area, surf smelt are believed to spawn throughout the year in Hood Canal, with the heaviest spawn occurring from mid-October through December. It is expected that surf smelt will be present in the project area year round; however, they will most likely be present in larger abundances during the peak spawning time.

Pacific Sand Lance

The Pacific sand lance (*Ammodytes hexapterus*), another small schooling fish, occurs throughout the coastal northern Pacific Ocean between the Sea of Japan and southern California, across Arctic Canada, and throughout the Puget Sound region. All life stages of sand lance feed on planktonic organisms, primarily crustaceans, with juveniles showing a preference for copepods. As with other forage fish, the Pacific sand lance is an important part of the trophic link between zooplankton and larger predators in local marine food webs. Bargmann (1998) indicates that 35 percent of all juvenile salmon diets and 60 percent of the juvenile Chinook diet, in particular, are sand lance. Other regionally important species (such as Pacific cod, Pacific hake, and dogfish) feed heavily on juvenile and adult sand lance.

Pacific sand lance are the third most abundant forage fish at NBK Bangor comprising seven percent of the forage fish catch (SAIC, 2006). Excellent documented spawning substrate and nearly pristine backshore (Long et al., 2005) in the vicinity justifies conservation efforts to preserve spawning habitat.

Sand lance spawning activity occurs annually from early November through mid-February. Sand lance deposit eggs on a range of nearshore substrates, from soft, pure, fine sand beaches to beaches armored with gravel up to 3 centimeters (1.2 inches) in diameter; however, most spawning appears to occur on the finer-grained substrates (Bargmann, 1998). Spawning occurs at tidal elevations ranging from 5 feet (1.5 m) above to about the mean higher high water (MHHW) line. Similar to juvenile surf smelt, juvenile sand lance have been detected near the project area from January through the mid-summer months (SAIC, 2006; Bhuthimethee et al., 2009) (Figure 3-11). Most of these juveniles were captured in sheltered cove-like areas of the nearshore and were in schools mixed with surf smelt and larval sand lance. Adult, juvenile, and larval sand lance are expected to be present in the project area throughout the year.

3.8.2 Environmental Consequences

3.8.2.1 No Action Alternative

Under the No Action Alternative the Test Pile Program would not be conducted. Baseline conditions, as described above, for fish would remain unchanged. Therefore, there would be no significant impacts to fish from implementation of the No Action Alternative.

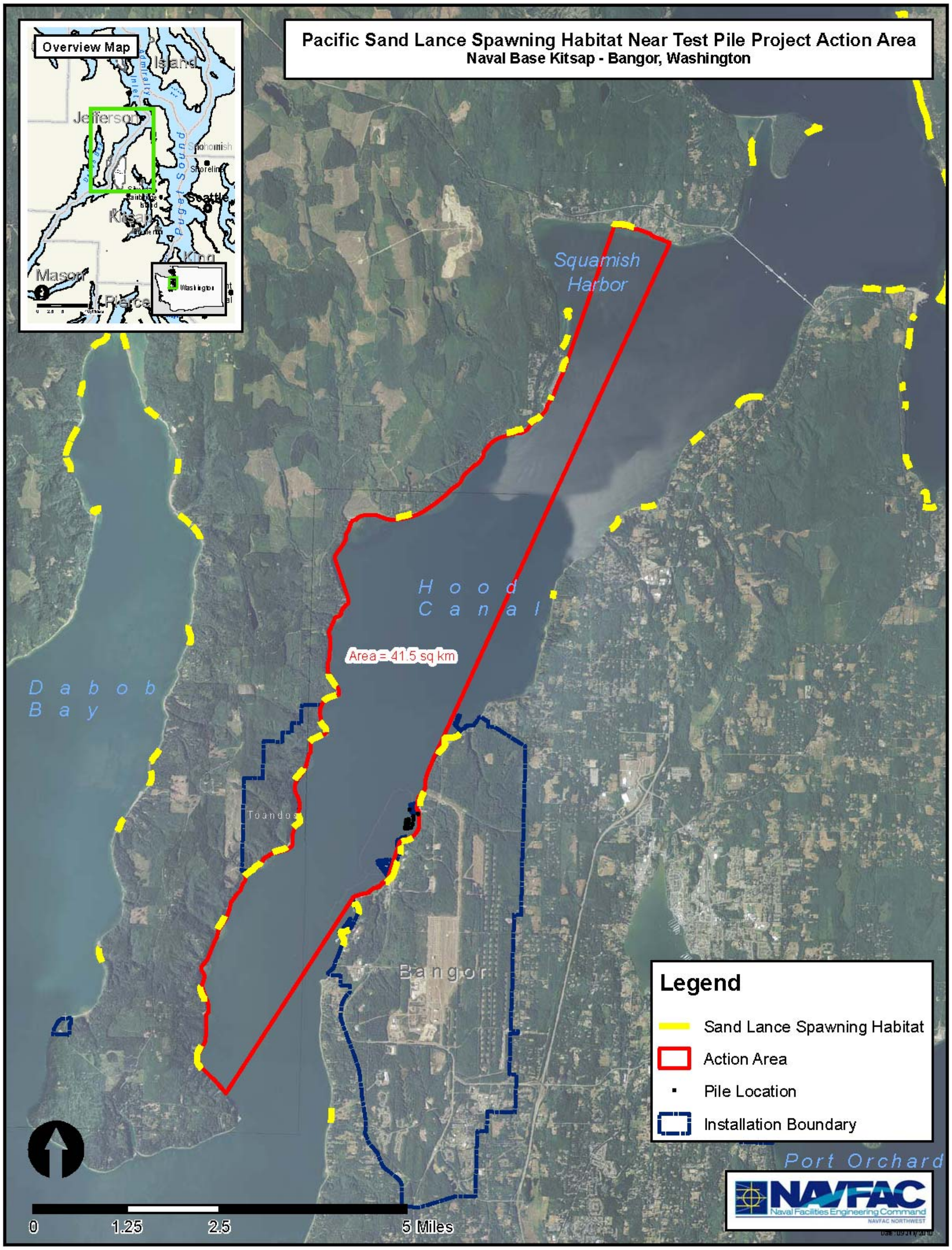


Figure 3-11 Pacific Sand Lance Spawning Habitat

3.8.2.2 Action Alternative

The evaluation of impacts to marine fish and their habitat considers whether the species is listed under the ESA, the species has important fishery value as a commercial or recreational resource (including EFH protected under the MSFCMA), a specific group has particular sensitivity to the proposed action's activities, and/or a substantial or important component of the group's habitat would be lost under the Test Pile Program.

Pile driving would impact fish and marine habitats in the project area by the generation of underwater sounds that exceed the thresholds for fish, established for both behavior and injury (Figure 3-12). Pile driving would also locally increase turbidity and disturb benthic habitats and forage fish in the immediate project vicinity however, these effects would be short-term and localized. Pile driving-related impacts to salmonid populations, which includes ESA-listed species, would be minimized by adhering to the in-water work period designated for northern Hood Canal waters, when less than five percent of all salmonids that occur in NBK Bangor nearshore waters are expected to be present (SAIC, 2006).

3.8.2.2.1 Pile Driving

Marine habitats used by fish species that occur along the NBK Bangor waterfront include offshore (deeper) habitat, nearshore habitats (intertidal zone and shallow subtidal zone), and other habitats, including piles used for structure and cover. The primary impacts to marine fish from the Test Pile Program would be related to noise associated with impact and vibratory pile driving and changes in turbidity (a component of water quality) in nearshore habitats. The most important impact to fish associated with pile driving would occur when underwater noise is being generated by impact pile driving, and to a lesser extent, vibratory pile driving. Underwater noise thresholds (Table 3.19) for behavioral disturbance and onset of injury would be exceeded for fish including federally listed ESA species (salmonids), which may be present during pile driving. However, measures described in Section 4.3 Mitigation Measures and Regulatory Compliance would reduce the likelihood of adverse impacts to these species.

<u>Water and Sediment Quality</u>

As indicated in Section 3.3, Water Resources, pile driving-related impacts to water quality from the Test Pile Program would be limited to temporary and localized changes associated with resuspension of bottom sediments during pile installation. Although large increases in turbidity have the potential to damage fish gills, the proposed action would only result in small-scale increases of suspended sediments, and would not likely result in gill tissue damage to fishes.

As concentrations of organic matter in NBK Bangor sediments are low, resuspension of these sediments is not expected to alter or depress DO below levels required by water quality standards. In surveys conducted along the NBK Bangor waterfront from 2005 to 2006, DO at the waterfront was measured at levels below the standard of 7.0 mg/L, but not below the level considered to have adverse impacts to fish (5 mg/L) (Newton et al., 2002). Such measurements were uncommon and occurred in considerably deeper water (20 to 60 meters [66-197 feet]). These low DO measurements may be due to the low DO levels known for the deeper waters of Hood Canal. The Test Pile Program would result in no measurable change to existing DO levels at the NBK Bangor waterfront or in Hood Canal in general. The proposed action would not result in violations of water quality standards for DO nor a local decrease in DO to a level impacting the health of fish and would, therefore, maintain water quality in the vicinity of the project area.

The primary potential adverse impact to water quality from pile installation and removal is suspension of bottom sediments and formation of a turbidity plume in near-bottom waters. Resuspended sediments can cause the release of sediment-bound contaminants to near-bottom waters. However, sediments in the project area contain low concentrations of organic carbon (i.e., TOC) and are characterized as uncontaminated (Hart Crowser, 2000; Foster Wheeler Environmental Corps., 2001; DoN, 2005; Hammermeister and Hafner, 2009). Therefore, increases in chemical contaminant concentrations in marine waters as a result of sediment resuspension during pile removal operations would be minor. Because suspended sediment and contaminant concentrations would be low, and exposures would be limited to the 40 day pile driving period, localized, acute, or chronic toxicity impacts would not occur.

Although some degree of localized changes in sediment grain size is expected during pile driving activities, due to fine-grained sediments dispersing and settling outside the project area, these impacts to sediment quality would be limited and localized to the general project area. Pile driving activities would not discharge contaminants or otherwise appreciably alter the concentrations of trace metal or organic contaminants in bottom sediments.

Watersheds

The Devil's Hole watershed, the only watershed at NBK Bangor that drains into Hood Canal and supports returning anadromous salmonids (Bhuthimethee et al., in prep., b), is located approximately 5,280 feet (1 mile) to the south of the project area and would not be impacted by the project. Due to their distance from the project area (1.9-3.2 kilometers [1 to 2 miles]), there would be no construction related impacts to the mixing patterns or locations of either the Cattail Lake or Devil's Hole systems. The nearest freshwater source to these waters is the Hunter's Marsh system, located immediately behind the EHW-1 structure. Due to the strong tides and currents in the project area, combined with a small outflow from the marsh, the waters in the project vicinity are well-mixed, with no habitat that acts as a sub-estuary.

Benthic Prey Availability

The Test Pile Program may result in localized and temporary changes to the benthic community during pile placement. A conservative estimate of total bottom disturbance from the barge anchors, spuds, and test piles is approximately 6,970 ft^2 (647 m^2). During the pile driving period (40 days), juvenile salmonids and other fish species may experience loss of available benthic prey at the project area due to the disturbance of pile installation, however, in-water work would occur during the time frame when few salmonids would be present, therefore adverse affect to benthic prey availability are not anticipated.

Forage Fish Community

The nearest forage fish spawning patches to the test piles are approximately 375 feet (114 m) to the north of the site and 450 feet (137 m) south of the site (Figure 3–11). The temporary increase of suspended solids during pile driving activities would be expected to remain in the immediate vicinity of the project area and would not adversely impact the spawning success of the nearest forage fish (sand lance) spawning habitat. Forage fish that occur in the immediate project area would be exposed to increased levels of turbidity and underwater noise levels that could injure or disturb fish occurring within the impact threshold zones during the period of pile driving. By observance of mitigation measures listed in Section 4.3, the Test Pile Program is not likely to result in an adverse affect to the forage fish community.

Aquatic Vegetation

The aquatic vegetation habitat of principal concern for foraging and refuge is eelgrass (*Zostera* sp.), as described by Simenstad et al. (1999), Nightingale and Simenstad (2001a,b), and Redman et al. (2005). Although the two largest eelgrass beds along the NBK Bangor shoreline occur near Devil's Hole and Cattail Lake, a relatively narrow band of eelgrass occurs along nearly the entire shoreline (Morris et al., 2009). Eelgrass in the immediate vicinity of the Test Pile Program project area occurs in a constricted nearshore band, with no large beds of eelgrass within 91 meters (300 feet) of the project area. Marine surveys at NBK Bangor have shown that eelgrass is only present in water down to 20 feet (6 m) MLLW (Garono and Robinson, 2002; Morris et al., 2009) which is well above the location of all but one test pile (Test Pile #2). With the exception of Test Pile #2, all test piles will be in waters deeper than 40 feet, thus eelgrass will be minimally impacted. The barge anchors, spuds, and test piles would result in indirect impacts, as well as direct mortality of marine vegetation with the pile driving footprints. Indirect impacts to marine vegetation are likely to result from turbidity caused by driving and removing barge anchors, spuds, and the test piles. The area within a 150-foot (46 m) radius of the pile driving footprints could have higher levels of turbidity. However, these impacts are minor and temporary in nature. Disturbed sediments would eventually redeposit and any disturbed marine vegetation will be expected to recover within a relatively short period of time. Therefore, the Action Alternative would have no significant impacts on marine vegetation.

Underwater Noise

Pile driving would result in increased underwater noise levels in Hood Canal. As many fish use their swim bladders for buoyancy, they are susceptible to rapid expansion/decompression due to peak pressure waves from underwater noises (Hastings and Popper, 2005). At a sufficient level this exposure can be fatal. Recently, underwater noise effects criteria for fish were revised and accepted for in-water projects following a multi-agency agreement that included concurrence from National Oceanic and Atmospheric Administration Fisheries and the USFWS (Fisheries Hydroacoustic Working Group [FHWG], 2008).

For impact pile driving, the underwater noise threshold criteria for fish injury from a single pile strike occurs at a sound pressure level of 206 dB peak pressure within a circle centered at the location of the driven pile out to a distance of approximately 13 feet (4 m) assuming properly functioning sound attenuation devices (such as the Gunderboom SAS™ or bubble curtains/walls) are used (10 dB reduction included for this distance). However, as the impact hammer driven piles for this project would be approximately 100 strikes per day, the approach requires using an accumulated Sound Exposure Level (SEL) as the threshold. Therefore, the applicable criteria for injury from impact pile driving to fish would be 187 dB accumulated SEL for a fish greater than or equal to 2 grams in weight within a circle centered at the location of the driven pile out to a distance of approximately 34 meters (112 feet) and 183 dB accumulated SEL for fish less than 2 grams in weight within a circle centered at the location of the driven pile out to a distance of approximately 63 meters (207 feet) assuming properly functioning sound attenuation devices are used (10 dB reduction included for these distances) (Fisheries Hydroacoustic Working Group, 2008) (Figure 3-12)

During pile driving, the associated underwater noise levels would result in behavioral responses, including avoidance of the project area, and would have the potential to cause injury. Average underwater baseline noise levels acquired along the NBK Bangor waterfront were measured at a level of 114 dB re 1μPa (Slater, 2009). Sound during impact pile driving would be detected above the average background noise levels at any nearby location in Hood Canal with a direct acoustic path (e.g., line-of-sight from the driven pile to the receiver location). The 150 dB rms re 1μPa behavioral threshold would be exceeded within a circle centered at the location of the impact driven pile out to a distance of approximately 2,154 meters (1.34 miles) (in a direct line-of-sight manner) assuming properly functioning sound attenuation devices are used (10 dB reduction included for this distance). The affected area includes most of the NBK Bangor waterfront and portions of the Toandos Peninsula shoreline (Figure 3-12). Locations beyond these points would receive lower noise levels because an interposing land mass would impede propagation of the sound.

Fish in the project area may display a startled response during initial stages of pile driving, and would likely avoid the immediate project vicinity during pile driving activities. However, field investigations of Puget Sound salmonid behavior, when occurring near pile driving projects (Feist, 1991; Feist et al., 1992), found little evidence that normally nearshore migrating salmonids move further offshore to avoid the general project area. In fact, some studies indicate that construction site behavioral responses, including site avoidance, may be as strongly tied to visual stimuli as to underwater sound (Feist, 1991; Feist et al., 1992; Ruggerone et al., in prep.). Therefore, it could be assumed that salmonids may alter their normal behavior, including startle response and avoidance of the immediate project area, but occurrence within most of the 2,154 meters (1.34 miles) disturbance area would not change.

To further minimize the underwater noise impacts during pile driving, a vibratory hammer would be used whenever possible to drive piles, and an impact hammer primarily used to proof load the piles to verify bearing load capacity, and not as the primary means to drive piles. When using the vibratory driver method, the distances at which the underwater noise thresholds occur would be reduced to 1,000 meters (3,280 feet) for behavioral disruption. There are currently no criteria for injury to fish from vibratory pile driving (Table 3.19 and Figure 3-12).

All pile driving activities would be conducted during the allowable in-water work period, July 16 to February 15 to reduce potential impacts to fish. NBK Bangor fish surveys in the 1970s and 2005 to 2008 indicate that greater than 95 percent of the juvenile salmonids in this part of Hood Canal occur during the closure period (Schreiner et al., 1977; Salo et al., 1980; Bax, 1983; SAIC, 2006; Bhuthimethee et al., in prep., a).

However, adult salmonids occur in northern Hood Canal waters during the allowable in-water work period. In addition, some juvenile salmonids would similarly occur, and may be impacted by elevated underwater sound during construction activities. To help protect these fish, a soft-start approach, using the pile driver, will be tested to see if lower initial sound pressure levels will encourage fish to move away from the immediate project area before pile driving is at its maximum level (see Section 4.3), further reducing the number of fish potentially exposed to harmful levels of underwater sound.

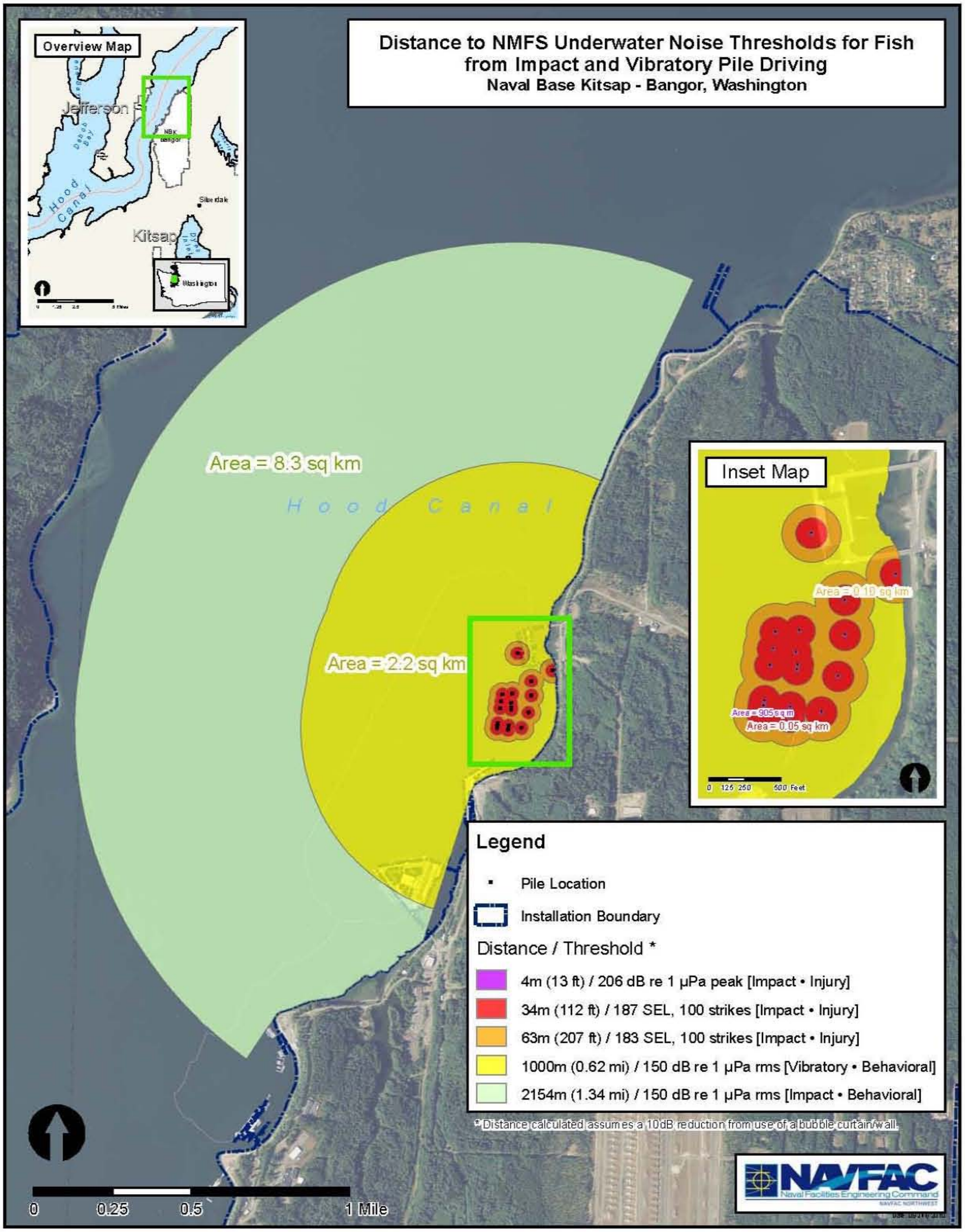


Figure 3-12 Distance to NMFS Underwater Noise Thresholds for Fish from Impact and Vibratory Pile Driving

TABLE 3.19 INTERIM CRITERIA AND DISTANCE TO EFFECT FOR FISH

Effect	Criteria	Distance (meters) to Effect for Impact Hammer	Distance (meters) to Effect for Vibratory Pile Driving
Onset of Injury – all fish	Peak 206 dB	4	N/A
Onset of Injury – fish two grams or greater	Cumulative SEL 187 dB	34	N/A
Onset of Injury – fish less than two grams	Cumulative SEL 183 dB	63	N/A
Extent of behavioral impacts[1] – all fish	150 dB rms	2,154	1,000

Source: FHWG, 2008
[1]Behaviorial criteria was not set forth by the FHWG, so as a conservative measure, NOAA Fisheries and USFWS generally use 150 dB rms as the threshold for behavioral effects to ESA-listed fish species (salmon and bull trout) for most biological opinions evaluating pile driving, however there are currently no research or data to support this threshold.

3.8.2.2.2 ESA-Listed Fish

Puget Sound Chinook Salmon

Chinook salmon are one of the least abundant salmonids occurring along the NBK Bangor waterfront in comparison to chum for example, however they are not entirely absent. Past surveys have found that Chinook are most frequent along the NBK Bangor waterfront from late May to early July. Smolts usually migrate to estuarine areas between April and July. Returning adult Chinook migrate past NBK Bangor from late August to late October. Therefore, based on the potential for adult Chinook or smolts to be present along the nearshore and exposed to underwater sound pressure levels that may injure, a may affect, likely to adversely affect determination is warranted.

Hood Canal Summer-run Chum Salmon

Surveys conducted along the shoreline of NBK Bangor between 2005 and 2008 found large numbers of chum salmon. Chum were the most abundant juvenile salmon captured by beach seining. Chum fry inhabit shallow nearshore areas often within 15 cm of the surface. As they mature, chum between 45–50 mm begin to move into slightly deeper water (1.5 – 5 m deep). Juvenile summer-run chum are expected to occur at NBK Bangor from January through early April with a peak in late March. Adult summer-run chum return to Hood Canal from early August through the first week in October. Adult summer-run chum are in part, distinguished from fall chum populations by their exclusive use of the nearshore marine habitat early in the run period. Therefore, while it is possible that a juvenile chum would be present along the nearshore in the early summer months, it is even more likely that a returning adult using the nearshore would be exposed to underwater sound pressure levels that may injure. Therefore, a may affect, likely to adversely affect determination is warranted.

Puget Sound Steelhead

Steelhead do not occur in large numbers along the NBK Bangor waterfront. Juvenile steelhead caught in beach seines since June of 2006 were the sixth most abundant of the salmonids captured. Steelhead are less likely than other salmonids to use the nearshore. Steelhead however occur most frequently in the late spring and summer months. WDFW suggests that juvenile out-migration in Hood Canal occurs from March through June, with peak out migration during April and May. Returning adult steelhead appear between February and June. Therefore, while perhaps less likely to be present during in-water work than Chinook, the potential still exists for a juvenile steelhead to be present further offshore in the deeper water, but still within the zones of injury during the early summer months. Therefore, a may affect, likely to adversely affect determination is warranted.

Bull Trout

Bull trout require snow-fed glacial streams and since there are none on the Kitsap Peninsula they would not be expected in any streams on NBK Bangor nor in any streams on the Kitsap Peninsula. They are present in streams on the Olympia Peninsula which drains to Hood Canal and thus they are present in the marine waters along the western shoreline. They are not known to move as far north as the Toandos Peninsula shoreline due west of NBK Bangor. Proposed critical habitat ends at the southern tip of Toandos Peninsula. As such, bull trout are not likely to be present in the project area, but cannot be completely dismissed because they are present in southern Hood Canal rivers. Therefore a may affect, not likely to adversely affect determination is warranted.

Rockfish

Due to the habitat characteristics of Hood Canal, the closest adult ESA-listed rockfish are likely several thousand feet away within waters deeper than 120 feet (37 m), and are not expected to be affected by project activities due to the distance of the project and attenuation of sound. It is possible that a few larval yelloweye rockfish, canary rockfish and bocaccio occur within the water column of the project area, and could be harmed or killed from the effects of pile driving. The number of injured or killed ESA-listed rockfish is expected to be very small because larval rockfish are readily dispersed by currents after they are born, making the concentration of larvae in any one location extremely small (NMFS 2003). Injury or death of individual fish might lower abundance within a specific cohort exposed to the pile driving, but not to the extent that population abundance would be appreciably changed. For instance, larval yelloweye rockfish, canary rockfish and bocaccio have an extremely low survival rate under fluctuating habitat conditions in most years (Love et al., 2002), and the birth of up to two million larvae per female is an adaptation to this high mortality rate. Thus the death of several larvae would not be expected to have consequence to the viability of the DPSs of each species of ESA-listed rockfish. So, while it is anticipated that individual fish in the populations will be negatively affected, it is not expected to reach a level or degree that affects population viability. Although the number of affected fish cannot be reasonably estimated, the percentage will be so small as to not affect the abundance, productivity, or spatial structure of the PS/Georgia Basin DPSs of yelloweye rockfish, canary rockfish or bocaccio. The injury or death of a small number of larval ESA-listed rockfish in the project area would not increase the risk of viability of the DPSs of each species. Therefore a may affect, likely to adversely affect determination is warranted.

Green Sturgeon

Green sturgeon are present in non-natal estuaries (including those in Washington) from June through October, thus the timing of the proposed project overlaps with the time when green sturgeon would most likely be in the Puget Sound estuary. However, their occurrence in Puget Sound remains rare and they are not expected to be present in Hood Canal. Therefore, the rare occurrence of this species in Puget Sound, along with limiting the work to within 40 days, makes it unlikely and therefore discountable that they would be exposed to sounds from the project. As such, a no effect determination is warranted because the species is not likely to be in the action area.

Pacific Eulachon/Smelt

Eulachon were thought to be caught in low numbers (six individuals in 2006) along the NBK waterfront in recent forage fish surveys. However, there is currently NMFS uncertainty on the species identification of the fish that were thought to be eulachon. In 2005 zero eulachon were identified, in 2006 six were thought to be present, in 2007 there were none identified, and in 2008 two were identified. Assuming that the identifications were correct, their presence in the action area is still rare and would be unexpected during this project. A recent WDFW technical report entitled "Marine Forage Fishes in Puget Sound" presents detailed data on the biology and status and trends of surf smelt and longfin smelt in Puget Sound, but states that "there is virtually no life history information within the Puget Sound Basin" available for eulachon (BRT 2010).

Therefore, the rare occurrence of this species in Hood Canal, along with limiting the work to within 40 days, makes it unlikely and therefore discountable that they would be exposed to sounds from the project. As such, a no effect determination is warranted because the species is not likely to be in the action area.

3.8.2.2.3 Non-ESA Listed Fish

Marine fish species that are found near the project area and share the same habitats as salmonids and would experience project-related impacts from operation of the Test Pile Program similar to those described for salmonids above.

The underwater noise thresholds for fish behavior, adopted by NMFS and U.S. Fish and Wildlife Service (USFWS) (Fisheries Hydroacoustic Working Group, 2008), are presented in Table 3.19. During the allowable in-water work period, some of the most abundant non-salmonid or forage fish species captured in the waters include Pacific herring, surf smelt, juvenile and adult shiner perch, juvenile English sole, gunnels, pricklebacks, sticklebacks, and sculpin (SAIC, 2006). To help protect these fish, a soft-start approach, using the pile driver, will be tested to see if lower initial sound pressure levels will encourage fish to move away from the immediate project area before pile driving is at its maximum level (see Section 4.3), further reducing the number of fish potentially exposed to harmful levels of underwater sound.

Average underwater baseline noise levels acquired near the NBK Bangor Marginal Wharf facility, which is near the project area, were measured at a level of 114 dB rms re 1μPa (Slater, 2009). Sound during impact pile driving would be detected above the average background noise levels at any location in Hood Canal with a direct acoustic path (i.e., "line of sight" from the driven pile to the receiver location). To the west of the project area, Toandos Peninsula bounds the extent of sound travel within the construction area; thus, geography would not allow direct sound path propagation south of Brown Point, nor north of Termination Peninsula at the western terminus of Hood Canal Bridge adjacent to Squamish Harbor. Locations beyond these points would receive substantially lower noise levels since there is no direct sound path, and thus no impacts would be observed.

Some fish may avoid the area, particularly closer to pile driving activities, or alter their normal behavior while in this area. However, studies have shown that some fish species may habituate to underwater noise (Feist, 1991; Feist et al., 1992; Ruggerone et al., in prep.), and would continue to occur within the behavioral disturbance zone (out to a distance of 2,154 meters [1.34 miles] for impact pile driving and a distance of 1,000 meters [0.62 miles] for vibratory pile driving). These impacts would be minimized by observation of the work window (July 16 to February 15) and allowable pile driving times (6:00 am to 6:00 pm).

3.8.2.2.4 Essential Fish Habitat

The Pacific Fisheries Management Council (PFMC) is responsible for designating essential fish habitat (EFH) for all federally managed species occurring in the coastal and marine waters off the coasts of Washington, Oregon, and California, including the Puget Sound. The PFMC designated EFH for these species within the fishery management plans (FMPs) for each of the four primary fisheries that they manage: Pacific Coast Groundfish, Pacific Coast Salmon, Coastal Pelagic Species, and West Coast Fisheries for Highly Migratory Species (PFMC, 1998a; 2003; 2007; 2008). Of these fisheries, only three (groundfish, salmon, and coastal pelagic species) contain species for which EFH has been designated within Hood Canal or in the vicinity of NBK Bangor.

The Navy has prepared an Essential Fish Habitat Assessment for the Test Pile Program at the NBK Bangor waterfront. This assessment can be found in Appendix E of this document. A summary of the designated EFH within the vicinity of NBK Bangor and the conclusions regarding potential impacts to EFH are described below.

Groundfish

Pacific coast groundfish species are considered sensitive to over-fishing, the loss of habitat, and water and sediment quality (PFMC, 2008). The groundfish EFH consists of the aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and for groundfish contributions to a healthy ecosystem (PFMC, 2008). The PFMC (2008) identifies the overall area designated as groundfish EFH for all species covered in the FMP as all waters and substrate within "depths less than or equal to 3,500 m [~ 11,500 feet] to mean higher high water level (MHHW) or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow." Furthermore, the PMFC (2008) has also designated EFH for each individual groundfish species by life stage. These designations are contained within Appendix B of the Pacific Groundfish FMP (PFMC, 2008). Using the Pacific Habitat Use Relational Database (HUD) developed by the PFMC, it was determined which groundfish species and life stages have EFH designated within the vicinity of the Test Pile Program site. The management unit in the Pacific Coast Groundfish FMP includes 83 groundfish species (PFMC, 2008). Of these, 32 were identified through the analysis of the HUD as having EFH designated in the vicinity of NBK Bangor. Based on the analysis, the primary habitats designated as EFH for these species include:

- The epipelagic zone of the water column, including macrophyte canopies and drift algae;
- Unconsolidated sediments consisting of mud, sand, or mixed mud/sand;
- Hard bottom habitats composed of boulders, bedrock, cobble, gravel, or mixed gravel/cobble;
- Mixed sediments composed of sand and rocks; and
- Vegetated bottoms consisting of algal beds, macrophytes, or rooted vascular plants.

Salmon

The salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters of Washington, Oregon, and California north of Point Conception out to the exclusive economic zone (200 miles) offshore (PFMC, 2003). In addition to the marine and estuarine waters, salmon species have a defined freshwater EFH, which includes all lakes, streams, ponds, rivers, wetlands, and other bodies of water that have been historically accessible to salmon (PFMC, 2003), including the waters of NBK Bangor. For the Pacific salmon fishery, EFH (which includes Hood Canal), is identified using U.S. Geological Survey (USGS) hydrologic units, as well as habitat association tables and life history descriptions of each life stage (PFMC, 2003). Pacific salmon species EFH is primarily affected by the loss of suitable spawning habitat, barriers to fish migration (habitat access), reduction in water and sediment quality, changes in estuarine hydrology, and decreases in prey food source (PFMC, 2003).

Coastal Pelagic Species

The EFH designations for coastal pelagic species are based on the geographic range and in-water temperatures where these species are present during a particular life stage (PFMC, 1998a). Specific EFH boundaries (i.e., the habitat necessary to provide sufficient fishery production) are based on best available scientific information and described in the Coastal Pelagics Fishery Management Plan (PFMC, 1998b). These boundaries include the waters of NBK Bangor. Two species identified as coastal pelagic species are known to occur in Hood Canal waters: northern anchovy and market squid (SAIC, 2006; Bhuthimethee et al., 2009). Aside from their value to commercial Pacific fisheries, coastal pelagic species are also recognized for their importance as food for other fish, marine mammals, and birds (63 FR 13833). Coastal pelagic species are considered sensitive to overfishing, the loss of habitat, reduction in water and sediment quality, and changes in marine hydrology, including entrainment through water intakes (PFMC, 1998b).

Habitat Areas of Particular Concern Designations

In addition to designating EFH, the PMFC is also responsible for identifying Habitat Areas of Particular Concern (HAPC) for federally managed species. Out of the four fisheries managed by the PFMC, HAPC have only been identified for groundfish. The four HAPC designated for these species include seagrass, canopy kelp, rocky reef, and estuarine habitats along the Pacific coast, including Puget Sound. Two of these HAPC, estuarine habitats and seagrass, are located within the vicinity of the Test Pile Program project area.

Impacts to Essential Fish Habitats

The primary impact during the proposed Test Pile Program will be the level of increased sound energy in the water. The effects to fish caused by the increased noise levels include disturbance, avoidance, injury, and even death. The level of impact is directly proportionate to the distance between the fish and the sound source. The Navy has adopted a number of mitigation measures and operational guidelines to reduce the level of impact pile driving operations will have on marine fish in the vicinity. Because the piles being driven are hollow steel piles, in accordance with the conservation measures set forth by NMFS (2004), the Navy will use a vibratory hammer to drive each pile into the sediment to the deepest extent possible. However, due to the need to conduct load bearing tests, each pile will be driven the final 3 to 4.5 meters (10 to 15 feet) using an impact hammer. To limit the amount of ensonification of the water resulting from the impact hammering, sound attenuation devices (e.g., Gunderboom SAS™, bubble curtain/wall) will be utilized during all impact hammering operations to reduce the transmission of the sound through the water column. Furthermore, the use of impact hammers will be limited to 100 strikes per day. In addition to these measures, all work will be limited to the in-water work window of July 16 through February 15 when juvenile salmon are not typically present within the vicinity of the proposed project area. These measures, in conjunction with the short duration of the proposed project (40 days) should greatly reduce the impact of the noise levels as a result of the pile driving activities.

The installation and subsequent removal of the piles, will have a localized impact on marine vegetation and the benthic epifauna/infauna within the immediate vicinity of each pile or anchoring site. However, to minimize impacts to marine vegetation, all except one of the test piles have been placed to avoid eelgrass and kelp beds along the NBK Bangor waterfront. While some disruption to marine vegetation and benthic communities is unavoidable as a result of the placement and recovery of the test piles, these impacts will be temporary in duration, with a minimal and localized zone of influence. Areas of disruption are expected to recover to pre-disruption levels within a single growing season.

The water column may experience increased sedimentation and turbidity during operational periods. However, due to the relatively low levels of organic contaminants and metals contained within the sediments at NBK Bangor, there will be temporary and minimal degradation of the water column, with little to no impact on DO levels in the vicinity of the proposed project area.

Overall, due to the temporary nature of the activities and the minimal level of impact, in light of the proposed mitigation measures and work guidelines for the project, the activities associated with the proposed Test Pile Program will not have an adverse affect on designated EFH or marine fish species within the vicinity of NBK Bangor and Hood Canal.

3.8.2.2.5 Summary of Effects

Individual fish may be exposed to sound pressure levels during pile driving operations at NBK Bangor which may result in behavioral disturbance depending on the distance of fish to sound source. Any fish which are behaviorally disturbed, may change their normal behavior patterns (i.e., swimming speed or direction, foraging habits, etc.) or be temporarily displaced from the area of construction. Any exposures would likely have only a minor effect and temporary impact on individuals and would not result in population level impacts. Adherence to mitigation measures and regulatory compliance will likely avoid most potential adverse underwater impacts to fish from pile driving. Nevertheless, some level of impact is unavoidable.

Endangered Species Act Conclusions

The following factors do allow one to conclude that the numbers of fish exposed to underwater noise, and thus to potential injury and death, will be very small: (1) The activity occurs when few Chinook salmon, steelhead, and Hood Canal summer chum are present, (2) steelhead don't use nearshore habitat in the project area, (3) there are very few juvenile or larval yelloweye rockfish, canary rockfish and bocaccio anywhere at any time, and (4) the project area is a very small proportion of the total area occupied by the listed fish. Given these considerations, the Navy expects very small numbers of Puget Sound Chinook salmon, Puget Sound steelhead, Hood Canal summer-run chum, and ESA-listed rockfish to be present during the in-water work window and fewer of those to be exposed to sound levels that would elicit adverse behavioral or physical responses. The bull trout would not be affected as a result of the proposed action. A may affect, likely to adversely affect determination has been made for the Pacific Sound Chinook salmon, Hood Canal Summer-run chum salmon, Puget Sound Steelhead, and the rockfish.

Magnuson-Stevens Fishery Conservation and Management Act Conclusions

Impacts to essential fish habitat (EFH) designated by the Magnuson-Stevens Fishery Conservation and Management Act would be minimal. However, while some disruption to marine vegetation and benthic communities is unavoidable as a result of the placement and recovery of the test piles, these impacts will be temporary in duration, with a minimal and localized zone of influence. Areas of disruption are expected to recover to pre-disruption levels within a single growing season.

Overall, due to the temporary nature of the activities and the minimal level of impact, in light of the proposed mitigation measures and work guidelines for the project, the activities associated with the proposed Test Pile Program will not have an adverse affect on designated EFH or marine fish species within the vicinity of NBK Bangor and Hood Canal.

National Environmental Policy Act Conclusions

The analysis presented above indicates that pile driving activities associated with the Navy's proposed Test Pile Program at NBK Bangor may have impacts to individual fish species, but any impacts observed at the population, stock, species, or evolutionary significant unit level would be negligible. Therefore, in accordance with NEPA, there would be no significant impact to fish from the Test Pile Program with implementation of mitigation measures in Section 4.3.

3.9 MARINE MAMMALS

There are ten marine mammal species, six cetaceans and four pinnipeds, which inhabit the inland waters of Washington State. Of these, only six may inhabit or transit through the waters nearby NBK Bangor in Hood Canal. These include the killer whale, harbor porpoise, Dall's porpoise, Steller sea lion, California sea lion, and the harbor seal. The Steller sea lion is the only marine mammal that occurs within the Hood Canal which is listed under the Endangered Species Act (ESA); The U.S. Eastern stock/ DPS is listed as threatened. While the Southern Resident killer whale (SRKW), which is listed as endangered under the ESA, is resident to the inland waters of Washington State and British Columbia it has not been observed in the Hood Canal in decades. However, due to the occurrence of its primary prey species (salmonids) within the Hood Canal this species has been carried forward in the analysis. All marine mammal species are protected under the Marine Mammal Protection Act (MMPA).

The other four species, the humpback whale, the gray whale, the minke whale, and the Northern elephant seal are more prevalent off the coast of Washington or in the Strait of Juan de Fuca or Puget Sound. Their occurrence within Hood Canal has been limited to an occasional sighting over the last several decades. As such, these species will not be considered further in the analysis. Table 3.20 lists the marine mammal species that could occur in the vicinity of NBK Bangor and their estimated densities within the project area.

TABLE 3.20 MARINE MAMMALS HISTORICALLY SIGHTED IN HOOD CANAL IN THE VICINITY OF NBK BANGOR

SPECIES	STOCK(S) ABUNDANCE[1]	RELATIVE OCCURRENCE IN HOOD CANAL, WASHINGTON	SEASON(S) OF OCCURRENCE	DENSITY IN THE WARM SEASON (INDIVIDUALS PER KM^2)[a]
Steller sea lion *Eumetopias jubatus* Eastern U.S. stock/DPS	48,519[2]	Rare to occasional use	Fall to late spring (Nov – mid April)	0.00
California sea lion *Zalophus californianus* U.S. Stock	238,000[4]	Common	Fall to late spring (Aug – May)	0.410[c]
Harbor seal *Phoca vitulina* WA inland waters stock	14,612[3] (CV = 0.15)	Common	Year-round; resident species in Hood Canal	1.31[b]
Killer whale *Orcinus orca* West Coast transient stock & Eastern North Pacific Southern Resident stock	314[5]	Rare to occasional use	Year-round	0.038[d]
	88[3, 8]	Not present in Hood Canal	Not applicable	0.00

TABLE 3.20 MARINE MAMMALS HISTORICALLY SIGHTED IN HOOD CANAL IN THE VICINITY OF NBK BANGOR (continued)

SPECIES	STOCK(S) ABUNDANCE[1]	RELATIVE OCCURRENCE IN HOOD CANAL, WASHINGTON	SEASON(S) OF OCCURRENCE	DENSITY IN THE WARM SEASON (INDIVIDUALS PER KM^2)[a]
Dall's porpoise *Phocoenoides dalli* CA/OR/WA stock	48,376[3] (CV = 0.24)	Rare to occasional use	Year-round	0.043[e]
Harbor porpoise *Phocoena phocoena* WA inland waters stock	10,682[3] (CV=0.38)	Rare to occasional use	Year-round	0.011 [e]

Sources: [1] NMFS marine mammal stock assessment reports at: http://www.nmfs.noaa.gov/pr/sars/species.htm [2] Angliss and Outlaw, 2008; [3] Carretta *et* al., 2008; [6] Carretta *et* al., 2007; [7] Allen and Angliss, 2010; [8] NMFS 2010 – OPR website; [a]Warm season refers to the period from May – Oct; [b] Jeffries et al., 2003 and Huber et al., 2001; [c] DoN, 2010a and Jeffries et al., 2000; [d] London, 2006; [e] Agness and Tannenbaum, 2009a.

3.9.1 Affected Environment

3.9.1.1 Regulatory Overview

Endangered Species Act

See section 3.8.1.1 for a description of the ESA.

Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 established, with limited exceptions, a moratorium on the "taking" of marine mammals in waters or on lands under U.S. jurisdiction. The Act further regulates "takes" of marine mammals in the global commons (i.e., the high seas) by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 USC 1362) of the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." "Harassment" was further defined in the 1994 amendments to the MMPA, which provided two levels of "harassment," Level A (potential injury) and Level B potential disturbance).

In terms of the proposed action, 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] (50 C.F.R, Part 216, Subpart A, Section 216.3-Definitions).

Level A is the more severe form of harassment because it may result in injury, whereas Level B only results in disturbance without the potential for injury (Norberg pers. comm. 2007a).

Section 101(a) (5) of the MMPA directs the Secretary of the Department 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 (exclusive of commercial fishing), if certain findings are made and regulations are issued. Permission will be granted by the Secretary for the incidental take of marine mammals if the taking will have a negligible impact on the species or stock and will not have an unmitigable adverse impact on the availability of such species or stock for taking for subsistence uses.

3.9.1.2 ESA-Listed Marine Mammals

Steller Sea Lion

Status and Management

The Steller sea lion is protected under the MMPA and was originally listed as threatened under the ESA in 1990. In 1997, NMFS re-classified Steller sea lions as two subpopulations. There are two distinct populations of Steller sea lions based on genetics and population trends, separated at 144°W longitude (Loughlin, 1997; Angliss and Outlaw, 2005). Steller sea lions west of 144°W longitude residing 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) are part of the Western U.S. Stock. The Eastern U.S. stock, which is the population that may occur within the project area, includes the animals east of Cape Suckling, Alaska (144°W) (NMFS, 1997; Loughlin, 2002; Angliss and Outlaw, 2005). The Eastern U.S. stock breeds on rookeries (places where they give birth and mate) located in southeast Alaska, British Columbia, Oregon, and California; there are no rookeries located in Washington. The re-classification in 1997, listed the Western Stock listed as endangered under the ESA, and maintained the threatened status for the Eastern stock (NMFS, 1997). There is a final revised species recovery plan that addresses both stocks (NMFS, 2008a).

Critical Habitat

Critical habitat has been designated for the Steller sea lion (NMFS, 1993). Critical habitat includes so-called "aquatic zones" that extend 3,000 ft (1 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 for the species in Washington.

Distribution

Steller sea lions are found along the coasts of Washington, Oregon, and northern California where they occur at breeding rookeries and numerous haulout locations along the coastline (Jeffries et al., 2000; Scordino, 2006). From breeding rookeries in northern California (St. George Reef) and southern Oregon (Rogue Reef), male Steller sea lions often disperse widely outside of the breeding season (Scordino, 2006). Based on mark recapture sighting studies, males migrate back into these Oregon and California locations from winter feeding areas in Washington, British Columbia, and Alaska (Scordino, 2006).

In Washington, Steller sea lions use haulout sites primarily along the outer coast from the Columbia River to Cape Flattery, as well as along the Vancouver Island side of the Strait of Juan de Fuca (Jeffries et al., 2000). Numbers vary seasonally in Washington with peak numbers present during the fall and winter months (Jeffries et al., 2000). Steller Sea lions are occasionally present in the Puget Sound at the Toliva Shauls haul-out site in south Puget Sound (Jeffries et al., 2000). At NBK Bangor, Steller sea lions were observed hauled out on submarines at Delta Pier on several occasions from 2008 through 2010 during winter and spring months (Bhuthimethee, 2008, personal communication; Walters, 2010, personal communication). Steller sea lions likely occupy habitats in Hood Canal similar to those of the California sea lion and harbor seal, which include marine water habitats for foraging and manmade structures for haul out.

Population Abundance

The U.S. Eastern stock was estimated to number between 46,000 and 58,000 animals in 2002, and has been increasing approximately 3 percent per year since the late 1970s (NMFS, 2008a; Pitcher et al., 2007). The most recent population estimate for the Eastern North Pacific stock of the Steller sea lion, which occurs along the WA coast and Puget Sound, is 48,519 individuals (Angliss and Outlaw, 2008). Although Steller sea lions have been documented in Hood Canal, the numbers (at least at present) are still fairly low. Steller sea lions are present in Hood Canal, but are only expected as far as the project area during November through mid-April. The Navy conducted daily waterfront surveys during April 2008 –June 2010 off the docks at NBK Bangor and recorded the number of sea lions hauled out on the submarines. The monthly average number hauled out ranged from 1 – 5 individuals during November through April, with a daily maximum of 6 sea lions hauled out during the cold season (DoN, 2010a). No in-water abundance estimates are available for the project area.

Behavior and Ecology

Steller sea lions are opportunistic predators, feeding primarily on fish and cephalopods, and their diet varies geographically and seasonally (Merrick et al., 1997). Foraging habitat is primarily shallow, nearshore and continental shelf waters; some Steller sea lions feed in freshwater rivers (Reeves et al., 1992; Robson, 2002). They also are known to feed in deep waters past the continental shelf break (Jefferson, 2005). 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). Haulout and rookery sites are located on isolated islands, rocky shorelines, and jetties. Steller sea lions also haul out on buoys, rafts, floats, and Navy submarines in Puget Sound (Jeffries et al., 2000, DoN, 2001a). In the Pacific Northwest, breeding rookeries are located in British Columbia, Oregon, and northern California. There are no rookeries in Washington (NMFS, 1992b; Angliss and Outlaw, 2005).

Acoustics

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). Mulsow and Reichmuth (2008) measured the unmasked aerial hearing sensitivity of one male Steller sea lion. The range of best hearing sensitivity was between 5 and 14.1 kHz (Mulsow and Reichmuth, 2008). Maximum sensitivity was found at 10 kHz, where the subject had a mean threshold of 7 dB re 20 µPa.

The underwater hearing of two Steller sea lions have been tested, the hearing threshold of the male was significantly different from that of the female. The range of best hearing for the male was from 1 to 16 kHz, with maximum sensitivity (77 dB re 1 µPa-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 1 µPa-m) at 25 kHz. However, because of the small number of animals tested, the findings could not be attributed to individual differences in sensitivity or sexual dimorphism (Kastelein et al., 2005).

Southern Resident Killer Whale

Status and Management

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, 2005a). The three distinct forms or types of killer whales recognized in the North Pacific Ocean are: 1) Residents, 2) Transients, and 3) Offshores. Resident killer whales in the North Pacific consists of the following populations; (1) Southern residents; (2) Northern residents; (3) Southern Alaska residents; and (4) Western Alaska North Pacific residents. The Southern Resident killer whale (SRKW) stock occurs in the inland waters of Washington and southern British Columbia, but not within Hood Canal, and is comprised of three pods, identified as the J, K, and L pods. The SRKW is protected under the MMPA and was listed as endangered under the ESA in 2005 (NMFS 2005; 70 FR 69903). A recovery plan was approved for the SRKWs in 2008 (NMFS 2008; 73 FR 4176).

Critical Habitat

Critical habitat was designated for the SRKW in 2006 (NMFS, 2006; 71 FR 69054). Critical habitat was designated for three specific areas (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca, which comprises approximately 2,560 sq. miles (6,630 sq. km) of marine habitat (NMFS 2006). There is no designated critical habitat for the species in the Hood Canal.

Distribution

The geographical range of SRKW includes the inland waters of Washington State and British Columbia (Strait of Georgia, Strait of Juan de Fuca, and Puget Sound), principally during the later spring, summer, and fall (Bigg 1982; Ford et al. 2000). The complete winter range of this stock is uncertain. The J pod spends much of the winter and early spring in inland waters, while the K and L pods tend to move to coastal areas during this period (Ford et al. 2000). The three pods visit coastal sites off Washington, and Vancouver island, but travel as far south as central California and as far north as the Queen Charlotte Islands. Offshore movements and distribution are largely unknown for the SRKWs (NMFS 2006).

Southern Resident killer whales (J pod) have been documented in the Hood Canal in the past. They were identified in the Hood Canal by sound recordings in 1958 (Ford 1991) and 1995 (Unger 1997), a photograph from 1973, and anecdotal accounts of historical use, but these latter sightings may have been transient whales (NMFS 2008b). It is not known whether these sightings reflect evidence of regular use or whether J Pod only rarely strayed into Hood Canal. Therefore, since NMFS could not confirm any evidence of SRKWs in Hood Canal waters since 1995, the agency concluded that available evidence did not support Hood Canal as "within the geographical area occupied by the species at the time of listing" (NMFS 2008b).

Population Abundance

The Southern Resident killer whale stock is a trans-boundary stock, including killer whales in inland Washington and southern British Columbia waters. According to the most recent NMFS stock assessment report, the 2007 population survey recorded 86 whales amongst the three pods (Caretta et al. 2008). Two additional calves have been observed since the fall 2007 surveys resulting in a total maximum population of 88 individuals (NMFS 2010).

Behavior and Ecology

While in the inshore waters of southern British Columbia and Washington, the SRKWs spend 95 percent of their time underwater, nearly all of which is between the surface and a depth of 30 meters (Baird 2000; Baird et al 2003; 2005). Fish are the major dietary component of resident killer whales in the northeastern Pacific, with 22 species of fish and one species of squid (*Gonatopsis borealis*) known to be eaten (Scheffer and Slipp 1948; Ford et al. 1998; 2000; Saulitis et al. 2000; Ford and Ellis 2006). Known feeding records for the SRKWs suggest a strong preference for Chinook salmon (78 percent of identified prey) during late spring to fall (Hanson et al. 2005; Ford and Ellis 2006). Chum salmon were also taken in significant amounts (11 percent), especially in the autumn. Other species such as coho (5 percent), steelhead (*O. mykiss,* 2 percent), sockeye (*O. nerka*, 1 percent), and non-salmonids (*e.g.* Pacific herring and quillback rockfish [*Sebastes maliger*] 3 percent combined) are also consumed. Little is known about the winter and early spring foods of SRKWs (NMFS 2008b). Resident killer whales travel in small, matrilineal groups, which contain one to seventeen (mean = 5.5) individuals spanning one to five generations. In the North Pacific, most mating is believed to occur from April to October (Nishiwaki 1972; Olesiuk et al. 1990a; 2005; Matkin et al. 1997). Estimates of calving intervals in SRKW population average between 4.9-7.7 years. The gestation period lasts about 17 months, with births peaking in late Fall (Sept. to Dec.) (Olesiuk et al. 2005). Calves are dependent on their mothers for the first couple years of their lives.

Acoustics

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

Both behavioral and auditory brainstem response technique indicate killer whales can hear in a frequency range of 1 to 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).

3.9.1.3 Non-ESA Listed Marine Mammals

California Sea Lion

Status and Management

The California sea lion is protected under the MMPA. Three geographic regions are used to separate this species into stocks: (1) the United States stock, which begins at the U.S./Mexico border and extends northward into Canada; (2) the Western Baja California stock which extends from the U.S./Mexico border to the southern tip of the Baja California Peninsula; and (3) the Gulf of California stock which includes the Gulf of California from the southern tip of the Baja California Peninsula and across to the mainland, extending into southern Mexico (Lowry et al., 1992). Only the United States stock is expected to occur in the vicinity of NBK Bangor.

Distribution

The geographic distribution of California sea lions includes a breeding range from Baja California 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 miles (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, 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).

Although there are no regular California sea lion haulouts within Hood Canal (Jeffries et al., 2000), they often haul out at several opportune areas. They are known to utilize man-made structures such as piers, jetties, offshore buoys, and oil platforms (Riedman, 1990). California sea lions in the Puget Sound even haul out on log booms and U.S. Navy submarines, and are often seen rafted off river mouths (Jeffries et al., 2000; DoN, 2001). As many as 40 California sea lions have been observed hauled out at NBK Bangor on manmade structures – submarines, the floating security fence, and barges (Agness and Tannenbaum, 2009a; Tannenbaum et al., 2009a; Walters, 2009, personal communication). California sea lions have also been observed swimming in 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, 2001).

Population Abundance

The U.S. stock of California sea lions is the stock that may occur in the marine waters nearby NBK Bangor. The estimated stock is 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 haulout 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). An estimated 3,000 to 5,000 California sea lions migrate to Washington and British Columbia waters during the non-breeding season from September to May (Jeffries et al., 2000). Peak numbers of up to 1,000 sea lions occur in Puget Sound (including Hood Canal) during this time period (Jeffries et al., 2000).

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 hake, walleye pollock, herring, and spiny dogfish (Calambokidis and Baird, 1994; London, 2006). In some locations where sea lions and salmon runs exist, California sea lions also feed on returning adult and out-migrating juvenile salmonids (London, 2006). California sea lions are gregarious during the breeding season and social on land during other times.

Acoustics

In air, 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 to 5 kHz, while pups make bleating sounds at 0.25 to 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 and 28 kHz (Schusterman et al., 1972). Functional underwater high frequency hearing limits are between 35 and 40 kHz, with peak sensitivities from 15 to 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 to 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 noise levels of 65 to 70 dB above the animal's threshold produced an average temporary threshold shift (TTS), a short-term effect possibly including temporary hearing loss, of 4.9 dB in the California sea lion (Kastak et al., 1999). Center frequencies were 1,000 hertz (Hz) for corresponding threshold testing at 1000 Hz and 2,000 Hz for threshold testing at 2,000 Hz; the duration of exposure was 20 minutes.

Harbor Seal

Status and Management

The Harbor seal is protected under the MMPA. Harbor seals inhabit coastal and estuarine waters and shoreline areas from Baja California to western Alaska. Three distinct stocks exist: 1) inland waters of Washington State (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 state stock is the only stock that may occur in the marine waters near NBK Bangor.

Distribution

Harbor seals occur throughout Hood Canal and are seen relatively commonly in the area. They are year-round, non-migratory residents, and pup (give birth) in Hood Canal. Surveys in 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 NBK Bangor in every month of surveys conducted from 2007 to 2010 (Agness and Tannenbaum, 2009b; Tannenbaum et al., 2009b). On the NBK Bangor waterfront, harbor seals have not been observed hauling out in the intertidal zone, but have been observed hauled out on manmade 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, with the closest haul-out area to the project area being 10 miles southwest of NBK Bangor at Dosewallips River Mouth (London, 2006).

Population Abundance

Estimated population numbers for the inland waters of Washington, including Hood Canal, Puget Sound, and the Strait of Juan de Fuca out to Cape Flattery are 14,612 (CV = 0.15) individuals (Carretta et al., 2007). The Harbor seal is the only species of marine mammals that is consistently abundant and considered resident in Hood Canal (Jeffries et al., 2003). The population of harbor seals in Hood Canal is a closed population, meaning 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).

Behavior and Ecology

Harbor seals are rarely found more than 12 miles (20 km) from shore, and frequently occupy bays, estuaries, and inlets (Baird, 2001). Individual seals have been observed several miles upstream in coastal rivers. 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). 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 NBK Bangor, including Pacific hake and Pacific herring and adult and out-migrating juvenile salmonids. Harbor seals in Hood Canal are known to feed on returning adult salmon, including threatened summer-run chum. Over a five year study of harbor seal predation in Hood Canal, the average percent escapement of summer-run chum consumed was 8 percent (London, 2006).

Ideal harbor seal habitat includes haulout sites, shelter during the breeding periods, and sufficient food (Bjorge, 2002). Haulout areas can include intertidal and subtidal rock outcrops, sandbars, sandy beaches, peat banks in salt marshes, and manmade 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 mate at sea and females gave 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 40 percent of their time in the water (Bowen et al., 1999).

Acoustics

In air, harbor seal males produce a variety of low-frequency (<4 kHz) vocalizations, including snorts, grunts, and growls. Male harbor seals produce communication sounds in the frequency range of 100 to 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 low frequency (100 Hz) sound detection thresholds in air at 65.4 dB re 20 µPa for harbor seal. In air, they hear frequencies from 0.25 kHz to 30 kHz and are most sensitive from 6 to 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 0.025 to 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 to 75 kHz (Southall, 2007) and can detect sound levels as weak as 60 to 85 dB re 1 µPa within that band. They are most sensitive at frequencies below 50 kHz; above 60 kHz sensitivity rapidly decreases.

West Coast Transient Killer Whale

Status and Management

Three distinct forms of killer whales, termed residents, transients, and offshores are recognized in the northeastern Pacific Ocean (NMFS 2006). Within the transient ecotype, 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, and 3) West Coast transients. Among the genetically distinct assemblages of transient killer whales, only the West Coast Transient stock, which occurs from southern California to southeastern Alaska, may occur in the project area. The transient killer whale is protected under the MMPA.

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 (11 and 6 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.

Population Abundance

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 314 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 20 individuals (Wiles, 2004).

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 10 animals and their social organization generally is more flexible than the resident killer whale (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 to 25 kHz (dominant frequency range: 1 to 6 kHz) (Thomson and Richardson, 1995; Richardson et al., 1995). Source levels of echolocation signals range between 195 and 224 dB re 1 μPa-m peak-to-peak, dominant frequencies ranging from 20 to 60 kHz, and durations of about 0.1 sec (Au et al., 2004). Source levels associated with social sounds have been calculated to range between 131 to 168 dB re 1 μPa-m and vary with vocalization type (Veirs, 2004).

Both behavioral and auditory brainstem response technique indicate killer whales can hear in a frequency range of 1 to 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

Status and Management

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

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°N and 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 porpoise in southern California waters only in the winter, generally when the water temperature was less than 15°C. 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 porpoise 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 porpoise could include the marine habitats found in the inland marine waters of Hood Canal. A Dall's porpoise was observed in the deeper water at NBK Bangor in summer 2008 (Tannenbaum et al., 2009a).

Population Abundance

The NMFS population estimate, recently updated in 2008 for the California/Oregon/Washington stock, is 48,376 (CV – 0.24) which is based on vessel line transect surveys by Barlow and Forney (2007) and Forney (2007) (Carretta et al., 2008). Additional numbers of Dall's porpoise occur in the inland waters of WA state, but the most recent estimate obtained in 1996 (900 animals; CV = 0.40) is over 10 years old (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.

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 eelpout, herring, Pollock, whiting, and sand lance (Walker et al., 1998). Groups of Dall's porpoises generally include fewer than 10 individuals and are fluid, probably aggregating for feeding (Jefferson, 1990; 1991, Houck and Jefferson, 1999). 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 porpoise breed in Puget Sound from August to September.

Acoustics

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

Harbor Porpoise

Status and Management

The Harbor porpoise is protected under the MMPA. Based on genetic data and density discontinuities identified from aerial surveys, NMFS identifies 8 stocks in the Northeast Pacific Ocean. Pacific coast harbor porpoise stocks include: 1) a Monterey Bay stock, 2) a San Francisco-Russian River stock, 3) a northern California/southern Oregon stock, 4) an Oregon/Washington coast stock, 5) an Inland Washington stock, 6) a Southeast Alaska stock, 7) a Gulf of Alaska stock, and 8) a Bering Sea stock. Only individuals from the Inland waters of Washington stock may occur in the project area.

Distribution

Harbor porpoise are generally found in cool temperature 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 coastal shallow 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 may occasionally occur in Hood Canal (Jeffries, 2006, personal communication). Harbor porpoise observations in northern Hood Canal have increased in recent years (Calambokidis, 2010, personal communication). A harbor porpoise was seen in deeper water at NBK Bangor during 2010 field observations (SAIC staff observations, 2010).

Population Abundance

Aerial surveys of the inside 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 porpoise as well as harbor porpoise 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, using a correction factor of 3.42 (1/g(0); g(0)=0.292, CV=0.366) (Laake et al., 1997), the estimated abundance for the Washington Inland Waters stock of harbor porpoise is 10,682 (CV=0.38) animals (Carretta et al., 2008).

Behavior and Ecology

Harbor porpoises are non-social animals usually seen in small groups of 2 to 5 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 porpoise primarily feed on Pacific herring (*Clupea pallasii*), market squid and smelts (Gearin et al., 1994). Females 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 to 150 kHz, with source levels of 135 to 177 dB re 1 μPa-m (Ketten, 1998). Echolocation signals include one or two low-frequency components in the 1.4 to 2.5 kHz range (Verboom and Kastelein, 1995).

A behavioral audiogram of a harbor porpoise indicated the range of best sensitivity is 8 to 32 kHz at levels between 45 and 50 dB re 1 μPa-m (Andersen, 1970); however, auditory-evoked potential studies showed a much higher frequency of approximately 125 to 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 to 140 kHz, with a reduced sensitivity around 64 kHz (Kastelein et al., 2002). Maximum sensitivity occurs between 100 and 140 kHz (Kastelein et al., 2002).

3.9.2 Environmental Consequences

3.9.2.1 No Action Alternative

Under the No Action Alternative the Test Pile Program would not be conducted. Baseline conditions, as described above, for marine mammals would remain unchanged. Therefore, there would be no significant impacts to marine mammals from implementation of the No Action Alternative.

3.9.2.2 Action Alternative

The evaluation of impacts to marine mammals considers the importance of the resource, the proportion of the resource impacted relative to its occurrence in the region, the particular sensitivity of the resource to project activities; and the duration of environmental impacts or disruption. In general, pile driving in the project area would include elevated underwater noise levels, increased human activity and noise, and changes in prey availability within the project area. In particular, underwater and airborne pile driving noise during the test pile period has the potential to disrupt marine mammals that may be traveling through, foraging or resting in the vicinity of the project area. Impacts to marine mammals are anticipated to be highly localized because marine mammals are wide-ranging in Hood Canal, relative to the area that might be impacted by pile driving within the project area.

3.9.2.2.1 Direct Effects of Pile Driving Activities

3.9.2.2.1.1 Background on Acoustics

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. Sound is generally characterized by several factors, including frequency and intensity. Frequency describes the sound's pitch and is measured in hertz (Hz), while intensity describes the sound's loudness. Due to the wide range of pressure and intensity encountered during measurements of sound, a logarithmic scale is used. In acoustics, the word "level" denotes a sound measurement in decibels. A decibel (dB) expresses the logarithmic strength of a signal relative to a reference. Because the decibel is a logarithmic measure, each increase of 20 dB reflects a ten-fold increase in signal amplitude (whether expressed in terms of pressure or particle motion), i.e., 20 dB means ten times the amplitude, 40 dB means one hundred times the amplitude, 60 dB means one thousand times the amplitude, and so on. Because the decibel is a relative measure, any value expressed in decibels is meaningless without an accompanying reference. In describing underwater sound pressure, the reference amplitude is usually 1 microPascal (µPa, or 10^{-6} Pascals), and is expressed as "dB re 1 µPa." For in-air sound pressure, the reference amplitude is usually 20 µPa and is expressed as "dB re 20 µPa."

The method commonly used to quantify airborne sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. This is called A-weighting, and the decibel level measured is called the A-weighted sound level (dBA). A filtering method that reflects hearing of marine mammals has not yet been developed. Therefore, underwater sound levels are not weighted and measure the entire frequency range of interest. In the case of marine construction work, the frequency range of interest is 10 to 10,000 Hz.

Table 3.21 summarizes commonly used terms to describe underwater sounds. Two common descriptors are the instantaneous peak sound pressure level (SPL) and the root mean square (rms) SPL (dB rms) during the pulse or over a defined averaging period. The peak pressure is the instantaneous maximum or minimum overpressure observed during each pulse or sound event and is presented in Pascals (Pa) or dB referenced to a pressure of one microPascal (dB re 1 µPa). The rms level is the square root of the energy divided by a defined time period. All underwater sound levels throughout the remainder of this application are presented in dB re 1 µPa unless otherwise noted.

TABLE 3.21 DEFINITIONS OF ACOUSTICAL TERMS

Term	Definition
Decibel, dB	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the pressure of the sound measured to the reference pressure. The reference pressure for water is 1 microPascal (µPa) and for air is 20 µPa (approximate threshold of human audibility).

TABLE 3.21 DEFINITIONS OF ACOUSTICAL TERMS (continued)

Term	Definition
Sound Pressure Level, SPL	Sound pressure is the force per unit area, usually expressed in microPascals (or 20 micro Newtons per square meter), where 1 Pascal is the pressure resulting from a force of 1 Newton exerted over an area of 1 square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressure exerted by the sound to a reference sound pressure. Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz	Frequency is expressed in terms of oscillations, or cycles, per second. Cycles per second are commonly referred to as hertz (Hz). Typical human hearing ranges from 20 Hz to 20,000 Hz.
Peak Sound Pressure (unweighted), dB re 1 μPa	Peak sound pressure level is based on the largest absolute value of the instantaneous sound pressure over the frequency range from 20 Hz to 20,000 Hz. This pressure is expressed in this application as dB re 1 μPa.
Root-Mean-Square (rms), dB re 1 μPa	The rms level is the square root of the energy divided by a defined time period. For pulses, the rms has been defined as the average of the squared pressures over the time that comprise that portion of waveform containing 90 percent of the sound energy for one impact pile driving impulse.[7]
Sound Exposure Level (SEL), dB re 1 μPa^2 sec	Sound exposure level is a measure of energy. Specifically, it is the dB level of the time integral of the squared-instantaneous sound pressure, normalized to a 1-second period. It can be an extremely useful metric for assessing cumulative exposure because it enables sounds of differing duration, to be compared in terms of total energy.
Waveforms, μPa over time	A graphical plot illustrating the time history of positive and negative sound pressure of individual pile strikes shown as a plot of μPa over time (i.e., seconds).
Frequency Spectra, dB over frequency range	A graphical plot illustrating the 6 to 12 Hz band-center frequency sound pressure over a frequency range (e.g., 10 to 10,000 Hz in this application).
A-Weighting Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A- or C-weighting filter network. The A-weighting filter de-emphasizes the low and high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective human reactions to noise.
Ambient Noise Level	The background sound level, which is a composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.

[7] Underwater sound measurement results obtained by Illingworth & Rodkin (2001) for the Pile Installation Demonstration Project in San Francisco Bay indicated that most impact pile driving impulses occurred over a 50 to 100 millisecond (ms) period. Most of the energy was contained in the first 30 to 50 ms. Analyses of that underwater acoustic data for various pile strikes at various distances demonstrated that the acoustic signal measured using the standard “impulse exponential time-weighting” on the sound level meter (35-ms rise time) correlated to the rms level measured over the duration of the pulse.

3.9.2.2.1.2 Potential Acoustic Effects of Pile Driving on Marine Mammals

Potential Effects of Underwater Noise

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 which are soft (i.e. sand) will absorb or attenuate the sound more readily than hard substrates (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.

Impacts to marine species are expected to be the result of physiological responses to both the type and strength of the acoustic signature (Viada et al., 2008). Behavioral impacts are also expected, though the type and severity of these effects 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 from brief acoustic effects such as behavioral disturbance, tactile perception, physical discomfort, slight injury of the internal organs and the auditory system, to death of the animal (Yelverton et al., 1973; O'Keefe and Young, 1984; DoN, 2001).

Physiological Responses

Direct tissue responses to impact/impulsive sound stimulation may range from mechanical vibration or compression with no resulting injury, to tissue trauma (injury). Because the ears are the most sensitive organ to pressure, they are the organs most sensitive to injury (Ketten, 2000). Sound related trauma can be lethal or sub-lethal. Lethal impacts are those that result in immediate death or serious debilitation in or near an intense source (Ketten, 1995). Sub-lethal impacts include hearing loss, which is caused by exposure to perceptible sounds. Severe damage, from a pressure wave, to the ear can include rupture of the tympanum, fracture of the ossicles, damage to the cochlea, hemorrhage, and cerebrospinal fluid leakage into the middle ear (NMFS, 2008a). Moderate injury implies partial hearing loss. Permanent hearing loss can occur when the hair cells are damaged by one very loud event, as well as prolonged exposure to noise. Instances of TTS and/or auditory fatigue are well documented in marine mammal literature as being one of the primary avenues of acoustic impact. Temporary loss of hearing sensitivity (TTS) has been documented in controlled settings using captive marine mammals exposed to strong sound exposure levels at various frequencies (Ridgway et al., 1997; Kastak et al., 1999; Finneran et al., 2005), but it has not been documented in wild marine mammals exposed to pile driving. While injuries to other sensitive organs are possible, they are less likely since pile driving impacts occur almost entirely through acoustic pathways, versus explosive sounds which also include a shock wave which can result in damage.

No physiological responses are expected from pile driving operations occurring during the Test Pile Program within the project area for several reasons. Firstly vibratory pile driving which is being utilized as the primary installation method, does not generate high enough peak sound pressure levels that are commonly associated with physiological damage. Any use of impulsive pile driving will only occur for a short period of time (~15 min per pile) and only to proof the piles. Additionally, during impact pile driving, the Navy will employ a sound attenuation system (i.e. Gunderboom SAS™, bubble curtain) to reduce initial sound pressure levels, thus decreasing the chance of physiological impacts. Furthermore, the Navy will have trained biologists monitoring a shutdown zone equivalent to the Level A Harassment zone (inclusive of the 180 dB re 1 μ Pa (cetaceans) and 190 dB re 1 μ Pa (pinnipeds) isopleths) to ensure no marine mammals are injured.

Behavioral Responses

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 noise, including its previous experience, its auditory sensitivity, and its biological and social status (including age and sex), and its behavioral state an activity at the time of exposure. With regard to pile driving, in most instances the severity of the response would be minimal and could result in temporary, short term changes in the animal's typical behavior. For instance, a marine mammal may swim further away from the sound source or become startled by the noise. Other potential behavioral changes could include increased swimming speed, increased surfacing time, and decreased foraging.

Controlled experiments with captive marine mammals have shown 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 sound sources (typically seismic airguns or acoustic harassment devices) have been varied but often consist of avoidance behavior or other behavioral changes suggesting discomfort (Morton and Symonds, 2002; Gordon et al., 2004; Wartzok et al., 2004; and Nowacek et al., 2007). Behavioral state may affect the type of response. For example, animals that are resting may show greater behavioral change in response to disturbing noise levels than animals highly motivated to remain in the area for feeding (Richardson et al., 1995; NRC, 2003; Wartzok et al., 2004). Habituation can occur when an animals' response to a stimulus wanes as a result of repeated exposure. Animals are most likely to habituate to sounds that are predictable and unvarying.

Since pile driving will 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 ultimately result in population level impacts, or affect the long-term fitness of the species.

Potential Effects of Airborne Noise

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 noise would have less impact on cetaceans than pinnipeds because noise from atmospheric sources does not transmit well underwater

(Richardson et al., 1995); thus airborne noise 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 noise. 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. Marine mammal observations during pile driving associated with the San Francisco-Oakland Bay Bridge provide realistic information regarding potential effects of airborne noise. Harbor seals and California sea lions monitored during pile driving which were hauled out 0.9 miles from pile driving barges did not react to pile driving noise, although the number of hauled out individuals increased during periods of construction activity, suggesting that noise could be disturbing them while in the water. Some harbor seals were noted moving away after the initiation of pile driving. In most observations, the seals in the vicinity at the onset of pile driving responded by looking toward the barges and exhibiting other signs of alertness and swimming away (Caltrans, 2001; 2006). Conversely, 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. Based on these observations marine mammals could exhibit temporary behavioral reactions to airborne noise, however, exposure is not likely to result in population level impacts. Injury or Level A harassment is not expected to occur from airborne noise.

3.9.2.2.1.3 Thresholds and Criteria for Pile Driving

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 (70 FR 1871). No studies have been conducted that examine impacts to marine mammal from pile driving sounds. Current NMFS practice regarding exposure of marine mammals to high level sounds 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 160dB rms for impulse sounds (e.g., impact pile driving) and 120dB rms for continuous noise (e.g., vibratory pile driving), but below injurious thresholds. The application of the 120 dB rms threshold can sometimes be problematic because this threshold level can be either at or below the ambient noise level of certain locations. In fact, there is no evidence that pinnipeds will react to continuous sounds at this level and more research is needed (Hollingshead, 2008, pers. comm.). As a result, these levels are considered precautionary (NMFS, 2009; 74 FR 41684). NMFS is developing new science-based thresholds to improve and replace the current generic exposure level thresholds, but the criteria have not been finalized (Southall et al., 2007). The current Level A (injury) and Level B (disturbance) thresholds are provided in Table 3.22.

3.9.2.2.1.4 Distance to Sound Thresholds

Underwater Noise from Pile driving

In-water construction activities associated with the Test Pile Program would include impact pile driving and vibratory pile driving. The sounds produced by these activities fall into one of two sound types: pulsed and non-pulsed (defined below). Impact pile driving produces pulsed sounds, while vibratory pile driving produce non-pulsed (or continuous) sounds. 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 as cited in Southall et al., 2007).

TABLE 3.22 INJURY AND DISTURBANCE THRESHOLDS FOR UNDERWATER AND AIRBORNE SOUNDS

Marine Mammals	**Airborne Marine Construction Criteria** (Impact & Vibratory Pile Driving) **(re 20 µPa)**	**Underwater Vibratory Pile Driving Criteria** (*e.g.* non-pulsed/continuous sounds) **(re 1 µPa)**		**Underwater Impact Pile Driving Criteria** (*e.g.* pulsed sounds) **(re 1 µPa)**	
	Disturbance Guideline Threshold (Haulout)[1]	**Level A Injury Threshold**	**Level B Disturbance Threshold**	**Level A Injury Threshold**	**Level B Disturbance Threshold**
Cetaceans (whales, dolphins, porpoises)	N/A	180 dB rms	120 dB rms	180 dB rms	160 dB rms
Pinnipeds (seals, sea lions, walrus; except harbor seal)	100 dB rms (unweighted)	190 dB rms	120 dB rms	190 dB rms	160 dB rms
Harbor seal	90 dB rms (unweighted)	190 dB rms	120 dB rms	190 dB rms	160 dB rms

[1] Sound level at which pinniped haulout disturbance has been documented. Not an official threshold, but used as a guideline.
dB = decibel; N/A = not applicable; rms = root mean square

Pulsed sounds (e.g. explosions, gunshots, sonic booms, seismic airgun pulses, and impact pile driving) are brief, broadband, atonal transients (ANSI, 1986; Harris, 1998) and occur either as isolated events or repeated in some succession (Southall et al., 2007). 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 (Southall et al., 2007). Pulsed sounds generally have an increased capacity to induce physical injury as compared with sounds that lack these features (Southall et al., 2007).

Non-pulse (intermittent or continuous sounds) can be tonal, broadband, or both (Southall et al., 2007). 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) (Southall et al., 2007). Examples of non-pulse sounds include vessels, aircraft, machinery operations such as drilling or dredging, vibratory pile driving, and active sonar systems (Southall et al., 2007). The duration of such sounds, as received at a distance, can be greatly extended in highly reverberant environments (Southall et al., 2007).

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 sound pressure levels recorded from pile driving projects is available for consideration. In order to determine reasonable sound pressure levels and their associated affects on marine mammals that are likely to result from pile driving at NBK Bangor, studies with similar properties to the proposed action were evaluated. Studies which met the following parameters were considered: 1. Pile materials - steel pipe piles (30-72" diameter); 2. Hammer machinery - vibratory and impact; and 3. Physical environment - shallow depth (<100 feet [30 m]). Table 3.23 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 sound pressure levels which could be anticipated.

TABLE 3.23 UNDERWATER SOUND PRESSURE LEVELS FROM SIMILAR IN-SITU MONITORED CONSTRUCTION ACTIVITIES

Project & Location	Pile Size &Type	Installation Method	Water Depth	Measured Sound Pressure Levels
Mukilteo Test Piles, WA[1]	36-inch Steel Pipe	Impact	7.3 m (24 feet)	195 dB re 1 μPa (rms) at 10 m
Richmond-San Rafael Bridge, CA[2]	66-inch Steel CISS Pile	Impact	4.0 m (13.1 feet)	195 dB re 1 μPa (rms) at 10 m
Unknown Location, CA[2]	72-inch Steel Pipe Pile	Vibratory	~5 m (16.4 feet)	180 dB re 1 μPa (rms) at 10 m

Sources: [1]WSDOT, 2007; [2] Caltrans, 2007

For all underwater calculations in this assessment, linear loss (C) was not used (i.e. C=0) and transmission loss was calculated using only logarithmic spreading. Therefore, using practical spreading (B=15), the revised formula for transmission loss is TL = 15 log10 (R).

Pile driving would generate underwater noise that potentially could result in disturbance to marine mammals swimming by the project area. Transmission loss (TL) underwater 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. The formula for transmission loss is:

$$TL = B * \log_{10}(R) + C * R,$$

Where:

B = logarithmic (predominantly spreading) loss
C = linear (scattering and absorption) loss
R = range from source in meters

For the Test Pile Program, the Navy intends to employ several noise reduction techniques during impact pile driving, including the use of a bubble curtain (or bubble wall). Additionally, vibratory pile driving will be the primary installation method. The calculations of the distances to the marine mammal noise criteria were calculated for impact installation with and without consideration for mitigation measures. Distances calculated with consideration for mitigation assumed a 10 dB reduction in source levels from the combined effects of the Gunderboom SAS™ or bubble curtain/wall. The Navy will be using the mitigated distances for impact pile driving for all further analysis in this EA. Calculations for the marine mammal noise criteria for vibratory installation were done based on in-situ recordings of vibratory installation/extraction data from Caltrans (2007) which indicated a SPL of 180 db re 1μPa at 10m. This concurred with published literature from other studies which have in the past used a 15 dB reduction factor from source levels from impact driving recordings to calculate sources levels for vibratory pile driving. Sound levels associated with vibratory pile removal are the same as those during vibratory installation (Caltrans, 2007) and have been taken into consideration in the modeling analysis. All calculated distances to and the total area encompassed by the marine mammal noise thresholds are provided in Tables 3.24 and 3.25 respectively.

TABLE 3.24 CALCULATED DISTANCE(S) TO THE UNDERWATER MARINE MAMMAL NOISE THRESHOLDS FROM PILE DRIVING

Description	Distance (m) to Threshold			
	Impact Level A – 190 dB[1]	Impact Level A – 180 dB[1]	Impact Level B – 160 dB[1]	Vibratory Level B – 120 dB[1]
Impact Driving, No mitigation	22	100	2,154	N/A
Impact Driving with bubble curtain – (Mitigation = 10 dB reduction in SPLs)	5	22	464	N/A
Vibratory pile driver	2	10	N/A	100,000[2]

All sound levels expressed in dB re 1 μPa rms.
CISS = cast-in-steel-shell; dB = decibel; N/A = not applicable; rms = root-mean-square; μPa = microPascal
Practical spreading loss (15 log, or 4.5 dB per doubling of distanced) used for calculations.
[1]Sound pressure level used for calculations were:195 dB re 1 μPa @ 10m for impact and 180 dB re1 μPa @ 10m for vibratory
[2]Range calculated is greater than what would be realistic. Hood Canal average width at site is 2.4 mi, and is fetch limited from N to S at 12.6 mi.

TABLE 3.25 CALCULATED AREA ENCOMPASSED (PER PILE) BY THE UNDERWATER MARINE MAMMAL THRESHOLDS FROM PILE DRIVING

Description	Area (km^2) Encompassed by the Threshold			
	Impact Level A – 190 dB[1]	Impact Level A – 180 dB[1]	Impact Level B – 160 dB[1]	Vibratory Level B – 120 dB[1]
Impact Driving with bubble curtain – (Mitigation = 10 dB reduction in SPLs)	0.000	0.002	0.676	N/A
Vibratory pile driver	0.000	0.000	N/A	31,416

The calculations presented in Tables 3.24 and 3.25 assumed a field free of obstruction, which is unrealistic, however, because Hood Canal does not represent open water conditions (free field) and therefore, sounds would attenuate as they encountered land masses or bends in the canal. As a result, some of the distances and areas of impact calculated cannot actually be attained at the project area. The actual distances to the behavioral disturbance thresholds for both impact and vibratory pile driving (464m and 100,000 m, respectively) may be shorter than those calculated due to the irregular contour of the waterfront, the narrowness of the canal, and the maximum fetch (furthest distance sound waves travel without obstruction [i.e. line of site]) at the project area. Table 3.26 and Figures 3-13 and 3-14 depict the actual distances and area encompassed by each underwater sound threshold that may actually occur at the project area due to pile driving for cetaceans and pinnipeds, respectively

TABLE 3.26 ACTUAL AREA ENCOMPASSED (PER PILE) BY THE UNDERWATER MARINE MAMMAL THRESHOLDS FROM PILE DRIVING

Description	Area (km^2) Encompassed by the Threshold			
	Impact Level A – 190 dB[1]	Impact Level A – 180 dB[1]	Impact Level B – 160 dB[1]	Vibratory Level B – 120 dB[1]
Impact Driving with bubble curtain – (Mitigation = 10 dB reduction in SPLs)	0.000	0.002	0.509	N/A
Vibratory pile driver	0.000	0.000	N/A	41.5

Airborne Noise from Pile Driving

Pile driving can generate airborne noise that could potentially result in disturbance to marine mammals (pinnipeds) which are hauled out or at the water's surface near the project area. In order to determine reasonable airborne sound pressure levels and their associated affects on marine mammals that are likely to result from pile driving at NBK Bangor, studies with similar properties to the proposed action were evaluated. Studies which met the following parameters were considered: 1. Pile materials - steel pipe piles (30-72" diameter); 2. Hammer machinery - vibratory and impact; and 3. Physical environment - shallow depth (<100 foot). Table 3.27 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 sound pressure levels which could be anticipated.

TABLE 3.27 AIRBORNE SOUND PRESSURE LEVELS FROM SIMILAR IN-SITU MONITORED CONSTRUCTION ACTIVITIES

Project & Location	Pile Size &Type	Installation Method	Water Depth	Measured Sound Pressure Levels
Northstar Island, AK[1]	42- inch Steel Pipe Pile	Impact	~12 m (40 feet)	97 dB re 20 µPa (rms) at 525 feet
Keystone Ferry Terminal, WA[2]	30- inch Steel Pipe Pile	Vibratory	~9 m (30 feet)	98 dB re 20 µPa (rms) at 36 feet

Sources: [1]Blackwell et al., 2004; [2]WSDOT, 2010

Based on in-situ recordings from similar construction activities, the maximum airborne noise levels that would result from impact and vibratory pile driving are estimated to be 97 dB re 20 µPa (rms) at 525 feet (160 m) and 98 dB re 20 µPa (rms) at 36 feet (11 m), respectively (Blackwell et al., 2004; WSDOT, 2010). 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.

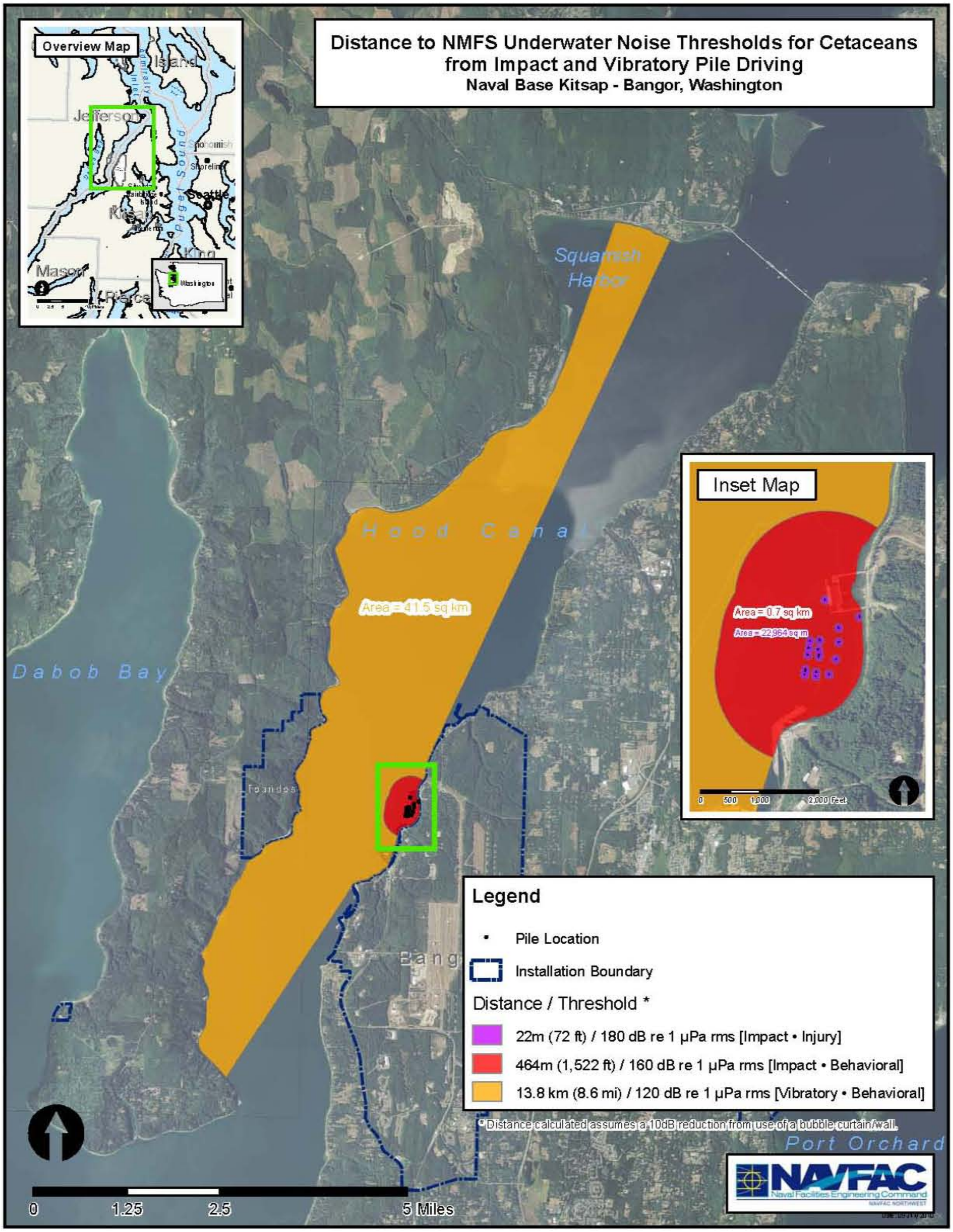


Figure 3-13 Distance(s) (m) to NMFS Underwater Sound Threshold for Cetaceans from Impact and Vibratory Pile Driving

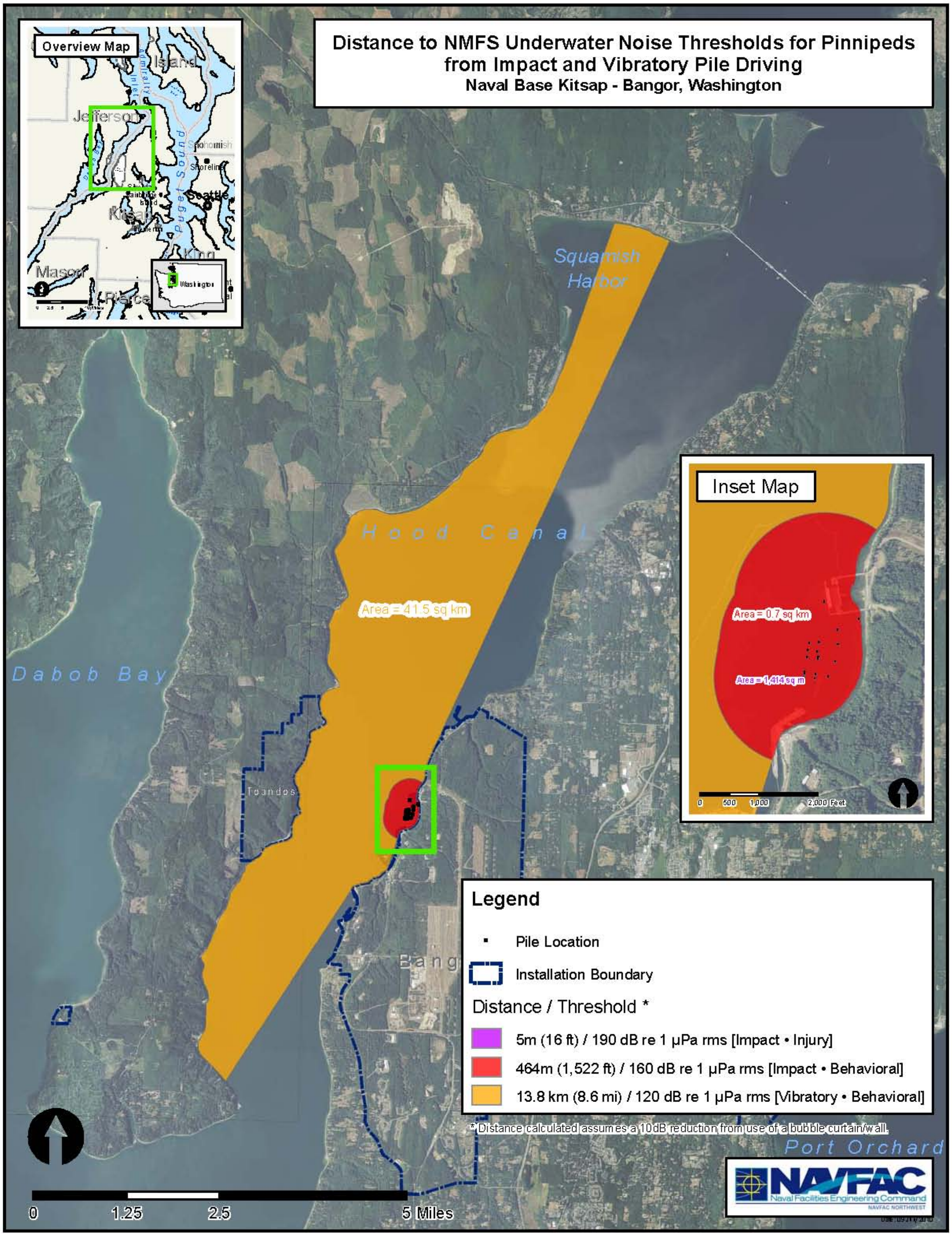


Figure 3-14 Distance(s) (m) to NMFS Underwater Sound Thresholds for Pinnipeds from Impact and Vibratory Pile Driving

The formula for calculating spherical spreading loss is:

$$TL = 20\log r$$

Where:

TL = Transmission loss

r = Distance from source to receiver

*Spherical spreading results in a 6 dB decrease in sound pressure level per doubling of distance.

The distance to the sea lion airborne threshold would be 371 feet (113 m) for impact pile driving, and 30 feet (9 m) for vibratory pile driving. The distance to the harbor seal airborne threshold would be 1175 feet (358 m) for impact pile driving, and 92 feet (28 m) for vibratory pile driving. These distances are all less than the distances calculated for underwater sound thresholds. Since protective measures are in place out to the distances calculated for the underwater thresholds, the distances for the airborne thresholds will be covered fully by monitoring. All construction noise associated with the project area would not extend beyond the buffer zone that would be established to protect seals and sea lions. All calculated distances to and the total area encompassed by the marine mammal noise thresholds are provided in Table 3.28 and 3.29, respectively. Figures 3-15 and 3-16 depict the actual distances for each airborne sound threshold that are predicted to occur at the project area due to pile driving pinnipeds.

TABLE 3.28 CALCULATED DISTANCE (M) TO THE MARINE MAMMAL THRESHOLD IN AIR FROM PILE DRIVING

Species	Threshold	Airborne Behavioral Disturbance	
		Distance (m) to Threshold Impact Pile Driving	Distance (m) to Threshold Vibratory Pile Driving
Pinnipeds (except harbor seal)	100dB re 20 µPa rms (unweighted)	113 m (371 feet)	9 m (30 feet)
Harbor seal	90dB re 20 µPa rms (unweighted)	358 m (1175 feet)	28 m (92 feet)

TABLE 3.29 CALCULATED AREA ENCOMPASSED (PER PILE) BY THE MARINE MAMMAL THRESHOLDS IN AIR FROM PILE DRIVING

Species	Threshold	Airborne Behavioral Disturbance	
		Area Encompassed by the Threshold for Impact Pile Driving	Area Encompassed by the Threshold for Vibratory Pile Driving
Pinnipeds (except harbor seal)	100dB re 20 µPa rms (unweighted)	0.040 km^2	0.000 km^2
Harbor seal	90dB re 20 µPa rms (unweighted)	0.403 km^2	0.002 km^2

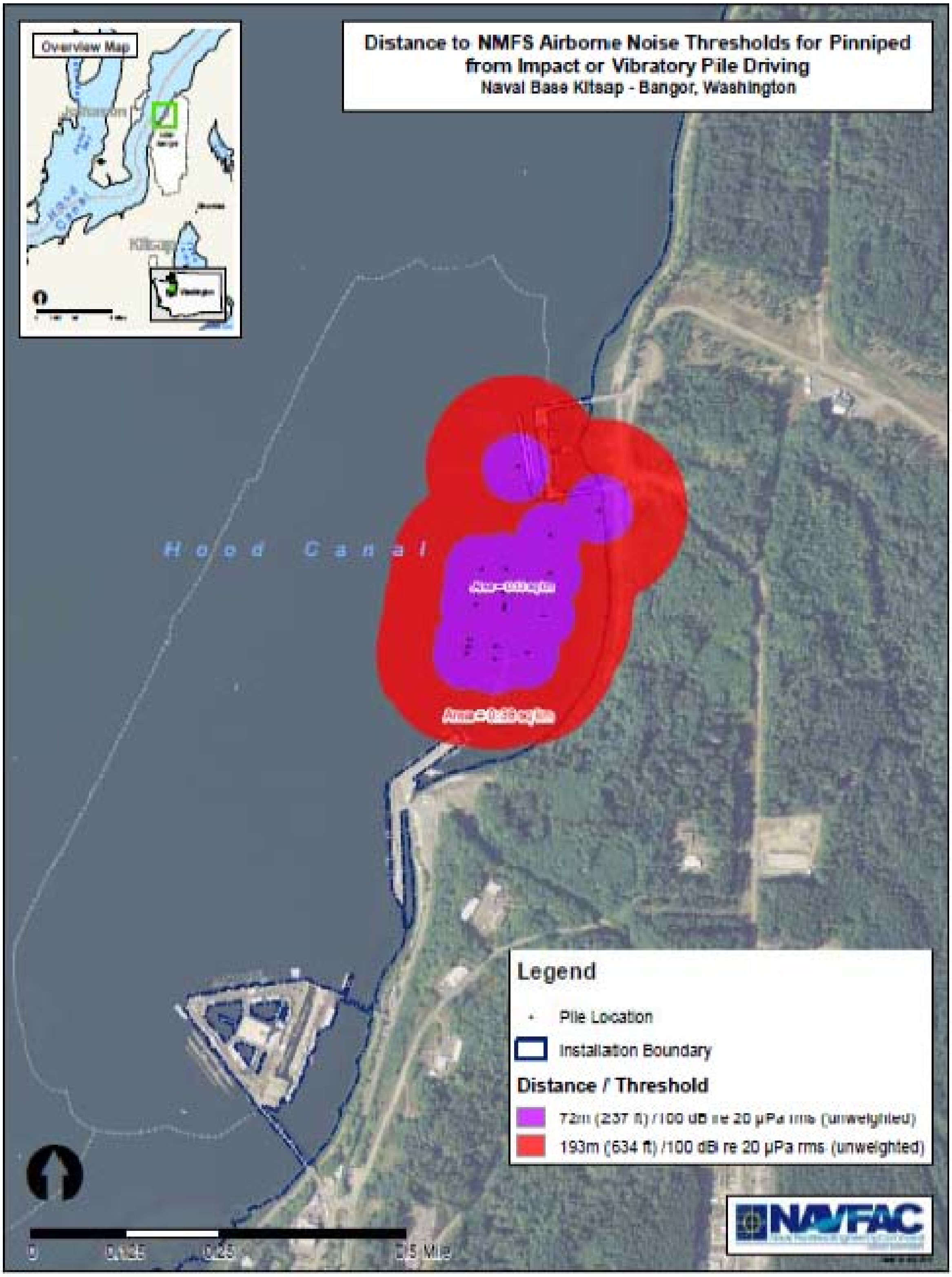


Figure 3-15 Distance(s) (m) to NMFS Airborne Sound Thresholds for Pinnipeds (except harbor seals) from Impact and Vibratory Pile Driving

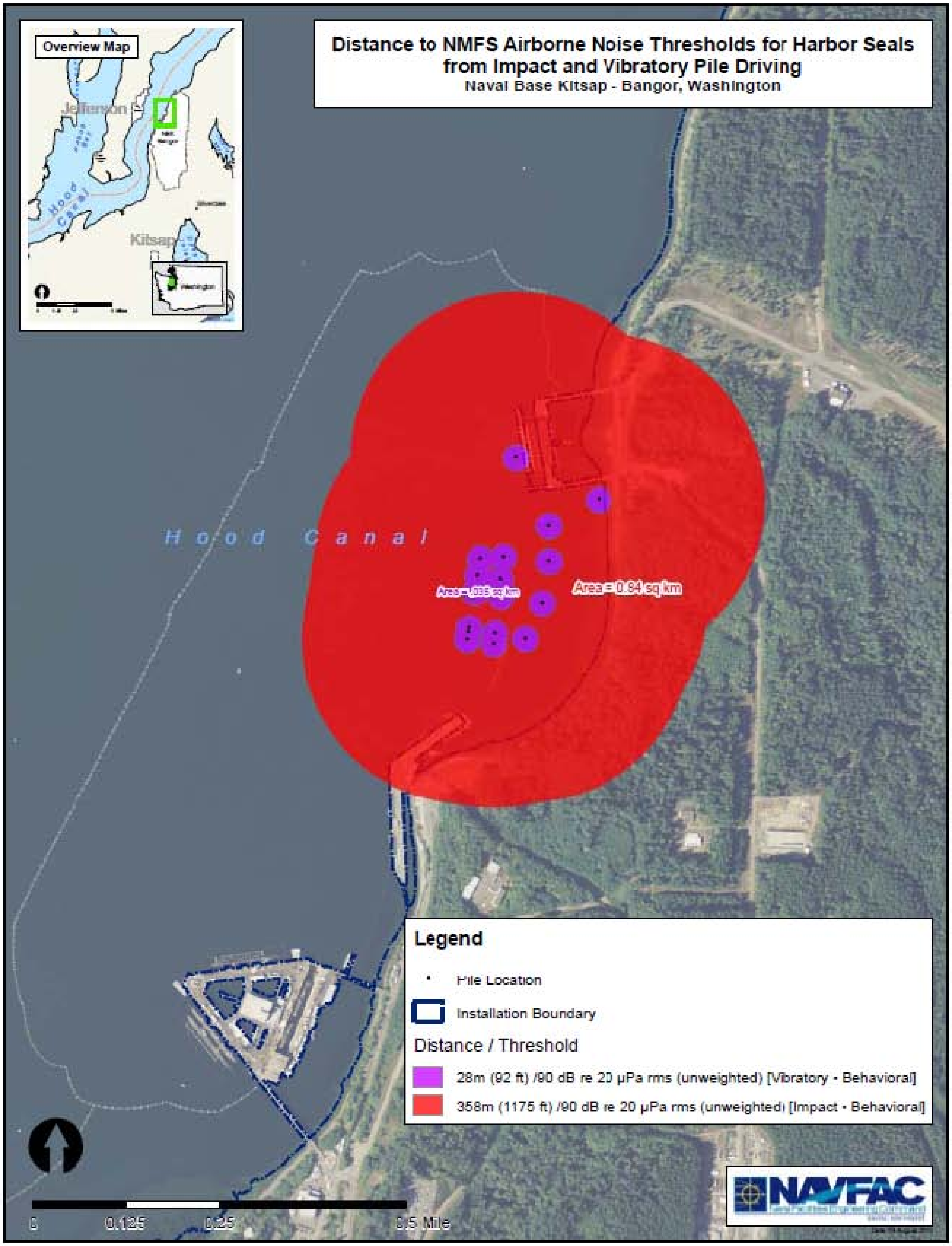


Figure 3-16 Distance(s) (m) to NMFS Airborne Sound Thresholds for Harbor Seals from Impact and Vibratory Pile Driving

3.9.2.2.1.5 Sound Exposure Modeling

The exposure calculations presented here relied on the best available data currently available for marine mammal populations in Hood Canal. The population data used is discussed within Sections 3.9.1.2 and 3.9.1.3. The formula was developed for calculating exposures due to pile driving and applied to each group specific noise impact threshold. The formula is founded on the following assumptions:

- Each species population is at least as large as any previously documented highest population estimate.
- All pilings to be installed would have a noise disturbance distance equal to the piling that causes the greatest noise disturbance (i.e. the piling furthest from shore).
- Pile driving will occur every day of the 40 day in-water work window. However it is estimated that no an average of 2 piles will be installed and removed per day. Therefore, a best estimate of the number of days during which pile driving would occur is 15 days, and this was used in all modeling calculations.
- Some degree of mitigation (i.e. sound attenuation system, etc.) will be utilized, as discussed previously.
- That an individual can only be taken once per method of installation during a 24 hour period.

The calculation for marine mammal exposures is estimated by:

Exposure estimate = (n *ZOI) * 15 days of total activity

Where:

n = density estimate used for each species/season
ZOI[8] = noise threshold zone of influence (ZOI) impact area
n * ZOI produces an estimate of the abundance of animals that could be present in the area for exposure, this must be a whole number, therefore, this value was rounded (down if <0.5, up if >0.5).

The ZOI impact area is the estimated range of impact to the noise criteria. The formula for determining the area of a circle ($\Pi * radius^2$) was used to calculate the ZOI around each pile, for each threshold. The distances specified in Tables 3.23 and 3.24 were used for the radius in the equation. 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. The ZOI impact area took into consideration the possible effected area of Hood Canal from the furthest from shore pile driving site with attenuation due to land shadowing from bends in the canal. As described earlier with regard to the distances, 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 aren't necessarily spherical and may be truncated.

[8] Zone of Influence (ZOI) is the area encompassed by all locations where the sound pressure levels equal or exceed the threshold being evaluated.

Forty days of total in-water work time is proposed, however only a "fraction" of that is actual pile driving time. Some days there will be only 30 minutes of pile driving, other days several hours. The contractor estimates that pile installation could occur at a maximum rate of four piles per day, however, it’s more likely that an average of two piles will be installed and removed per day. 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 15 minutes per pile with no more than 100 blows executed per day. All piles will be extracted using a vibratory hammer. Extraction is anticipated to take approximately 30 minutes per pile. Overall, this results in a maximum of two hours of pile driving per pile, or approximately four hours per day.

An average work day (two hours post-sunrise to two hours prior to sunset) is approximately 8-9 hours, depending on the month. While it’s anticipated that only 4 hours would need to be spent pile driving per day, to take into account deviations from the estimated times for pile installation and removal and to account for the additional use of the impact pile driver in case of failure of the vibratory hammer to reach the desired embedment depth the Navy modeled potential impacts as if the entire day could be spent pile driving.

Based on the proposed action, the total pile driving time from vibratory or impact pile driving would be less than 15 days (29 piles at minimum of 2 per day). Therefore, impacts were modeled as if the action were to occur throughout the duration of 15 days.

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 significant note in these exposure estimates, additional mitigation methods (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 that are strongly influenced by limited biological data. While the numbers generated from the pile driving exposure calculations provide conservative overestimates of marine mammal exposures for consultation with NMFS, the short duration and limited geographic extent of test pile project would further limit actual exposures.

Steller Sea Lion

Although Steller sea lions have been documented in Hood Canal, the numbers (at least at present) are still fairly low and their presence is only expected in the project area during November through mid-April. Because this action will occur between July 16 – Oct 31, when Steller sea lions are not likely to be present in the project area, no acoustic impacts from pile driving operations are expected for this species.

Southern Resident Killer Whale

Southern Resident killer whales have not been documented in the Hood Canal since 1995, and recent sightings may have been of transient killer whales (NMFS 2008b). As a result, the Hood Canal is not considered within the current geographic range occupied by the species. As such, there will be no acoustic impacts from pile driving operations on this species.

California Sea Lion

California sea lions are present in Hood Canal almost year-round with the exception of mid-June through August. The Navy conducted year round waterfront surveys for marine mammals at NBK Bangor in 2008 and 2009 (DoN 2010a). During these surveys, the daily maximum number of California sea lions hauled out for the months July – October (the timeframe of the Test Pile Program), were 0, 0, 12, and 47 in 2008 and 0, 1, 32, and 44 in 2009, respectively. Because the proportion of pile driving that could occur in a given month is dependent on several factors (i.e. availability of materials, weather, etc.) the Navy assumed that pile driving operations could occur at any time in the construction window. Therefore, an average of the maximum number of California sea lions observed per day across the months of July – October was used in the modeling analysis. The monthly average of the maximum number of California sea lions observed per day was 17 individuals. Exposures were calculated using a density derived from this value (17 individuals), divided by the potential acoustic impact area (41.5 km^2) and the formula presented in Section 3.9.2.2.1.5. Table 3.30 depicts the number of acoustic harassments that are estimated from vibratory and impact pile driving both underwater and in-air.

TABLE 3.30 NUMBER OF POTENTIAL EXPOSURES OF CALIFORNIA SEA LIONS WITHIN VARIOUS ACOUSTIC THRESHOLD ZONES

Season	Density of California Sea Lions	Underwater			Airborne
		Impact Injury Threshold (190dB)	Impact Disturbance Threshold (160dB)	Vibratory Disturbance Threshold (120dB)	Impact & Vibratory Disturbance Threshold (100dB)*
Warm (May-Oct)	0.410	0	15**	255	0

Note: The take estimates include both those from impact and vibratory pile driving.
* The airborne exposure calculations assumed that 100% of the in-water densities were available at the surface to be exposed to airborne sound.
** The modeling indicated that zero California sea lions were likely to be exposed to sounds that would qualify as behavioral harassment during impact pile driving (160 dB zone). However, the Navy feels based on the abundance of this species in the waters along NBK, including their presence at nearby haulouts, that it's likely that an individual could pass through this zone in transit to or from a haulout, Therefore, the Navy is requesting a behavioral take of California sea lion by impact pile driving each day of pile driving, for a total of 15 takes over the course of the proposed action.

Potential takes would likely involve sea lions that are moving through the area en route to a submarine haulout or during the return trip to the ocean when pile driving would occur. California sea lions that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, California sea lions may move away from the sound source and be temporarily displaced from the areas of pile driving. Disturbance from underwater noise impacts is not expected to be significant because it is estimated that only a small number of California sea lions may be affected by acoustic harassment. Additionally, marine mammal observers will be monitoring the shutdown and buffer zones (see Chapter 4 for a detailed discussion of mitigation measures) for the presence of marine mammals, and will alert work crews when to begin or stop work due to presence of sea lions in or near the shutdown and buffer zones, reducing the potential for acoustic harassment. Based on the exposure analysis, no California sea lions are anticipated to experience airborne sound pressure levels that would qualify as harassment. With the absence of any major rookeries and only a few isolated haul-out areas near or adjacent to the project area, potential takes by disturbance will have a negligible short-term effect on individual California sea lions and would not result in population-level impacts.

Harbor Seal

Harbor seals are present year-round and are the most abundant marine mammal in Hood Canal. The Navy conducted boat surveys of the waterfront area in 2008 from July to September (Agness and Tannenbaum, 2009a). Harbor seals were sited during every survey and were found in all marine habitats including near and hauled out on man-made objects such as piers and buoys. Jeffries et al. (2003) completed a more comprehensive stock assessment of Hood Canal in 1999 and counted 711 harbor seals hauled out. This abundance was adjusted using a correction factor of 1.53 to account for seals in the water and not counted to provide a population estimate of 1,088 harbor seals in Hood Canal (Jeffries et al 2003). Research by Huber et al. (2001) indicates that approximately 35% of harbor seals are in the water at any one time. Underwater exposures were calculated using a density derived from the number of harbor seals that are present in the water at any one time (35% of 1,088 or ~381 individuals), divided by the area of Hood Canal (291 km^2) and the formula presented in Section 3.9.2.2.1.5.

While Huber et al.'s (2001) data suggests that harbor seals typically spend 65% of their time hauled out; the Navy's waterfront surveys found that it is extremely rare for harbor seals to haul out in the vicinity of the Test Pile Program project area. Therefore, the only population of harbor seals that could potentially be exposed to airborne sounds are those that are in-water but at the surface. Based on the diving cycle of tagged harbor seals near the San Juan Islands we can estimate that seals are on the surface approximately 16.4 percent of the of their total in-water duration (Suryan and Harvey, 1998). Therefore, by multiplying the percentage of time spent at the surface (16.4%) by the total in-water population of harbor seals at any one time (~381 individuals), the population of harbor seals with the potential to experience airborne impacts (~63 individuals) can be obtained. Airborne exposures were calculated using a density derived from the maximum number of harbor seals available at the surface (~63 individuals), divided by the area of Hood Canal (291 km^2) and the formula presented in Section 3.9.2.2.1.5. Table 3.31 depicts the number of acoustic harassments that are estimated from vibratory and impact pile driving both underwater and in-air.

TABLE 3.31 NUMBER OF POTENTIAL EXPOSURES OF HARBOR SEALS WITHIN VARIOUS ACOUSTIC THRESHOLD ZONES

Season	Density of Harbor Seals	Underwater			Airborne
		Impact Injury Threshold (190dB)	Impact Disturbance Threshold (160dB)	Vibratory Disturbance Threshold (120dB)	Impact & Vibratory Disturbance Threshold (90 dB)*
Warm (May-Oct)	1.31	0	15	810	0

Note: The take estimates include both those from impact and vibratory pile driving.
*Airborne densities were base on the percentage (16.4%) of in-water density available on surface to be exposed (Suryan and Harvey, 1998).

Potential takes would likely involve seals that are moving through the area on foraging trips when pile driving would occur. Harbor seals that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, harbor seals may move away from the sound source and be temporarily displaced from the areas of pile driving. Disturbance from underwater noise impacts is not expected to be significant because it is estimated that only a small number of harbor seals may be affected by acoustic harassment. Additionally, marine mammal observers will be monitoring the shutdown and buffer zones (see Chapter 4 for a detailed discussion of mitigation measures) for the presence of marine mammals, and will alert work crews when to begin or stop work due to presence of seals in or near the shutdown and buffer zones, reducing the potential for acoustic harassment. Based on the exposure analysis, no harbor seals are anticipated to experience airborne sound pressure levels that would qualify as harassment. With the absence of any major rookeries and only a few potential haul-out areas near the project area, potential takes by disturbance will have a negligible short-term effect on individual harbor seals and would not result in population-level impacts.

Transient Killer Whale

Transients are uncommon visitors to Hood Canal, but may be present anytime during the year. In 2003 and 2005, small groups of transient killer whales (6 – 11 individuals per event) visited Hood Canal to feed on harbor seals and remained in the area for significant periods of time (59 – 172 days) between the months of January and July (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 Hood Canal for January to July is 0.038/km^2 (11 individuals divided by the area of Hood Canal [291 km^2]). Since this timeframe overlaps the period in which the Test Pile Program will occur (July – Oct), this density was used for all exposure calculations. Exposures were calculated using the formula presented in Section 3.9.2.2.1.5. Table 3.32 depicts the number of acoustic harassments that are estimated from vibratory and impact pile driving.

TABLE 3.32 NUMBER OF POTENTIAL EXPOSURES OF KILLER WHALES WITHIN VARIOUS ACOUSTIC THRESHOLD ZONES

Season	Density of Killer Whales	Underwater		
		Impact Injury Threshold (180dB)	Impact Disturbance Threshold (160 dB)	Vibratory Disturbance Threshold (120dB)
Warm (May-Oct)	0.038	0	9*	30

Note: The take estimates include both those from impact and vibratory pile driving.
* The modeling indicated that zero killer whales were likely to be exposed to sounds that would qualify as behavioral harassment during impact pile driving (160 dB zone). However, while Transient killer whales are rare in the Hood Canal, when these animals are present they occur in pods, so their density in the project area is unlikely to be uniform, as was modeled. If they are present during impact pile driving it's possible that one or more individuals within a pod could travel through the behavioral harassment zone. Therefore, the Navy is requesting nine behavioral takes of Transient killer whales – based on the average size of pods seen previously in the Hood Canal - by impact pile driving over the course of the proposed action.

Potential takes would likely involve transient killer whales that are moving through the area on foraging trips when pile driving would occur. Killer whales that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, killer whales may move away from the sound source and be temporarily displaced from the areas of pile driving. Disturbance from underwater noise impacts is not expected to be significant because it is estimated that only a small number of killer whales may be affected by acoustic harassment. Additionally, marine mammal observers will be monitoring the shutdown and buffer zones (see Chapter 4 for a detailed discussion of mitigation measures) for the presence of marine mammals, and will alert work crews when to begin or stop work due to presence of killer whales in or near the shutdown and buffer zones, reducing the potential for acoustic harassment. Potential takes by disturbance will have a negligible short-term effect on individual killer whales and would not result in population-level impacts.

Dall's Porpoise

Dall's porpoise may be present in Hood Canal year-round and may be expected as far south in the Hood Canal as the project area. Their use of inland Washington waters, however, is mostly limited to the Strait of Juan de Fuca. The Navy conducted boat surveys of the waterfront area in 2008 from July to September (Agness and Tannenbaum, 2009a). During one of the surveys a single 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 seasonal density (warm season only) was derived from the waterfront survey by the number of individuals seen divided by total number of kilometers of survey effort (6 surveys with approximately 3.9km^2 of effort each), assuming strip transect surveys. In absence of any other survey data for Hood Canal, this density is assumed to be throughout the project area. Exposures were calculated using the formula presented in Section 3.9.2.2.1.5 Table 3.33 depicts the number of acoustic harassments that are estimated from vibratory and impact pile driving.

TABLE 3.33 NUMBER OF POTENTIAL EXPOSURES OF DALL'S PORPOISE WITHIN VARIOUS ACOUSTIC THRESHOLD ZONES

Season	Density of Dall's Porpoise	Underwater		
		Impact Injury Threshold (190 dB)	Impact Disturbance Threshold (160dB)	Vibratory Disturbance Threshold (120 dB)
Warm (May-Oct)	0.043	0	1*	30

Note: The take estimates include both those from impact and vibratory pile driving.

* The modeling indicated that zero Dall's porpoise were likely to be exposed to sounds that would qualify as behavioral harassment during impact pile driving (160 dB zone). Dall's porposies are rare in the Hood Canal; only one animal, seen located in deep waters offshore the base has been seen in the project area in the past few years. However, it's possible that additional animals exist or that this single individual could pass through the behavioral harassment zone (160 dB) while transiting along the waterfront. Therefore, the Navy is requesting a single behavioral take of Dall's porpoise by impact pile driving over the course of the proposed action.

Potential takes would likely involve Dall's porpoise that are moving through the area on foraging trips when pile driving would occur. Dall's porpoise that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, Dall's porpoise may move away from the sound source and be temporarily displaced from the areas of pile driving. Disturbance from underwater noise impacts is not expected to be significant because it is estimated that only a small number of Dall's porpoises may be affected by acoustic harassment. Additionally, marine mammal observers will be monitoring the shutdown and buffer zones (see Chapter 4 for a detailed discussion of mitigation measures) for the presence of marine mammals, and will alert work crews when to begin or stop work due to presence of porpoises in or near the shutdown and buffer zones, reducing the potential for acoustic harassment. Potential takes by disturbance will have a negligible short-term effect on individual Dall's porpoise and would not result in population-level impacts.

Harbor Porpoise

Harbor porpoises may be present in the Hood Canal year-round, however their presence is rare. The Navy has conducted boat surveys of the waterfront area from July to September over the past few years (2008 – present) (Agness and Tannenbaum, 2009a). During one of the surveys a single Dall's porpoise was sighted in the deeper waters offshore the waterfront. In the absence of an abundance estimate for the entire Hood Canal, a seasonal density (warm season only) was derived from the waterfront survey by the number of individuals seen divided by total number of kilometers of survey effort (24 surveys with approximately 3.9 km^2 of effort each), assuming strip transect surveys. In the 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 in Section 3.9.2.2.1.5. Table 3.34 depicts the number of acoustic harassments that are estimated from vibratory and impact pile driving both underwater for each season.

TABLE 3.34 NUMBER OF POTENTIAL EXPOSURES OF HARBOR PORPOISE WITHIN VARIOUS ACOUSTIC THRESHOLD ZONES

Season	Density of Harbor Porpoise	Underwater		
		Impact Injury Threshold (190 dB)	Impact Disturbance Threshold (160dB)	Vibratory Disturbance Threshold (120 dB)
Warm (May-Oct)	0.011	0	0	15*

Note: The take estimates include both those from impact and vibratory pile driving.
* The modeling indicated that zero harbor porpoise were likely to be exposed to sounds that would qualify as behavioral harassment during vibratory pile driving (120 dB zone). However, while harbor porpoises are rare, one has been sighted in surveys over the last few years in the deep waters offshore the base. It's possible this offshore region is encapsulated within the vibratory disturbance zone due to its size (41.5 sq. km), Therefore the Navy feels based on the possibility of this animal to be present in the offshore waters during every day of construction, the Navy is requesting a single behavioral take of harbor porpoise by vibratory pile driving each day of pile driving, for a total of 15 takes over the course of the proposed action.

Potential takes could occur if harbor porpoises move through the area on foraging trips when pile driving would occur. Harbor porpoise that are taken could exhibit behavioral changes such as increased swimming speeds, increased surfacing time, or decreased foraging. Most likely, harbor porpoises may move away from the sound source and be temporarily displaced from the areas of pile driving. Disturbance from underwater noise impacts is not expected to be significant

Additionally, marine mammal observers will be monitoring the shutdown and buffer zones (see Chapter 4 for a detailed discussion of mitigation measures) for the presence of marine mammals, and will alert work crews when to begin or stop work due to presence of marine mammals in or near the shutdown zones, reducing the potential for acoustic harassment. Potential takes by disturbance would have a negligible short-term effect on individual harbor porpoises and would not result in population-level impacts.

All Species

Based on the modeling results presented above, a summary of the total number of exposures that may occur within the project area are presented below in Table 3.36. In the warm season, there is the potential for 40 Level B disturbance exposures (160 dB) of various species from impulsive pile driving operations, and an additional 1,140 Level B disturbance exposures (120 dB) of various species from vibratory pile driving due to underwater sound. The following species and numbers of Level B disturbance exposures could occur due to underwater sound as a result of impact pile driving operations: 15 California sea lions, 15 harbor seals, 9 transient killer whales, and 1 Dall's porpoise. The following species and number of Level B disturbance takes could occur due to underwater sound as a result of vibratory pile driving operations: 255 California sea lions, 810 harbor seals, 30 transient killer whales, 30 Dall's porpoises, and 15 harbor porpoises. Due to their lack of presence within the project area during the timeframe for the Test Pile Program (July 16 – Oct 31), no ESA-listed Steller sea lions would be acoustically harassed. Also, due to their lack of presence within the Hood Canal no ESA-listed Southern Resident killer whales would be acoustically harassed. Lastly, no species of pinnipeds are expected to be exposed to airborne sound pressure levels that would cause harassment.

TABLE 3.36 SUMMARY OF POTENTIAL EXPOSURES FOR ALL SPECIES IN THE WARM (MAY-OCTOBER) SEASON

Species	Underwater				Airborne	
	Impact Injury Threshold (190 dB)	Impact Injury Threshold (180dB)	Impact Disturbance Threshold (160dB)	Vibratory Disturbance Threshold (120dB)	Impact & Vibratory Disturbance Threshold (100dB)*	Impact & Vibratory Disturbance Threshold (90dB)*
California sea lion	0	N/A	15	255	0	N/A
Harbor seal	0	N/A	15	810	N/A	0
Transient killer whale	N/A	0	9	30	N/A	N/A
Dall's porpoise	N/A	0	1	30	N/A	N/A
Harbor porpoise	N/A	0	0	15	N/A	N/A
Total	**0**	**0**	**40**	**1140**	**0**	**0**

3.9.2.2.2 In-Direct Effects to Marine Mammals from Pile Driving Activities

3.9.2.2.2.1 Pile Driving Effects on Potential Prey (fish, etc.)

Impacts to Prey

Construction activities will produce both pulsed (i.e. impact pile driving) and continuous sounds (i.e. vibratory pile driving). 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 noise 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). Fish that occur in the immediate project area would be exposed to underwater noise that could injure or disturb fish during pile driving activity. Because vibratory pile driving is the primary installation and removal methodology, the most likely impact to fish from pile driving activities at the project area would be temporary behavioral disturbance or 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. See Section 3. 8 for a detailed analysis of the impacts of the Test Pile Program to fish species. In general, impacts to marine mammal prey species are expected to be minor and temporary due to the short-time frame for the Test Pile Program. However, adverse impacts may occur to a few species of rockfish (bocaccio, yellowweye, and canary rockfish), chinook salmon, and summer run chum as a result of potential impacts to their eggs and larvae.

Impacts to Prey Habitat

The Test Pile Program may result in localized and temporary changes to the benthic community during pile placement. A conservative estimate of total bottom disturbance from the barge anchors, spuds, and test piles is approximately 647 m^2 (6,970 ft^2). During the pile driving period (40 days), juvenile salmonids and other fish species may experience loss of available benthic prey at the project site due to the disturbance of pile installation. However, in-water work would occur during the time frame when few salmonids would be present, therefore adverse affect to benthic prey availability are not anticipated. Additionally, the area impacted by the Test Pile Program that could be used as possible foraging habitat is relatively small compared to the available habitat in the Hood Canal. Potentially a maximum area of 1.82 m^2 (based on a 60-inch diameter pile) of foraging habitat may have decreased foraging value as each pile is driven. 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.

3.9.2.2.2.2 Pile Driving Effects on Water Quality

Dissolved Oxygen

During pile removal and replacement activities, suspension of anoxic sediment compounds may result in reduced dissolved oxygen in the water column. However, the high existing dissolved oxygen at the site during the proposed work windows reduces the potential for dissolved oxygen to drop to harmful levels, particularly due to the short duration of the in-water work period.

Turbidity

Some degree of localized reduction in water quality would occur as a result of in-water construction activities. Most of this effect would occur during the installation and removal piles from the substrate when bottom sediments would be disturbed. Effects to turbidity are expected to be short term and minimal. Turbidity would return to normal levels within a short time from completion of the Test Pile Program.

No direct effects to marine mammals are expected from turbidity impacts. Short-term exposure of salmonids and marine fish (prey species for marine mammals) to suspended sediments may occur as the sediment enters the water column. Factors potentially affecting salmonids and marine fish from temporary increases in turbidity could include damage to gill tissue, physiological stress, reduced foraging efficiency, and avoidance behavior.

The minimal and temporary increases in suspended sediments that may result from this project would not likely result in gill tissue damage to fish. Studies investigating similar potential impacts to fish from larger scale sediment dredging operations have shown that increased turbidity levels from these activities were insufficient to cause gill damage in salmonids (Redding et al. 1987; Servizi and Martens 1987). Suspended sediments in high concentrations (500 to 2,000 mg/L of suspended sediment) have been shown to cause physical stress in salmonids (Redding et al. 1987; Servizi and Martens 1987). Behavioral responses of salmonids to elevated levels of suspended sediment include feeding disruption and changes in migratory behavior (Martin et al. 1977; Salo et al. 1980; Servizi 1988). Salmonid foraging behavior can also be impaired by high concentrations of suspended sediment (Bisson and Bilby 1982; Berg and Northcote 1985; Redding et al. 1987). Behavioral changes include not rising to the surface to feed, reduction in prey location, and avoidance of areas of increased suspended sediment.

Therefore, while some degree of localized, short-term turbidity is expected during pile driving and removal activities, unconfined salmonids and other marine fish are likely to avoid areas with elevated suspended sediment concentrations (Salo et al. 1980). As such, they would not be expected to experience physiological or behavioral stress from the proposed action.

3.9.2.2.3 Summary of Effects

Individual marine mammals may be exposed to sound pressure levels during pile driving operations at NBK Bangor which may result in behavioral disturbance. Any marine mammals which are behaviorally disturbed, may change their normal behavior patterns (i.e. swimming speed, foraging habits, etc.) or be temporarily displaced from the area of construction. Any exposures would likely have only a minor effect and temporary impact on individuals and would not result in population level impacts. The sound generated from vibratory pile driving is non-pulsed (e.g., continuous) which is not known to cause injury to marine mammals. Mitigation is likely to avoid most potential adverse underwater impacts to marine mammals from impact pile driving. Nevertheless, some level of impact is unavoidable. Impacts to marine mammals from changes in water quality as a result of pile driving operations are not expected to occur.

In-direct impacts to marine mammals as a result of effects to their prey varies by prey species. The Test Pile Program has been scheduled to maximize the use of recommended work windows to avoid important salmonid spawning periods. However, some fish species are still likely to be present. Fish that occur in the immediate project area would be exposed to underwater noise that could injure or disturb fish or their eggs/larvae during pile driving activity. Because vibratory pile driving is the primary installation method, the most likely impact to fish from pile driving activities at the project area would be temporary behavioral disturbance or avoidance of the area. In general, impacts to marine mammal prey species are expected to be minor and temporary due to the short-time frame for the Test Pile Program. However, adverse impacts may occur to a few species of rockfish (bocaccio, yellowweye, and canary rockfish), chinook salmon, and summer run chum. In-direct impacts to marine mammal prey as a result of changes in water quality are expected to be minor and temporary. Dissolved oxygen levels are not expected to be drop to levels that would result in harm to prey species. Some degree of localized, short term increase in turbidity is expected to occur during installation and removal of the piles. Prey species are expected to avoid areas with elevated suspended sediments or experience minor behavioral effects due to changes in turbidity.

Endangered Species Act Conclusions

Acoustic exposures to the Steller sea lion are not predicted for pile driving operations associated with the Test Pile Program due to this species lack of presence during the project time frame. In-direct effects to this species may be possible due to the adverse effect to several of their prey species (i.e. rockfish ssp. and salmon spp.). Based on NMFS guidance for ESA consultations with the Northwest region (NMFS 2008d), despite this species extremely unlikely presence in the project area during the time period of the proposed action, because they have been recorded in the months immediately preceding the work window, and because the proposed action has adverse effects to salmonids and generates sound pressure levels above ambient noise levels, the Test Pile Program may affect, but is not likely to adversely affect the ESA listed Steller sea lion.

Acoustic exposures to Southern Resident killer whales are not predicted for pile driving operations associated with the Test Pile Program due to this species lack of presence within the Hood Canal. However, due to in-direct adverse effects from pile driving activities to their primary prey species (Chinook salmon and Chum salmon), the Test Pile Program may affect, but is not likely to adversely affect the ESA listed Southern Resident killer whale.

Marine Mammal Protection Act Conclusions

Acoustic exposure estimates from pile driving operations indicate the potential for Level B harassment as defined by MMPA. No marine mammals would be exposed at levels that would result in injury or mortality. In-direct impacts to marine mammals from changes in water quality and prey availability as a result of the Test Pile program are expected to be minimal and would be temporary in nature. Although there may be impacts to individual marine mammals, the impacts at the population, stock, or species level would be negligible.

National Environmental Policy Act

The analysis presented above indicates that pile driving activities associated with the Navy's proposed Test Pile Program at NBK Bangor may have impacts to individual marine mammals, but any impacts observed at the population, stock, or species level would be negligible. Therefore, in accordance with NEPA, there would be no significant impact to marine mammal populations from the Test Pile Program.

3.10 BIRDS

The marbled murrelet is the only ESA-listed species that may occur in the vicinity of NBK Bangor. Two other species, the osprey and great blue heron are currently acknowledged as species of concern under the ESA. The bald eagle, has been de-listed from threatened status under the ESA due to its recovery, but remains protected under the Bald and Golden Eagle Protection Act (16 USC § 668-668a), which prohibits the taking, possession of, or commerce in bald and golden eagles as well as the Migratory Bird Treaty Act (MBTA). Table 3.37 provides examples of the different types of all birds known or expected to occur at NBK Bangor and includes information on seasons of occurrence.

At NBK Bangor, marine bird density is highest in winter, with large numbers of marine waterfowl occurring at this time. In surveys conducted in the 1990s by Nysewander et al. (2005), the combined density of marine birds during summer months in the vicinity of the NBK Bangor waterfront was 10 to 29 birds per square mile, compared to 29 to 77 birds per square mile during winter. Many of the marine bird species are migratory or only occur during part of the year.

TABLE 3.37 MARINE BIRD GROUPINGS AND FAMILIES AT THE NBK BANGOR WATERFRONT

Marine Bird Grouping	Marine Bird Families	Season(s) of Occurrence	Preferred Habitats	Preferred Prey
Shorebirds and Wading Birds	Plovers, sanderlings, dowitchers, sandpipers, yellowlegs, and phalaropes Great blue heron	• Killdeer: year-round • Great blue heron: year-round • Spotted sandpiper: summer • Phalaropes: during migration • All other species: winter and during spring and/or fall migration	• Great blue heron: shoreline, shallow marine and freshwater • Shorebirds: Intertidal zone, mudflats, beaches	• Great blue heron: crustaceans, small fishes • Shorebirds: marine worms, insect larvae, aquatic insects
Marine Waterfowl	Diving ducks (goldeneye, scoters, bufflehead), mergansers, grebes, loons, dabbling ducks (mallard, wigeon), and geese	• Canada goose, red-necked and hooded mergansers, and some dabbling ducks: year-round • Surf and white-winged scoters: winter and in non-breeding flocks during summer • All other species: winter and/or during migration (spring and/or fall migration)	• Canada goose, mergansers, dabbling ducks: marine and freshwater shorelines, eelgrass beds, and shallow water • Scoters, goldeneyes: marine nearshore and deeper water, near pilings • Grebes, loons: marine nearshore and deeper water	• Canada goose: vegetation • Mergansers: small fishes • Dabbling ducks: marine and freshwater vegetation, freshwater and marine larvae, aquatic and terrestrial insects • Scoters, goldeneyes: molluscs, barnacles, crustaceans, other invertebrates, small fishes • Grebes, loons: small fishes
Seabirds	Pursuit divers: auklets, murres, murrelets, guillemots, and cormorants Surface feeders: gulls and terns	• *Gulls*: glaucous-winged gulls: year-round; Ring-billed gull: year-round; mew gull: winter, migrant; Bonaparte's gull: fall and spring migrant; other species: winter • *Terns*: Caspian terns: summer; common tern: fall migrant • All other species: year-round	• Pursuit divers: marine nearshore and deeper water • Surface feeders (gulls, terns): shoreline, marine nearshore, deeper water	• Pursuit divers: small fishes, invertebrates, zooplankton • Surface feeders: small fishes, molluscs, crustaceans, garbage, carrion
Raptors	Bald eagle Osprey	• Year-round • Summer resident	• Forested shoreline, shoreline, marine nearshore, freshwater	• Bald eagle: fishes, waterfowl, shorebirds, carrion • Osprey: fishes

Sources: Smith et al. 1997; Navy 2001; Opperman et al. 2003; Larsen et al. 2004; Wahl et al. 2005; WDFW 2005.

3.10.1 Affected Environment

3.10.1.1 Regulatory Overview

ESA

See section 3.8.1.1 for a description of the ESA.

Migratory Bird Treaty Act

Migratory birds are any species or family of birds that live, reproduce or migrate within or across international borders at some point during their annual life cycle. The Migratory Bird Treaty Act (MBTA) of 1918 is the primary legislation in the United States established to protect migratory birds (16 USC 703-712). The MBTA prohibits the taking, killing or possessing of migratory birds unless permitted. The list of bird species protected by the MBTA appears in 50 CFR 10.13.

Bald and Golden Eagle Protection Act

In 1940 bald eagles gained protection under the Bald and Golden Eagle Protection Act. Bald eagles were listed as an endangered species under the Endangered Species Preservation Act of 1966 on March 11, 1967 and in 1972 the bald eagle became protected under the MBTA. On February 14, 1978 the bald eagle was listed as an endangered species in 43 of the continuous states under the Endangered Species Act (ESA) and listed as threatened in 5 states (Michigan, Minnesota, Wisconsin, Oregon and Washington) (43 FR 6230, February 14, 1978).

Effective 8 August 2007, the USFWS delisted the Bald Eagle under the authority of the ESA (see 72 FR 37345, July 9, 2007), removing it from the ESA's List of Endangered and Threatened Wildlife throughout most of its range. The prohibitions of the ESA no longer apply except to the Sonoran Desert nesting Bald Eagle population which is currently listed as threatened. In May 2007 the USFWS issued a set of National Bald Eagle Management Guidelines providing landowners and others with guidance on how to ensure that actions taken on private property are consistent with the Bald and Golden Eagle Protection Act and the MBTA, which both protect Bald Eagles by prohibiting killing, selling or otherwise harming eagles, their nests or eggs (USFWS, 2007) A modification to the definition of "disturb," a term specifically prohibited as a "take" by the Bald and Golden Eagle Protection Act was implemented on July 5, 2007 (72 FR 31132, June 5, 2007). The revised definition defines "disturb" as "to agitate or bother a Bald or Golden Eagle to a degree that causes, or is likely to cause, based on the best scientific information available:

1. "Injury to an eagle,
2. A decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or,
3. Nest abandonment, by substantially interfering with normal breeding, feeding or sheltering behavior (USFWS, 5 June 2007, 72 FR 31132)."

This definition provides clarity to the public while continuing protection for Bald Eagles (USFWS 2007). On September 11, 2009 the USFWS published its Final Rule on Authorizations

Under the Bald and Golden Eagle Protection Act for Take of Eagles (74 FR 46836). This Final Rule establishes permit provisions for Bald and Golden Eagle takes under limited circumstances.

3.10.1.2 ESA-Listed Birds

Marbled Murrelet

Status and Management

In 1992, the marbled murrelet was listed as threatened in California, Oregon, and Washington under the ESA (57 FR 45328). Primary causes of the species' decline include direct mortality from oil spills and by-catch in gill-net fisheries, as well as loss of nesting habitat (61 FR 26256).

Critical Habitat

Critical habitat for nesting was designated for the marbled murrelet in 1996 (61 FR 26256) and is currently proposed for revision, but the revised critical habitat will not include military lands (71 FR 53838). NBK Bangor is not within designated marbled murrelet critical habitat (61 FR 26256; 71 FR 53838). Designated critical habitat closest to Hood Canal includes forest lands west and south from Dabob Bay, which is within flight distance of the Test Pile Program project area (less than 84 kilometers [52 miles]) for breeding murrelets (61 FR 26256).

Distribution and Abundance

Marbled murrelets are seabirds that spend most of their life in the marine environment and nest in mature and old-growth forests (USFWS, 1997). Murrelets use the marine environment in Hood Canal for courtship, loafing, and foraging (USFWS, 2010, in preparation). In this area, their nesting season is between April 1 and September 15. During the breeding season, murrelets tend to forage in well-defined areas along the shoreline in relatively shallow marine waters (Strachan et al. 1995). Murrelets forage at all times of the day and in some cases at night (Strachan et al. 1995).

During the pre-basic molt flightless murrelets must select foraging sites that provide adequate prey resources within swimming distance (Carter and Stein 1995). During the non-breeding season, murrelets typically disperse and are found farther from shore (Strachan et al. 1995).

Murrelets can occur year-round in Puget Sound and Hood Canal, although their flock size, density, and distribution vary by season (Falxa et al., 2008; Nysewander et al., 2005). Murrelet summer foraging groups occur more often in flock sizes of two, with singles and flocks of three or more birds occurring less often (Merizon et al., 1997; Ramos, 2009). Winter flock size is often times greater than four birds (USFWS, 2010, in prep).

Murrelet presence in Hood Canal has been documented through a number of survey efforts. The most accurate information comes from the consistent sampling used to estimate population size and trends under the Northwest Forest Plan Murrelet Effectiveness Monitoring Program (Raphael et al., 2007). Other survey data were generated through the Puget Sound Ambient Monitoring Program (PSAMP), conducted by WDFW. These two survey efforts (conducted since the mid-1990s) have estimated marbled murrelet densities in inland Washington marine waters. Surveys conducted for the NWFPEMP estimated a density of 3.7 birds per square mile in Hood Canal during the 2003 breeding season (April–September) (Miller et al., 2006). The

PSAMP surveys estimated marbled murrelet density in northern Hood Canal from 2.8 to 7 birds per square mile during the winter from 1993 to 2006, and 1.4 to 2.8 birds per square mile during the summer from 1992 to 1999 (WDFW, 2007b).

USFWS (2010, in preparation) approximated the murrelet summer density for Floral Point (an area at the northern end of the NBK Bangor waterfront) using the survey results for stratum 2 (conducted in July and August 2008) in Conservation Zone 1 (Falxa et al., 2009). To approximate murrelet winter density at Floral Point, USFWS (2010, in prep) developed an index using the results of winter surveys reported by Nysewander et al. (2005) for the Puget Sound Ambient Monitoring Program (1992-1999). This resulted in a multiplication of the summer density by a factor of 1.84. Table 3.38 summarizes the density which will be used for marbled murrelets in the remainder of this analysis.

Additional surveys specific to marbled murrelet presence at NBK Bangor have been conducted. Marbled murrelets were observed in shoreline and at-sea surveys conducted over several months from 2007 to 2010 (Agness and Tannenbaum, 2009b; Tannenbaum et al., 2009b), and the Kitsap Audubon Society reported marbled murrelets in three annual Christmas Bird Count surveys between 2001 and 2007 (Kitsap Audubon Society, 2008). Murrelets were observed in nearshore and deeper waters, including one individual near EHW-1 in September 2008.

Marbled murrelets nest solitarily in trees with features typical of coniferous old-growth (stand age from 200 to 250 years old, trees with multi-layered canopy). Although old-growth forest is the preferred habitat for nesting, marbled murrelets are known to nest in mature second growth forest with trees as young as 180 years old (Hamer and Nelson, 1995). WDFW Priority Habitat Species maps do not indicate the presence of marbled murrelet nests in the upland areas including, and adjacent to, NBK Bangor (WDFW, 2007c). Although forest stand inventories at NBK Bangor indicate that stands are typically less than 110 years old, some relict, old-growth trees can be found near Devil's Hole and a small, "old-growth" stand has been recently located at the northern portion of the base (International Forestry, 2000; Navy forester, 2010). This stand is scheduled for delineation to determine suitability as "potential habitat" for marbled murrelets."

TABLE 3.38 THE COMPUTED DENSITY AND NUMBER OF MURRELETS PRESENT BY FLORAL POINT DURING SUMMER AND WINTER

Area	Number and Density of Murrelets			
	Summer Season		Winter Season	
	Density† (no./km^2)	Number of Murrelets	Density‡ (no./km^2)	Number of Murrelets
Floral Point	1.61	155	2.96	284

†This was the mean density of murrelets in Conservation Zone 1 as reported by Falxa et al. (*in litt.*).
‡The estimated density of murrelets is projected to increase by a factor of 1.84 (1.61 x 1.84 = 2.96).

3.10.1.3 Species with Special Protection Status

Bald Eagle

Bald eagles in the Pacific Northwest include resident birds and winter migrants that breed farther north. Migration patterns in general are timed to track the availability of spawning salmonids (Buehler, 2000). Many resident eagles in the Pacific Northwest migrate in late summer, when juveniles and adults move north up the coast to meet salmon runs in Alaska. At the end of these salmon runs in late fall, Alaskan and Pacific Northwest eagles move south along the coast following salmon runs. Adults reach wintering grounds in Pacific Northwest states in November or December, followed by juveniles in January (Buehler, 2000). Eagles that breed in more northern latitudes return to their breeding grounds during spring migration from January to March, depending on food resources and weather conditions.

WDFW identified 1,125 bald eagle territories in Washington in 2005, of which 75 percent were occupied (WDFW, 2007d). Near Hood Canal and the NBK Bangor waterfront, bald eagles nest along the shoreline of Dabob Bay on the Bolton Peninsula and along the shoreline of Quilcene Bay, west of Dabob Bay, in Hood Canal. Bald eagles have been observed feeding, perching or roosting, and bathing at NBK Bangor year round (Don, 2001; Agness and Tannenbaum, 2009b; Tannenbaum et al., 2009b). An active bald eagle nest is located south of Devil's Hole near the waterfront (Leicht, 2008, personal communication) and bald eagle nesting territories occur within 1.7 kilometers (1 mile) of the base (WDFW, 2007c). The closest known nesting territory outside the base contains two nests, one of which is approximately 260 meters (850 feet) north of the NBK Bangor property line. A third nest in this territory, which was about 167 meters (550 feet) from the property line, no longer exists (Slater, 2009). Five known bald eagle territories are located on the Toandos Peninsula of Hood Canal (WDFW, 2007c).

Osprey

Ospreys are listed as a species of concern under the ESA and are a species to monitor for the state of Washington. Ospreys are summer-resident raptors that occur and nest near water, including marine shorelines, rivers, lakes, and streams where fish are available for foraging (Poole et al., 2002). Their nests are usually located in tall trees near large bodies of water. They have been observed flying, perching, and foraging at NBK Bangor (Agness and Tannenbaum, 2009b; Tannenbaum et al., 2009b). Four active osprey nests at NBK Bangor with fledged young were cited in the INRMP (DoN, 2001), including a nest south of Cattail Lake. These nest sites are protected with 30-meter (100-foot) no-harvest buffer zones.

Great Blue Heron

Great blue heron are listed as a species of concern under the ESA and are a species to monitor for the state of Washington. Great blue herons forage on fish, amphibians, and aquatic invertebrates in wetlands, streams, and marine shorelines and, although distributed throughout the state of Washington, are most common in lowlands (Quinn and Milner, 2004). They are year-round residents in low-elevation areas of western Washington. Great blue herons breed in colonies (rookeries) that are typically located near a body of water. The INRMP cited up to six great blue heron rookeries (Don, 2001) located at Hunter's Marsh and other wetlands at NBK Bangor. However, no evidence of breeding was observed during May 2008 field visits to Hunter's Marsh, the only rookery cited in the INRMP that would be in the vicinity of the project area. The Navy manages heron rookeries with 30 meter (100-foot) no-harvest buffer zones (DoN, 2001). In 2008, three new nests were constructed on a tower at EHW-1, at least two of which had chicks during summer 2008 marine wildlife surveys (Tannenbaum et al., 2009b).

3.10.1.4 Non-Listed ESA Birds

Shorebirds

Shorebirds occurring at or near the project area are mainly present during winter and/or migration, depending on species life history (Table 3.37). Exceptions include the killdeer, which is present year round, and the spotted-sandpiper, a summer resident and potential breeder at NBK Bangor. Shorebirds primarily rely on resources at NBK Bangor for foraging during the non-breeding season when over-wintering or as a stopover during spring and fall migrations (for species such as phalaropes) (Buchanan, 2004). Both the killdeer and spotted sandpiper nest close to water (Opperman, 2003) and may nest on the shoreline in the vicinity of the Test Pile Program project area. Shorebirds focus on intertidal habitat for all foraging activities (Johnson and O'Neil, 2001). Many shorebird species (e.g., plovers, sanderlings, sandpipers, and dowitchers) forage on larvae, and aquatic insects (Buchanan, 2004). Other food sources of shorebirds include amphipods, copepods, crustaceans, and molluscs. Shorebirds rest or sleep (roost) in a variety of location-dependent habitats. Some roosting habitats used by shorebirds include salt flats adjacent to intertidal foraging areas, higher elevation sand beaches, fields, or grassy areas near intertidal foraging areas; roost sites occasionally include piles, log rafts, floating docks, or other floating structures when natural roost sites are limited (Buchanan, 2004).

Marine Waterfowl

Most marine waterfowl species only occur at the NBK Bangor waterfront during the winter and migrate north during their breeding season. However, common and hooded mergansers, Canada geese, and some dabbling duck species (mallard, gadwall, and northern shoveler) can be found near the project area year round. Of these species, only the Canada goose and merganser have been regularly sighted during summer months (Agness and Tannenbaum, 2009b; Tannenbaum et al., 2009b). Surf and white-winged scoters primarily occur in winter but can occur in summer (Opperman, 2003), although sightings of scoters are less common during summer months (Agness and Tannenbaum, 2009b). Marine waterfowl primarily forage in the nearshore environment, including near manmade structures (such as EHW-1), but are also found in inland deeper marine waters (Agness and Tannenbaum, 2009b). The primary forage resources of marine waterfowl include molluscs, crustaceans, and plant material. Other secondary food sources of marine waterfowl in the nearshore vicinity of the Test Pile Program project area are aquatic larvae and invertebrates. In the Puget Sound region, eelgrass beds are important foraging zones for dabbling ducks (American wigeon and mallard) (Lovvorn and Baldwin, 1996). Mergansers, such as the common merganser, nest close to water in rock crevices, tree cavities, or under tree roots (Opperman, 2003) and may nest along the shoreline habitat near the project area during summer. Marine waterfowl also rest on shore and the intertidal zone (Agness and Tannenbaum, 2009b).

Seabirds

There are two primary guilds of seabirds that occur near the project area: surface feeding and pursuit-diving. In addition, the parasitic jaeger is a predatory seabird that may occur in the vicinity of NBK Bangor during fall migration (late September to early October) in pursuit of small birds (such as common terns, which are also in migration during this time) (Opperman, 2003). Depending on individual species life history, surface-feeding seabirds occur during different seasons. Whereas glaucous-winged gulls occur year round (Hayward and Verbeek, 2008), other gull species only occur during a portion of the year (see Table 3-38). Glaucous-winged gulls breed at established colonies, and the closest colony to the Test Pile Program project area is located approximately 48 kilometers (30 miles) to the northwest (Protection Island) (Hayward and Verbeek, 2008). Non-breeding Caspian terns and breeders disperse from colonies after the breeding season ends in June or July and are common in the vicinity of the Test Pile Program site from April to August. Gulls and terns in the vicinity forage on small schooling fish, visible from the water surface in the nearshore marine and inland marine deeper water habitats (e.g., Pacific herring, Pacific sand lance, and juvenile salmonids). Additional forage resources taken opportunistically by gulls include objects gleaned on the water surface, garbage on shore or inland, scavenged carrion, and small birds and eggs. Gulls can also forage in the intertidal zone; for example, gulls can feed on molluscs by dropping a mollusc from the air to break the shell on the beach or other hard surface, such as EHW-1.

Pursuit-diving seabirds can occur year round in the vicinity of the project area; however, numbers of some species are greater during winter months (e.g., pelagic cormorant, common murre, and pigeon guillemot). Cormorants, such as the double-crested cormorant, nest in colonies along the outer coast of Washington; however, non-breeding cormorants are found year round at NBK Bangor. Cormorants roost on buoys and other structures at the waterfront in groups of 10 individuals, the majority of which are juveniles (Agness and Tannenbaum, 2009b). Gulls roost in similar sized groups (Agness and Tannenbaum, 2009b).

With the exception of the pigeon guillemot, seabirds such as the common murre and rhinoceros auklet do not nest near the project area (Wilson and Manuwal, 1986; Ainley et al., 2002; Agness and Tannenbaum, 2009b). Non-breeding common murres can occur year round. In general however, common murres are most abundant in inland waters of Washington during the winter (Johnson and O’Neil, 2001), whereas rhinoceros auklets are more common in inland waters during the summer (Johnson and O’Neil, 2001; Opperman, 2003).

Pursuit-diving seabirds are found in nearshore and inland marine deeper waters near the Test Pile Program area, where they dive to capture prey underwater. These seabirds are also found near manmade structures, such as the EHW-1, where algal and invertebrate communities (which provide additional forage resources) have become established on underwater piles. Primary forage resources of these seabirds include small schooling fish and other nearshore fish, such as Pacific sand lance and Pacific herring (Vermeer et al., 1987). The pigeon guillemot forages opportunistically on a more general diet of epibenthic fish and invertebrates than some other pursuit-divers, such as the common murre (Vermeer et al., 1987). Additional forage resources of pursuit-diving marine birds in the marine water habitats include zooplankton and aquatic invertebrates.

3.10.2 Environmental Consequences

3.10.2.1 No Action Alternative

Under the No Action Alternative the Test Pile Program would not be conducted. Baseline conditions, as described above, for birds would remain unchanged. Therefore, there would be no significant impacts to birds from implementation of the No Action Alternative.

3.10.2.2 Action Alternative

The evaluation of impacts to marine birds considers the importance of the resource, the proportion of the resource affected relative to its occurrence in the region, the particular sensitivity of the resource to project activities; and the duration of environmental impacts or disruption. In general, impacts from pile driving at the Test Pile Program site would be similar to those described for marine mammals (see Section 3.9), including elevated underwater noise levels, increased human activity and noise, and changes in prey availability within the project area. In particular, underwater and airborne pile driving noise during the test pile period has the potential to disrupt marine bird nesting, foraging, and resting in the vicinity of the project area. Impacts to marine birds are anticipated to be highly localized because marine birds are wide-ranging and have a large foraging habitat available in Hood Canal, relative to the foraging area that might be impacted by pile driving within the project area.

3.10.2.2.1 Potential Effects of Pile Driving on Birds

The primary impacts to marine birds from the Test Pile Program would be associated with noise resulting from pile driving. Impacts to marine birds associated with water quality changes (turbidity) in nearshore habitats and changes in prey availability (benthic community and forage fish) would be localized and temporary during the 40 day pile driving period and are not discussed further in this section. The most important impact to marine birds associated with pile driving would occur when birds are foraging underwater at the same time underwater noise is being generated by impact pile driving, and to a lesser extent, vibratory pile driving.

Underwater Noise

Underwater noise associated with pile driving activities would likely be one of the most important impacts to marine birds present during pile driving within the project area. As described in Section 3.9.2.2.2, Underwater Noise, pile driving within the project area would result in increased underwater noise levels. Impact pile driving using a single-acting diesel impact hammer and 168-cm (66-inch) steel piles would produce peak underwater noise levels of 210 dB re 1 μPa peak and average RMS levels of 195 dB re 1 μPa at a distance of 10 meters (33 feet) from the pile in the absence of any noise mitigation devices. Existing underwater noise levels measured along the NBK Bangor waterfront were measured at 114 dB re 1 μPa (Slater, 2009). Any location in Hood Canal with a direct line-of-sight to the source of impact pile driving would experience noise levels above the average background noise. However, locations with an intervening land mass would experience lower noise levels from pile driving.

There are no empirical data specific to impact pile driving and its effects on any seabird, but studies that have evaluated other types of underwater sounds (underwater blasting and seismic testing) on vertebrates provided some basis for evaluating the effects of pile driving on seabirds (Entranco and Hamer Environmental, 2005). Exposure to high sound pressure levels (SPLs) can result in barotrauma, physical injury caused by a change in pressure usually occurring in the ear (Hastings and Popper, 2005; USFWS, 2006), i.e., internal injuries, including hemorrhage and rupture of internal organs caused by a difference in pressure between an air space inside the body and the surrounding gas or liquid.

USFWS (2006) uses a threshold for physical injury (such as permanent threshold shift [PTS]) of 180 dB re 1 μPa peak. Applying this guideline to the project area, the impact area for PTS injury would be 215 meters (705 feet), assuming properly functioning sound attenuation devices are used (-10 dB reduction included for this distance) (see Table 3.39 and Figure 3-17). Marbled murrelets (and other diving birds) exposed to impact pile driving noise underwater within the 215 meters (705 feet) distance could be injured. Recent construction-period monitoring at Hood Canal Bridge, approximately 35 kilometers (22 miles) from NBK Bangor, described a pigeon guillemot that appeared to be distressed and initially unable to fly following underwater exposure to impact pile driving at a distance of approximately 68 meters (225 feet) (Entranco and Hamer Environmental, 2005).

A complicating factor is the possibility that fish may be killed or injured as a result of pile driving, which in turn may attract foraging marine birds to the project area in spite of the noise levels. Even without this attractant, some marine birds may continue to forage close to the construction area and be exposed to noise-related injury. Monitoring work at Hood Canal Bridge (Entranco and Hamer Environmental, 2005) demonstrated that marbled murrelets continued to dive and forage within 300 meters (984 feet) of active pile driving operations, well within the injury impact area predicted by the USFWS threshold. This observation indicates that some foraging marine birds may habituate to pile driving.

Behavioral responses of birds to pile driving are not well known and were extrapolated from the literature on fishes by USFWS, recognizing that there is considerable uncertainty on the subject (USFWS, 2006). In the analysis of pile driving impacts to marbled murrelets at the Anacortes, Washington, ferry terminal, USFWS stated that they would anticipate that SPLs in excess of 150

TABLE 3.39 CALCULATED DISTANCE (M) TO THE USFWS GUIDELINE THRESHOLD FOR UNDERWATER IMPACTS FROM PILE DRIVING ON THE MARBLED MURRELET

Description	66-inch pile[1]	
	USFWS Guidance for Physical Injury	USFWS Guidance for Behavioral Disturbance
	Distance (m) to 180 dB re 20 μPa peak	Distance (m) to 150 dB re 20 μPa peak[2]
Impact Driving with confined bubble curtain (-10 dB reduction)	215	2,154[2]

CISS = cast-in-steel-shell; dB = decibel; N/A = not applicable; rms = root-mean-square; μPa = microPascal
Practical spreading loss (15 log, or 4.5 dB per doubling of distanced) used for water depths 10-50 feet.
[1]66-inch pile representative of test piles used; source levels based on measurements of 66-inch CISS piles (195 dB @ 10 m).
[2]Range calculated is greater than what would be realistic. Hood Canal average width at site is 2.4km, and is fetch limited from N to S at 8.4 km.

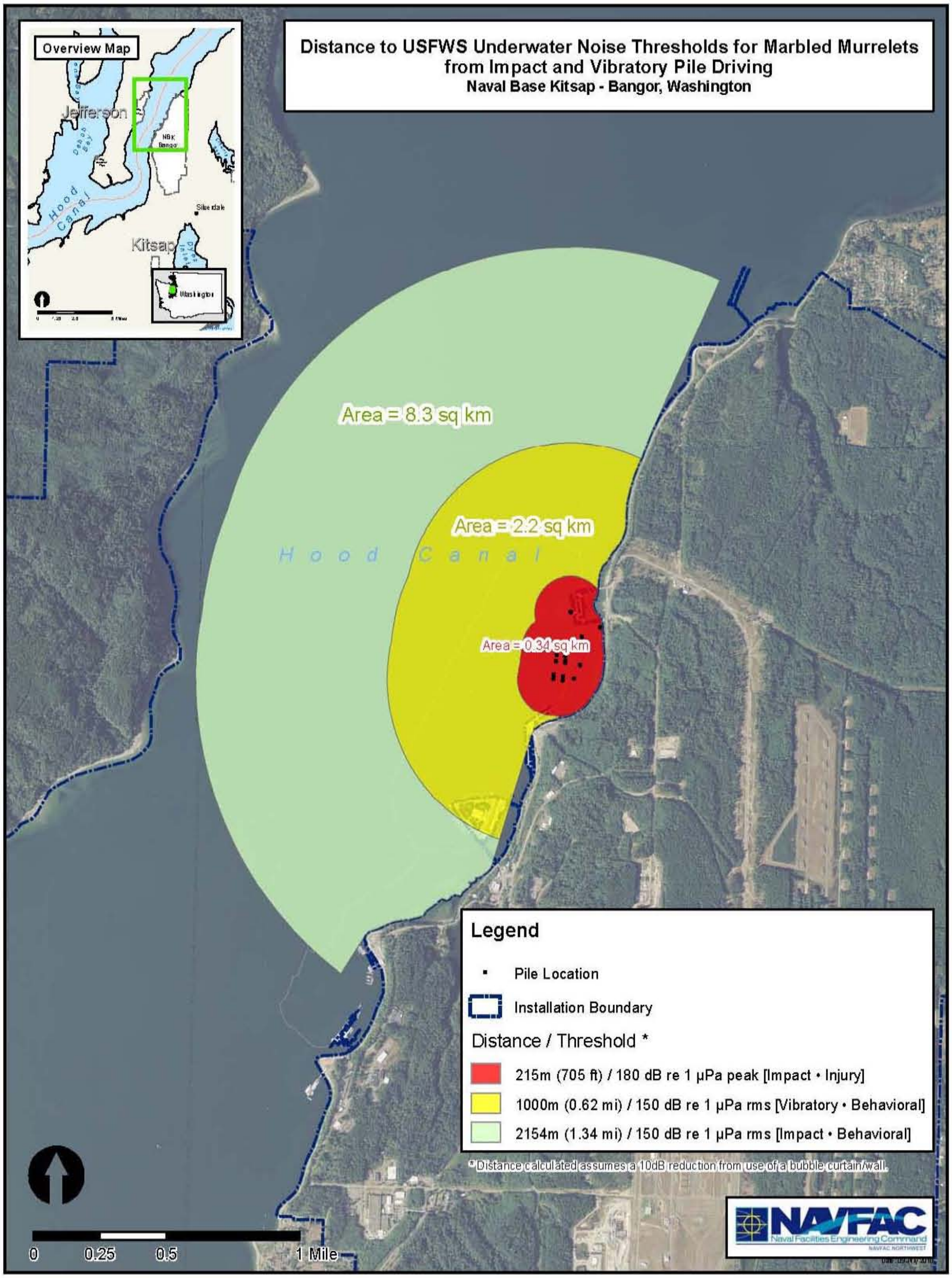


Figure 3-17 Distance to USFWS Underwater Noise Thresholds for Marbled Murrelets from Impact and Vibratory Pile Driving

dBRMS could cause significant disruption of normal behaviors (USFWS, 2006). Behaviors that would indicate disturbance of marbled murrelets and other marine birds include flushing (startle reaction), aborted feeding attempts, delayed feeding, or avoidance of the area. TTS can also result from exposure to elevated underwater noise, potentially affecting communication and/or ability to detect predators or prey. Responses of marine bird species in general are expected to be similar to those predicted for marbled murrelets. If the 150 dB re 1 μPa threshold is applied with the project area, the potential area for behavioral changes would be as great as 2,154 meters (7,067 feet) from a driven pile, assuming properly functioning sound attenuation devices are used (-10 dB reduction included for this distance) (see Table 3.35 and Figure 3-16). Marine birds would likely avoid the immediate pile driving site but would likely habituate to pile driving noise well within the disturbance impact area due to sound attenuation with increasing distance from the source.

Airborne Noise

Marine birds are also disturbed by airborne noise associate with pile driving. Impact pile driving has been recorded at 105 dB re 20 μPa at a distance of 15 meters (50 feet) from the source and vibratory pile driving was recorded at 95 dB re 20 μPa at 15 meters (50 feet) from the source. USFWS (2004a) identified a sound-only injury threshold for marbled murrelets at nest sites of 92 dB re 20 μPa, where injury is defined as a bird flushing from the nest or the young missing a feeding. If this guidance is applied to murrelets foraging and resting in the marine environment of the project area, impact pile driving would exceed the 92 dB re 20 μPa airborne injury threshold to a distance of approximately 68 meters (223 feet) over water, and vibratory would exceed the airborne threshold for approximately 22 meters (72 feet) over the water (See Table 3.40 and Figure 3-18). USFWS (2004a) has also identified noise-only alert and disturbance thresholds for marbled murrelets, where alert behavior refers to the bird showing apparent interest in the noise source and disturbance is indicated by avoidance of the noise. These threshold levels change depending on the baseline noise level, and do not widely apply (USFWS, 2004a; WSDOT, 2008; Teachout, 2009, personal communication). The airborne threshold was derived from studies of nesting murrelets, and responses of foraging and resting birds in the marine environment are less well known. However, murrelets on the water may be impacted by pile driving through injury or behavioral disturbance within the aforementioned distances.

Noise-related thresholds have not been established for marine bird species other than marbled murrelets that occur on the waterfront, such as scoter species, pigeon guillemots, goldeneye species, cormorants, and grebes, but they are likely to respond similarly to pile strikes. Behavioral responses of seabirds, including marbled murrelets, were monitored during construction of Hood Canal Floating Bridge in Washington (Entranco and Hamer Environmental, 2005). At the beginning of pile driving work, the majority of seabirds in the vicinity responded by flushing, but over time some habituation occurred. Most of these species use the NBK Bangor waterfront for foraging and resting (Agness and Tannenbaum, 2009b; Tannenbaum et al., in prep., b).

TABLE 3.40 CALCULATED DISTANCE (M) TO THE USFWS GUIDELINE THRESHOLD FOR AIRBORNE IMPACTS FROM PILE DRIVING ON THE MARBLED MURRELET

Description	66-inch pile[1]
	USFWS Guidance Threshold for Physical Injury
	Distance (m) to 92 dB re 20 µPa rms
Impact Driving with confined bubble curtain (-10 dB reduction)	68
Vibratory Driving with confined bubble curtain (-10 dB reduction)	22

CISS = cast-in-steel-shell; dB = decibel; N/A = not applicable; rms = root-mean-square; µPa = microPascal
Practical spreading loss (15 log, or 4.5 dB per doubling of distanced) used for water depths 10-50 feet.
[1]66-inch pile representative of test piles used; source levels based on measurements of 66-inch CISS piles (195 dB @ 10 m).

ESA-Listed Birds

Marbled Murrelet

Noise from pile driving has the potential to cause injury and behavioral disturbance for marbled murrelets. Estimated numbers of exposures of marbled murrelets are presented in Table 3.41.

Although murrelets would likely avoid the immediate pile driving site and would habituate to pile driving noise well within the disturbance impact area, potential impacts may occur, especially considering the observations at Hood Canal Bridge (Entranco and Hamer Environmental, 2005), described in Section 3.10.2.2.1, Potential Effects from Pile Driving on Birds, Underwater Noise. The pile driving period (40 days) overlaps marbled murrelet nesting period (April 1 to September 15), however, murrelet densities are lowest during the summer period in which this project would take place (Nysewander et al., 2005). The Test Pile Program would only occur in the warm season, so the maximum estimated number of murrelets that would be exposed to behavioraFl disturbance is 180 individuals.

In accordance with ESA, the Action Alternative may affect, likely to adversely affect the marbled murrelet. In accordance with NEPA, the Action Alternative would have no significant impact on marbled murrelets. Several mitigation measures would be employed to minimize noise-related impacts to marbled murrelets. Gunderboom SAS™ or bubble curtains/walls would reduce pile removal and driving noise, and slowly ramping up sound levels at the beginning of each pile removal and driving session would discourage marbled murrelets from remaining in the vicinity.

Species with Special Protection Status

Other protected marine bird species that forage along the waterfront and nest in the vicinity of the project area include the bald eagle, osprey, and great blue heron. Because these species capture prey in the nearshore and intertidal habitats, they are susceptible to the same potential airborne noise impacts from pile driving and removal described above for marbled murrelets.

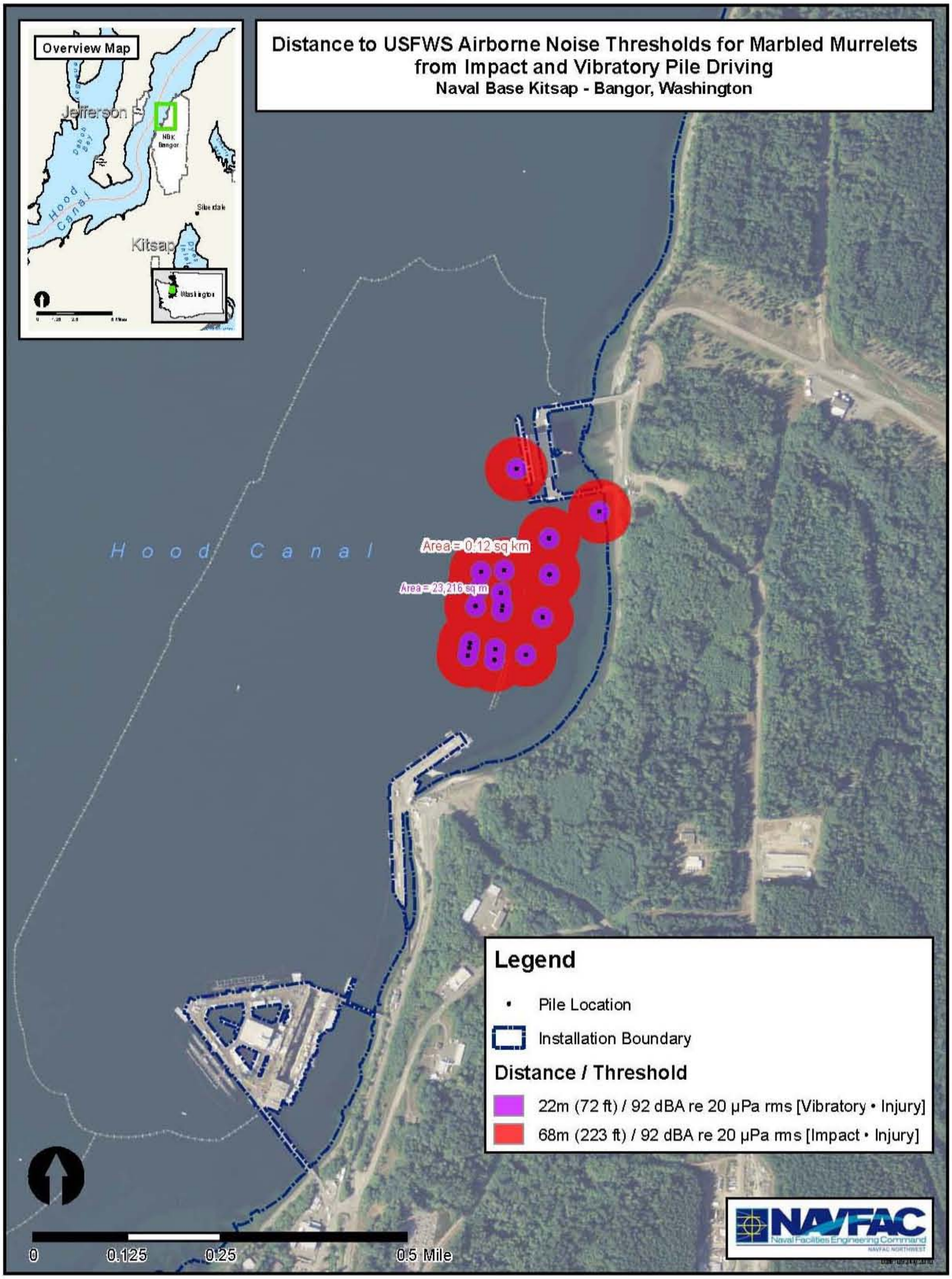


Figure 3-18 Distance to USFWS Airborne Noise Thresholds for Marbled Murrelets from Impact and Vibratory Pile Driving

TABLE 3.41 POTENTIAL EXPOSURES OF MARBLED MURRELETS WITHIN VARIOUS NMFS ACOUSTIC THRESHOLD ZONES

		USFWS Injury Guidance Threshold (Underwater)*	USFWS Behavioral Guidance Threshold (Underwater)*	USFWS Injury Guidance Threshold (airborne impact pile driving)	USFWS Injury Guidance Threshold (airborne vibratory pile driving)
Season	**Density of Marbled Murrelets**	**180dB re 20 µPa peak Threshold**	**150dB re 20 µPa peak Threshold**	**92dB re 20 µPa rms Threshold**	**92dB re 20 µPa rms Threshold**
Warm (May-Oct)	1.61	0	180	0	0

*The take estimates for 180 and 150dB include both those from impact and vibratory pile driving.

Bald Eagle

One bald eagle was observed foraging on the shoreline approximately 975 meters (3,200 feet, 0.6 mile) north of the project area (Tannenbaum et al., in prep., b). USFWS (2003) determined that elevated noise levels from impact pile driving at a dock in Port Angeles could disrupt the normal feeding behavior of adult bald eagles within approximately 0.5 mile of the dock site. Watson and Pierce (1998) found that vegetative screening and distance were the two most important factors determining the impact of visual disturbances for bald eagles. There is no effective vegetative screening within 0.5 mile of the project area along the shoreline; therefore, bald eagles would most likely avoid foraging within this area during the Test Pile Program. However, the area does not currently appear to receive much use by bald eagles, therefore no impacts to foraging bald eagles are expected.

The bald eagles observed during spring and summer marine bird surveys at NBK Bangor are probably the resident pair at the nests located in the Vinland neighborhood, and a resident pair nesting near Devil's Hole, since this species is highly territorial during the breeding season. The closest nest is over 1 mile from the project area, with vegetative screening present, therefore no impacts to nesting bald eagles are expected. The Action Alternative would have no significant impacts on the bald eagle.

Osprey

Ospreys have been observed foraging along the shoreline south of EHW-1 (Tannenbaum et al., in prep., b), adjacent to the project area. Pile driving and removal for the Test Pile Program would overlap the ospreys' period of residence in the area (July through October). Ospreys present during the test period, would probably avoid foraging within this area due to the noise. However, any potential disturbance would be short-term (40-day project schedule). The Action Alternative would have no significant impacts on the osprey.

Great Blue Heron

Great blue herons are intolerant of disturbance while foraging and nesting (Eissinger, 2007) and conduct both activities in the area around EHW-1 (Tannenbaum et al., in prep., b). Great blue herons would likely avoid foraging within this area during pile driving.

The INRMP (DoN, 2001) designated a 100-foot protection zone around great blue heron rookeries. Three pairs of great blue herons nested on a tower at EHW-1 in summer 2008 (Tannenbaum et al., in prep., b). Pile driving within the project area would be greater than 30 meters (100 feet) from the great blue heron nests at EHW-1, and there would be no physical disturbance to the rookery from construction activities. Pile driving and removal would occur during the great blue heron nesting season (15 February-31 July). However, great blue herons would be unlikely to nest at the site during pile driving due to the noise associated with the construction activities. Moreover, there would be no visual screening between the nests and pile driving activities, and this species is intolerant of noise and human disturbance (Eissinger, 2007). Great blue heron colonies may move from year to year in response to disturbance (Eissinger, 2007), and other suitable nesting sites are available (and have been used) in forest stands at NBK Bangor (DoN, 2001). Thus, avoidance of the EHW-1 tower nesting location during the pile driving period would not impact the great blue heron population in the area.

Impacts associated with pile driving would be limited to behavioral disturbance or short-term avoidance of the area. The Action Alternative would have no significant impacts on the great blue heron.

Migratory Birds

Most migratory and winter-resident seabirds, shorebirds, and waterfowl do not breed in the vicinity of the NBK Bangor waterfront. Six species recognized by the USFWS as species of concern could occur in the project area, and include the Caspian tern, yellow-billed loon, pelagic cormorant, western grebe, lesser yellowlegs, and short-billed dowitcher (USFWS, 2008a). Of these species, pelagic cormorants have been observed in Christmas bird counts (Kitsap Audubon Society, 2008) and summer surveys (Agness and Tannenbaum, 2009; Tannenbaum et al., in prep.). Pelagic cormorants do not breed in the vicinity, however. Western grebes have been observed during the spring migration (Agness and Tannenbaum, 2009) and Christmas bird counts (Kitsap Audubon Society, 2008). Migratory marine bird species would be subject to underwater and airborne noise. While it is likely that most marine birds would avoid the immediate vicinity of the project area during pile driving, it is possible that some individuals may habituate. Diving species such as loons, grebes, and cormorants could be exposed to underwater noise. Mitigation measures employed for the marbled murrelet may also minimize noise-related impacts to other diving migratory birds (see Section4.4, Mitigation Measures and Regulatory Compliance). Migratory marine birds are widespread throughout Puget Sound in winter months, and the project area is very small compared to their habitat overall.

3.10.2.2.2 Summary of Effects

Endangered Species Act Conclusions

Underwater and airborne sound levels from impact and vibratory pile driving have the potential to harm or harass marbled murrelets foraging and resting in the vicinity of the Test Pile Program.

Nearshore waters in the vicinity provide foraging habitat and prey species, and marbled murrelets have been observed in the area during the proposed construction window for pile driving. Some construction activities may temporarily affect the presence of this species, such as water quality changes (turbidity) in nearshore habitat and dislocation of prey populations (benthic community and forage fish). The presence of construction workers, barges, cranes, other vessels and equipment, and associated activities would create visual disturbances for marbled murrelets attempting to forage or rest in surrounding waters. It is expected that murrelets are at risk to direct effects from the pile driving activities, which if exposed to underwater and airborne sound levels from pile driving, could reduce the murrelet population size as a result of direct mortality of adults and juveniles. Adult mortality during the breeding season (April to September) could lead to population-level effects if breeding adults are killed or injured (including nestling mortality). Therefore, a “may affect, likely to adversely affect” determination is warranted for either summer or winter activities that all are conducted during the in-water work window.

National Environmental Policy Act

The analysis presented above indicates that pile driving activities associated with the Navy’s proposed Test Pile Program at NBK Bangor may have impacts to individual birds, but any impacts observed at the population, stock, or species level would be negligible. Therefore, in accordance with NEPA, there would be no significant impact to bird populations from the Test Pile Program.

Migratory Bird Treaty Act

The Action Alternative would not diminish the capacity of a population of migratory bird species to maintain genetic diversity, to reproduce, and to function effectively in its native ecosystem, and therefore would not have a significant adverse effect on migratory bird populations. The Action Alternative would have no significant impacts on migratory birds

3.11 TRIBAL FISHERIES/ACCESS

3.11.1 Affected Environment

In 1855, Territorial Governor Isaac Stevens negotiated treaties with 24 of the 29 modern-day federally-recognized tribes located in Washington State. The treaties known as the "Stevens Treaties" included language pronouncing that "[T}he right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory. . .together with the privilege of hunting and gathering roots and berries on open and unclaimed lands." Subsequent legal decisions (the Boldt decisions) have identified usual and accustomed (U&A) areas and afforded tribes the right to fifty percent of all fish and shellfish present or passing through the tribe's historical U&A areas, including off-reservation areas. The Skokomish, Lower Elwha Klallam, Port Gamble S'Klallam, Jamestown S'Klallam and Suquamish have adjudicated U&A in the Hood Canal which includes the project area.

The Navy has a cooperative agreement with the Skokomish, Lower Elwha Klallam, Port Gamble S'Klallam, and Jamestown S'Klallam allowing access to intertidal beaches for shellfish harvesting. Due to national security needs, shellfish harvesting is restricted south of Delta Pier.

COMNAVREG NW Instruction 11010.14 sets forth policy, procedures and responsibilities for the Commander, Navy Region Northwest consultations with federally recognized American Indian and Alaska Native tribes. The goal of the policy is to establish permanent working relationships built upon respect, trust and openness with tribal governments. Consultations have been initiated with the Skokomish Tribe and Suquamish Tribe; however, the Lower Elwha Klallam Tribe declined and the Jamestown S'Klallam and Port Gamble Klallam Tribes did not respond to the invitation to consult. Further correspondence with all tribes is planned after release of EHW2 DEIS.

3.11.2 Environmental Consequences

3.11.2.1 No Action Alternative

Under the No Action Alternative, the Test Pile Program would not be conducted. Baseline conditions, as described above, for tribal fisheries/access would remain unchanged. Therefore, there would be no significant impacts to tribal fisheries/access from implementation of the No Action Alternative.

3.11.2.2 Action Alternative

In accordance with Department of the Navy policy and policy issued by Commander, Navy Region Northwest invited the tribes with U&A to enter into government-to-government consultation in regard to the proposed action. In the spring of 2009, Naval Base Kitsap invited five tribes to initiate government-to-government for the proposed construction of EHW-2. The tribes also receive invitations to comment on the scope of the Environmental Impact Statement being developed for the construction and operation of the proposed wharf. The Suquamish was the only tribe to provide comments.

On 18 June 2010, the Commanding Officer of Naval Base Kitsap held a government-to-government meeting with the Chairman of the Suquamish Tribe and presented the known details of the alternatives being outlined in the EIS. The details of the Test Pile Program were also presented. The Suquamish indicated they had no objection to the Test Pile Program (but expected ongoing consultation on the wharf construction). On 29 July 2010 the Commanding Officer of Naval Base Kitsap has a similar government-to-government meeting with the Chairman of the Skokomish Tribe. The Skokomish Tribe did not express any concern over the proposed Test Pile Program. A third government-to-government is scheduled for 31 August 2010 with the Jamestown S'Klallam and Port Gamble S'Klallam Tribes, and the Point-No-Point Treaty Council. No adverse comments on the Test Pile Program are expected as a result of this meeting. A government-to-government meeting with the Lower Elwha Klallam Tribe has not been scheduled, but no impacts to the Lower Elwha Klallam Tribe's resources are anticipated because their U&A is far north of Bangor.

Under the Action Alternative access to the project area remains unchanged from current conditions.

3.12 ENVIRONMENTAL HEALTH AND SAFETY

3.12.1 Affected Environment

The NBK Bangor waterfront is restricted from public access. Figure 1-3 indicates the restricted areas associated with the base. As a result, recreation and commercial fishing and other public activities are restricted from the NBK Bangor waterfront.

The nearest off-base residence consists of a small rural population approximately 1.5 north of the proposed project location. As a result, the Test Pile Program is not occurring in the direct vicinity of a populous area.

3.12.2 Environmental Consequences

3.12.2.1 No Action Alternative

Under the No Action Alternative, the Test Pile Program would not be conducted. Baseline conditions would remain unchanged. Therefore, there would be no significant impacts to environmental health and safety from implementation of the No Action Alternative.

3.12.2.2 Action Alternative

The Action Alternative would result in the operation of a barge and pile driving equipment along the NBK Bangor waterfront. The Action Alternative is not expected to result in any impacts related to public environmental health and safety. Construction activities are not likely to release hazardous materials to the environment. Noise associated with the impact hammer is expected to attenuate to 61 dBA at 1.5 miles (2,414 m) and 60 dBA at 1.68 miles (2,710 m). Noise associated with the vibratory hammer is expected to attenuate to 60 dBA at .53 miles (860 m). Thus the nearest residence would be within the permissible noise levels per the Washington noise regulations (WAC 173-60-040). Therefore, there would be no significant impacts to environmental health and safety from implementation of the Action Alternative.

3.13 SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Table 3.42 summarizes the conclusions for each resource area analyzed in this EA. The table includes summaries for both the Action Alternative and the No Action Alternative.

TABLE 3.42 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES BY RESOURCE

Resource	Action Alternative	No-Action Alternative
Bathymetry	The Test Pile Program is short-term in duration and any impacts to bathymetry would be inconsequential. The proposed action would not result in significant impacts to bathymetry.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to bathymetry.
Geology and Sediments	The Test Pile Program would have no impact on subsurface slope stability nor is it likely to cause chemical constituents to violate SQS. The Test Pile Program would not result in significant impacts to geology and sediments.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to geology and sediments.
Water Resources	The Test Pile Program would not alter temperature or salinity in the project area. DO concentrations would not decrease as a result of pile installation and removal. Pile driving would not result in long term impacts to turbidity. The Test Pile Program would not violate WQS. The Test Pile Program would not result in significant impacts to water resources.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to water resources.
Air Quality	The Test Pile Program would not exceed PSCAA thresholds or greenhouse gas reporting thresholds. The Test Pile Program would not result in significant impacts to air quality.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to air quality.
Ambient Noise	The Test Pile Program is short-term and would not result in impacts to sensitive receptors. The Test Pile Program would not result in significant impacts to ambient noise.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to ambient noise.
Marine Vegetation	The Test Pile Program would not result in long term impacts to marine vegetations. Indirect impacts to marine vegetation could occur but these impacts would be temporary and marine vegetation would be expected to recover. The Test Pile Program would not result in significant impacts to marine vegetation.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to marine vegetation.
Benthic Invertebrates	The Test Pile Program would result in a temporary loss of benthic habitat and direct mortality of less motile species. Benthic invertebrates would likely recover from the impacts of pile driving. The Test Pile Program would not result in significant impacts to benthic invertebrates.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to benthic invertebrates.

TABLE 3.42 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES BY RESOURCE (continued)

Resource	Action Alternative	No-Action Alternative
Fish	The Test Pile Program would not affect the North American Green Sturgeon and the Pacific eulachon. Foraging fish are not likely to be adversely affected by the pile driving activities. The Test Pile Program is determined to have a may affect, not likely to adversely affect for the bull trout. The Test Pile Program is determined to have a may affect, likely to adversely for the Pacific Sound Chinook salmon, the Hood Canal Summer-run chum, the Puget Sound Steelhead and the rockfish. The Test Pile Program will not adversely affect essential fish habitat. The Test Pile Program would not result in significant impacts to fish.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to fish.
Marine Mammals	The Test Pile Program may affect, not likely to adversely affect Stellar sea lions and Southern Resident killer whales due to the indirect impact of the adverse effect on salmonid fish species. No marine mammals would be exposed to sound levels resulting in injury or mortality during pile driving activities. The Test Pile Program would result in negligible impacts to the population, stock or species level. The Test Pile Program would not result in significant impacts to marine mammals.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to marine mammals.
Birds	The Test Pile Program is determined to have a may affect, likely to adversely affect for the marbled murrelet. There would be no adverse effect on migratory birds or special status birds. The Test Pile Program would not result in significant impacts to birds.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to birds.
Tribal Resources	Tribal consultations are ongoing	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to tribal resources.
Environmental Health and Safety	The Test Pile Program is not expected to result in any impacts related to public environmental health and safety. Construction activities are not likely to release hazardous materials to the environment. The Test Pile Program would not result in significant impacts to environmental health and safety.	The Test Pile Program would not be conducted. There would be no change in existing conditions and no impacts to environmental health and safety.

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4 MITIGATION AND MONITORING

4.1 MARINE MAMMAL MITIGATION MEASURES

The exposures outlined in Section 3.9 represent the maximum expected number of marine mammals that could be exposed to acoustic sources reaching Level B harassment levels. The Navy proposes to employ a number of mitigation measures, discussed below, in an effort to minimize the number of marine mammals potentially affected.

4.1.1 Mitigation for Pile Driving Activities

The modeling results for zones of influences (ZOIs) discussed in Section 3.9 were used to develop mitigation measures for pile driving activities at NBK Bangor. 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 to support the Test Pile Program.

1. Shutdown and Buffer Zone -

   - The shutdown zone shall include all areas where the underwater sound pressure levels (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).
   - The buffer zone shall include all areas where the underwater sound pressure levels are anticipated to equal or exceed the Level B (disturbance) Harassment criteria for marine mammals (160 dB isopleths). The distance encompassing these zones will be adjusted to accommodate any difference between predicted and measured sound levels.
   - The shutdown and buffer zones will be monitored throughout the time required to drive 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 approaches/enters the shutdown zone, at which point all pile driving activities will be halted.
   - All buffer and shutdown zones will initially be based on the distances from the source which were predicted for each threshold level. However, in-situ acoustic monitoring will be utilized to determine the actual distances to these threshold zones , and the size of the shutdown and buffer zones will be adjusted accordingly (increased or decrease) based on received sound pressure levels.

2. Visual Monitoring -

   - <u>Impact Installation</u>: Monitoring will be conducted for a 22 m shutdown zone and a 464 m buffer zone (Level B harassment) surrounding each pile for the presence of marine mammals before, during, and after pile driving activities. Monitoring will take place from 30 minutes prior to initiation through 30 minutes post-completion of pile driving activities.

- Vibratory Installation: Monitoring will be conducted for a 10 m shutdown zone. The 120 dB disturbance criterion predicts an affected area of 41.5 sq. km. Due to the difficulty of effectively monitoring such a large area, the Navy intends to monitor a buffer zone equivalent to the size of the Level B disturbance zone for impact pile driving (464 m) surrounding each pile for the presence of marine mammals before, during, and after pile driving activities. Sightings occurring outside this area will still be recorded and noted as a take, but detailed observations outside this zone will not be possible. Monitoring will take place from 30 minutes prior to initiation through 30 minutes post-completion of pile driving activities.
- Monitoring will be conducted by qualified observers. A trained observer will 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/delay procedures when applicable by calling for the shut-down to the hammer operator.
- Prior to the start of pile driving activity, the shutdown and safety zones will be monitored for 30 minutes to ensure that it is clear of marine mammals. Pile driving will only commence once observers have declared the shutdown zone clear of marine mammals; Animals will be allowed to remain in the buffer zone and their behavior will be monitored and documented.
- If a marine mammals approaches/enters the shutdown zone during the course of pile driving operations, pile driving will be halted and delayed until either the animal has voluntarily left and been visually confirmed beyond the shutdown zone or 30 minutes have passed without re-detection of the animal.

3. Sound Attenuation Devices –Sound attenuation devices (*e.g.* Gunderboom SAS™, bubble curtain, etc.) will 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 of each pile. The Navy plans to use a Gunderboom Sound Attenuation System™ (SAS) as mitigation for in-water sound during construction activities. The Gunderboom SAS™ is a multipurpose enclosure that absorbs sound, attenuates pressure waves, excludes marine life from work areas, and controls the migration of debris, sediments and process fluids. The Gunderboom SAS™ is comprised of a water-permeable double layer of polypropylene/polyester fabric. Compressed air is released at the bottom of the fabric and moves up to the top of the fabric inflating the fabric and creating a wall. A traditional bubble curtain/wall will be used as a backup mitigation if the Navy cannot obtain the Gunderboom SAS™ or if it does not achieve the proposed noise attenuation. The Navy will also test the feasibility and effectiveness of using sound attenuation devices with vibratory hammers. The Navy will employ the Gunderboom SAS™ or bubble curtain/wall on 2 of the vibratory driven piles to test the practicability of this concept and see if the air interface reduces the source energy level.

4. Acoustic Measurements – Acoustic measurements will be used to empirically verify the proposed shutdown and buffer zones. For further detail regarding the acoustic monitoring plan see Section 4.2.

5. 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. Therefore, all pile driving would occur only between 16 July – 31 October of the approved in-water work window from July 16 through February 15 to minimize the number of fish exposed to underwater sound and other disturbance. Additionally, these months (July – Oct.) were selected because they overlap with times when Steller sea lions and the majority of California sea lions are not expected to be present within the study area.

6. Soft Start – The use of a soft-start procedure is believed to provide additional protection to marine mammals by providing a warning and/or giving marine mammals a chance to leave the area prior to the hammer operating at full capacity. The Test Pile Program will utilize soft-start (ramp-up/dry-fire) techniques recommended by NMFS for impact and vibratory pile driving. These measures are as follows:

   "*The soft-start requires contractors to initiate noise from vibratory hammers for 15 seconds at reduced energy followed by a 1-minute waiting period. This procedure should be repeated two additional times. If an impact hammer is used, contractors are required to provide an initial set of three strikes from the impact hammer at 40 percent energy, followed by a 1-minute waiting period, then two subsequent 3-strike sets.*"

7. Daylight Construction – Pile driving will only be conducted between two hours post-sunrise through two hours prior to sunset.

4.1.2 Mitigation Effectiveness

It should be recognized that although marine mammals will be protected from Level A harassment by the utilization of a bubble curtain/wall and marine mammal observers (MMOs) monitoring the near-field injury zones, mitigation may not be one hundred 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 will be experienced biologists with training in marine mammal detection and behavior. Due to their specialized training the Navy expects that visual mitigation will 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 Hood Canal, only infrequently experience winds with velocities in excess of 25 knots (Morris et al., 2008). The typically light winds afforded by the surrounding highlands coupled with the fetch limited environment of Hood Canal result in relatively calm wind and sea conditions throughout most of the year. The proposed Test Pile Program project area has a maximum fetch of 8.4 miles to the north, and 4.2 miles to the south, resulting in maximum wave heights of from 2.85-5.1 feet (Beaufort Sea State between 2-4), even in extreme conditions (30 knot winds) (CERC, 1984). Visual detection conditions are considered optimal in Beaufort Sea State conditions of 3 or less, which align with the conditions that should be expected for the Test Pile Program at NBK Bangor.

Observers will be positioned in locations which provide the best vantage point(s) for monitoring. This will probably be an elevated position as they provide a better range of viewing angles. Also, the shutdown and buffer zone has a relatively small radius to monitor which should improve detectability.

4.2 MARINE MAMMAL MONITORING AND REPORTING MEASURES

4.2.1 Monitoring Plan

The following monitoring measures would be implemented along with the mitigation measures (Section 4.1) in order to reduce impacts to marine mammals to the lowest extent practicable. The monitoring plan includes the following components: acoustic measurements and visual observations.

4.2.2 Acoustic Measurements

The Navy will conduct acoustic monitoring for impact driving of steel piles in order to determine the actual distances to the 190 dB re 1μPa rms/180 dB re 1μPa rms and the 160 dB re 1μPa rms isopleths and to determine the relative effectiveness of the Gunderboom SAS™/bubble curtain system at attenuating sound underwater. The Navy will also conduct acoustic monitoring for vibratory pile driving in order to determine the actual distance to the 120 dB re 1μPa rms isopleth for behavioral harassment relative to background levels. The monitoring plan addresses both underwater and airborne sounds from the Test Pile Program.

At a minimum, the methodology includes:

- A stationary hydrophone placed at mid-water depth and 10 meters from the source pile to measure the effectiveness of the bubble curtain system; A weighted tape measure will be used to determine the depth of the water. The hydrophone will be attached to a nylon cord or steel chain if current is swift enough, to maintain a constant distance from the pile. The nylon cord or chain will be attached to a float or tied to a static line at the surface 10 meters from the piles.
- All hydrophones will be calibrated at the start of the action and will be checked at the beginning of each day of monitoring activity.
- For each monitored location, a two-hydrophone set-up will be used, with the first hydrophone at mid-depth and the second hydrophone at ~1 meter from the bottom in order to evaluate site specific attenuation and propagation characteristics that by be present throughout the water column.
- In addition to determining the are encompassed by the 190, 180, 160, and 120 dB RMS isopleths for marine mammals, hydrophones would also be placed at other distances as appropriate to accurately capture spreading loss which occurs at the Test Pile project area or to determine the distance to the thresholds for fish, and birds (these include peak, rms, and sound exposure levels [SEL]);

- Ambient conditions, both airborne and underwater, would be measured at the project site in the absence of construction activities to determine background sound levels. Ambient levels are intended to be recorded over the frequency range from 10 Hz to 20 kHz. Ambinet conditions will be recorded for 1 minute every hour of the work day, for one week of each month of the Test Pile Program.
- Underwater sound pressure levels would be continuously monitored during the entire duration of each pile being driven. Sound pressure levels will be monitored in real time. Sound levels will be measured in Pascals which are easily converted to decibel (dB) units.
- Sound levels associated with soft-start techniques will also be measured
- Airborne levels would be recorded as unweighted, as well as in dBA and the distance to marine mammal and/or avian thresholds (respectively) would be measured;
- The effectiveness of using a bubble curtain/wall system with a vibratory hammer will be tested during the driving of 2 vibratory piles. The following on/off regime will be utilized during the pile installation:

Pile Driving Timeframe	Sound Attenuation Device Condition
Initial 30 seconds	Off
Next minute (minimum)	On
Middle of pile driving segment 30 seconds	Off
Next minute (minimum)	On
Final 30 seconds	Off

- Environmental data would be collected including but not limited to: wind speed and direction, air temperature, humidity, surface water temperature, water depth, wave height, weather conditions and other factors that could contribute to influencing the airborne and underwater sound levels (e.g. aircraft, boats, etc.);
- The chief inspector would supply the acoustics specialist with the substrate composition, hammer model and size, hammer energy settings and any changes to those settings during the piles being monitored, depth of the pile being driven, and blows per foot for the piles monitored.
- Post-analysis of the sound level signals will include determination of absolute peak overpressure and under pressure levels recorded for each pile, RMS value for each absolute peak pile strike, rise time, average duration of each pile strike, number of strikes per pile, SEL of the absolute peak pile strike, mean SEL, and cumulative SEL (Accumulated SEL = single strike SEL + 10*log (# hammer strikes) and a frequency spectrum both with and without mitigation, between 10 and 20,000 Hz for up to eight successive strikes with similar sound levels.

4.2.3 Visual Marine Mammal Monitoring

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

4.2.3.1 Qualifications

All observers will be trained in marine mammal identification and behaviors. NMFS requires that the observers have no other construction related tasks while conducting monitoring.

4.2.4 Methods of Monitoring

The Navy will monitor the shut down zone and safety zone before, during, and after pile driving. Based on NMFS requirements, the Marine Mammal Monitoring Plan would include the following procedures for impact pile driving:

- Marine mammal observers (MMOs) would be located at the best vantage point(s) in order to properly see the entire shut down zone and safety zone. This may require the use of a small boat to monitor certain areas while also monitoring from one or more land based vantage points;
- During all observation periods, observers would use binoculars and the naked eye to search continuously for marine mammals;
- To verify the required monitoring distances, the zones would be clearly marked with buoys or other suitable aquatic markers;
- If the shut down or safety zones are obscured by fog or poor lighting conditions, pile driving would not be initiated until all zones are visible;
- The shut down and safety zones around the pile will be monitored for the presence of marine mammals before, during, and after any pile driving activity;
- Pre-Activity Monitoring:
    - The shut down and buffer zones will be monitored for 30 minutes prior to initiating the soft start for pile driving. If marine mammal(s) are present within the shut down 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 MMO has determined, through sighting or by waiting approximately 30 minutes that the animal(s) has moved outside the shut down zone.
- During Activity Monitoring:
    - The shutdown and buffer zones will also be monitored throughout the time required to drive 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 shutdown zone, at which point all pile driving activities will 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 30 minutes.
- Post-Activity Monitoring: Monitoring of the shutdown and buffer zones would continue for 30 minutes following the completion of pile driving.

4.2.5 Data Collection

NMFS requires that the MMOs use NMFS-approved sighting forms. NMFS requires that a minimum, the following information be collected on the sighting forms:

- Date and time that pile driving begins or ends;
- Construction activities occurring during each observation period;
- Weather parameters identified in the acoustic monitoring (e.g. wind, humidity, temperature);
- Tide state and water currents;
- Visibility;
- Species, numbers, and if possible sex and age class of marine mammals;
- Marine mammal behavior patterns observed, including bearing and direction of travel, and if possible, the correlation to sound pressure levels;
- Distance from pile driving activities to marine mammals and distance from the marine mammal to the observation point;
- Locations of all marine mammal observations;
- Other human activity in the area.

4.2.6 Reporting

A draft report would be submitted to NMFS within 45 days of the completion 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. A final report would be prepared and submitted to the NMFS within 30 days following receipt of comments on the draft report from the NMFS. At a minimum, the report shall include:

- Size and type of piles.
- A detailed description of the bubble curtain/wall, including design specifications.
- The impact or vibratory hammer force used to drive/extract the piles.
- A description of the monitoring equipment.
- The distance between hydrophone(s) and pile.
- The depth of the hydrophone(s).
- The depth of water in which the pile was driven.
- The depth into the substrate that the pile was driven.
- The physical characteristics of the bottom substrate into which the piles were driven.
- The ranges and means for peak, RMS, and SEL’s for each pile.

- 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.
- The results of the airborne noise measurements including dBA and unweighted levels.
- 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.
- Results: Including the detectability of marine mammals, species and numbers observed, sighting rates and distances, behavioral reactions within and outside of safety zones.
- A refined take estimate based on the number of marine mammals observed in the safety and buffer zones. This may be reported as one or both of the following: a rate of take (number of marine mammals per hour), or take based on density (number of individuals within the area).

4.3 FISH MITIGATION AND MONITORING

The following mitigation measures apply to marine fish:

- In-water construction would observe the Puget Sound Marine Area 13 (northern Hood Canal) in-water work window (July 16 to February 15) as outlined in WAC 220-110-271 and USACE (2008) to minimize in-water project impacts on potentially occurring juvenile salmonids that would otherwise be exposed to underwater noise produced during pile driving.
- Due to the size of the piles (estimated at 60-inch [152 cm]), bubble curtain/wall would be employed to decrease the amount of underwater pile driving noise.
- The pile driving contractor would use a mechanical soft-start approach (noise attenuator) during impact pile driving by using low hammer energy values to provide time for swimmers, divers, fish, and wildlife to hear the noise and react to it by moving away from the sound. Alternatively, use of an acoustic deterrent device to produce an acoustic soft-start could accomplish the same result. Each day impact pile driving occurs, a soft start time of 20 to 30 minutes would initiate the activity.
- During the test pile installation, a vibratory driver would be used whenever possible to drive piles. An impact hammer would be used to proof load the piles to verify bearing load capacity, and would not be used as the primary means to drive piles.
- Forage Fish Surveys – The proposed action overlaps in time with when forage fish may be spawning along the NBK Bangor shoreline. In a recent Biological Opinion (BO) NMFS (2010, tracking number 2010/00686) concurred with the Washington State Department of Transportation and Washington State Ferries that the applicant cease impact pile driving if forage fish eggs were detected in the action area and were covered with water. The Navy proposes to test whether or not this is a viable mitigation measure for forage fish. Specifically, sound attenuates rapidly in shallow water, therefore the risk to these eggs may actually be very small. As such, immediately prior to impact pile driving, forage fish (salmonid and marbled murrelet prey) beach surveys will be conducted along the NBK Bangor shoreline in the immediate vicinity of the Test Pile

location to determine the presence of surf smelt or sand lance eggs. This will determine whether or not spawned eggs are actually present. Then hydroacoustic measurements will attempt to collect data on sound pressure levels received at these locations.

4.4 MARBLED MURRELET MITIGATION

4.4.1 Methodology

The Navy will conduct marbled murrelet surveys based on the protocol and methodology modified from the field methods established by U.S. Forest Service, Pacific Northwest Research Station (Raphael, et al., 2007) and the marbled murrelet survey report for the Carderock Division Research Facility Wave Screen project at Naval Base Kitsap, Bangor, WA.

If any alcid species (e.g., marbled murrelets, pigeon guillemots, common murres, auklets, puffins) are detected within the area to be surveyed during any monitoring period, the surveyor(s) shall observe and monitor these species and record their behavior, particularly if they are behaving abnormally. The Bird Observation Record form will be completed by each observer for each transect. The Beaufort Wind Scale will be used to determine sea-state.

4.4.2 Observer Qualifications

All observers will be experienced biologists with USFWS training in marbled murrelet identification and behaviors. Trained observers have specific knowledge of marbled murrelet 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.

USFWS requires that the observers have no other construction related tasks while conducting monitoring. The Navy will monitor the shut down injury zone and disturbance buffer zone before, during and after pile driving.

4.4.3 Data Collection

The marbled murrelet observers will use the USFWS-approved Bird Observation Record Form which will be completed by each observer for each survey day. The following information will be collected on the sighting form.

- Date and time that pile driving begins or ends;
- Construction activities occurring during each observation period;
- Weather parameters identified in the acoustic monitoring (e.g. wind, humidity, temperature);
- Tide state and water currents: The Beaufort Wind Scale (Appendix B) will be used to determine sea-state.
- Visibility
- Species, numbers, and if possible, sex and age class of marbled murrelets;
- Marbled murrelet behavior patterns observed, including bearing and direction of travel. If possible, include the correlation to sound pressure levels;

- Distance from pile driving activities to marbled murrelets and distance from the marbled murrelet to the observation point;
- Locations of all alcid observations;
- Other human activity in the area.

4.4.4 Injury and Behavioral Disturbance Zones

Buffer zones are created to delineate areas that are important to species that are sensitive to the proposed action. Monitoring these zones and implementing other minimization measures, such as the use of the Gunderboom SAS™ or bubble curtains, will reduce the impacts of underwater sound from pile driving on these species.

To verify the required monitoring distances, the survey boats will be equipped with Global Positioning System (GPS) units in order to mark the impact injury zone (up to 500 meter radius from pile driving activity) and/or the impact/vibratory behavioral zone (1000 meter radius from pile driving activity). The zones will be monitored for presence of marbled murrelets before, during, and after any pile driving activity. During all observation periods, observers would use binoculars and the naked eye to search continuously for marbled murrelets.

If the monitoring zones are obscured by fog, Beaufort Wind Scale greater than 2, or poor lighting conditions, pile driving would not be initiated until all zones are visible.

4.4.5 Monitoring Techniques

It should be recognized that although marbled murrelets will be protected from injury by the utilization of the Gunderboom SAS™ or a bubble curtain/wall, observers monitoring the near-field injury and behavioral modification zone may not be one hundred percent effective at all times in locating marbled murrelets. However, 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.

4.4.6 Visual Survey Protocol Prior to Pile Driving

- Transect lines will be established using GPS;
- Transect lines will be no more than 100 m apart. If the sea-state is greater than Beaufort 2, the transect lines will be no more than 50 m apart;
- The two survey boats within the vibratory behavioral zone (1000 meter radius from pile driving activity) and/or within the impact behavioral zone (2154 meter radius from pile driving activity) will move north to south (for the southern half of the survey area) and south to north (for the northern half of the survey area) as indicated in Figure 4-1 to clear these zones so that pile driving can commence;
- One survey boat will monitor for alcids flying over the airborne vibratory injury zone (22 meter radius from pile driving activity), airborne impact injury zone (68 meter radius from pile driving activity), and the underwater impact injury zone (215 meter radius from pile driving activity) during both vibratory and impact pile driving;
- The above described monitoring efforts will be run concurrently;

- Impact pile driving will not commence until entire survey area has been completely surveyed and it is determined that no marbled murrelets are in the water within these zones (airborne and underwater injury);
- If marbled murrelets are not within these surveyed zones, the observers are to raise a green flag and radio the Pile Driving Engineer Lead that impact pile driving can commence;
- If seabirds are within these surveyed zones, the survey will continue and impact pile driving will NOT commence;
- Survey boats will maintain speed equal to or less than 10 knots per hour;
- Each boat will have a minimum of two observers using aid of binoculars (not including the boat operator);
- Observers will have completed USFWS marbled murrelet monitoring training to accurately verify species sighted;
- In case of fog or reduced visibility, the observers must be able to see a minimum of 50 m or pile driving cannot commence;
- If any alcid species (e.g., marbled murrelets, pigeon guillemots, common murres, auklets, puffins) are detected outside the specified survey zones during the pre-pile driving monitoring and after pile driving is initiated, the observers shall observe and monitor these birds and record their behavior.
- All bird observations will be recorded on the Bird Observation Record forms

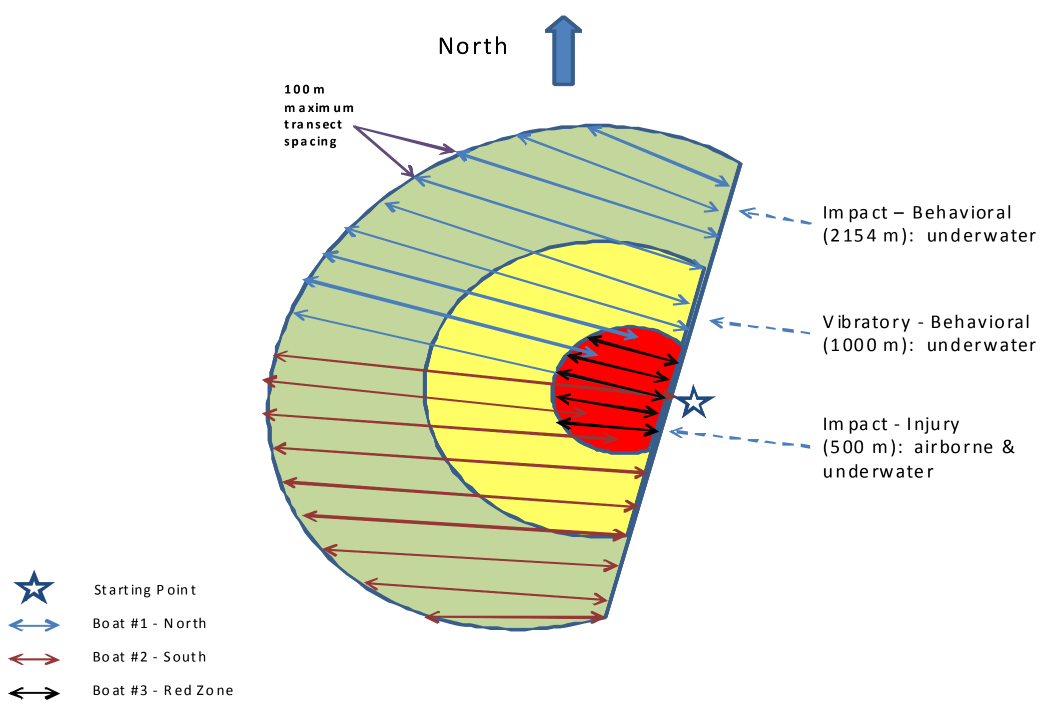

Figure 4-1 Marbled Murrelet Survey Protocol

4.4.7 Visual Survey Protocol During Pile Driving

Both the injury and behavioral disturbance zones will be monitored throughout the time required to drive the pile. The following monitoring protocol will be implemented:

- The survey protocol identified above in Section 4.4.5 will continue and repeat during pile driving with the following additional conditions;
- If a marbled murrelet is seen approaching injury zones (500 meter radius during impact pile driving and it appears likely that the bird will dive into the water or land in the water within that zone, the observers will immediately raise a red flag and radio to alert the Pile Driving Engineer Lead. This action will require an immediate "all-stop" on pile driving;
- Once it is determined that the marbled murrelet has indeed landed in the water within the behavior modification and injury zones (as defined above), then pile driving will not begin again until the "pre-pile driving survey" (See Section 4.4.5) has been completed and the zone has been cleared of all marbled murrelets;
- If marbled murrelets are detected, the observers will continue to monitor these individuals and record their behavior. Bird Observation Record forms will be used to document observations.

4.4.8 Visual Post Pile Driving Observational Survey

During these surveys, dead, injured or sick seabirds may be discovered. The post-pile driving surveys will be conducted upon completion of pile driving activity. These surveys will focus on observing and reporting unusual or abnormal behavior of marbled murrelets and other alcids. Survey results will be noted in the Bird Observation Record form.

Any dead bird found within the survey area will be collected and submitted to USFWS for necropsy using Chain of Custody Record Form. If transfer to USFWS cannot be performed within the same day, salvaged birds will be frozen.

4.4.9 Interagency Notification

Observers will immediately notify the USFWS upon locating a dead, injured or sick marbled murrelet specimen. Notification must be made to the USFWS Law Enforcement Office at (425) 883-8122 or the Services' Western Washington Fish and Wildlife Office at (360) 753-9440, and include the date, time, precise location of the injured bird or carcass, and any other pertinent information.

Care should be taken in handling sick or injured specimens to preserve biological materials in the best possible state for later analysis of cause of death, if that occurs. In conjunction with the care of the sick or injured specimens or preservation of biological materials from a dead animal, the finder has the responsibility to ensure that evidence associated with the specimen is not unnecessarily disturbed.

4.4.10 Survey Report

A draft report will be submitted to USFWS within 45 days of the completion of acoustic measurements and marbled murrelet monitoring. The results will be summarized in graphical form and include summary statistics and time histories of impact sound values for each pile. A final report will be prepared and submitted to the USFWS within 30 days following receipt of comments on the draft report from the USFWS. The report shall include:

- General data:
  - Date and time of activity
  - Water conditions (e.g., sea-state, surface water temperature)
  - Weather conditions (e.g., wind speed and direction, air temperature, humidity)
  - Physical characteristics of the bottom substrate into which the piles are driven
- Specific pile driving data:
  - Description of the pile driving activity being conducted (size and type)
  - Detailed description of the sound attenuation device, including design specifications
  - Impact or vibratory hammer force used to drive/extract the piles
  - Description of the monitoring equipment
  - Distance between hydrophone(s) and pile
  - Depth of the hydrophone(s)
  - Depth of water in which the pile was driven
  - Depth into the substrate that the pile was driven
  - Ranges and means for peak, RMS, and SEL's for each pile
  - Results of the acoustic measurements, including the frequency spectrum, peak and RMS SPL's, and single-strike and cumulative SEL with and without the attenuation system
  - Results of the airborne noise measurements including dBA and unweighted levels;
- Pre-activity observational survey-specific data:
  - Dates and time survey is initiated and terminated
  - Description of any observable bird, marine mammals, fish behavior in the immediate area during monitoring
  - If possible, the correlation to underwater sound levels occurring at the time of this observable behavior
  - Actions performed to minimize impacts to marbled murrelets
- Post-activity observational survey-specific data:
  - Results, which include the detectability of marbled murrelets, species and numbers observed, sighting rates and distances, behavioral reactions within and outside of both zones;
  - Birds salvaged for necropsy (if applicable)

- Use Chain of Custody Record Form for dead birds/threatened and endangered species (as required)
- Necropsy results, based on information provided by the Agencies (as required)

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5 CUMULATIVE IMPACTS

5.1 APPROACH

The approach taken in the analysis of cumulative impacts follows the objectives of NEPA and CEQ regulations and guidance. Cumulative impacts have been defined by the CEQ in 40 CFR 1508.7 as:

> "Impacts on the environment which result from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

The CEQ regulations further require that NEPA environmental analyses address connected, cumulative and similar actions in the same document (40 CFR 1508.25). This requirement prohibits segmentation of a project into smaller components to avoid required environmental analysis.

Additionally, CEQ further explained in Considering Cumulative Effects Under the National Environmental Policy Act (CEQ, 1997) that "each resource, ecosystem and human community must be analyzed in terms of its ability to accommodate additional effects, based on its own time and space parameters." Therefore, cumulative effects analysis may go beyond the scope of project-specific direct and indirect impacts to include expanded geographic boundaries beyond the immediate area of the proposed action, and a time frame, including past actions and foreseeable future actions, in order to capture these additional effects.

Focusing the cumulative effects analysis is a complex undertaking, appropriately limited by practical considerations. CEQ notes that:

> "It is not practical to analyze how the cumulative effects of an action interact with the universe; the analysis of environmental effects must focus on the aggregate effects of past, present, and reasonably foreseeable future actions that are truly meaningful. The scope of the cumulative impact analysis is related to the magnitude of the environmental impacts of the proposed action. Proposed actions of limited scope typically do not require as comprehensive an assessment of cumulative impacts as proposed actions that significant environmental impacts over a large area (CEQ, 2005)."

The USEPA's guidance states that information should be presented commensurate with the impacts of the project, with a greater degree of detail for more potentially serious impacts (USEPA, 1999).

The cumulative impacts analysis for the Test Pile Program considers known past, present, and reasonably foreseeable future actions throughout Hood Canal, including NBK Bangor. Hood Canal (and its watershed) is the most relevant region for defining populations or communities of marine and coastal resources occurring at NBK Bangor. Surrounding communities in which actions at NBK Bangor are most likely to contribute to cumulative social impacts include Silverdale, Poulsbo, and Bremerton, all of which are located on the Kitsap Peninsula and within Kitsap County. The level of detail required for cumulative effects analysis presented in this EA is appropriate and in context with the scope and magnitude of the proposed action and alternatives because of the limited extent and temporary nature of the proposed action.

5.2 HISTORICAL CONTEXT

On June 5, 1944 the Navy established the U.S. Naval Magazine on the land which is now NBK Bangor, and began operations in January 1945. The Marginal Wharf was built during World War II to handle the loading of ammunition on Navy transport ships headed for the Pacific Theater. The Keyport/ Bangor docks were built in 1951 and used by small craft from the Naval Undersea Weapons Engineering Station at Keyport. Bangor continued its role as a U.S. ammunitions depot after World War II and throughout the Korean and Vietnam conflicts. As a U.S. ammunitions depot, Bangor was responsible for shipping conventional weapons abroad. The base became a Polaris Missile Storage Facility in 1964.

In 1973, Bangor was established as a homeport for the OHIO Class submarines and as a support facility for the TRIDENT Missile Program. Housing, offices, and industrial complexes were constructed to support operations for surface ships and submarines home ported at Bremerton and Bangor. Delta pier was completed in 1980 to support this program. The EHW-1 was then constructed shortly thereafter. In 1982 the program became fully operational when the first TRIDENT submarine (USS OHIO) arrived at Delta Pier. Later, in 2004, Naval Submarine Base Bangor merged with Naval Station Bremerton and Naval Base Kitsap emerged. Naval Base Kitsap is responsible for all Navy properties in Kitsap County, Washington. This includes Bangor, Bremerton, Keyport, Manchester, and other locations.

The TRIDENT Facilities EIS and its associated supplements (Navy, 1974, 1976, 1978 and 1989) have analyzed most of the major development associated with NBK Bangor over the past 40 years. The development of NBK Bangor underwent considerable scrutiny to limit the impacts to the surrounding environment. Although numerous actions were taken to mitigate harmful impacts to the environment from constructing and operating this facility at the base, a number of unavoidable adverse impacts were identified in the final EIS. These impacts included drawdown of the water table for potable water supply, loss of hundreds of acres of vegetation and associated wildlife and plant habitat from land clearing, loss of benthic and eelgrass habitat from placement of in-water structures, reduced productivity of algae and eelgrass from shading by overwater structures, and changes in fish and benthic habitat from in-water structures. The land was primarily forest, orchards, and farmland when purchased in 1944.

Subsequent environmental analyses at NBK Bangor included preparation of environmental documents that assessed specific development actions at the base and adjacent waterfront. Additional facilities have been constructed throughout the base, with varying project-specific environmental impacts. The base remains largely forested with a flourishing native Pacific Northwest vegetation and wildlife community.

5.3 PUGET SOUND TREND DATA (INCLUDING HOOD CANAL)

The 2007 Puget Sound Update—Ninth Report of the Puget Sound Assessment and Monitoring Program summarizes trend data in the Puget Sound area (PSAT, 2007a). These trends were used in Section 5.6, Cumulative Impacts to Environmental Resources, where applicable to help indicate the cumulative impacts of past, present, and future actions. Some of the relevant trends include the following:

- A decrease in marine birds (particularly scoters, loons, and grebes) and increase in California sea lions and harbor seals;
- A decline in native eelgrass in Hood Canal;
- An increase in the size and duration of phytoplankton blooms and a corresponding decrease in overall DO levels;
- A decrease in some fish stocks (salmon, rockfish, spiny dogfish, Pacific cod, and hake);
- Increasing shoreline sediment erosion due to shoreline armoring and in-water structures; and
- An overall decline in fecal coliform levels.

5.4 PAST, PRESENT AND REASONABLY FORSEEABLE FUTURE NAVY ACTIONS

Table 5–2 and Table 5–3 (at the end of this chapter) list the past, present, and reasonably foreseeable future actions at NBK Bangor that have had, continue to have, or would be expected to have some impact to the natural and human environment. Table 5–2 provides general descriptions of construction projects and other actions. Table 5–3 identifies project impacts in several key areas such as overwater shading, marine habitat loss, long term water quality impacts, etc. The actions shown in Table 5–2 and Table 5–3 represent the best information available at this time. Because of the nature of concept development and funding for projects, plans for future actions are dynamic and subject to change. Continuing NEPA analysis and documentation would be provided as appropriate for all programs and projects as they are developed and implemented as required by NEPA and OPNAVINST 5090.1C.

The Test Pile Program would result in the installation and removal of 29 test and reaction piles. Eighteen of the piles would be installed with a vibratory hammer and then proofed with an impact hammer. An additional 11 piles would be installed with a vibratory hammer to assist in performing lateral load and tension load tests on the piles. The data collected from the Test Pile Program would then be used to validate the design concepts and construction methods for the proposed EHW-2 and future projects at the Bangor waterfront.

5.5 OTHER PAST, PRESENT AND REASONABLY FORSEEABLE ACTIONS (NON-NAVY) AND HOOD CANAL AGENCY PLANS

Past and present actions outside NBK Bangor that may contribute to cumulative impacts associated with the proposed action primarily consists of those actions located within Hood Canal watershed in the vicinity of the base. Development in the upland area has mostly consisted of residential units on larger lots that have retained some natural areas. As a result of this development strategy, impacts to the surrounding environment have been reduced. Some exceptions are the Vinland and Lofall neighborhoods north of the base, which are residential communities on smaller lots, as well as some scattered commercial uses (neighborhood convenience stores and gas stations), located in the upland area.

Relatively intense development along the shoreline of Hood Canal has also occurred. Compared to residential units in the upland area, smaller residential units dominate this landscape, some with docks. Commercial uses are scattered along the shoreline and include the community of Seabeck to the south, which has a store, a few businesses, a marina, and a retreat center. Scenic Beach State Park is further south.

The following sections describe past, present and reasonably foreseeable future plans and actions that are focused on shoreline developments in the vicinity of Hood Canal. These actions have a potential to result in cumulative impacts, in combination with the proposed action, to the marine environment. These projects were identified through contacts with the Kitsap County and Jefferson County Departments of Community Development, Washington State Department of Transportation (WSDOT), natural resource agencies, and American Indian tribes.

5.5.1 Hood Canal Bridge East Half Replacement and West Half Rehabilitation Project—Water Shuttle

The Washington Department of Transportation (WSDOT) constructed two docks, one at Lofall and one at South Point, for the passenger-only water shuttle that ran during the closure of Hood Canal Bridge for approximately two months in 2009. The Lofall site was located approximately 5 miles (8 km) north of the NBK Bangor waterfront on the east side of Hood Canal. The dock was temporary in order for WSDOT to receive federal funding, (i.e., torn down after the bridge improvements are completed).

The South Point water shuttle site was located approximately 5 miles (8 km) north of the NBK Bangor waterfront on the west side of Hood Canal. This shuttle was available during closure of Hood Canal Bridge. Two temporary passenger-only water shuttles with the capacity to move 150 passengers each operated every 30 minutes. This yielded a capacity of 300 passengers per hour in each direction during peak periods. Temporary vehicle park-and-ride lots were also constructed on each side of Hood Canal. This project resulted in short-term water quality and noise impacts during construction, as well as shading and loss of marine habitat while the docks were in place. Upland vegetation was cleared for the park-and-ride lots.

5.5.2 Olympic View Marina

In January 2010, Olympic View Marina, LLC began replacing the abandoned Seabeck Marina located on Seabeck Bay approximately 7 miles (11 km) south of NBK Bangor on the east side of Hood Canal. The new marina involves installation of 72,510 sq ft of piers, floats, and gangways (approximately 1.66 acres of overwater structures) for the moorage of approximately 200 boats.

In order to permit rebuilding of the marina, the shoreline designation of the old Seabeck marina in the Kitsap County Shoreline Management Master Program was amended from "conservancy" to "rural" in April 2009. Although workers have begun installing pilings for the docks, construction was put on hold from February 15 until July 16 to comply with the fish window.

5.5.3 Kitsap Memorial State Park

Washington State Parks is planning a slope stabilization project for an approximately 1,000-foot-long (305 m) creosote treated bulkhead at Kitsap Memorial State Park in Poulsbo on Hood

Canal. Removal of the treated wood bulkhead and "naturalization" of the shoreline is being planned as part of the project. This project is not yet permitted but is active.

5.5.4 Fred Hill Materials Pit-to-Pier Project

Fred Hill Material has proposed the construction of a 1,000 foot (305 m) long pier located approximately 3 miles (5 km) north of the NBK Bangor waterfront on the west side of Hood Canal. Fred Hill Materials would move gravel from the Shine gravel pit, which is owned by Miles Sand & Gravel, on a 4 mile (7 km) long conveyor belt to Thorndyke Bay, located on Hood Canal. Once the gravel has been brought to Thorndyke Bay, it would be loaded onto barges and ships on the newly constructed pier. Once erect, the pier would be supported by piles placed approximately 100 feet (31 m) apart. As a result of the pier construction, aesthetic impacts and potential interference with marine vessel traffic could occur and upland vegetation would be cleared for construction of the conveyor belt, with potential impacts to erosion/water quality and wetlands.

This project has been identified by Fred Hill Materials as the Thorndyke Resources Operation Complex (TROC). This project has also been referred to as the Pit-to-Pier. Fred Hill Materials sold their lease of the Shine Hub Operations and Wahl Lake area mining sites in the spring of 2009 to Miles Sand and Gravel. Although, Fred Hill retained lease ownership of the 690-acre Merridian area proposed for extraction in conjunction with the conveyor and pier project for marine transportation only. The TROC proposal no longer includes the Wahl Lake area and the Shine Hub Operations, which are now leased from Pope Resources by Miles Sand and Gravel (not affiliated with Fred Hill Materials). Fred Hill Materials filed for Chapter 11 bankruptcy on February 4, 2010. The TROC conveyor and pier proposal is undergoing the environmental review process for permitting and Jefferson County is waiting for Fred Hill Materials to submit updated studies to complete a gap analysis. The application is still open, but there is considerable uncertainty as to whether this project will be implemented.

5.5.5 Pleasant Harbor Marina and Golf Resort

The Statesman Group of Companies is proposing a new master planned development at Pleasant Harbor south of Brinnon. The proposed project would be located on the west side of Hood Canal approximately 9 miles (15 km) southwest of NBK Bangor. The 256-acre development would include resort housing, a hotel, a restaurant, a spa, a clubhouse, an 18-hole golf course, and other resort-type facilities. It would refurbish an existing 285-boat marina and involve development of resort facilities along the shoreline. Planning is ongoing for this project and a supplemental EIS is being prepared. A Scoping meeting was held on October 28, 2009 as part of the EIS process.

Short-term water quality and noise impacts would likely occur from project construction. Some loss of nearshore marine benthic habitat in the immediate project vicinity would be anticipated as a result of the refurbished marina. The golf course and upland facilities would likely result in considerable clearing of upland vegetation (estimated at 50 percent or 128 acres), with a potential for impacts to erosion/water quality and wetlands. Impervious surfaces are predicted to be approximately 15 percent of the total area, or approximately 38 acres.

5.5.6 Misery Point Boat Launch

WDFW is proposing a $2.5 million boat launch replacement project located approximately 9 miles (15 km) south of the NBK Bangor waterfront on the east side of Hood Canal. The project involves replacing an on-grade, concrete, boat launch ramp with a 27-foot (8 m) wide, 230-foot (70 m) long elevated ramp. In addition to the ramp, the project would replace an existing vault restroom, restripe a paved parking lot, and regrade a gravel overflow lot. This project is under review by Kitsap County and WDFW. This project would result in short-term water quality impacts during construction, as well as long-term loss of shallow marine habitat.

5.5.7 Agency Plans for Improving Environmental Conditions in Hood Canal

There are several water quality parameters of concern in Hood Canal including low dissolved oxygen (DO) levels and high nutrients, particularly in the southern part of the canal. Several governmental entities and community groups have joined together to plan and develop programs to improve environmental conditions in Hood Canal because of these water quality problems, and concern for salmon and the overall environmental health of Hood Canal. Hood Canal Coordinating Council (HCCC) is a consortium of county governments, tribes, and other groups that was formed to help recover summer-run chum salmon populations in Hood Canal and the eastern Strait of Juan de Fuca and restore native plant communities along adjacent shorelines.

A primary action plan for Hood Canal was developed by the HCCC to assist in counteracting the adverse effects of past actions and improve environmental conditions in Hood Canal in the future. This is accomplished by the governments and groups of the HCCC working together to educate and help landowners restore nearshore area, control septic runoff into Hood Canal, remove invasive plants and weeds, and identify properties for conservation acquisition.

The HCCC, under its Marine Riparian Initiative, is working with several entities and programs to develop a coordinated approach to re-vegetating marine shorelines (HCCC, undated). Under this initiative, Master Gardeners, Water Watchers, and other volunteer groups are trained to provide site-specific planting plans for landowner that address soil and slope stability; sediment control; wildlife; microclimate; shade; nutrient input for detrital food webs; fish prey production; habitat/large woody debris structure; water quality; human health and safety; and aesthetics.

The HCCC's primary action plan includes updating Kitsap County's Shoreline Master Plan and critical areas ordinances, conducting a nearshore assessment, adopting the Kitsap County draft shoreline environmental designations, and continued monitoring of the Big Beef Creek summer-run chum salmon reintroduction project as recommended key actions (HCCC, 2005).

A portion of the Upper Hood Canal has been identified by the Kitsap County Health District (2005) as a restoration area. The goals of the Upper Hood Canal Restoration Project are to protect public health and the environment by identifying and correcting sources of fecal coliform contamination from failing onsite sewage systems and inadequate animal waste management, obtaining water quality data, and educating Upper Hood Canal residents about the low DO problem and actions they can take to reduce bacteria and nutrient concentrations in Hood Canal.

The restoration area extends approximately 20 miles (32 km) along the eastern shore of Hood Canal from Olympic View Road in the north to the Kitsap County/Mason County line in the south. Most of this area lies directly south of NBK Bangor, but a portion lies along the western edge of the southern part of the base. Low DO levels are of particular concern, resulting from algal blooms, which are triggered by increases in nutrients from failing onsite sewage systems, inadequate animal waste management (i.e., hobby farms), and stormwater flowing into Hood Canal. The area of concern for low DO levels is south of the NBK Bangor waterfront.

5.6 CUMULATIVE IMPACTS TO ENVIRONMENTAL RESOURCES

An assessment is provided for the cumulative environmental impacts of the Test Pile Program Action Alternative when combined with past, present, and reasonably foreseeable actions. The purpose of the cumulative impact analysis is to identify and describe impacts of the proposed action that may be insubstantial by themselves but would be considered substantial in combination with the impacts of other actions and trends. The impacts of other actions are assessed using available information, and trends in environmental conditions were derived from the 2007 Puget Sound Update—Ninth Report of the Puget Sound Assessment and Monitoring Program (PSAT, 2007a). The format for assessing cumulative impacts for each resource area is as follows:

1. Assess the impacts of past and present actions to arrive at the existing environmental condition.

2. Present available trend data for each resource to help assess future impacts; these data are not available for all resources (see Section 5.3, Puget Sound Trend Data [Including Hood Canal]).

3. Provide an estimate of potential impacts from future non-Navy actions (see Section 5.5, Other Past, Present, and Reasonably Foreseeable Future Actions [Non-Navy] and Hood Canal Agency Plans) and Navy actions (see Table 5–2 and Table 5–3 at the end of this chapter).

4. Present the impacts of the proposed action and conclude with an assessment of the cumulative impacts of past, present, and future actions including the proposed action.

Since the information available on past, present, and reasonably foreseeable actions varies in quality and level of detail, impacts for these actions are quantified where possible and data exists; otherwise, professional judgment and experience were used to make a qualitative assessment of impacts. In some cases, there may be a combination of both quantitative and qualitative analysis. Where this is the case, professional judgment was used to evaluate the impact.

5.6.1 Bathymetry

5.6.1.1 Past and Present Actions

Past and present placement of in-water structures such as anchors, pilings, floats, and boat ramps, and in-water construction for Navy projects such as Marginal Wharf, Service Pier, Keyport/Bangor (KB) Docks, Delta Pier, and EHW-1 may cause localized scouring and deposition. Changes in current velocities may alter bottom sediment characteristics such as the ratio of fine to coarse-grained sediments near pilings, anchors, and boat ramps. The overall bathymetry of Hood Canal has likely changed over time as a result of sediment delivered by the streams and rivers that enter it. However, such changes are probably restricted to the mouth of the tributaries and evidenced by deltaic sediment fans.

5.6.1.2 Future Actions

Future shoreline development and placement of in-water structures, including the TPS/Port Ops Facilities and the Olympic View Marina, would likely add to existing erosion and accretion of shoreline sediments. However, the overall impact to Hood Canal's bathymetry would be negligible.

5.6.1.3 Proposed Action

The proposed action is to install 29 test and reaction piles at NBK Bangor supported by two barges, spuds and anchors. All work is temporary and the equipment and test piles will be demobilized and removed after 40 days. The impacts to bathymetry are temporary in nature and not significant.

5.6.1.4 Cumulative Impacts

Puget Sound is a glacially carved fjord comprised of five major basins with Hood Canal being the westernmost. The major components of Hood Canal are the entrance, Dabob Bay, the central region, and The Great Bend at the southern end. A shallow sill extends across the short axis of the canal south of Hood Canal Floating Bridge and the northern end of NBK Bangor in the vicinity of South Point and Thorndyke Bay. Southward of the sill the bottom on the western side drops off steeply, while the eastern side slopes more gently downward. The main current runs along the west side of the channel, forming a hanging valley at the sill crest. The sill limits exchanges of dense water between the deeper southern reach and Admiralty Inlet, the channel linking Puget Sound to the North Pacific Ocean via the Strait of Juan de Fuca. South of the sill, the bottom along the thalweg is extremely rough, varying by + 80 feet (25 m) over 0.6 miles (1 km) or less. However, an accurate description of the hydraulic properties of Hood Canal is hindered by its complex geometry and bathymetry.

The impacts of the proposed action would be strictly localized, however, and compared to the circulation and current movement produced by tides, winds, and density differences throughout the entire Hood Canal water body, the changes to circulation from the proposed action are not expected to contribute to cumulative impacts in Hood Canal. Driving the test piles will create a minor and temporary re-deposition of sediments. The proposed action, in combination with other Navy and non-Navy past, present and reasonably foreseeable future actions, will not contribute to cumulative impacts in Hood Canal.

5.6.2 Geology and Sediments

5.6.2.1 Past and Present Actions

Past and present Navy and non-Navy actions involving land clearing and disturbance of soils has resulted in soil and sediment erosion along Hood Canal. The establishment of vegetation can become hindered due to soil and sediment loss contributing to further erosion. Eroded soils can then be carried into Hood Canal by stormwater runoff and thus impact water quality. Adverse impacts to geologically hazardous areas, such as steep slopes, have occurred as a result of past non-Navy projects. These projects have increased the stormwater runoff and/or overburdened the tops of slopes with structures, leading to slope failure. However, geologically hazardous areas are now managed more carefully by following the guidance or standards of local governments or agencies (e.g., Kitsap County Code for Geologically Hazardous Areas) and applying construction BMPs for sloped surfaces. Standard stormwater construction BMPs have also reduced the amount of soil erosion that occurs during land disturbing activities.

Past and present actions involving in-water construction (i.e., pile driving and dredging) in Hood Canal have caused or are causing short-term disturbances to sediment. Pier replacement projects and shoreline armoring have resulted in erosion and coarsening of shoreline sediments in some areas of Hood canal. In-water structures, such as EHW-1, create accretion of sediments in some locations and erosion of sediments on the down-drift side of these structures. As a result of some of these in-water projects, the assumption has been made that some slight changes in sedimentation have occurred over time.

5.6.2.2 Future Actions

Future Navy and non-Navy actions could result in erosion and accretion of shoreline sediments.

The future EHW-2 project, the TPS/Port Ops Facilities and the Olympic View Marina are a few examples. Construction BMPs are expected to largely control erosion resulting from these actions.

5.6.2.3 Proposed Action

The proposed action would install and remove 29 test and reaction piles into Hood Canal substrate. This action is temporary, occurring over a 40 day period. Low amounts of sediments would be disturbed and suspended in the water column as a result of pile driving. The stability of the subsurface slope would not be compromised as a result of the proposed action. Construction activities would not result in the discharge of wastes containing metals or otherwise alter the concentrations of trace metals in bottom sediments. Therefore, the proposed action would not result in a significant impact to geology or sediments.

5.6.2.4 Cumulative Impacts

The Test Pile Program could result in additional disturbance of shoreline sediments. The impacts to sediments resulting from the proposed action would be temporary and localized. The proposed action, in combination with Navy and non-Navy past present and reasonably foreseeable future events would not have a significant cumulative impact on geology and sediments.

5.6.3 Water Resources

5.6.3.1 Past and Present Actions

Water quality in Hood Canal has been and is being impacted by past and present in-water and upland actions (Table 5–3). In-water development has impacted water quality from: (1) incidental spills associated with boat operations, such as fueling, or other activities conducted on piers, wharfs, and floats; (2) sediment disturbance and turbidity from propeller wash in shallow areas; (3) use of materials, such as treated wood pilings that, over time, leak toxins into the marine waters; and (4) stormwater runoff. Most of these events, except for treated materials, result in periodic inputs of pollutants (i.e., fuel, oil, and other contaminants) directly to Hood Canal, which can impact turbidity, pH, temperature, salinity, DO, and biochemical oxygen demand (BOD).

Unless there is a major spill of material such as fuel, oil, or other toxic material transported or associated with boat traffic that would impact water quality conditions, incidental spills usually do not result in long-term cumulative impacts. Hood Canal is a large enough water body that it can absorb small spills, such as those that may occur when fueling vessels, without any long-term impacts to water quality.

Propeller wash in shallow areas impacts water quality by disturbing sediment and causing turbidity. However, this is typically a short-term impact and does not usually result in a cumulative impact to water quality because sediment settles out fairly rapidly.

Most of the waterfront structures at NBK Bangor and other existing non-Navy sites are supported by pilings, many of which were treated with creosote, which is now known to contain toxic chemicals. Other wood materials historically used to construct docks, boathouses, and other facilities included pressure treated wood, which is now known to leach chromated copper arsenate and other pesticides. Over time, these materials are no longer being used and are being replaced with environmentally neutral materials that do not leak toxins (discussed below). Thus the impacts to water quality from this source have decreased over time.

Upland development has caused localized deterioration in the water quality in Hood Canal, mainly from uncontrolled stormwater runoff, failing septic systems, and mismanagement of animal wastes. Stormwater runoff can carry contaminants, such as heavy metals and oils from hard surfaces such as roads, and nitrogen and phosphorus from lawn fertilizers into streams that empty into Hood Canal. While irregular in nature, stormwater-related inputs to water quality may be relatively intense during storm events. Contaminants in the stormwater runoff can adversely impact DO, BOD, pH, and other water quality parameters in localized areas.

Most development in Hood Canal watershed (excepting NBK Bangor) uses septic systems, and many older systems have failed over time. Fecal coliform bacteria and nutrients are periodically discharged into Hood Canal through stormwater runoff from areas with inadequate septic systems. Though fecal coliform bacteria are not harmful to humans, the presence of fecal coliform indicates the possible presence of pathogenic viruses or bacteria. Fecal coliform bacteria can also be absorbed and concentrated in shellfish making them unsuitable for human consumption.

Nutrients are a larger problem because they can cause algae to bloom. When algal blooms occur, they cause DO to be rapidly used up during bacterial decomposition of dead plankton. This rapid loss of DO can result in fish kills. Similarly, animal wastes from hobby farms or sites where animals are bred are also a source of nutrients. These sources of nutrients have long been recognized as causing the low DO problem in Hood Canal. Efforts have been ongoing to eliminate the use of septic systems or to repair failing systems to the extent possible particularly in nearshore areas, and to control point sources such as hobby farms. However, in Hood Canal watershed, some future development would continue to use septic systems because sewers are not available in many areas.

Nevertheless, recent trend data predict an overall reduction in fecal coliform in the future (PSAT, 2007b) because of plans for constructing some new sewer lines in southern Hood Canal and other actions (Section 5.5.9, Agency Plans for Improving Environmental Conditions in Hood Canal).

Although fecal coliform levels are expected to decrease, the State of the Sound Report (PSAT, 2007b) states that the overall trend is for continued deterioration of water quality in Hood Canal due to a rise in toxic contaminants and a lowering of DO levels, which are several of the water quality parameters of concern. There are a number of waters in Puget Sound that are listed as impaired by the WDOE, including southern Hood Canal (PSAT, 2007b).

5.6.3.2 Future Actions

Future development actions in Hood Canal region would have the potential for the same types of water quality impacts discussed above for past actions. Future actions would be designed to minimize such impacts. For example, all new piers, including the proposed EHW-2, would use concrete or steel pilings and, unlike creosote-treated piles used in the past, would not have the potential for leaching toxic compounds into the water. Projects proposed by Hood Canal agency plans would be implemented specifically to improve water quality in Hood Canal (see Section 5.5.9).

5.6.3.3 Proposed Action

There would be a slight risk of accidental fuel spills from the proposed action. Piles would be chemically neutral so there would be no impact to water quality from this source. Operation of boats would occur mostly in deeper water so there would be few instances of increased turbidity. Overall, no water quality standards would be violated under the action alternative. Water quality impacts caused by the proposed action would be limited to temporary and localized impacts of construction or accidental spills.

5.6.3.4 Cumulative Impacts

Although past, present, and future actions have had, have, or would have several water quality impacts, as described above, the localized and temporary impacts of the proposed action would not overlap in time or space with the water quality impacts of other actions. Nevertheless, the proposed action would contribute incrementally to cumulative water quality impacts in Hood Canal overall. For mobile species such as fish, marine mammals, and marine birds, the water quality impacts of the proposed action could be additive with impacts from other actions in Hood Canal (see Sections 5.6.8, 5.6.9, and 5.6.10, respectively).

If the construction periods for the proposed EHW-2 and the TPS/Port Ops Facilities project overlap in time (see Section 5.4, Past, Present, and Reasonably Foreseeable Future Navy Actions), there is little potential for the water quality impacts of the two projects to overlap in space, because these impacts would be localized. However, both projects would contribute incrementally to cumulative water quality impacts in Hood Canal, and mobile species occurring at NBK Bangor could be affected by both projects within a short time period. The proposed action, in combination with Navy and non-Navy past present and reasonably foreseeable future events would not have a significant cumulative impact on water resources.

5.6.4 Air Quality

5.6.4.1 Past and Present Actions

Existing air quality has been or is being impacted by past and present actions to varying degrees, depending on the nature of the project. For example, residences and facilities such as parks have had little impact to air quality, while vehicles and industrial operations may produce a significant amount of emissions including volatile organic compounds, nitrogen oxides, particulates, or other emissions. Water and land-based construction activities along Hood Canal such as the construction of piers, docks, marinas, homes and businesses may also result in air emissions.

The trend for air quality is fairly stable, since point sources have been targeted by regulations which limit their emissions. Also, outside of the county's urban boundaries, air emission sources such as woodstoves are spread over a fairly large area due to large lot development, and any impacts are localized. Air quality in Hood Canal region is rated as "good" (PSCAA, 2008) and is in compliance with all air quality standards.

5.6.4.2 Future Actions

Future Navy and non-Navy actions have the potential to affect air quality in the vicinity of Hood Canal. The future EHW-2 project, the TPS/Port Ops Facilities and the non-Navy projects listed above are a few examples. The construction activities associated with these projects all contribute to increased air emissions.

Future Navy and non-Navy actions that produce sizeable air emissions would be required to obtain a permit and to comply with permit conditions to limit emissions of air pollutants generated. Thus, it is not anticipated that future actions would result in violations of air quality standards.

5.6.4.3 Proposed Action

The proposed action would require the installation and removal of 29 test and reaction piles from the NBK Bangor waterfront. The proposed action would occur within a 40-day period and would be temporary in nature. Air emissions resulting from the proposed action would be below the thresholds required to obtain a permit. The proposed action would not have a significant impact on air quality.

5.6.4.4 Cumulative Impacts

The proposed action is temporary in nature and would occur within a 40-day period. In addition, anticipated emissions would be below the thresholds required to obtain a permit. This action in combination with other past, present and reasonably foreseeable actions would not have a significant effect on air quality in Hood Canal and the surrounding communities. Therefore, operation of the proposed action would not contribute to cumulative air quality impacts when added to other past, present, and future actions.

5.6.5 Ambient Noise

5.6.5.1 Past and Present Actions

Most past and present actions have generated or are generating some type of noise, whether it is from a facility itself, and vehicles traveling to and from a site, or from humans. Noise is typically a nuisance factor for sensitive receptors such as wildlife, residences, hospitals, or parks where quiet conditions are important. This is particularly true during evening hours. Close proximity to high sound levels can result in physiological problems or hearing damage.

Over time the trend has been for noise levels to increase as development has occurred, particularly during daytime hours when activity levels are highest. Noise levels tend to be fairly low outside the urban areas of Kitsap County due to development on large lots (greater than 5 acres in size) and a general lack of industrial activity. However, there are some industrial areas, such as the NBK Bangor waterfront, that generate higher noise levels.

5.6.5.2 Future Actions

Future Navy and non-Navy actions would also generate noise. For example, the proposed EHW-2 will produce noise associated with pile driving and the construction of the wharf. Although the analysis for this project is not yet complete, some level of ambient noise would be attributed to this project. The type of noise and noise level produced would be dependent on the specific project. The impact of these noise sources would depend on their location relative to sensitive receptors, but it is likely that some of these future actions would produce nuisance noise. There are requirements to limit the level of noise produced by residential, commercial, or industrial land uses. Thus, some future development would have requirements to provide soundproofing measures.

5.6.5.3 Proposed Action

The proposed action would result in the driving and removal of 29 test and reaction piles in Hood Canal along the NBK Bangor waterfront. The proposed action would generate noise from equipment, industrial activities, vessel movement, and humans, although the highest noise levels would result from pile driving. The proposed action would not have a significant impact on ambient noise along the NBK Bangor waterfront.

5.6.5.4 Cumulative Impacts

The cumulative impacts of pile driving noise to fish, mammals, marine birds, and surrounding communities are discussed in Sections 5.6.6, 5.6.10, 5.5.11, and 5.6.12. The proposed action is temporary lasting no more than 40 days. This action in combination with other past, present and reasonably foreseeable actions would not contribute to a substantial increase in ambient noise for Hood Canal and the surrounding communities. Therefore, operation of the proposed action would not contribute to cumulative noise impacts when added to other past, present, and future actions.

5.6.6 Vegetation

5.6.6.1 Past and Present Actions

Marine vegetation in Hood Canal has been or is being disturbed by past and present placement of in-water structures such as pilings and anchors, dredging, underwater fills, and construction of overwater structures. These impacts include temporary and/or permanent loss of marine vegetation, reduced productivity, and changes in the type or abundance. Important marine habitat, such as eelgrass, has decreased over time in Hood Canal as indicated by recent trend data: eelgrass coverage in Hood Canal declined between 8 and 15 percent in every year between 2001/2 and 2004/5 (PSAT, 2007a).

There is a total of approximately 37.7 acres of eelgrass that runs in a strip along the intertidal/nearshore zone of the NBK Bangor. Based on the known extent of current eelgrass beds, an estimated 5.2 acres of eelgrass may have been lost over time due to placement of in-water structures, such as pilings and anchors. Approximately 24.7 acres of overwater shading have been created by past actions at NBK Bangor (Table 5.1). The overwater shading reduces the productivity of marine vegetation such as eelgrass and macroalgae.

TABLE 5.1 CUMULATIVE LOSS OF MARINE VEGETATION AT NBK BANGOR (ACRES)

Parameter	Total Overwater Shading	Eelgrass Loss[1]	Macroalgae Loss[1]
Past Navy Waterfront Construction	24.7	5.2	Not determined
Proposed EHW-2 (Deep-Water Trestle)	6.4	0.16	2.2
TPS/Port Ops Facilities	0.34[2]	0.17	2.6
Land/Water Interface	< 0.1	< 0.1	< 0.1
Non-Navy Future Hood Canal Projects	3	Not determined	Not determined
Total	**34.5**	**5.6 plus undetermined amount**	**4.9 plus undetermined amount**

1 For the purposes of cumulative impact assessment, eelgrass loss is the area harvested prior to construction for replanting elsewhere on the base, and macroalgae loss is the known areas of macroalgae under the proposed structures.

2 Overwater shading for TPS/Port Ops Facilities is the net value of the new TPS/Port Ops Facilities structure minus the overwater area of the Magnetic Silencing Facility, which would be demolished under that project.

5.6.6.2 Future Actions

It is estimated that TPS/Port Ops Facilities and Land Water Interface would result in approximately 0.1 acre of shading and loss of 0.17 acre of eelgrass. These actions will be designed to avoid eelgrass beds as much as possible. The proposed EHW-2 would be anticipated

to create approximately 6 acres of overwater shading. Other future non-Navy actions would also reduce the amount of eelgrass and macroalgae from placement of pilings and anchors and shading. It is estimated that approximately 3 acres of overwater structure would be created by the actions described in Section 5.5, Other Past, Present, and Reasonably Foreseeable Future Actions (Non-Navy) and Hood Canal Agency Plans, which would result in a loss of approximately 0.4 acre of eelgrass.

5.6.6.3 Proposed Action

The Test Pile Program would result in no loss of eelgrass and some minimal loss of macroalgae from the in-water activities. A conservative estimate of total bottom disturbance from the barge anchors, spuds and test piles is approximately 6,970 ft^2 (647 m^2) or 0.16 acre. Due to the depth, only a portion of this area contains macroalgae which would be negatively affected during the in-water activities.

5.6.6.4 Cumulative Impacts

The total combined impact of past Navy actions, future Navy and non-Navy actions, and the Test Pile Program is approximately 34.5 acres of shading as well as an unquantified loss of eelgrass and macroalgae, which has been and would continue to be part of the observed decline in eelgrass in Hood Canal (PSAT, 2007a). Hood Canal currently supports approximately 550 acres of eelgrass; northern Hood Canal (north of the tip of Toandos Peninsula) supports approximately 220 acres (Simenstad et al., 2008). Cumulative impacts to eelgrass beds would affect the functions of these habitats, including primary productivity, habitat for invertebrates and epiphytic algae, and feeding and refuge for juvenile fish. The impacts of the proposed action will be limited to a small area of macroalgae which would be overshadowed by the proposed EHW-2.

5.6.7 Benthic Invertebrates

5.6.7.1 Past and Present Actions

Past and present Navy and non-Navy actions, including marinas, residential docks, boat ramps, and piers involving placement of pilings and anchors have resulted in the direct loss of the natural benthic soft-bottom habitat. This habitat is replaced by the hard surfaces of pilings and anchors, and as a result, the types of benthic organisms have changed and are changing in these localized areas. Hard surfaces create sites for colonization by species adapted to these surfaces such as mussels and sea anemones. Thus, the impact of in-water structures has been to replace native soft-bottom habitat with hard-surface habitat over time. This has adversely impacted some species (including prey species for juvenile salmonids), while benefiting others. It is estimated that approximately 2.4 acres of benthic soft-bottom habitat has been lost and converted to hard-surface habitat due to placement of in-water structures along the NBK Bangor waterfront (Table 5–3).

5.6.7.2 Future Actions

Future in-water structures would similarly result in a direct loss of benthic habitat and organisms. The overwater portion of the proposed EHW-2 has the potential to increase shading and nighttime lighting impacts on benthic organisms. Shading can impact the abundance of some benthic organisms and lighting can increase predation rates. Shading and loss/alteration of soft-bottom habitat has impacted the type and abundance of benthic organisms that occur in the vicinity of these structures. In addition, in-water structures have resulted in accretion of sediments in some areas and possibly erosion in others. The most relevant of these areas is an area of accretion about 2 acres in size within EHW-1. Any areas of erosion would result in adverse impacts to sediment-dwelling species. These changes would adversely affect foraging by juvenile salmon, which prefer species typical of fine-grained sediments and eelgrass beds.

Future in-water structures would similarly result in a direct loss of soft-bottom habitat and it is estimated that approximately 0.07 acre of soft-bottom habitat would be replaced with hard surfaces, based on the number of piles in the proposed Navy structures. Other future non-Navy actions identified in Section 5-5 are estimated to result in a loss of approximately 0.05 acre of soft-bottom habitat, based on review of available information for those projects.

5.6.7.3 Proposed Action

The installation of the test piles will involve driving 18 steel pipe piles ranging in size from 30 inches to 60 inches in diameter into the substrate. Additionally, three lateral load tests will be performed. The lateral load tests will require re-installing 2 of the 60 inch piles and 1-48 inch pile. There could be a temporary loss of 6,970 ft^2 (647 m^2) of soft-bottom habitat. Disturbance will be confined to a 40 day window after which all piles will be removed and equipment demobilized. The proposed action would not have a significant impact to benthic invertebrates.

5.6.7.4 Cumulative Impacts

The recent trend for the benthic community in Hood Canal is a reduction in abundance and diversity (PSAT, 2007a). This trend is strongest in southern Hood Canal and in deeper waters but includes decreases in the native Olympia oyster, which occurs intertidally. Stress-sensitive species are more abundant in northern Hood Canal, which includes NBK Bangor, than in southern Hood Canal. Low levels of DO are considered a likely cause of this trend, but other contributing factors are being investigated (PSAT, 2007a).

The conversion of soft-bottom habitat to hard surfaces from past, present, and other foreseeable future actions would include approximately 2.5 acres from Navy actions (Table 5–3) and an unquantified area from past non-Navy actions. Approximately 2 acres is expected to experience accretion of sediments, and areas down-drift (north) of the proposed EHW-2 may experience erosion and loss of sediment-dwelling benthic community. The trend for Hood Canal as a whole is for decreasing abundance and diversity of the benthic community, although this trend is stronger in southern Hood Canal than in the NBK Bangor area. The proposed action is temporary and will not contribute to any permanent cumulative losses to benthic communities.

5.6.8 Fish

5.6.8.1 Past and Present Actions

Salmonids

Past actions have adversely impacted populations of salmonids (salmon, steelhead, and trout, including threatened and endangered species) in Hood Canal and tributaries through loss of foraging and refuge habitat in shallow areas, reduced function of migratory corridors, loss and degradation of spawning habitat in streams, interfering with migration, adverse impacts to forage fish habitat and spawning, contamination of water and sediments, and depletion of DO. Another factor that has resulted in adverse impacts to salmonid abundance is the overharvest by fisheries. The impact has been greatest on native stocks. Practically all chum salmon, most Chinook, and all sockeye salmon spawning in Hood Canal stream systems are derived from naturalized hatchery stock. Populations of pink salmon, coho salmon, bull trout, and steelhead are also in decline. The net result is that several Hood Canal salmonid species have been listed as threatened under the ESA. Existing Navy structures have affected salmonid and forage fish habitat, and have probably impeded and continue to impede juvenile salmon migration to some degree. Current and future waterfront projects at NBK Bangor would be designed and implemented to minimize impacts to salmonid habitat and migration, and to forage fish.

The State of the Sound Report (PSAT, 2007b) describes several trends that may be indicative of cumulative impacts to the growth and development of salmonids. There is an increasing trend for toxics to be concentrated in the tissues of Puget Sound Chinook and coho salmon. These salmon have been found to have 2 to 6 times the PCBs and 5 to 17 times the PBDEs (polybrominated diphenyl ethers) in their bodies compared to other West Coast salmon populations. Wild salmon stocks have declined from 93 to 81 healthy stocks from 1992 to 2002, and during that same period seven stocks have become extinct.

Other Marine Species

Prior to the 1980s, in-water construction of docks, piers, and boat ramps in Hood Canal impacted fish species presence and abundance, particularly when it was not yet recognized that in-water construction work should not occur during spawning of forage fish species such as sand lance, Pacific herring, and surf smelt. For example, underwater noise from pile driving is intense and can cause fish mortality, as well as changes in fish behavior. Prior to the 1980s, in-water construction of docks, piers, and boat ramps in Hood Canal impacted fish species and abundance. Even so, underwater construction noise continues to adversely impact the abundance and occurrence of some fish close to the construction activities.

The placement of in-water structures by the Navy and from non-Navy actions has changed and would continue to change fish habitat in and around these structures. In-water structures can impact fish in several ways, including: (1) increasing the presence of predators that prey on juvenile fish; (2) posing a barrier to fish movement, particularly juvenile fish; (3) causing direct loss of marine vegetation such as eelgrass, which is important habitat for forage fish and other species; and (4) creating shade that reduces the productivity of aquatic vegetation and benthic organisms, which are preyed on by fish.

Water quality has been and is being impacted by past and present actions and could be impacted by potential future development. In particular, DO levels in Hood Canal are chronically impacted by nutrient levels from development activities that have increased over time. Nutrients can cause algal blooms that deplete DO and result in fish kills (see Section 5.6.3, Water Resources). Many of the other types of past and ongoing impacts described above for salmonids also apply to other marine species.

Trend data have shown a decrease in some fish species such as rockfish, spiny dogfish, Pacific cod, and hake, as well as increased toxics in the tissues of some species such as Chinook salmon (PSAT, 2007a).

5.6.8.2 Future Actions

Salmonids

Future Navy and non-Navy actions have the potential to have some of the same impacts as described above for past actions, notably habitat loss or alteration, and the decreased function of migratory corridors. However, federal or federally funded actions that have occurred since legislation, such as the ESA, MMPA, and NEPA, was enacted have been considering and are required to consider environmental impacts to threatened and endangered species, prepare analysis (including a biological assessment), and consult with federal oversight agencies to minimize project impacts. Future actions are also required to go through this same process. Future actions at NBK Bangor will be designed and implemented to minimize impacts to salmonids.

Currently, efforts are being made to reverse the decline of fish populations by regulating development and restoring fish habitat. Numerous salmon preservation and restoration groups have proposed and constructed habitat restoration projects in Hood Canal. Most of these projects are on the east and south sides of the canal, where most of the salmonid-bearing river systems are found. Efforts to reduce construction impacts to salmonids and other fish have resulted in a schedule of in-water work periods that all projects must adhere to if authorized by state (WDFW) or federal (USACE) regulatory authorities. The work windows help minimize adverse impacts to migrating and spawning fish.

Other Marine Species

Future Navy and non-Navy actions have the potential to have some similar impacts as those described above for past actions. The protective measures taken to minimize impacts during construction activities, and the design elements that reduce long-term impacts to nearby habitats, as well as strengthened environmental review of recent and future actions, is expected to reduce impacts to fish populations. Future actions, including Navy actions, will be designed and implemented to minimize impacts to fish and their habitat. In addition, many of the habitat restoration projects discussed above for salmonids would also benefit non-salmonid fish species.

5.6.8.3 Proposed Action

Salmonids

The proposed action may impact salmonids through pile driving noise and temporary, localized water quality changes (turbidity) in nearshore habitats. However, through mitigation efforts, these impacts would be minimized and mitigated as described in Section 4.3, Mitigation Measures and Regulatory Compliance.

Other Marine Species

Nearshore habitat impacts on other marine fish would be similar to those described above for salmonids. The impacts of turbidity and underwater noise generated during pile driving would also be expected to be similar.

5.6.8.4 Cumulative Impacts

Salmonids

Past, present, and future development projects have had, have, and would have the potential to result in many of the impacts to salmonids described above, and add to declining population trends. Although there are ongoing and future actions and plans intended to improve conditions for salmonids in Hood Canal (described above), the impacts of the proposed action would result in short-term increases in underwater noise and turbidity therefore potentially contributing to past and ongoing cumulative impacts to these species. However, because impacts are short-term and localized if actual construction schedules for projects involving pile driving do not overlap, resulting cumulative impacts would be reduced accordingly.

Other Marine Species

Nearshore cumulative impacts on other marine fish would be similar to those described above for salmonids.

5.6.9 Marine Mammals

5.6.9.1 Past and Present Actions

Construction and operation of past and present waterfront projects, such as Delta Pier and KB Docks, (see Tables 5-2 and 5–3), as well as non-Navy actions such as Hood Canal Bridge replacement, have resulted in increased human presence, underwater and airborne noise, boat movement, and other activities, which has likely impacted some water-dependent wildlife such as marine mammals in the area. Increased anthropogenic noise in the marine environment has the potential to cause behavioral reactions in marine mammals including avoidance of certain areas. However, the abundance and coexistence of these species with existing anthropogenic activities suggests that cumulative effects have not been significant. Population trend data for Hood Canal indicate that most of the marine mammal species expected to be in the project area are either stable or increasing in recent years based on NMFS stock assessment reports despite past and present actions (Carretta et al., 2008; Allen and Angliss, 2010). For instance, the U.S. stock of California sea lions is nearly at its carrying capacity, harbor seals within the inland waters of WA are at their optimum sustainable population level, and the Eastern stock of Steller sea lions was recently proposed as a candidate for removal from the ESA based on an increase in population size of ~3.0% per year since 1970 (NMFS, 2008a). Continued regulation of marine mammal exposures to anthropogenic disturbance by NMFS under the MMPA, coupled with stock assessments, documentation of mortality causes, and research into acoustic effects, ensure that cumulative effects would be minimized. The regulatory process also ensures that each project proposing take of marine mammals is assessed in light of the status of the species and other actions affecting it in the same region.

5.6.9.2 Future Actions

Future Navy and non-Navy waterfront projects may have similar impacts to past and present actions including increased anthropogenic sound (both airborne and underwater), increased human presence, increased boat movements and other associated activities. These actions could result in behavioral impacts to local populations of marine mammals, such as temporary avoidance of habitat, decreased time spent foraging, increased or decreased time spent hauled out (depending on the activity), and other minor behavioral impacts. All impacts would likely be short-term and temporary in nature and unlikely to affect the overall fitness of the animals. Additionally, proposed projects along the NBK Bangor waterfront, such as the Test Pile Program, would occur in an area that already has industrial uses with higher than normal activity and noise levels. Thus, marine mammals in the area may be habituated to these higher levels of ongoing activity and less impacted by ongoing waterfront development.

5.6.9.3 Proposed Action

The primary impact of the proposed action to marine mammals is behavioral disturbance from underwater sound generated by pile driving operations at NBK Bangor associated with the Test Pile Program. Any marine mammals which are behaviorally disturbed may change their normal behavior patterns (i.e. swimming speed, foraging habits, etc.) or be temporarily displaced from the area of construction. Any exposures would likely have only a minor effect and temporary impact on individuals and would not result in population level impacts.

5.6.9.4 Cumulative Impacts

As described in Section 3.9, Marine Mammals, implementation of pile driving at the Test Pile Program site would have minimal effects on most marine mammals, but may affect, not likely to adversely affect the ESA-listed Steller sea lion. The proposed action may result in behavioral disturbance to marine mammals from underwater sounds associated with pile driving; however, these effects will be limited to localized, temporary disturbances to marine mammals within the Test Pile Program project area.

Past, present, and future development projects have had, are having, and would have the potential to result in many of the impacts to mammals described above, and could also have additional impacts to the species, their habitat, and prey. For instance, fishing operations in the area could reduce local abundance of forage fish or result in by-catch of marine mammals. Because marine mammals are highly mobile, the noise impacts of the proposed action could be cumulative with underwater and airborne noise impacts to marine mammals from other actions and activities in Hood Canal region. However, because the expected impacts of the proposed action on marine mammals in general would be temporary, cumulative impacts to marine mammals associated with pile driving noise are considered unlikely.

Cumulative impacts to marine mammals have the greatest potential to occur during simultaneous pile driving exposure events from the Test Pile Program and other projects in the vicinity. However, continued adherence to the requirements of the ESA and MMPA by NBK Bangor would limit disturbance to marine mammals and ensure that important habitats do not become degraded. Furthermore, existing regulatory mechanisms and mitigation measures would protect marine mammals (see Sections 3.9 and Chapter 4) and further decrease the likelihood of potential cumulative impacts to these species.

5.6.10 Birds

5.6.10.1 Past and Present Actions

Construction and operation of past and present waterfront projects, such as Delta Pier and KB Docks (see Tables 5-2 and 5–3), as well as non-Navy actions, has resulted in increased human presence, underwater and airborne noise, boat movement, and other activities, which has likely deterred some water-dependent wildlife such as marine birds from these areas. Marine birds typically avoid areas with continuous activity or that produce periodic impacts such as loud noises. Often, birds will return to these areas when human presence is lower or there is less activity. There may also be some benefits as some birds may use these in-water structures for roosting or nesting.

Trend data for Hood Canal indicate that marine bird species have been on the decline. Of the 30 most common marine birds, 19 have experienced declining populations of 20 percent or more over the past 20 years. It is unknown what is causing this decline, but possible reasons include increased predation, habitat loss, changing migration patterns, decreases in forage fish populations, hunting, and disturbance to breeding grounds in the Arctic (PSAT, 2007a). The marbled murrelet, listed as threatened under the ESA, declined more than 20 percent in population in the Puget Sound region from the 1970s through the 1990s but has been fairly stable in recent years (PSAT, 2007a). The principal reason for the earlier decline was loss of nesting habitat (old-growth forest).

5.6.10.2 Future Actions

Future Navy and non-Navy waterfront projects may have similar impacts to those of the past and present actions. However, proposed projects along the NBK Bangor waterfront, such as the Test Pile Program, would occur in an area that already has industrial uses with higher than normal activity and noise levels. Thus, marine birds in the area may be somewhat used to these higher levels of activity and less impacted by ongoing waterfront development.

5.6.10.3 Proposed Action

The primary impact of the proposed action to marine birds is the disturbance, displacement, and possible physiological impacts from underwater and airborne noise associated with pile driving and removal. Of most concern, is the threatened marbled murrelet.

5.6.10.4 Cumulative Impacts

As described in Section 3.10, Birds, implementation of pile driving at the Test Pile Program project area would have minimal effects on most marine birds, but may affect, and is likely to adversely affect the ESA-listed species, marbled murrelet. The proposed action would likely have underwater and airborne noise impacts to birds, but most effects would be limited to localized, temporary disturbances to birds in the Test Pile Program project area.

Past, present, and future development projects have had, are having, and would have the potential to result in many of the impacts to marine birds described above, and add to past or current declining population trends. Because marine birds are highly mobile, the noise impacts of the proposed action could be cumulative with underwater and airborne noise impacts to marine birds from other actions and activities in Hood Canal region. However, because the expected impacts of the proposed action on marine birds in general would be temporary, cumulative impacts to marine birds associated with pile driving noise are considered unlikely.

Cumulative impacts to marbled murrelets have the greatest potential to occur during simultaneous pile driving exposure events from the Test Pile Program and other projects in the vicinity. This effect would be reduced if the actual pile driving period overlap is scheduled in accordance with other noise producing projects near the project area. Additionally, continued adherence to the requirements of EO 13186 and the Bald and Golden Eagle Protection Act (16 USC 668a-d dated June 8 1940 as twice amended) by NBK Bangor would limit disturbance to migratory birds and ensure that important habitats do not become degraded. Furthermore, existing regulatory mechanisms and mitigation measures would protect bald eagles and the ESA-listed marbled murrelet (see Section 3.10, Birds) and further decrease the likelihood of potential cumulative impacts to these species.

5.6.11 Tribal Fisheries/Access

5.6.11.1 Past and Present Actions

Tribal fisheries/access has the potential to be affected by past and present actions. Activities such as the construction of piers, docks, marinas, and other shoreline and in-water construction are examples. As such, the Navy consults with tribes regarding the impacts to tribal access and fishing rights.

5.6.11.2 Future Actions

Future Navy or non-Navy actions may impact tribal Usual and Accustomed areas and treaty-reserved resources. However, most of these traditional use areas, subsistence resources, and special places, have been identified and are will be avoided whenever possible. Access to these resources is also allowed for Native American tribes with treaty rights.

5.6.11.3 Proposed Action

The installation and removal of 29 test and reaction piles is proposed to occur over a 40 day period. Since no tribal harvests occur in the Test Pile Program project area, the proposed action would not restrict tribal access. Tribal consultations will be completed as part of this EA.

5.6.11.4 Cumulative Impacts

Traditional use areas, subsistence resources, and special places (religious and traditional) may have been impacted over time as a result of land development and population that resulted in increased use of natural resources such as fish and shellfish. Impacts to cultural resources include loss of access to traditional areas, conversion of a traditional area or special place to another land use, and reduction in the abundance of resources used for subsistence or ceremonial/religious uses.

The proposed action, because of its temporary nature, in combination with any past, present or future Navy and non-Navy actions, is unlikely to produce any lasting or noticeable cumulative impacts to treaty-reserved resources. However, prior to implementation of the proposed action, all tribal consultations will be completed and mitigations measures identified.

5.6.12 Environmental Health and Safety

5.6.12.1 Past and Present Actions

Environmental health and safety has the potential to be affected by past and present actions. Activities along Hood Canal such as the construction of piers, docks, marinas, and other in-water and shoreline construction are examples. These actions produce ambient and underwater noise, can stir up contaminants in the sediments, can affect tribal access and have the potential to contaminate the water with toxins and chemicals.

5.6.12.2 Future Actions

Future Navy and non-Navy actions have the potential to affect the environmental health and safety of Hood Canal residents. Sediment contaminants, toxins and other pollutants, noise and other impacts result from in-water and shoreline construction. Although Navy actions occur in restricted areas where the public cannot gain access, non-Navy actions can occur in public areas where more precautionary measure might be taken.

5.6.12.3 Proposed Action

The proposed action would require the installation and removal of 29 test and reaction piles from the NBK Bangor waterfront. The NBK Bangor waterfront is restricted from public access and the nearest non-navy residence is 1.5 miles to the north of the base. The proposed action would not have a significant impact to environmental health and safety.

5.6.12.4 Cumulative Impacts

The proposed action is temporary lasting no more than 40 days. The proposed action will occur in the restricted waters of NBK Bangor. As a result, there will not be any impacts to public safety or access because the public is restricted from the area where the proposed action would occur. This action in combination with other past, present and reasonably foreseeable actions would not have a significant effect to environmental health and safety for Hood Canal and the surrounding communities. Therefore, operation of the proposed action would not contribute to cumulative environmental health and safety impacts when added to other past, present, and future actions.

5.7 CONCLUSION

Resources that are irreversibly or irretrievably committed to a project are those that are used on a long-term or permanent basis. This includes the use of non-renewable resources such as metal and fuel, and other natural or cultural resources. These resources are irretrievable in that they would be used for this project when they could have been used for other purposes. Human labor is also considered an irretrievable resource. Another impact that falls under this category is the unavoidable destruction of natural resources that could limit the range of potential uses of that particular environment.

Implementation of the proposed action would involve the consumption of fuel, oil, and lubricants for the vibratory hammer, the impact hammer and the barges/tugboats. Human energy invested in the Test Pile Program would be irretrievably lost. Implementation of the proposed action would not result in significant irreversible or irretrievable commitment of resources.

NEPA requires an analysis of the relationship between a project’s short-term impacts on the environment and the effects that these impacts may have on the maintenance and enhancement of the long-term productivity of the affected environment. Impacts that narrow the range of beneficial uses of the environment are of particular concern. This refers to the possibility that choosing one development option reduces future flexibility in pursuing other options, or that giving over a parcel of land or other resources to a certain use often eliminates the possibility of other uses being performed at that site.

In the short-term, effects to the human environment with implementation of the proposed action would primarily relate to the pile driving activities associated with the Test Pile Program. Air quality, ambient and underwater noise, marine mammals, birds, fish and sediments would all expect to be impacted in the short-term. In the long-term, productivity of the area would not be affected by the Test Pile Program. All impacted resources would be expected to recover from the effects of the Test Pile Program. The proposed action would not result in any impacts that would reduce environmental productivity or permanently narrow the range of beneficial uses of the environment.

Implementation of the proposed action would not result in significant impacts to the environment. The Test Pile Program would utilize mitigation measures and monitoring to ensure marine mammals, fish and birds are protected to the maximum extent possible. Implementation of the proposed action, in conjunction with other past, present, and reasonably foreseeable future actions, would not be expected to result in significant cumulative impacts to the environment.

TABLE 5.2 PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR

	Project Name	Location	NEPA/ESA Documentation	Project Status	Description
1.	TRIDENT Support Site	Entire base	EIS, 1974 with supplements 1976, 1977, 1978	Completed	Construction of TRIDENT Submarine Base including 3 piers and a dry dock, 400 units of family housing, bachelor enlisted quarters to house 660 personnel, the TRIDENT Training Facility (a 300,000 sq ft structure), the Refit Industrial Facility (270,000 sq ft), and the TRIDENT Missile Assembly and Support Facilities; includes dredging of 220,000 cubic yards at the dry dock and operation of a groundwater dewatering system
2.	Keyport/Bangor Dock Dredging	NBK Bangor waterfront, Dock	CWA Section 10 permit, 1985	Completed	Dredging of approximately 3,000 cubic yards; USACE permit No. 071-0YB-2-010081
3.	Drydock Caisson Moorage	NBK Bangor waterfront, Delta Pier	EA, 1992	Completed	Construction and operation of a berthing pier for a second caisson (100 by 65 by 18 feet), including dredging of 12,000 cubic yards of sediment; new pier is 140 by 20 feet long
4.	Construction of Supporting Shore and Waterfront Facilities for USS PARCHE	NBK Bangor waterfront, Service Pier	EA, 1994	Completed	Upgrade of Service Pier (extension of 290 feet) to accommodate USS PARCE and 5 barges; removal of 106 piles and reinstallation of 180 piles, new detachment support building (48,272 sq ft), parking area (6,600 sq ft), lay down area (27,990 sq ft), road (64,350 sq ft)
5.	Marginal Wharf Pier Repairs at SUBASE Bangor	NBK Bangor waterfront North pier of Marginal Wharf	BA, 2000	Completed	Replacement of missing dolphin and 10 piles
6.	Operable Unit #7 (site 26, Marine Sediments)	Bangor Waterfront	ROD, 2000	Completed	Select marine sediments monitored for chemical contamination
7.	Installation and Operation of Force Protection Barrier	NBK Bangor waterfront area	EA, 2002	Completed	Above-water fencing that is 14 feet high placed on pontoons along the waterfront restricted area

TABLE 5.2 PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR (continued)

	PROJECT NAME	LOCATION	NEPA/ESA DOCUMENTATION	PROJECT STATUS	DESCRIPTION
8.	U.S. Navy Dabob Bay and Hood Canal Military Operating Area	Testing in Dabob Bay and launch and recovery testing in Hood Canal near NBK Bangor waterfront	EA, 2002	Completed	Launch and recovery testing for research and experiments, proofing and fleet departures with potential for release of gas fumes, propellant spills, turbidity, release of lead and copper in water, and some noise emissions at 180 dB
9.	SUBDEVRON 5 Support Facilities (Submarine Development Squadron 5 Detachment)	NBK Bangor waterfront, Service Pier	EA, 2003	Completed	Facility upgrades to existing Service Pier, size increase of 18,000 sq ft, construction of new waterfront support facility (12,560 sq ft), expansion of existing shore-based support facilities
10.	Service Pier Expansion	NBK Bangor waterfront, Service Pier	EA, 2004	Completed	Expansion of pier by 5,000 sq ft and 20 new piles
11.	EHW Pile Replacement	NBK Bangor waterfront, EHW	Abbreviated BA, JARPA in 2004	Completed	Removal and replacement of piles using vibratory hammer
12.	EHW Pile Replacement	NBK Bangor waterfront, EHW	JARPA filed in 2005, piles changed in 2006	Completed	Removal of 12 hollow concrete piles at Bents 14 and 20 and replacement with like number of hollow steel piles; permit indicated use of vibratory hammer and silt curtain
13.	Navy Surface Warfare Center Carderock Division (NSWCCD) Detachment Bremerton Command Consolidation	NBK Bangor waterfront Carlson Spit	EA 2005	Completed	Construction of in-water facilities including a new access pier (8,800 sq ft), pontoon (21,600 sq ft), vessel overwater footprint (13,623 sq ft) and associated mooring components, 102 new steel piles, road improvements to Carlson Spit Access Road, 23,000 sq ft building, 100 additional workers

TABLE 5.2 PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR (continued)

	PROJECT NAME	LOCATION	NEPA/ESA DOCUMENTATION	PROJECT STATUS	DESCRIPTION
14.	Mission Support Facilities	NBK Bangor waterfront, Marginal Wharf	EA, 2005	Completed	Addition of 2 new power booms and 2 captivated camels, requires 10 steel piles and results in 5,000 sq ft of overwater shading; installation of emergency power generation capability
15.	Dredging south side of Delta Pier	NBK Bangor waterfront, Delta Pier	BA, EA 2005	Completed	Removal of 3,000 cubic yards of sediment
16.	Transit Protection System, Interim Operational Capability	NBK Bangor waterfront, Keyport/ Bangor dock	EA, 2007	Completed	Extension to existing dock with steel floating pier (293 by 12 feet) with 4 smaller finger piers (two at 120 by 10 feet, and two at 80 by 8 feet); 24 piles, all floats 5 feet in depth and held by sixteen 24-inch diameter piles and eight 30-inch diameter piles
17.	Water Source Heat Pump	Delta Pier	CATEX, 2008	Complete	Project uses seawater for heat source to operate heat pump for space heating
18.	Replace Dolphins	Bangor Service Pier	CATEX, 2009	Completed	Replace two creosote-treated timber dolphins with steel pile dolphins.
19.	Install Swimmer Interdiction System (SISS)	NBK Bangor waterfront	EIS, 2009	Completed	Install a system of up to 20 marine mammals to patrol and interdict intruders. Project includes installation of animal pens.
20.	U.S. Navy EOD Training Operations	Hood Canal off the northern portion of NBK Bangor	BA, 2000 EA 2004	Ongoing	A training program for the Navy's EOD units in the Puget Sound region; training consists of using explosive charges to destroy or disable inert (dummy) mines underwater up to four times per year
21.	Pile Replacement - Explosives Handling Wharf (EHW) at SUBASE Bangor	NBK Bangor, waterfront area, EHW	BA, 2001	Ongoing	Removal of approximately 130 hollow core concrete piles and replacement with combination of concrete and steel piles; expected to be completed over 10-year period

TABLE 5.2 PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR (continued)

	PROJECT NAME	LOCATION	NEPA/ESA DOCUMENTATION	PROJECT STATUS	DESCRIPTION
22.	2008 Magnetic Silencing Facility Repairs	NBK Bangor waterfront, Magnetic Silencing Facility	EA, 2008	Ongoing	Renovation of eroding portions of the facility to include cable trays under water, decking on pier, and structural cross members
23.	Transit Protection Systems Operation Final Operating Conditions	Navigable waters from Port Angeles to Bangor, Dabob Bay, and NBK Bangor waterfront	NEPA in process	Ongoing	Operate approximately 10 escort vessels; install and operate maintenance and fueling capability for vessels.
24.	Bangor Keyport/Bangor Dock repair	NBK Bangor waterfront	NEPA in process	Ongoing	The proposed project would clean and paint 42 steel piles, repair tears in the wraps on three piles, install a fiberglass jacket on one pile, remove and replace 18 deteriorated treated timber fender members/fender piles. The existing piles will be removed entirely and new treated timber piles will be installed in the same location. This action is scheduled for fiscal year 2011.
25.	NAVSEA NUWC Keyport Range Complex Extension EIS/OEIS	Hood Canal and other areas outside of NBK Bangor	Final EIS 2010	Ongoing	Increase in underwater military range areas including areas in Hood Canal
26.	Waterfront Security Enclave and Security Barriers	NBK Bangor waterfront/shore line area	EA in process, FY11	Future	Project would construct fence system from south of Delta Pier to North of EHW. Project includes permanent loss of 50 acres of vegetation and 2 acres of wetlands. Mitigation project will restore 2 acres of estuary.

TABLE 5.2 PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR (continued)

	Project Name	Location	NEPA/ESA Documentation	Project Status	Description
27.	Northwest Training Range Complex/ Overseas EIS	Hood Canal	Draft EIS, 2008 EIS 2010	Future	Increase in underwater military range activities including areas in Hood Canal
28.	Port Security Barrier Relocation	Waterfront Restricted Area	NEPA in process	Future	Project will realign existing floating fence to improve operations and security
29.	Mooring Point Installation	North of KB Dock	Future NEPA document	Future	Anchor and mooring buoy installation
30.	Seawall repairs along Sea Lion Road	South of Delta Pier to Devil's Hole	Future NEPA document	Future	Repair of 447 feet of seawall
31.	Explosive Handling Wharf 2	NBK Bangor Waterfront	EIS in process, FY12	Future	Construction of major wharf and trestles for submarine/missile operations. Total overwater area 250,000 sq ft. 1,200 to 1,600 piles.
32.	Relocate Nearshore Port Security Barriers	NBK Bangor Waterfront	Future NEPA document, FY11	Future	Relocate mooring buoys and anchors which are in the footprint of the proposed EHW-2
33.	Replace EHW-1 Piles, FY10/11	EHW-1	Future NEPA document, FY11	Future	Project would replace concrete piles with steel piles. Project is part of multi-year plan to replace deteriorated piles.
34.	Caisson Repair	Bangor Dry Dock	Future NEPA Document, FY2011	Future	Install a protective costing of concrete over existing steel sheet piles which form the structure for the dry dock. The concrete coating would be applied from -2' MLLW to approximately +21'MLLW.
35.	Construct Land-Water Interface	Bangor Intertidal Area	Future NEPA document	Future	Project would construct a fence in the intertidal zone, connecting the landside Security Enclave with the waterborne Port Security Barriers.
36.	Pier Extension	Bangor Service Pier	Future NEPA document	Future	Project would construct finger pier extension
37.	Electro-magnetic range	Just north of Bangor, ~1,000 feet off-shore	Future NEPA document	Future	Installation of an underwater instrument array, data/power cables, a pile-supported platform, and an in-water navigation aid.

Acronyms:
BA = Biological Assessment; BRAC = Base Realignment and Closure; CATEX = Categorical Exclusion; EOD = Explosives Ordnance Disposal; ESS = Electronic Security Systems; NSWCCD = Navy Surface Warfare Center Carderock Division; OA = Operational Area; ROD = Record of Decision; SISS = Swimmer Interdiction Security System; SWFPAC = Strategic Weapons Facility, Pacific

TABLE 5.3 ENVIRONMENTAL IMPACTS OF PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR

	PROJECT NAME	LAND CLEARING (ACRES)	IMPERVIOUS SURFACE (ACRES)	OVERWATER SHADING (SQ FT)	MARINE HABITAT LOSS/ CONVERSION (SQ FT)	LONG-TERM WATER QUALITY IMPACTS	LONG-TERM NOISE IMPACTS	LONG-TERM AIR QUALITY IMPACTS
1.	TRIDENT Support Site and subsequent expansions	780	585	985,600	98,560	Yes	Yes	Yes
2.	Keyport/Bangor Dock Dredging	No	No	No	TBD	No	No	No
3.	Drydock Caisson Moorage	No	No	2,800	280	No	No	No
4.	Construction of Supporting Shore and Waterfront Facilities for USS PARCHE	9	6.8	5,800	465	No	No	No
5.	Marginal Wharf Pier Repairs at SUBASE Bangor	No	No	No	No	No	No	No
6.	Operable Unit #7 (site 26, Marine Sediments)	No	No	No	No	No	No	No
7.	Installation and Operation of Force Protection Barrier	No	No	Negligible	3,850	No	No	No
8.	U.S. Navy Dabob Bay and Hood Canal Military Operating Area	No	No	No	No	Yes	Yes	Yes

1 **TABLE 5.3 ENVIRONMENTAL IMPACTS OF PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR (continued)**

	PROJECT NAME	LAND CLEARING (ACRES)	IMPERVIOUS SURFACE (ACRES)	OVERWATER SHADING (SQ FT)	MARINE HABITAT LOSS/ CONVERSION (SQ FT)	LONG-TERM WATER QUALITY IMPACTS	LONG-TERM NOISE IMPACTS	LONG-TERM AIR QUALITY IMPACTS
9.	SUBDEVRON 5 Support Facilities (Submarine Development Squadron 5 Detachment)	9	6.8	18,000	1,800	No	No	No
10.	Service Pier Expansion	No	No	5,000	126	No	No	No
11.	EHW Pile Replacement	No	No	No	No	No	No	No
12.	EHW Pile Replacement	No	No	No	No	No	No	No
13.	Navy Surface Warfare Center Carderock Division (NSWCCD) Detachment Bremerton Command Consolidation	5	3.8	45,945	641	No	Yes	No
14.	Mission Support Facilities	3	2.3	5,000	63	No	Yes	Yes
15.	Dredging south side of Delta Pier	No	No	No	No	No	No	No
16.	Transit Protection System, Interim Operational Capability	0.75	No	No	No	No	No	No

TABLE 5.3 ENVIRONMENTAL IMPACTS OF PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR (continued)

	PROJECT NAME	LAND CLEARING (ACRES)	IMPERVIOUS SURFACE (ACRES)	OVERWATER SHADING (SQ FT)	MARINE HABITAT LOSS/ CONVERSION (SQ FT)	LONG-TERM WATER QUALITY IMPACTS	LONG-TERM NOISE IMPACTS	LONG-TERM AIR QUALITY IMPACTS
17.	Water Source Heat Pump	No	No	No	No	No	No	No
18.	Replace Service Pier Dolphins	No	No	No	No	No	No	No
19.	Install Swimmer Interdiction System (SISS)	No	No	3,852	No	No	No	No
20.	U.S. Navy EOD Training Operations	No	No	No	No	No	Yes	No
21.	Pile Replacement - EHW at SUBASE Bangor	No	No	No	Negligible	Yes	Yes	No
22.	2008 Magnetic Silencing Facility Repairs	No	No	No	No	No	No	No
23.	Transit Protection Systems Operation Final Operating Conditions	No	No	No	No	No	No	Yes
24.	Bangor Keyport/Bangor Dock repair	No	No	No	No	No	No	No
25.	NAVSEA NUWC Keyport Range Complex Extension EIS/OEIS	No	No	No	No	No	No	No

26.	Waterfront Security Enclave and Security Barriers	50	37.5	No	No	No	No	No

TABLE 5.3 ENVIRONMENTAL IMPACTS OF PAST, PRESENT, AND REASONABLY FORSEEABLE NAVY ACTIONS AT NBK BANGOR (continued)

	Project Name	Land Clearing (Acres)	Impervious Surface (Acres)	Overwater Shading (sq ft)	Marine Habitat Loss/ Conversion (sq ft)	Long-Term Water Quality Impacts	Long-Term Noise Impacts	Long-Term Air Quality Impacts
27.	Northwest Training Range Complex/ Overseas EIS	No	No	No	No	No	Yes	No
28.	Port Security Barrier Relocation	No	No	No	Minimal	No	No	No
29.	Mooring Point Installation	No	No	No	Minimal	No	No	No
30.	Seawall repairs along Sea Lion Road	No	No	No	Yes	No	No	No
31.	Explosive Handling Wharf 2	1.5	1.5	278,784	Yes	No	No	No
32.	Relocate Nearshore Port Security Barriers	No	No	No	No	No	No	No
33.	Replace EHW-1 Piles, FY10/11	No	No	No	No	No	No	No
34.	Caisson Repair	No	No	No	No	No	No	No
35.	Construct Land-Water Interface	75	23	5,000 (est)	Yes	No	No	No
36.	Service Pier Extension	No	No	36,000	Yes	No	No	No
37.	Electro-magnetic range	No	No	TBD	TBD	No	No	No

Notes: The amount of overwater coverage was multiplied by 10 percent to estimate the amount of soft-bottom marine habitat converted to hard surface by installation of piles when the number of piles was unknown. The amount of land clearing was multiplied by 75 percent to estimate new impervious surface when the amount of impervious surface created by the project was unknown.

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7 LITERATURE CITED

Abbott, D.P., and D.J. Reish, 1980. Polychaeta: The marine annelid worms. Pages 448-489 *in:* Morris, R.H., D. P. Abbott, and E.C. Haderlie (eds.), *Intertidal Invertebrates of California.* Stanford University Press: Stanford, CA. 690.

Adams PB, Grimes C, Hightower J, Lindley ST, Moser ML, Parsley MJ (in press). Population status of North American green sturgeon, Acipenser medirostris. Environmental Biology of Fish.

Agness, A., and B.R. Tannenbaum. 2009a. Naval Base Kitsap at Bangor marine mammal resource report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Agness, A., and B.R. Tannenbaum. 2009b. Naval Base Kitsap at Bangor marine bird resource report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Ainley, D.G., D.N. Nettleship, H.R. Carter, and A.E. Storey. 2002. Common Murre (*Uria aalge*). *The Birds of North America Online*, ed. Poole, A. Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/666 (Accessed August 20, 2008).

Allen. B. M., and R. P. Angliss. 2010. Alaska Marine Mammal Stock Assessments, 2009. U.S. Dep. Commerce, NOAA Technical Memorandum NMFS-AFSC-206, 276 p.

Anchor Environmental. 2002. Interim Remedial Action: Log Pond Cleanup/Habitat Restoration-Year 2 Monitoring Report. Prepared for Georgia Pacific West, Inc. Bellingham, WA. Prepared by Anchor Environmental, LLC, Seattle, WA. December 2002.

Andersen, S. 1970. Auditory sensitivity of then harbour porpoise Phocoena phocoena. *Invest Cetacea*, *2*, 255-259.

Angell, T. and K.C. Balcomb III. 1982. *Marine birds and mammals of Puget Sound*. University of Washington Press: Seattle, 145 pp.

Angliss, R.P. and R.B. Outlaw. 2008. Alaska Marine Mammal Stock Assessments, 2007. NOAA Technical Memorandum NMFS-AFSC-180.

Angliss, R.P. and R.B. Outlaw. 2005. Alaska Marine Mammal Stock Assessment, 2005. NOAA Technical Memorandum NMFS-AFSC-161.

ANSI. 1986. Methods for measurement of impulse noise (ANSI S12.7-1986). New York: Acoustical Society of America.

Antonelis, G.A., Jr., B.S. Stewart, and W.F. Perryman. 1990. Foraging characteristics of female northern fur seals (*Callorhinus ursinus*) and California sea lions (*Zalophus californianus*). *Canadian Journal of Zoology, 68*, 150-158.

Au, W.W.L., J.K.B. Ford, J.K. Horne, and K.A. Newman Allman. 2004. Echolocation signals of free ranging killer whales (Orcinus orca) and modeling of foraging for chinook salmon (Oncorhynchus tshawytscha). *Journal of the Acoustical Society of America 115*(2), 901-909.

Babson, A.L., M. Kawase, and P. MacCready. 2006. Seasonal and interannual variability in the circulation of Puget Sound, Washington: A box model study. *Atmosphere-Ocean.* 44(1): 29-45.

Baird, R.W. 2001. Status of harbour seals, *Phoca vitulina*, in Canada. *Canadian Field-Naturalist 115*(4), 663-675.

Baird, R.W. and H. Whitehead. 2000. Social organization of mammal-eating killer whales: Group stability and dispersal patterns. *Canadian Journal of Zoology, 78*, 2096-2105.

Baird, R.W. and L.M. Dill. 1995. Occurrence and behaviour of transient killer whales: Seasonal and pod-specific variability, foraging behaviour, and prey handling. *Canadian Journal of Zoology 73*, 1300- 1311.

Baird, R.W. and L.M. Dill. 1996. Ecological and social determinants of group size in transient killer whales. *Behavioral Ecology 7*(4), 408-416.

Bargmann, G. 1998. Forage Fish Management Plan. Washington State Department of Fish and Wildlife. Olympia, WA. http://wdfw.wa.gov/fish/forage/manage/foragman.pdf.

Barlett, M.L., and G.R. Wilson. 2002. Characteristics of small boat signatures. *The Journal of the Acoustical Society of America. 112*(5), 2221.

Barlow, J. and K.A. Forney. 2007. Abundance and population density of cetaceans in the California Current ecosystem. *Fishery Bulletin, 105*, 509-526.

Barlow, J. and D. Hanan. 1995. An assessment of the status of harbor porpoise in central California. *Rept. Int. Whal., Special Issue, 16*, 123-140.

Barnard, J.L., D.E. Bowers, and E.C. Haderlie. 1980. Amphipoda: The amphipods and allies. In *Intertidal Invertebrates of California*, Morris, R.H., D.P. Abbott and E.C. Haderlie, eds. Stanford: Stanford University Press. 559-566.

Barrett-Lennard, L. G. 2000. Population structure and mating patterns of killer whales (*Orcinus orca*) as revealed by DNA analysis. Ph.D. Thesis, University of British Columbia, Vancouver, BC, Canada, 97 pp.

Barry A. Vittor & Associates, Inc. 2001. Puget Sound Benthic Community Assessment – June 1999. Prepared for U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration National Centers for Coastal Ocean Science Center for Coastal Monitoring and Assessment, Silver Spring, MD.

Barss, W.H. 1989. Maturity and reproductive cycle for 35 species from the family Scorpaenidae found off Oregon. Report No. 89-7. Oregon Department of Fish and Game, Portland, OR.

Bax, N.J., E.O. Salo, and B.P. Snyder. 1980. Salmonid outmigration studies in Hood Canal. Final report, Phase V, January to July 1979. Fisheries Research Institute, College of Fisheries, University of Washington. Seattle, WA.FRI-UW-8010.

Bax, N.J. 1983. The early marine migration of juvenile chum salmon (*Oncorhynchus keta*) through Hood Canal: Its variability and consequences. Ph.D. thesis, University of Washington, Seattle.

Berg, L., and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile Coho Salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. *Canadian Journal of Fisheries and Aquatic Sciences.* 42, 1410-1417.

Bhuthimethee, M. 2008. Mary Bhuthimethee, Marine Scientist, Science Applications International Corporation, Bothell, WA. November 25, 2008. Personal communication with Bernice Tannenbaum, Wildlife Biologist, Science Applications International Corporation, Bothell, WA, re: Steller sea lions at NAVBASE Kitsap Bangor.

Bhuthimethee, M., C. Hunt, G. Ruggerone, J. Nuwer, and W. Hafner. 2009. NAVBASE Kitsap Bangor 2007-2008 fish presence and habitat use field survey report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Bibikov, N.G. 1992. Auditory brainstem responses in the harbor porpoise (Phocoena phocoena). In Marine Mammal Sensory Systems (ed. J. A. Thomas, R. A. Kastelein and A. Y. Supin), pp. 197- 211. New York: Plenum Press.

Bigg, M.A. 1981. Harbour seal *Phoca vitulina* Linnaeus, 1758 and *Phoca largha* Pallas, 1811. Pages 1-27 IN: S.H. Ridgway and R. Harrison, eds. *Handbook of marine mammals*, *Volume 2: Seals*. San Diego: Academic Press.

Blackwell, S.B. and C.R. Greene Jr. 2002. Acoustic measurements in Cook Inlet, Alaska during August 2001. Greeneridge Report 271-2. Report from Greeneridge Sciences, Inc., Santa Barbara for National Marine Fisheries Service, Anchorage, AK. 43 p.

Blackwell, S.B., J.W. Lawson, and M.T. Williams. 2004. Tolerance by ringed seals (*Phoca hispida*) to impact pipe-driving and construction sounds at an oil production island. *Journal of the Acoustical Society of America. 115*(5), 2346-2357

BjØrge, A. 2002. How persistent are marine mammal habitats in an ocean of variability? Pages 63-91 in P.G.H. Evans, and J.A. Riga, eds. *Marine Mammals: Biology and Conservation*. Kluwer Academic/Plenum Publishers, New York.

Boggs, S., Jr. 1995. *Principles in Sedimentology and Stratigraphy*, Second Edition. Prentice-Hall, Inc., Upper Saddle River, NJ.

Bonnell, M.L. and M.D. Dailey. 1993. Marine mammals. Pages 604-681. in M. D. Dailey, D. J. Reish and J.W. Anderson, eds. *Ecology of the Southern California Bight: A synthesis and interpretation*. Berkeley: University of California Press.

Bonnell, M.L. and R.G. Ford. 1987. California sea lion distribution: A statistical analysis of aerial transect data. *Journal of Wildlife Management 51*(1),13-20.

Bonnell, M.L., M.O. Pierson, and G.D. Farrens. 1983. *Pinnipeds and sea otters of central and northern California, 1980 - 1983: Status, abundance, and distribution*. Volume III, Book 1. OCS Study MMS 84-0044. Los Angeles, California: Minerals Management Service.

Boveng, P. 1988. Status of the Pacific harbor seal population on the U.S. west coast. Admin. Rep. LJ-88- 06. Southwest Fisheries Science Center, National Marine Fisheries Service, P.O. Box 271, La Jolla, CA 92038. 43 pp.

Bowen, W.D., and D.B. Siniff. 1999. Distribution, population biology, and feeding ecology of marine mammals. In *Biology of marine mammals*, ed. Reynolds, J.E. and S.A. Rommel. Washington: Smithsonian Institution Press. 423-484.

Bowen, W.D., D.J. Boness, and S.J. Iverson. 1999. Diving behaviour of lactating harbour seals and their pups during maternal foraging trips. *Canadian Journal of Zoology 77*, 978-988.

Brown, R. F. 1988. Assessment of pinniped populations in Oregon. Processed Report 88- 05, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, Washington.

Buchanan, J.R. 2004. Shorebirds: Plovers, oystercatchers, avocets and stilts, sandpipers, snipes, and phalaropes. In *Management recommendations for Washington's priority species, Volume IV: Birds*, ed. Larsen, E.M., J.M. Azerrad and N. Nordstrom. Olympia: Washington Department of Fish and Wildlife.

Buehler, D.A. 2000. Bald eagle (*Haliaeetus leucocephalus*). *The Birds of North America Online*, ed. Poole, A. Ithaca: Cornell Laboratory of Ornithology; Retrieved from The Birds of North America Online database: http://bna.birds.cornell.edu/bna (Accessed August 20, 2008).

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memo NMFS-NWFSC-27. http://www.nwfsc.noaa.gov/publications/techmemos/tm27/tm27.htm

Cailliet, G.M., E.J. Burton, J.M. Cope, and L.A. Kerr, eds. 2000. *Biological characteristics of nearshore fishes of California: A review of existing knowledge and proposed additional studies for the Pacific Ocean Interjurisdictional Fisheries Management Plan Coordination and Development Project*. Moss Landing, CA: Moss Landing Marine Laboratories. G.M. Cailliet, Principal Investigator. Submitted to Mr. Al Didier, Pacific States Marine Fisheries Commission.

Calambokidis, J. 2010. John Calambokidis, senior marine mammal biologist and co-founder of Cascadia Research, Olympia, WA. September 15, 2001. Personal communication with Chris Hunt, Marine Scientist, Science Applications International Corporation, Bothell, WA, re: the rare occurrence of large whales (e.g., gray/humpback whales) occurring south of the Hood Canal Bridge since its construction.

Calambokidis, J., and R.W. Baird. 1994. Status of marine mammals in the Strait of Georgia, Puget Sound, and the Juan de Fuca Strait, and potential human impacts. *Canadian Technical Report of Fisheries and Aquatic Sciences. 1948*, 282-300.

Calambokidis, J. and S.J. Jeffries. 1991. Censuses and disturbance of harbor seals at Woodard Bay and recommendations for protection. Final report. Prepared for Washington Department of Natural Resources, Olympia, Washington by Cascadia Research Collective, Olympia, Washington and Washington Department of Wildlife.

Calambokidis et al. 1985 Biology of Puget Sound marine mammals and marine birds: Population health and evidence of pollution effects. NOAA Tech. Memo. NOS OMA 18, National Technical Information Service, Springfield , Virginia 159 p.

Calambokidis, J., J.L. Laake, and S.D. Osmek. 1997. Aerial surveys for marine mammals in Washington and British Columbia inside waters. Final report to the National Marine Mammal Laboratory, Seattle, WA.

CALTRANS. 2007. Compendium of Pile Driving Sound Data. Report. Published Sept. 27, 2007.

Campbell, G.S., R.C. Gisiner, D.A. Helweg, and L.L. Milette. 2002. Acoustic identification of Female Steller sea lions (Eumetopias jubatus). *Journal of the Acoustical Society of America 111*(6), 2920- 2928.

Carretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, and M.M. Muto. 2007. U.S. Pacific marine mammal stock assessments: 2007. NOAA TM NMFS-SWFSC-414. U.S. Department of Commerce. http://swfsc.noaa.gov/publications/TM/SWFSC/NOAA-TM-NMFS-SWFSC-414.pdf.

Caretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, D. Johnston, B. Hanson, M.M. Muto, D. Lynch, and L. Carswell. 2008. U.S. Pacific Marine Mammal Stock Assessments: 2008. NOAA Technical Memorandum NMFS-SWFSC-434.

Carlson, T.J., D.A. Woodruff, G.E. Johnson, N.P. Kohn, G.R. Plosky, M.A. Weiland, J.A. Southard, and S.L. Southard. 2005. Hydroacoustic measurements during pile driving at the Hood Canal Bridge, September through November 2004. Battelle Marine Sciences Laboratory Sequim, WA.

Cavanaugh, W.J., and G.C. Tocci. 1998. Environmental noise: The invisible pollutant. Environmental Excellence in South Carolina (E2SC). USC Institute of Public Affairs, Los Angeles, CA. Vol. 1, No. 1.

CERC (Coastal Engineering Research Center). 1984. *Shore Protection Manual*, Fourth ed., U.S. Army Corps of Engineers, Washington, D.C.

CH2M Hill. 1995. South Cap monitoring report, Seattle Ferry Terminal. Task 4, Amendment No. O, Agreement Y-5637. Prepared for Washington Department of Transportation, Olympia, WA.

Chivers, S. J., A. E. Dizon, P. J. Gearin, and K. M. Robertson. 2002. Small-scale population structure of eastern North Pacific harbour porpoises (*Phocoena phocoena*) indicated by molecular genetic analyses. *J. Cetacean Res. Manage. 4*(2), 111-122.

Cohen, A.N., C.E. Mills, H. Berry, M.J. Wonham, B. Bingham, B. Bookheim, J.T. Carlton, J.W. Chapman, J.R. Cordell, L.H. Harris, T. Klinger, A. Kohn, C.C. Lambert, G. Lambert, K. Li, D. Secord, and J. Toft. 1998. Report of the Puget Sound Expedition, September 8-16, 1998; A rapid assessment survey of nonindigenous species in the shallow waters of Puget Sound. Prepared for the Washington State Department of Natural Resources, Olympia WA, and United States Fish and Wildlife Service, Olympia WA.

Council on Environmental Quality (CEQ). 1997. Considering Cumulative Effects Under the National Environmental Policy Act. Washington, D.C. January 1997.

Council on Environmental Quality (CEQ). 2005. Guidance on the Consideration of Past Actions in Cumulative Effects Analysis. June 2005.

Critchley, A. T., W. F. Farnham, and C. H. Thorp. 1997. On the co-occurrence of two exotic, invasive marine organisms: The brown seaweed Sargssum muticum (Yendo) Fensholt and the spirorbid tube worm Janua (Neodex-iospira) brasiliensis (Grube), in association with the indigenous eelgrass, Zostera marina L. and Wrack, Fucus serratus L. in the south-west Netherlands and the Channel Islands, Europe. South-African-Journal-of-Botany. 1997; 63(6): 474-479.

Danish EPA. 1999. Tributyltin. Environmental Project No. 451. Ministry of Environment and Energy, Copenhagen, Denmark. http://www2.mst.dk/Udgiv/publications/1999/87-7909-223-3/pdf/87-7909-223-3.pdf

DeLacy, A.C., B.S. Miller, and S.F. Borton. 1972. Checklist of Puget Sound fishes. WSG 72-3. Washington Sea Grant, University of Washington, Seattle, WA. 43 pp.

DeMott, G.E. 1983. Movement of tagged lingcod and rockfishes off Depoe Bay, Oregon. Master of Science, Oregon State University.

DoN. 1974. EIS for the Navy Trident Support Site. Department of the Navy, Bangor, WA.

DoN. 1976. Candidate EIS. Department of the Navy, Bangor, WA.

DoN. 1978. Update of the Candidate EIS. Department of the Navy, Bangor, WA.

DoN. 1989. Supplement Trident Facilities EIS. Department of the Navy, Bangor, WA.

DoN. 1988. Environmental assessment for Marine Mammal Facility, SUBASE Bangor, Washington. Prepared by Pacific Northwest Laboratory, Richland, WA. Prepared for Naval Facilities Engineering Command, Western Division, Silverdale, WA.

DoN. 2001a. Integrated natural resources management plan. Naval Submarine Base Bangor, Silverdale, WA. Department of the Navy.

DoN. 2001b. Final Environmental Impact Statement. Shock trial of the WINSTON S. CHURCHILL (DDG 81):.

DoN. 2005a. Second five-year review of Record of Decisions, Final. September 16, 2005. Naval Base Kitsap at Bangor, Silverdale, WA. Department of the Navy, Naval Facilities Engineering Command, NW, Poulsbo, WA. http://www.epa.gov/superfund/sites/fiveyear/f0610002.pdf

DoN. 2005b. Environmental Assessment. Installation and Operation of Underwater Surveillance System (USS) at Sub-base Bangor, Silverdale, WA. January 2005.

DoN. 2006a. Naval Base Kitsap at Bangor Silverdale, Washington Oil Spill Prevention, Control, and Countermeasure Plan. May 2006.

DoN. 2006b. Marine Resources Assessment for the Pacific Northwest Operating Area. Prepared by Geo-Marine, Inc. Prepared for Naval Facilities Engineering Command, Pacific, Pearl Harbor, HI.

DoN. 2009. Virginia Capes Range Complex FEIS/OEIS Appendix K: Resource regulatory framework.

DoN. 2010. COMNAVREG NW Instruction 5090.1B. Oil and Hazardous Substance Integrated Contingency Plan. January 2010.

Downing, J. 1983. *The coast of Puget Sound: its processes and development*. Washington Sea Grant, University of Washington, Seattle, WA.

Drake, J., E. Berntson, J. Cope, R. Gustafson, E. Holmes, P. Levin, N. Tolimieri, R. Waples, and S. Sogard. 2008. Preliminary and scientific conclusions of the review of the status of 5 rockfish: bocaccio (*Sebastes paucispinis*), canary rockfish (*Sebastes pinniger*), yelloweye rockfish (*Sebastes ruberrimus*), greenstriped rockfish (*Sebastes elongatus*), and redstripe rockfish (*Sebastes proriger*) in Puget Sound, Washington. National Marine Fisheries Service Northwest Fisheries Science Center, Seattle, WA. http://www.nwr.noaa.gov/Other-Marine-Species/Puget-Sound-Marine-Fishes/upload/PS-rockfish-review-08.pdf.

Eissinger, A.M. 2007. *Great blue herons in Puget Sound*, *Valued Ecosystem Components Report Series*. Olympia, WA: Puget Sound Nearshore Partnership.

Encyclopedia Britannica. 2009. Ozone. In *Encyclopedia Britannica Online*.

Entranco, I., and Hamer Environmental LP. 2005. Marbled Murrelet Hazing Report - SR 104 Hood Canal Bridge East-Half Replacement and West-Half Retrofit Project.

Eschmeyer, W.N., E.S. Herald, and H. Hammann (Illustrator). 1983. *A field guide to Pacific Coast fishes of North America: from the Gulf of Alaska to Baja, California*, *The Peterson Field Guide Series*. Boston: Houghton Mifflin.

Everitt, R.D., P.J. Gearin, J.S. Skidmore, and R.L. DeLong. 1981. Prey items of harbor seals and California sea lions in Puget Sound, Washington. *Murrelet 62*(3), 83-86.

Falxa, G., and M. Huff. 2008. Marbled Murrelet Effectiveness Monitoring in the Northwest Forest Plan.

Feist, B.E. 1991. Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. MS thesis, University of Washington, Seattle, WA.

Feist, B.E., J.J. Anderson, and R. Miyamoto. 1992. *Potential impacts of pile driving on juvenile pink (Oncorhynchus gorbuscha) and chum (O. keta) salmon behavior and distribution*. Seattle, WA: Fisheries Research Institute, School of Fisheries, and Applied Physics Laboratory, University of Washington.

Felleman, F.L., J.R. Heimlich-Boran, and R.W. Osborne. 1991. The feeding ecology of killer whales (Orcinus orca) in the Pacific Northwest. Pages 113-147 in Pryor, K. and K.S. Norris, eds. *Dolphin societies: Discoveries and puzzles*. Berkeley: University of California Press.

Ferrero, R. C., and W. A. Walker. 1999. Age, growth, and reproductive patterns of Dall's porpoise (*Phocoenoides dalli*) in the central North Pacific Ocean. *Marine Mammal Science, 15*, 273-313.

Finneran, J. J., D. A. Carder, C. E. Schlundt, and S. H. Ridgway, 2005. Temporary threshold shift in bottlenose dolphins (*Tursiops truncatus*) exposed to mid-frequency tones. *Journal of the Acoustical Society of America, 118*, 2696–2705.

Fisheries Hydroacoustic Working Group. 2008. Memorandum on agreement in principle for interim criteria for injury to fish from pile driving. California Department of Transportation (CALTRANS) in coordination with the Federal Highway Administration (FHWA). http://www.wsdot.wa.gov/NR/rdonlyres/4019ED62-B403-489C-AF05-5F4713D663C9/0/InterimCriteriaAgreement.pdf

Ford, J.K.B. 2002. Dialects. Pages 322-323 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. *Encyclopedia of marine mammals*. San Diego, California: Academic Press.

Ford, J. K. B., and G. M. Ellis. 1999. *Transients: Mammal-Hunting Killer Whales of British Columbia, Washington, and Southeastern Alaska*. University of British Columbia Press, Vancouver, BC. 96 pp.

Ford, J.K.B. and G.M. Ellis. 2005. Prey selection and food sharing by fish-eating 'resident' killer whales (*Orcinus orca*) in British Columbia. DFO Canadian Science Advisory Secretariat Research Document 2005/041.

Ford, J. K. B., G. M. Ellis, and K. C. Balcomb. 1994. *Killer Whales: The Natural History and Genealogy of Orcinus orca in British Columbia and Washington State*. University of British Columbia Press, Vancouver, BC, and University of Washington Press, Seattle. 102 pp.

Ford, J.K.B., G.M. Ellis, and P.F. Olesiuk. 2005. Linking prey and population dynamics: Did food limitation cause recent declines of 'resident' killer whales (Orcinus orca) in British Columbia? Canadian Science Advisory Secretariat Research document 2005/042. Department of Fisheries and Oceans.

Ford, J.K.B., G.M. Ellis, L.G. Barrett-Lennard, A.B. Morton, R.S. Palm, and K.C. Balcomb III. 1998. Dietary specialization in two sympatric populations of killer whales (Orcinus orca) in coastal British Columbia and adjacent waters. *Canadian Journal of Zoology. 76*(8), 1456-1471

Forney, K.A. 2007. Preliminary estimates of cetacean abundance along the U.S. west coast and within four National Marine Sanctuaries during 2005. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-406. 27 p.

Forney, K.A. and J. Barlow. 1998. Seasonal patterns in the abundance and distribution of California cetaceans, 1991-1992. *Marine Mammal Science 14*(3), 460-489.

Foster Wheeler Environmental Corporation. 2001. Floral Point/Site 26 Hood Canal sediment monitoring, Naval Submarine Base Bangor, WA. Final technical memorandum No. 3, Contract No. N44255-95-D-6030. RACII/Delivery Order No. 0013. Bothell, WA.

Fresh, K.L., R. Cardwell, and R. Koons. 1981. Food habits of Pacific salmon, baitfish and their potential competitors and predators in the marine waters of Washington, August 1978 to September 1979. Washington State Department of Fisheries, Olympia, WA.

Garono, R.J., and R. Robinson. 2002. Assessment of estuarine and nearshore habitats for threatened salmon stocks in the Hood Canal and Eastern Strait of Juan de Fuca, Washington State. Focal areas 1-4. CASI vegetation grids (electronic data and supporting document). Prepared by Wetland & Watershed Assessment Group, Earth Design Consultants, Inc. in cooperation with Charles Simenstad, Wetland Ecosystem Team, University of Washington. Prepared for Point No Point Treaty Council, Corvallis, OR.

Gilbert, J.R. and N. Guldager. 1998. Status of harbor and gray seal populations in northern New England. Woods Hole, Massachusetts: National Marine Fisheries Service.

Green, G.A., J.J. Brueggeman, R.A. Grotefendt, C.E. Bowlby, M.L. Bonnell, and K.C. Balcomb III. 1992. Cetacean distribution and abundance off Oregon and Washington, 1989-1990. Pages 1-1 to 1-100 in Brueggeman, J.J., ed. Oregon and Washington marine mammal and seabird surveys. OCS Study MMS 91-0093. Los Angeles, California: Minerals Management Service.

Gregg, M.C. and L.G. Pratt. 2010. Flow and hydraulics near the sill of Hood Canal, a strongly sheared, continuously stratified fjord. American Meteorological Society, May 2010, pp. 1087-1105.

Gustafson R.G., W.H. Lenarz, B.B., McCain, C.C., Schmitt, W.S., Grant, T.L. Builder, and R.D. Methot. 2000. Status review of Pacific Hake, Pacific Cod, and Walleye Pollock from Puget Sound, Washington. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC- 44, 275 p.

Hamer, T.E., and S.K. Nelson. 1995. Characteristics of marbled murrelet nest trees and nesting stands. In *Ecology and conservation of the marbled murrelet*. Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, J.F. Piatt, technical editors. General Technical Report. PSW-GTR-152. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture. 69-82.

Hammermeister, T., and W. Hafner. 2008. Naval Base Kitsap Sediment Quality Investigation: January 18, 2008 data report draft. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Hammermeister, T., and W. Hafner. 2009. Naval Base Kitsap sediment quality investigation: data report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Hanggi, E.B. and R.J. Schusterman. 1994. Underwater acoustic displays and individual variation in male harbour seals, *Phoca vitulina*. *Animal Behaviour 48*, 1275-1283

Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound steelhead (*Oncorhynchus mykiss*). NOAA Tech. Memo. NMFS-NWFSC-81. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Seattle, WA. 117 pp.

http://www.nwfsc.noaa.gov/assets/25/6649_07312007_160715_SRSteelheadTM81Final.pdf

Harris. C.M. 1998. *Handbook of acoustical measurements and noise control* (3rd Edition). Huntington, NY: Acoustical Society of America.

Harris, D.E., B. Lelli, and S. Gupta. 2003. Long-term observations of a harbor seal haul-out site in a protected cove in Casco Bay, Gulf of Maine. Northeastern *Naturalist 10*(2), 141-148.

Hart Crowser. 2000. Final First Base-Wide Five-Year Review of Records of Decision, Naval Submarine Base, Bangor Silverdale, Washington. Prepared by Hart Crowser, Seattle, WA. Prepared for Department of the Navy, Seattle, WA http://www.epa.gov/superfund/sites/fiveyear/f00-10002.pdf.

Hart Crowser, Inc. 2010. Final Report of In Situ Pressuremeter Geotechnical Investigation Conducted for Explosive Handling Wharf 2 (EHW2) Naval Base Kitsap-Bangor. Hart Crowser, Inc. 1700 Westlake Avenue North, Suite 200 Seattle, WA 98109-33056.

Hastings, M.C., and A.N. Popper. 2005. Effects of sound on fish. Prepared by Jones & Stokes. Prepared for California Department of Transportation, Sacramento, CA. http://www.dot.ca.gov/hq/env/bio/files/Effects_of_Sound_on_Fish23Aug05.pdf.

Hayward, J.L. and N.A. Verbeek. 2008. Glaucous-winged Gull (*Larus glaucescens*), In *The Birds of North America Online* (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Birds of North America Online: http://bna.birds.cornell.edu/bna/species/059 (Accessed August 20, 2008).

HCCC (Hood Canal Coordinating Council). 2005. Draft summer chum salmon recovery plan; Hood Canal and eastern Strait of Juan de Fuca. November 15, 2005. http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/HC-Recovery-Plan.cfm

HCCC. Undated. The Hood Canal Marine Riparian Initiative. Brochure. Hood Canal Coordinating Council, Poulsbo, WA. http://hccc.wa.gov/Downloads/Downloads_GetFile.aspx?id=206381&fd=0.

HCDOP (Hood Canal Dissolved Oxygen Program). 2005. Hood Canal low dissolved oxygen background information, April 2005. 8 pp. http://www.hoodcanal.washington.edu/documents/PSHCDOP/hcdop_backgroundfinal.pdf

HCDOP. 2009. What do we need to know? Hood Canal Dissolved Oxygen Program. http://www.hoodcanal.washington.edu/aboutHC/whatdoweneedtoknow.html (Accessed January 27, 2009)

Healey, M.C. 1982. Juvenile Pacific salmon in estuaries: The life support system. In *Estuarine Comparisons*, ed. Kennedy, V.S. New York, NY: Academic Press. 315-341.

Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). In *Pacific salmon life histories*, ed. Groot, C. and L. Margolis. Vancouver: University of British Columbia Press. 311-394.

Heath, C. B. 2002. California, Galapagos, and Japanese sea lions– *Zalophus californianus, Z. wollebaeki, and Z. japonicus.* Pages 180 to 186 in: Perrin, W. F., B. Würsig, and J. G. M. Thewissen, editors. 2002. *Encyclopedia of Marine Mammals*. Academic Press.

Heimlich-Boran, J.R. 1988. Behavioral ecology of killer whales (Orcinus orca) in the Pacific Northwest. *Canadian Journal of Zoology 66*, 565-578.

Herbich, J.B. 2000. *Handbook of dredging engineering* (2nd ed.): McGraw-Hill Inc., New York, New York.

Herbich, J.B., and S.B. Brahme. 1991. Literature review and technical evaluation of sediment resuspension during dredging: Contract Report HL-91-1 for U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS, 87 p.

Hildebrand, J. 2007. Sources of anthropogenic sound in the marine environment. Marine Mammal Commission. http://www.mmc.gov/sound/internationalwrkshp/pdf/hildebrand.pdf

Hirschi, R., T. Doty, A. Keller, and T. Labbe. 2003. Juvenile salmonid use of tidal creek and independent marsh environments in North Hood Canal: summary of first year findings. Port Gamble S'Klallam Tribe, Kingston, WA.

Hoelzel, A. R., M. E. Dahlheim, and S. J. Stern. 1998. Low genetic variation among killer whales (*Orcinus orca*) in the Eastern North Pacific, and genetic differentiation between foraging specialists. *J. Heredity 89*, 121-128.

Hollingshead, K. 2008. Personal communication via email between Ken Hollingshead (Fishery Biologist in Resource Management at NMFS headquarters) and Andrea Balla-Holden (URS Corporation Fisheries and Marine Mammal Biologist) in March 2008 regarding the origin of the 120 dB re 1μPa rms threshold and application to pinnipeds.

Holmberg, E.K., D. Day, N. Pasquale, and B. Pattie. 1967. Research report on the Washington trawl fishery 1962-64. Washington Department of Fisheries, Research Division. Technical Report, unpublished.

Horvitz, G.E., Veenstra, Matthew & Douglas Lindquist. (2010) Draft Geotechnical Data Report P-990 Explosives Handling Wharf # 2 Bangor, Washington. Hart Crowser, Inc. 1700 Westlake Avenue North, Suite 200 Seattle, WA 98109-33056.

Houck W.J. and T.A. Jefferson. 1999. Dall's porpoise - Phocoenoides dalli (True, 1885). In: Handbook of Marine Mammals (Ridgway SH, Harrison SR Eds.) Vol. 6: *The second book of dolphins and porpoises*. pp. 443-472

Hubbs, C. 1960. The marine invertebrates of the outer coast. In: The biogeography of Baja California and adjacent seas, part 2. *Systematic Zoology 9*, 134-147.

Huber, H.R., S.J. Jeffries, R.F. Brown, R.L. DeLong, and G. VanBlaricom. 2001. Correcting aerial survey counts of harbor seals (*Phoca vitulina richarsdi*) in Washington and Oregon. *Marine Mammal Science. 17*, 276-293.

International Forestry Consultants, Inc. 2000. Timber inventory: Naval Submarine Base, Bangor, WA; Naval Magazine, Indian Island; Naval Undersea Warfare Station, Keyport, WA; Jim Creek Radio Station; Whidbey Island Naval Air Station; and Naval Observatory Flagstaff And Detachment, Bayview, ID.

Jabusch, T., A. Melwani, K. Ridalfi, and M. Connor. 2008. Effects of short-term water quality impacts due to dredging and disposal on sensitive fish species in San Francisco Bay. Contribution No. 560. Prepared by The San Francisco Estuary Institute, Oakland, CA. Prepared for U.S. Army Corps of Engineers, San Francisco District, San Francisco.

Jefferson, T.A. 1988. Phocoenoides dalli. *Mammalian Species, 319*, 1-7.

Jefferson, T.A. 1989. Status of Dall's porpoise, Phocoenoides dalli, in Canada. *Canadian Field-Naturalist, 104*, 112-116.

Jefferson, T.A. 1990. Sexual dimorphism and development of external features in Dall's porpoise Phocoenoides dalli. *Fishery Bulletin, 88*, 119-132.

Jefferson, T.A. 1991. Observations on the distribution and behaviour of Dall's porpoise (Phocoenoides dalli) in Monterey Bay, California. *Aquatic Mammals, 17*(1):12-19.

Jefferson, T.A. 2005. NMFS-SWFSC, Personal Communication., 14-18 March 2005.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO species identification guide. Marine mammals of the world. Rome, Italy: Food and Agriculture Organization of the United Nations.

Jeffries. S. 1985. Occurrence and distribution patterns of marine mammals in the Columbia River and adjacent coastal waters of northern Oregon and Washington. In: Marine mammals their interactions with fisheries of the Columbia River and adjacent waters 1980-1982 (Beach et al.). Third Annual Report to National Marine Fisheries Service, NWAFC Processed Report 8504, Seattle, WA. 315 p.

Jeffries, S. 2006. Steve Jeffries, Marine Mammal Specialist, Washington Department of Fish and Wildlife. December 14, 2006. Personal communication with Alison Agness, Science Applications International Corporation, re: occurrence of marine mammals in Hood Canal.

Jeffries, S.J., P.J. Gearin, H.R. Huber, D.L. Saul, and D.A. Pruett. 2000. Atlas of seal and sea lion haul-out sites in Washington. Washington State Department of Fish and Wildlife, Wildlife Science Division, Olympia, WA. 150 pp. http://wdfw.wa.gov/wlm/research/papers/seal_haulout/

Jeffries, S.J., H. Huber, J. Calambokidis, J. Laake. 2003. Trends and status of harbor seals in Washington State: 1978-1999. *The Journal of Wildlife Management. 67*(1), 208-219.

Johnson, D.H., and T.A. O'Neil. 2001. *Wildlife-habitat relationships in Washington and Oregon*. Corvallis, OR: Oregon State University Press.

Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. NOAA technical memorandum NMFS-NWFSC-32. U.S. Department of Commerce, [Seattle, Wash.]; Springfield, VA. 280 pp. http://www.nwfsc.noaa.gov/publications/techmemos/tm32/.

Johnson, T. 2006. Thom Johnson, Fisheries Biologist, Washington State Department of Fish and Wildlife. December 6, 2006. Personal communication, e-mail to Alison Agness, Science Applications International Corporation, re: steelhead stocks in Hood Canal.

Kastak, D. and R.J. Schusterman. 1998. Low-frequency amphibious hearing in pinnipeds: methods, measurements, noise, and ecology. *Journal of the Acousical Society of America* 103(4), 2216-2228.

Kastak, D. and R.J. Schusterman. 2002. Changes in auditory sensitivity with depth in a free-diving California sea lion (*Zalophus californianus*). *Journal of the Acoustical Society of America 112*(1), 329-333.

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. Journal of the Acoustic Society of America. *Journal of the Acoustical Society of America. 106*(2), 1142-1148.

Kastelein, R. A., P. Bunskoek, M. Hagedoorn, W. W. L. Au, and D. de Haan. 2002. Audiogram of a harbor porpoise (Phocoena phocoena) measured with narrrow-band frequency-modulated signals. *Journal of the Acoustical Society of America 112*(1), 334-344.

Kastelein, R.A., R. van Shie, W.C. Verboom and R. de Hann. 2005. Underwater hearing sensitivity of a male and a female Steller sea lion (*Eumetopias jubatus*). *Journal of the Acoustical Society of America 118*(3), 1820-1829.

Kellogg, Jonathan P. (March 12, 2004). Hydraulic flow and energy dissipation over the Hood Canal sill. University of Washington School of Oceanography Seattle, Washington.

Kent, C.S., and R. McCauley 2006. Review of "Environmental Assessment off the Batholiths Marine Seismic Survey, Inland Waterways and Near- Offshore, Central Coast off British Columbia." Prepared by The Centre for Marine Science and Technology, Curtin University. Prepared for The Living Oceans Society. October, 2006.

Keple, A.R. 2002. Seasonal abundance and distribution of marine mammals in the southern Strait of Georgia, British Columbia. Master's thesis, University of British Columbia.

Ketten, D.R. 1995. Estimates of blast injury and acoustic trauma zones for marine mammals from underwater explosions. Pp. 391-407. In: R.A. Kastelein, J.A. Thomas, and P.E. Nachtigall (eds.). *Sensory Systems of Aquatic Mammals*. Woerden, The Netherlands: De Spil Publishers.

Ketten, D.R. 1998. Marine mammal auditory systems: A summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA Technical Memorandum NMFS-SWFSC-256:1-74.

Ketten, D.R. 2000. Cetacean ears. Pp. 43-108. In: W.W.L. Au, A.N. Popper, and R.R. Fay (eds.). *Hearing by Whales and Dolphins*. New York: Springer-Verlag.

Kincaid, T. 1919. *An annotated list of Puget Sound fishes*. Olympia: Washington Department of Fisheries.

Kirby, A. 2001. Ulva, the Sea Lettuce. Marine Botany course project from Stanford University's Hopkins Marine Station. http://www.mbari.org/staff/conn/botany/greens/anna/frontpages/nutrien.htm

Kitsap Audubon Society. 2008. Kitsap Audubon Society Christmas Bird Counts, 2001-2007. Area 8: NAVBASE Kitsap Bangor. Data provided by Nancy Ladenberger, Area 8 Leader, Kitsap Audubon, Poulsbo, WA.

Kitsap County Health District. 2005. Upper Hood Canal Restoration Project. http://www.kitsapcountyhealth.com/environmenta_health/water_quality/docs/upper_hood_canal_final_report.pdf

Kozloff, E.N. 1983. *Seashore life of the Northern Pacific Coast: An illustrated guide to northern California, Oregon, Washington, and British Columbia*. Seattle, WA: University of Washington Press.

Krahn, M.M., M.J. Ford, W.F. Perrin, P.R. Wade, R.P. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2002. Status review of Southern Resident killer whales *(Orcinus orca)* under the Endangered Species Act. U.S. Dept. Commerce., NOAA Tech. Memo. NMFS-NWFSC-54.

Laake, J. L. National Marine Mammal Laboratory, AFSC, NMFS, 7600 Sand Point Way NE, Seattle, WA 98115.

LaSalle, M., D.G. Clarke, J. Homziak, J.D. Lunz, and T.J. Fredette. 1991. A Framework for Assessing the Need for Seasonal Restrictions on Dredging and disposal Operations. Technical Report D-91-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Laughlin, J. 2006. Underwater sound levels associated with pile driving at the Cape Disappointment Boat Launch Facility, Wave Barrier Project. Prepared by Washington State Department of Transportation, Office of Air Quality and Noise, Seattle, WA.

Le Boeuf, B.J. 2002. Status of pinnipeds on Santa Catalina Island. Proceedings of the California Academy of Sciences 53(2):11-21.

Le Boeuf, B. J., and M. L. Bonnell. 1980. Pinnipeds of the California islands: abundance and distribution. Pages 475-493 in D. Power, ed. *The California islands*. Santa Barbara Museum of Natural History 787 pp.

Lee, W.L., and M.A. Miller, 1980. Isopoda and Tanaidacea: The Isopods and Allies. Pages 536-558 *in:* Morris, R.H., D. P. Abbott, and E.C. Haderlie (eds.), *Intertidal Invertebrates of California.* Stanford University Press: California. 690 p.

Leicht, G. 2008. Gregory Leicht. Naval Base Kitsap Environmental Director, Bremerton, WA. July 18, 2008. Personal communication with Ted Turk, Science Applications International Corporation, Bothell, WA, re: bald eagle nest discovered at NAVBASE Kitsap Bangor.

Levy, D.A., and T.G. Northcote. 1982. Juvenile Salmon Residency in a Marsh Area of the Fraser River Estuary. *Canadian Journal of Fisheries and Aquatic Sciences*. *39*, 270-276.

LFR Levine-Fricke (LFR), 2004. Framework for Assessment of Potential Effects of Dredging on Sensitive Fish Species in San Francisco Bay. Prepared for USACE, San Francisco District.

London, J.M. 2006. Harbor seals in Hood Canal: Predators and prey. Ph.D. dissertation, University of Washington, Seattle, WA. http://www.sitkawhalefest.org/LondonFinal.pdf.

Loughlin, T. R. 1997. Using the phylogeographic method to identify Steller sea lion stocks. Pp. 329-341 *In* A. Dizon, S. J. Chivers, and W. Perrin (eds.), Molecular genetics of marine mammals, incorporating the proceedings of a workshop on the analysis of genetic data to address problems of stock identity as related to management of marine mammals. Soc. Mar. Mammal., Spec. Rep. No. 3.

Loughlin, T.R. 2002. Steller's sea lion, Eumetopias jubatus. Pages 1181-1185 in Perrin, W.F., B. Würsig, and J.G.M. Thewissen, eds. *Encyclopedia of marine mammals*. San Diego, California: Academic Press.

Loughlin, T.R., M.A. Perez, and R.L. Merrick. 1987. Eumetopias jubatus. *Mammalian Species 283,* 1-7.

Love, M.S., M.H. Carr, and L.J. Haldorson. 1991. The ecology of substrate-associated juveniles of the genus *Sebastes*. *Environmental Biology of Fishes. 30*, 225-243

Love, M.S., M. Yoklavich, and L.K. Thorsteinson. 2002. *The rockfishes of the northeast Pacific*. Berkeley: University of California Press.

Love, M.S., D.M. Schroeder, and W.H. Lenarz. 2005. Distribution of bocaccio (*Sebastes paucispinis*) and cowcod (*Sebastes levis*) around oil platforms and natural outcrops off California with implications for larval production. *Bulletin of Marine Science, 77*(3), 397-408.

Love, M.S., D.M. Schroeder, W. Lenarz, A. MacCall, A.S. Bull, and L. Thorsteinson. 2006. Potential use of offshore marine structures in rebuilding an overfished rockfish species, bocaccio (*Sebastes paucispinis*). *Fishery Bulletin, 104*(3), 383-390.

Lovvorn, J.R., and J.R. Baldwin. 1996. Intertidal and farmland habitats of ducks in the Puget Sound region: A landscape perspective. *Biological Conservation, 77*(1), 97-114.

Lowry, M.S., B.S. Stewart, C.B. Heath, P.K. Yochem, and J.M. Francis. 1991. Seasonal and annual variability in the diet of California sea lions Zalophus californianus at San Nicolas Island, California, 1981-86. *Fishery Bulletin, 89*, 331-336.

MacGregor, J.S. 1970. *Fecundity, multiple spawning, and description of the gonads in Sebastodes*, *Special Scientific Report -- Fisheries 59*. Washington: U.S. Dept. of the Interior, Bureau of Commercial Fisheries.

Maniscalco, J.M., K. Wynne, K.W. Pitcher, M.B. Hanson, S.R. Melin, and S. Atkinson. 2004. The occurrence of California sea lions (*Zalophus californianus*) in Alaska. *Aquatic Mammals. 30*(3), 427-433.

Matarese, A. C., A. W. Kendall, Jr., D. M. Blood, B. M. Vinter. 1989. Laboratory guide to early life history stages of northeast Pacific fishes. U.S. Department of Commerce., NOAA Technical Report. NMFS-80.

Mate, B.R. 1975. Annual migrations of the sea lions *Eumetopias jubatus* and *Zalophus californianus* along the Oregon coast. Rapports et Proces-Verbaux des Reunions Commission Internationale pour l'Exploration Scientifique de la Mer Mediterranee Monaco *169*, 455-461.

Matkin, C. and E. Saulitis. 1997. Killer whale Orcinus orca. Restoration Notebook (Publication of the Exxon Valdez Oil Spill Trustee Council) November:1-12.

Matkin, C., G. Ellis, E. Saulitis, L. Barrett-Lennard, and D. Matkin. 1999. Killer Whales of Southern Alaska. North Gulf Oceanic Society. 96 pp.

McCauley, R.D., J. Fewtrell, A.J. Duncan, C. Jenner, M.-N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe. 2000. Marine seismic surveys: analysis and propagation of air-gun signals; and effects of air-gun exposure on humpback whales, sea turtles, fishes and squid. Prepared for the Australian Petroleum Production Exploration Association. Project CMST 163 Report R99-15. Centre for Marine Science and Technology, Curtin University of Technology. August 2000.

Merizon, R.A. et al. 1997. Seabird Surveys in Puget Sound 1996, Report to Northwest Indian Fisheries Commission.

Merriam-Webster. 2009. Smog. In *Merriam-Webster Online.*

Merrick, R. L., M. K. Chumbley, and G. V. Byrd. 1997. Diet diversity of Steller sea lions (*Eumetopias jubatus*) and their population decline in Alaska: a potential relationship. *Canadian Journal of Fisheries and Aquatic Sciences, 54,* 1342-1348.

Miller, B.S., and S.F. Borton. 1980. *Geographical distribution of Puget Sound fishes : maps and data source sheets*. Vol. 2: Family Percichthyidae (Temperate Basses) through Family Hexagrammidae (greenlings). Seattle, WA: Fisheries Research Institute, College of Fisheries, University of Washington.

Miller, G.W., R.E. Elliott, W.R. Koski, V.D. Moulton, and W.J. Richardson. 1999. Whales. *In:* Marine Mammal and Acoustical Monitoring of Western Geophysical's Open-Water Seismic Program in the Alaskan Beaufort Sea, 1998, LGL and Greeneridge, eds. LGL Report TA 2230-3. King City, Ont., Canada: LGL Ecological Research Associates, Inc., 109 pp.

Miller, S.L., C.J. Ralph, M.G. Raphael, C. Strong, C.W. Thompson, J. Baldwin, M.H. Huff, and G.A. Falxa. 2006. At-sea monitoring of marbled murrelet population status trend in the Northwest Forest Plan area. In *Northwest Forest Plan—The first 10 years (1994-2003): Status and trends of populations and nesting habitat for the marbled murrelet.* Gen. Tech. Rep. PNW-GTR-650, ed. Huff, M.H., M.G. Raphael, S.L. Miller, S.K. Nelson and J. Baldwin. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Moriyasu, M., R. Allain, K. Benhalima, R. Claytor. 2004. Effects of seismic and marine noise on invertebrates: A literature Review. Canadian Science Advisory Secretariat Research Document - 2004/126.

Morejohn, G.V. 1979. The natural history of Dall's porpoise in the North Pacific Ocean. Pages 45–83 in *Behavior of Marine Animals*, Vol. 3, Cetaceans. H.E. Winn and B.L. Olla (Eds). Plenum Press, New York.

Morris, J.T., V.I. Osychny, and P.J. Luey. 2008. Naval Base Kitsap Bangor – Supplemental Current Measurement Survey: August 2007 field data report. Final. Prepared by Science Applications International Corporation, Newport, RI. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Morris, J.T., G. Berman, M.S., Cole, and P.J. Luey. 2009. Naval Base Kitsap at Bangor comprehensive eelgrass survey field survey report. Prepared by Science Applications International Corp., Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Morton, A. B. 1990. A quantitative comparison of the behaviour of resident and transient forms of the killer whale off the central British Columbia coast. *Reports of the International Whaling Commission, (Special Issue 12)*, 245-248.

Moser, H.G. 1996. Scorpaenidae: scorpionfishes and rockfishes. In *The early life stages of fishes in the California current region*, ed. Moser, H.G. Lawrence, KS: Allen Press. 733-795.

Moulton, V. D., W. J., Richardson, R. E., Elliott, T. L., McDonald, C., Nations, & M. T. Williams. 2005. Effects of an offshore oil development on local abundance and distribution of ringed seals (*Phoca hispida*) of the Alaskan Beaufort Sea. *Marine Mammal Science, 21*, 217-242.

Moyle, P.B., P.J., Foley, and R.M Yoshiyama. 1992. Status of green sturgeon, *Acipenser medirostris*, in California. Final report to National Marine Fisheries Service by University of California at Davis.

Moyle, P.B., R.M., Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California. Second edition. Final report to CA Department of Fish and Game, contract 2128IF.

Mulsow, J. and C. Reichmuth. 2008 in prep. Aerial Hearing Sensitivity in a Steller Sea Lion. Extended abstract presented at the Acoustic Communication by Animals, Second International Conference. Corvallis, Oregon. August 12 – 15, 2008. Citations were used with permission from the authors.

Mumford, T.F. 2007. Kelp and eelgrass in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-05. Seattle District, U.S. Army Corps of Engineers, Seattle, WA.

Munk, K. 2001. Maximum ages of groundfishes in waters off Alaska and British Columbia and consideration of age determination. *Alaska Fishery Research Bulletin. 8*, 12-21.

Newton, J.A., S.L. Albertson, K. Nakata, and C. Clishe. 1998. Washington State marine water quality in 1996 and 1997. Washington State Department of Ecology, Environmental Assessment Program, Publication No. 98-338. http://www.ecy.wa.gov/pubs/98338.pdf

Newton, J.A., S.L. Albertson, K. Van Voorhis, C. Maloy, and E. Siegel. 2002. Washington State marine water quality, 1998 through 2000. Washington State Department of Ecology Environmental Assessment Program, Publication No. 02-03-056. http://www.ecy.wa.gov/pubs/0203056.pdf

Newton, J., C. Bassin, A. Devol, M. Kawase, W. Ruef, M. Warner, D. Hannafious, and R. Rose. 2007. Hypoxia in Hood Canal: an overview of status and contributing factors. Presented at Puget Sound Georgia Basin Research Conference. March 26-29, 2007, Seattle, WA.

Nightingale, B., and C.A Simenstad. 2001a. Overwater structures: Marine issues white paper. Prepared by the University of Washington School of Marine Affairs and the School of Aquatic and Fishery Sciences for the Washington State Department of Transportation. 181 pp.

Nightingale, B., and C.A Simenstad. 2001b. Dredging Activities: Marine Issues white paper. Prepared by University of Washington, Wetland Ecosystem Team, School of Aquatic and Fishery Sciences. Submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. July 13, 2001.

NMFS. 1992. Final recovery plan for Steller sea lions *Eumetopias jubatus*. NMFS Office of Protected Resources, Silver Spring, MD.92pp.

NMFS. 1993. Designation of Critical Habitat for the Steller Sea Lion. Final Rule. Federal Register, Vol. 58, No. 165, Friday August 27, 1993, pages 45269 - 45285.

NMFS. 1996. Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale. Environmental and Technical Services Division, Habitat Conservation Branch.

NMFS. 1997. Investigations of scientific information on the impacts of California sea lions and Pacific harbor seals on salmonids and on the coastal ecosystems of Washington, Oregon, and California. NOAA National Marine Fisheries Service. NOAA Technical Memorandum NMFS-NWFSC-28. http://www.nwfsc.noaa.gov/publications/techmemos/tm28/tm28.htm

NMFS. 1999. The Habitat Approach: Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids. Memo for NMFS/NWR Staff. National Marine Fisheries Service Northwest Region Habitat Conservation and Protected Resources Divisions. http://www.nwr.noaa.gov/Publications/Reference-Documents/upload/habitatapproach_081999-2.pdf

NMFS. 2004. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fisheries Conservation and Management Act Essential Fish Habitat Consultation NOAA Fisheries No. 2003/00758. SR 104 Edmonds Crossing Ferry Terminal Project, Snohomish County.

NMFS. 2005a. Status review update for Puget Sound steelhead. Puget Sound Steelhead Biological Review Team, National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. 114 pp. http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR2005-steelhead.pdf.

NMFS. 2005b. Endangered Fish and Wildlife; Notice of intent to prepare an environmental impact statement. 70 FR 1871.

NMFS. 2005c. Final Rule; Endangered Status for Southern Resident Killer Whales. 70 FR 69903.

NMFS. 2007. Final Rule: Threatened Fish and Wildlife; Change in Listing Status of Steller Sea Lions Under the Endangered Species Act. 62 FR 24345.

NMFS. 2008a. Recovery plan for the Steller sea lion eastern and western distinct population segments (*Eumetopias jubatus*). Revision. National Marine Fisheries Services Office of Protected Resources, Silver Spring, MD. 325 pp. http://www.nmfs.noaa.gov/pr/pdfs/recovery/stellersealion.pdf

NMFS. 2008b. Taking of marine mammals incidental to specified activities; construction of the east span of the San Francisco-Oakland Bay Bridge. 73 FR 38180, July 3, 2008.

NMFS. 2008c. Draft Environmental Assessment: Reducing the impact on at-risk salmon and steelhead by California sea lions in the area downstream of Bonneville Dam on the Columbia River, Oregon and Washington. NOAA National Marine Fisheries Service, Northwest Region, Seattle, Washington. pp. 127.

NMFS. 2009. Taking of marine mammals incidental to specified activities; construction of the East Span of the San Francisco-Oakland Bay Bridge. 74 FR 41684.

NMFS. 2010. Status Review of Eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-105, 360 p.

Noggle, C.C. 1978. Behavioral, physiological and lethal effects of suspended sediment on Juvenile salmonids. MS thesis, University of Washington, Seattle, WA.

Norberg, B. 2007a. Personal email communication between Brent Norberg (National Marine Mammal Laboratory Biologist) and Andrea Balla-Holden (URS Corporation Fisheries and Marine Mammal Biologist) on Monday April 30, 2007.

Norris, K.S., and B. Mohl. 1983. Can odontocetes debilitate prey with sound? *The American Naturalist*. *122*(1), 85-104.

Norris, K.S., and J.H. Prescott. 1961. Observations on Pacific cetaceans of Californian and Mexican waters. *University of California Publications in Zoology 63*, 291-402.

Northwest Training Range Complex Final Environmental Impact Statement/Overseas Environmental Impact Statement Volume 1 EIS/OEIS, November 2009

Nysewander, D.R., J.R. Evenson, B.L. Murphie, and T.A. Cyra. 2005. Report of marine bird and marine mammal component, Puget Sound ambient monitoring program, for July 1992 to December 1999 period. Prepared for the Washington State Department of Fish and Wildlife and Puget Sound Action Team. Washington State Department of Fish and Wildlife, Wildlife Management Program, Olympia, WA. January 31, 2005.

Ockelmann, K.W., and K. Muus. 1978. The Biology, Ecology and Behavior of the Bivalve *Mysella bidentata* (Montagu). *Ophelia. 17*(1), 1-93.

O'Keeffe, D.J. and G.A. Young. 1984. Handbook on the environmental effects of underwater explosions. Naval Surface Weapons Center, Dahlgren and Silver Spring, NSWC TR 83-240.

Opperman, H. 2003. *A birder's guide to Washington*. Colorado Springs, CO: American Birding Association.

Orr, A.J., A.S. Banks, S. Mellman, H.R. Huber, R.L. DeLong, and R.F. Brown. 2004. Examination of the foraging habits of Pacific harbor seal (Phoca vitulina richardsi) to describe their use of the Umpqua River, Oregon, and their predation on salmonids. *Fishery Bulletin 102*, 108-117.

Osborne, R., J. Calambokidis, and E.M. Dorsey. 1988. *A guide to marine mammals of Greater Puget Sound*. Anacortes, WA: Island Publishers.

Osmek, S.D., J. Calambokidis, J. Laake, P. Gearin, R. Delong, J. Scordino, S. Jeffries, and R. Brown. 1996. Assessment of the status of harbor porpoise (*Phocoena phocoena*) in Oregon and Washington Waters. December 1996. NOAA Technical Memorandum NMFS-AFSC-76.

Osmek, S.D., J. Calambokidis, and J.L. Laake. 1998. Abundance and distribution of porpoise and other marine mammals of the inside waters of Washington and British Columbia. In Proceedings of the Fourth Puget Sound Research Conference, Strickland, R., ed. *Puget Sound Water Quality Action Team, Olympia, WA*. 868-880 pp; March 12-13, 1998, Seattle, WA.

Palsson, W.A., T.-S. Tsou, G.G. Bargmann, R.M. Buckley, J.E. West, M.L. Mills, Y.W. Cheng, and R.E. Pacunski. 2008. The biology and assessment of rockfishes in Puget Sound, Draft Document. Fish Management Division, Fish Program Washington Department of Fish and Wildlife.

Palsson, W.A., T.-S. Tsou, G.G. Bargmann, R.M. Buckley, J.E. West, M.L. Mills, Y.W. Cheng, and R.E. Pacunski. 2009. The biology and assessment of rockfishes in Puget Sound, Technical Report. Marine Resources Unit.

Parametrix. 1994. Metro North Beach epibenthic operational monitoring program, 1994 surveys. Prepared for King County Department of Metropolitan Services, Seattle, Washington by Parametrix, Inc., Kirkland, Washington.

Parametrix. 1999. St. Paul Waterway area remedial action and habitat restoration project. 1998 monitoring report. Prepared by Parametrix, Inc., Kirkland, WA. Prepared for Simpson Tacoma Kraft Co., Tacoma, WA.

Payne, P.M. and L.A. Selzer. 1989. The distribution, abundance an selected prey of the harbor seal, *Phoca vitulina concolor*, in southern New England. *Marine Mammal Science 5*(2), 173-192.

Pentec. 2003. Marine and terrestrial resources security force facility and enclave fencing at Naval Submarine Base Bangor, WA. Prepared by Pentec Environmental. Prepared for SRI International. November 18, 2003.

Penttila, D.E. 1997. Newly documented spawning beaches of the surf smelt (*Hypomesus*) and the Pacific sand lance (*Ammodytes*) in Washington State, May 1996 through June 1997. Manuscript Report. Marine Resource Division, Washington Department of Fish and Wildlife.

PFMC (Pacific Fishery Management Council). 1998a. The Coastal Migratory Species Fishery Management Plan. Portland, Oregon: Pacific Fishery Management Council.

PFMC. 1998b. The Coastal Pelagic Species Management Plan. (Appendices prepared for the Council and its advisory entities by the National Marine Fisheries Service). http://www.pcouncil.org/cps/cpsfmp.html

PFMC (Pacific Fishery Management Council). 2003. Pacific Coast Plan: Fishery Management Plan for Commercial and Recreational Salmon Fisheries Off the Coasts of Washington, Oregon and California as Revised through Amendment 14. Portland, Oregon: Pacific Fishery Management Council.

PFMC (Pacific Fishery Management Council). 2007. Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species. Portland, Oregon: Pacific Fishery Management Council.

PFMC (Pacific Fishery Management Council). 2008. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery as Amended through Amendment 19. Portland, Oregon: Pacific Fishery Management Council.

Phillips, J.B. 1960. Canary rockfish. In *California ocean fisheries resources to the year 1960*. California Department of Fish and Game. 39.

Phillips, J.B. 1964. Life history studies on ten species of rockfish (*Genus Sebastodes*). *Fish Bulletin No. 126*. California Department of Fish and Game.

Phillips, C., B. Dolan, and W. Hafner. 2008. Water quality along the Naval Base Kitsap at Bangor shorelines. Phase I survey report for 2005 – 2007. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Phillips, C., B. Dolan, and W. Hafner. 2009. Naval Base Kitsap at Bangor water quality 2005 and 2006 field survey report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Pitcher, K. W., and D. G. Calkins. 1981. Reproductive biology of Steller sea lions in the Gulf of Alaska. *Journal of Mammalogy. 62*, 599-605.

Pitcher, K. W., P. F. Olesiuk, R. F. Brown, M. S. Lowry, S. J. Jeffries, J. L. Sease, W. L. Perryman, C. E. Stinchcomb, and L. F. Lowry. 2007. Status and trends in abundance and distribution of the eastern Steller sea lion (*Eumetopias jubatus*) population. *Fishery Bullentin 107*(1), 102-115.

Poole, A.F., R.O. Bierregaard, and M.S. Martell. 2002. Osprey (*Pandion haliaetus). The Birds of North America Online*, ed. Poole, A. Ithaca: Cornell Laboratory of Ornithology, Retrieved from The Birds of North America Online database: http://bna.birds.cornell.edu/bna (Accessed August 20, 2008).

Prescott, R. 1982. Harbor seals: Mysterious lords of the winter beach. *Cape Cod Life 3*(4), 24-29.

Prinslow, T.E., C.J. Whitmus, J.J. Dawson, N.J. Bax, B.P. Snyder, and E.O. Salo. 1980. Effects of wharf lighting on outmigrating salmon, 1979. Final report, January to December 1979. Prepared by Fisheries Research Institute and University of Washington, Seattle, WA. Prepared for U.S. Department of the Navy, Silverdale, WA. 137 pp.

PSAT. 2007a. 2007 Puget Sound update. Puget Sound Assessment and Monitoring Program. Olympia, WA.

PSAT. 2007b. State of the Sound 2007. Puget Sound Action Team. Publication No. PSAT 07-01. Office of the Governor, Olympia, WA. March 2007

PSCAA (Puget Sound Clean Air Agency). 2008. 2007 air quality data summary. October 2008. Seattle, WA.

PSCAA. 2009. Regulation I, of the PSCAA. http://www.pscleanair.org/regulated/reg1/reg1.pdf (Accessed February 5, 2009)

Quinn, T., and R. Milner. 2004. Great blue heron (*Ardea herodias*). In *Management recommendations for Washington's priority species, Volume IV: Birds*. Larsen, E., J.M. Azerrad, and N. Nordstrom, eds. Washington State Department of Fish and Wildlife, Olympia, WA.

Raphael, M. G., J. Baldwin, G. A. Falxa, M. H. Huff, M. Lance, S. Miller, S. F. Pearson, C. J. Ralph, C. Strong, and C. Thompson. 2007. Regional Population Monitoring of the Marbled Murrelet: Field and Analytical Models. General Technical Report. PNW-GTR-716. Washington, D.C.: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Read, A.J. 1990. Reproductive seasonality in harbour porpoises, Phocoena phocoena, from the Bay of Fundy. *Canadian Journal of Zoology 68*, 284-288.

Read, A.J., 1999. Harbour porpoise Phocoena phocoena (Linnaeus, 1758). Pages 323-355 in Ridgway, S.H. and R. Harrison, eds. *Handbook of marine mammals*. Volume 6: The second book of dolphins and the porpoises. San Diego, California: Academic Press.

Read, A.J. and A.A. Hohn. 1995. Life in the fast lane: The life history of harbor porpoises from the Gulf of Maine. *Marine Mammal Science 11*(4), 423-440.

Redding, M. J., C.B. Schreck, and F.H. Everest. 1987. Physiological effects on coho salmon and steelhead of exposure to suspended solids. *Transactions of the American Fisheries Society*. *116*, 737-744.

Redman, S. D. Myers, and D. Averill (eds.). 2005. Regional nearshore and marine aspects of salmon recovery in Puget Sound. Compiled from contributions by the editors and K.T Fresh and B. Graeber, NOAA Fisheries. Delivered to Puget Sound Partnership for inclusion in the regional salmon recovery plan.

Reeves, R.R., P.A. Folkens, and National Audubon Society. 2002. *Guide to marine mammals of the world*. New York: Alfred A. Knopf.

Reeves, R.R., B.S. Stewart, and S. Leatherwood. 1992. *The Sierra Club handbook of seals and sirenians*. San Francisco, California: Sierra Club Books.

Reeves RR, Dalebout ML, Jefferson TA, Karczmarski L, Laidre K, O'Corry-Crowe G, Rojas-Bracho L, Secchi ER, Slooten E, Smith BD, Wang JY, Zhou K (2008) IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2. <www.iucnredlist.org>.

Reyff, J. 2003. Memo to Caltrans District 4 regarding SFOBB East Span Construction Pier 16E. Dated July 24, 2003.

Richards, L.J., J. Paul, A.J. Cass, L. Fitzpatrick, R. van den Broek, and C. Lauridsen. 1985. SCUBA survey of rockfish assemblages in the Strait of Georgia, July to October 1984. Canadian Data Report of Fisheries and Aquatic Sciences 545. Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, British Columbia.

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

Richardson, W.J. 1995. Marine mammal hearing. Pages 205-240 in Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson, eds. *Marine mammals and noise*. San Diego, California: Academic Press.

Ridgway, S. H., D. A. Carder, R. R. Smith, T. Kamolnick, C. E. Schlundt, and W. R. Elsberry, 1997. Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, Tursiops truncatus, to 1-second tones of 141 to 201 dB re 1 μPa. Technical Report 1751, Revision 1. San Diego, California: Naval Sea Systems Command.

Riedman, M. 1990. *The pinnipeds: Seals, sea lions, and walruses*. Berkeley, California: University of California Press.

Riedman, M.L. and J.A. Estes. 1990. The sea otter (Enhydra lutris): Behavior, ecology, and natural history. U.S. Fish and Wildlife Service Biological Report 90(14). Washington, D.C.: U.S. Fish and Wildlife Service.

Robson, B.W., ed. 2002. Fur seal investigations, 2000-2001. NOAA Technical Memorandum NMFS-AFSC-1 34:1-80.

Roffe, T. and B. Mate. 1984. Abundance and feeding habits of pinnipeds in the Rogue River, OR. *Journal of Wildlife Management, 48*, 1,262-1,277.

Romberg, P.G.. 2005. Recontamination Sources At Three Sediment Caps In Seattle. In: *Proceedings of the 2005 Puget Sound Georgia Basin Research Conference*. King County Department of Natural Resources and Parks, Seattle, WA.

Ruggerone, G.T., S.E. Goodman, and R. Miner. In Preparation. Behavioral response and survival of juvenile coho salmon to pile driving sounds. Natural Resources Consultants, Inc., and Robert Miner Dynamic Testing, Inc.

SAIC (Science Applications International Corporation). 2006. Naval Base Kitsap-Bangor: Fish Presence and Habitat Use Combined Phase I and II Field Survey Report (Draft). Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville MD.

Salo, E.O., N.J. Bax, T.E. Prinslow, C.J. Whitmus, B.P. Snyder, and C.A. Simenstad. 1980. The effects of construction of Naval facilities on the outmigration of juvenile salmonids from Hood Canal, Washington. Final report. Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA. Prepared for the U.S. Navy, OICC Trident. April 1980. 159 pp.

Salo, E.O. 1991. Life history of chum salmon (*Oncorhynchus keta*). In *Pacific salmon life histories*, ed. Groot, C. and L. Margolis. Vancouver: University of British Columbia Press. 231-310.

Sandercock, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). In *Pacific salmon life histories*, ed. Groot, C. and L. Margolis. Vancouver: University of British Columbia Press. 396-445.

Saulitis, E. L. 1993. The behavior and vocalizations of the "AT" group of killer whales (*Orcinus orca*) in Prince William Sound, Alaska. M.S. Thesis, University of Alaska Fairbanks, Fairbanks, AK, 193 pp.

Saulitis, E., C.O. Matkin, L.G. Barrett-Lennard, K. Heise, and G.M. Ellis. 2000. Foraging strategies of sympatric killer whale (*Orcinus orca*) populations in Prince William Sound, Alaska. *Marine Mammal Science. 16***,** 94–109.

Schneider, D.C. and P.M. Payne, 1983. Factors affecting haul-out of harbor seals at a site in southeastern Massachusetts. *Journal of Mammalogy 64*(3), 518-520.

Schreiner, J.U. 1977. Salmonid outmigration studies in Hood Canal, Washington. M.S. thesis, University of Washington, Seattle, WA.

Schreiner, J.U., E.O. Salo, B.P. Snyder, and C.A. Simenstad. 1977. Salmonid outmigration studies in Hood Canal. Final report, Phase II. Prepared for the U.S. Navy by the Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, WA. FRI-UW-7715. May 1977. 64 pp.

Schusterman, R.J. 1974. Auditory sensitivity of a California sea lion to airborne sound. Journal of the Acoustical Society of America, 56:1248-1251.

Schusterman, R.J. 1977. Temporal patterning in sea lion barking (*Zalophus californianus*). Behavioral Biology, 20:404-408.

Schusterman, R.J. and R.F. Balliet. 1969. Underwater barking by male sea lions (*Zalophus californianus*). Nature 222(5199):1179-1181.

Schusterman, R.J., R. Gentry, and J. Schmook. 1966. Underwater vocalization by sea lions: Social and mirror stimuli. Science 154(3748):540-542.

Schusterman, R.J., Gentry, R., and Schmook, J. 1967. Underwater sound production by captive California sea lions. Zoologica, 52:21-24.

Schusterman, R.J., R.F. Balliet, and S. St. John. 1970. Vocal displays under water by the gray seal, the harbor seal, and the stellar [sic] sea lion. Psychonomic Science 18(5):303-305.

Schusterman, R.J., Balliet, R.F., and Nixon, J. 1972. Underwater audiogram of the California sea lion by the conditioned vocalization technique. Journal of the Experimental Analysis of Behavior, 17:339-350.

Schusterman, R.J., Gentry, R., and Schmook, J. 1996. Underwater vocalizations by sea lions: social and mirror stimuli. Science, 154:540-542.

Scordino, J. 2006. Steller sea lions (*Eumetopias jubatus*) of Oregon and Northern California: Seasonal haulout abundance patterns, movements of marked juveniles, and effects of hot-iron branding on apparent survival of pups at Rogue Reef. Master of Science thesis, Oregon State University, Corvallis, OR. 92 pages.

Servizi, J.A. and D.W. Martens. 1987. Some effects of suspended Fraser River sediments on sockeye salmon (*Oncorhynchus nerka*). In *Sockeye salmon* (Oncorhynchus nerka) *population biology and future management*. H.D. Smith, L. Margolis, and C.C. Wood, eds. *Canadian Special Publication of Fisheries and Aquatic Sciences*. 96. 254-264.

Servizi, J.A., and Martens, D.W. 1991. Effect of temperature, season, and fish size on acute lethality of suspended sediments to coho salmon, *Oncorhynchus kisutch*. *Canadian Journal of Fisheries and Aquatic Sciences*. *48,* 493–497

Shepard, M.F. 1981. Status review of the knowledge pertaining to the estuarine habitat requirement and life history of Chum and Chinook salmon juveniles in Puget Sound, Washington. Cooperative Fishery Research Unit, College of Fisheries, University of Washington, Seattle, WA.

Simenstad, C.A. and J.R. Cordell. 2000. Ecological assessment criteria for restoring anadromous salmonid habitat in Pacific Northwest estuaries. *Ecological Engineering. 15,* 283-302.

Simenstad, C.A., B.J. Nightingale, R.M. Thom, and D.K. Shreffler. 1999. Impacts of ferry terminals on juvenile salmon migrating along Puget Sound shorelines. Phase I: Synthesis of state of knowledge. Prepared for the Washington State Transportation Commission in Cooperation with the U.S. Department of Transportation Federal Highway Administration. June 1999. http://depts.washington.edu/trac/bulkdisk/pdf/472.1.pdf

Simenstad, C.A., R.J. Garono, T. Labbe, A.C. Mortimer, R. Robinson, C. Weller, S. Todd, J. Toft, J. Burke, D. Finlayson, J. Coyle, M. Logsdon, and C. Russell. 2008. Assessment of intertidal eelgrass habitat landscapes for threatened salmon in the Hood Canal and Eastern Strait of Juan de Fuca, Washington State. Technical Report 08-01. Point No Point Treaty Council, Kingston, WA. 152 pp.

Slater, M.C. 2009. Naval Base Kitsap, Bangor baseline underwater noise survey report. Prepared by Science Applications International Corporation, Bremerton, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

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.

Stout, H.A., R.G. Gustafson, W.H. Lenarz, B.B. McCain, D.M. Van Doonik, T.L. Builder, and R.D. Methot. 2001. Status review of Pacific Herring in Puget Sound, Washington. U.S. NOAA Technical Memo. NMFS-NWFSC- 45. 175 pp. http://www.nwfsc.noaa.gov/publications/techmemos/tm45/tm45.htm

Sumida, B.Y., and H.G. Moser. 1984. Food and feeding of bocaccio and comparison with Pacific hake larvae in the California Current. *California Cooperative Oceanic Fisheries Investigations Report. 25*, 112-118.

Szymanski, M.D., D.E. Bain, K. Kiehl, S. Pennington, S. Wong, and K.R. Henry. 1999. Killer whale (*Orcinus orca*) hearing: auditory brainstem response and behavioral audiograms. *The Journal of the Acoustical Society of America*, *106*(2), 1134-1141.

Tannenbaum, B.R., M. Bhuthimethee, L. Delwiche, G. Vedera, and J.M. Wallin. 2009a. Naval Base Kitsap at Bangor 2008 Marine Mammal Survey Report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Tannenbaum, B.R. M. Bhuthimethee, L. Delwiche, G. Vedera, and J.M. Wallin. 2009b. Naval Base Kitsap at Bangor 2008 Marine Bird Survey Report. Prepared by Science Applications International Corporation, Bothell, WA. Prepared for BAE Systems Applied Technologies, Inc., Rockville, MD.

Teachout, E. 2009. Emily Teachout, Transportation Liaison for USFWS, Washington State Department of Transportation, Lacey, WA. May 4, 2009. Personal communication, email, with Bernice Tannenbaum, Science Applications International Corporation, Bothell, WA. re: noise thresholds for marled murrelets.

Temte, J. L. 1986. Photoperiod and the timing of pupping in the Pacific harbor seal (*Phoca vitulina richardsi*) with notes on reproduction in northern fur seals and Dall porpoises. Thesis, Oregon State University, Corvallis, USA.

Terhune, J. M., and K., Ronald. 1975. Underwater hearing sensitivity of two ringed seals (*Pusa hispida*) *Canadian Journal of Zoology, 53*(3), 227–231.

Terhune, J. and S. Turnbull. 1995. Variation in the psychometric functions and hearing thresholds of a harbour seal. Pages 81-93. in R.A. Kastelein, J.A. Thomas, and P.E. Nachtigall, eds. *Sensory systems of aquatic mammals*. De Spil Publishers, Woerden, Netherlands.

Thomson, D. H. and W. J. Richardson. 1995. Marine mammal sounds. Pages 159-204 in Richardson, W. J., C. R. Greene, Jr., C. I. Malme, and D. H. Thomson, eds. *Marine mammals and noise*. San Diego: Academic Press.

Thorson, P. and J.A. Reyff. 2004. Marine mammal and acoustic monitoring for the eastbound structure. San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. Report submitted for Incidental Harassment Authorization issued November 14, 2003 to Caltrans.

Tollit, D. J., Greenstreet, S. P. R. & Thompson, P. M. 1997. Prey selection by harbour seals (*Phoca vitulina*) in relation to variations in prey abundance. *Canadian Journal of Zoology*, *75*, 1508–1518.

Urick, Robert J. 1983. *Principles of underwater sound.* 3rd ed. New York: McGraw-Hill.

URS Consultants, Inc. 1994. Final remedial investigation report for the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Northwest Area. Remedial investigation for Operable Unit 7, CTO-0058, SUBASE Bangor, Bremerton, WA. Prepared by URS Consultants, Inc., Seattle, WA. Prepared for Engineering Field Activity, Northwest, Western Division, Naval Facilities Engineering Command, Silverdale, WA. June 13, 1994.

USACE. 2008. Approved work windows in all marine/estuarine areas excluding the mouth of the Columbia River (Baker Bay) by tidal reference area. Seattle District, United States Army Corps of Engineers, Seattle, WA. http://www.nws.usace.army.mil/publicmenu/DOCUMENTS/REG/work_windows_-_all_marine_&_estuarine2.pdf.

USEPA. 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Washington, DC.

USEPA. 1997. Volunteer stream monitoring: A methods manual. EPA 841-B-97-003. November 1997. USEPA Office of Water. http://www.epa.gov/volunteer/stream/index.html

USEPA. 1999. Consideration of Cumulative Impacts in EPA Review of NEPA Documents. May 1999.

USEPA. 2009. National Ambient Air Quality Standards (NAAQS) Available from http://www.epa.gov/air/criteria.html.

USEPA. 2010a. What are Six Common air Pollutants? Accessed April 21, 2010. http://epa.gov/air/urbanair.

USEPA. 2010b. Lead in Air. Accessed April 21, 2010. http://epa.gov/air/lead.

USEPA. 2010c. Lead. Accessed April 21, 2010. http://epa.gov/air/emissions/pb.htm.

USFWS (U.S. Fish and Wildlife Service). 1997. Recovery plan for the threatened Marbled Murrelet (*Brachyramphus marmoratus*) in Washington, Oregon, and California. Portland, Oregon. U.S. Fish and Wildlife Service Region1, Portland, OR. 203 pp.

USFWS. 2003. Biological Opinion SR 104 Hood Canal Bridge Retrofit and East Half Replacement Project. USFWS LOG3-1-3-02-F-1484. U.S. Fish and Wildlife Service, Western Washington Fish and Wildlife Office, Lacey, WA.

USFWS. 2004. Biological Opinion and Letter of Concurrence for effects to bald eagles, marbled murrelets, northern spotted owls, bull trout, and designated critical habitat for marbled murrelets and northern spotted owls from Olympic National Forest Program of Activities for August 5, 2003 to December 31, 2008. FWS Reference Number 1-3-03-F-0833. U.S. Fish and Wildlife Service, Lacey, WA.

USFWS. 2006. Endangered Species Act – Section 7 Consultation Biological Opinion. Anacortes Ferry Terminal Tie-Up Slip Relocation and Dolphin Replacement. Skagit County, Washington. USFWS No. 1-3-06-FR-0411, X-ref: 1-3-05-F-0150. August 2006. Consultation conducted by USFWS Western Washington Fish and Wildlife Office, Lacey, WA. 124 pp. plus Appendix 1 and 2.

USFWS. 2007. National Bald Eagle Management Guidelines. May 2007. Accessed: November 2009. http://www.fws.gov/migratorybirds/baldeagle.htm

USFWS. 2008a. Birds of conservation concern 2008. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, VA. 99 pp. December 2008. http://migratorybirds.fws.gov/reports/bcc2002.pdf

USFWS. 2008b. Endangered Species Glossary. Accessed: May 27, 2010. http://www.fws.gov/endangered/glossary.html

URS Consultants, Inc. 1994. Final remedial investigation report for the Comprehensive Long-Term Environmental Action Navy (CLEAN) Program, Northwest Area. Remedial investigation for Operable Unit 7, CTO-0058, SUBASE Bangor, Bremerton, WA. Prepared by URS Consultants, Inc., Seattle, WA. Prepared for Engineering Field Activity, Northwest, Western Division, Naval Facilities Engineering Command, Silverdale, WA. June 13, 1994.

USGS (U.S. Geological Survey). 2002. Simulation of the ground-water flow system at Naval Submarine Base Bangor and vicinity, Kitsap County, Washington. U.S. Geological Survey Water-Resources Investigations Report 02-4261. Prepared in cooperation with Department of the Navy, Engineering Field Activity, Northwest Naval Facilities Engineering Command, Port Orchard, WA.

USGS. 2003. Estimates of residence time and related variations in quality of groundwater beneath Submarine Base Bangor and vicinity, Kitsap County, Washington. U.S. Geological Survey Water-Resources Investigations Report 03-4058. Prepared in cooperation with Department of the Navy, Engineering Field Activity, Northwest Naval Facilities Engineering Command, Port Orchard, WA.

USGS. 2010. Glossary of Glacier Terminology: Hanging Valley. Accessed: July 7, 2010. Website: http://pubs.usgs.gov/of/2004/1216/h/h.html

U.S. v. State of Washington 384 R. Supp. 312; 1974 U.S. Dist. LEXIS 12291

Van Parijs, S.M., P.J. Corkeron, J. Harvey, S.A. Hayes, D.K. Mellinger, P.A. Rouget, P.M. Thompson, M. Wahlberg, and K.M. Kovacs. 2003. Patterns in the vocalizations of male harbor seals. *Journal of the Acoustical Society of America 113*, (6), 3403-3410.

Veirs, V. 2004. Source levels of free-ranging killer whale (Orcinus orca) social vocalizations. *Journal of the Acoustical Society of America, 116* (4, Pt. 2), 2615.

Verboom, W. C. and R.A. Kastelein. 1995. Acoustic signals by harbour porpoises (Phocoena phocoena). In Harbour Porpoises – Laboratory Studies to Reduce Bycatch (ed. P. E. Nachtigall, J. Lien, W. W. L. Au and A. J. Read), pp. 1-39. Woerden, The Netherlands: De Spil Publishers.

Vermeer, K., S.G. Sealy, and G.A. Sanger. 1987. Feeding ecology of Alcidae in the eastern North Pacific Ocean. In *Seabirds: Feeding ecology and role in marine ecosystems*. Croxall, J.P., ed. Great Britain: Cambridge University Press. Chapter 9. 189–227.

Viada, S.T., R.M. Hammer, R. Racca, D. Hannay, M.J. Thompson, B.B. Balcom, and N.W. Phillips. 2008. Review of potential impacts to sea turtles from underwater explosive removal of offshore structures. *Environmental Impact Assessment Review, 28*, 267-285.

Walker, W.A., M.B. Hanson, R.W. Baird and T.J. Guenther. 1998. Food habits of the harbor porpoise, Phocoena phocoena, and Dall's porpoise, Phocoenoides dalli, in the inland waters of British Columbia and Washington. Pages 63-75 in Marine Mammal Protection Act and Endangered Species Act Implementation Program 1997. AFSC Processed Report 98-10.

Walters, A. 2009. Allison Walters, Naval Base Kitsap Environmental, Bangor, WA. January 23, 2009. Personal communication, email, with Bernice Tannenbaum, Science Applications International Corporation, Bothell, WA. re: occurrence of Steller sea lions, California sea lions, and harbor seals at Naval Base Kitsap Bangor.

Ward, W.D. 1997. Effects of high intensity sound. In M.J. Crocker (Ed.) *Encyclopedia of acoustics, Volume III*. (pp 1497-1507). New York: John Wiley & Sons.

Warner, M.J. 2007. Historical comparison of average dissolved oxygen in Hood Canal. Hood Canal Dissolved Oxygen Program. February 2007. http://www.hoodcanal.washington.edu/observations/historicalcomparison.jsp

Warner, M.J., M. Kawase, and J.A. Newton. 2001. Recent studies of the overturning circulation in Hood Canal. In Proceedings of the 2001 Puget Sound Research Conference, Puget Sound Action Team, Olympia, WA. 9 pp. http://www.hoodcanal.washington.edu/documents/document.jsp?id=1561

Washington, P.M., R.E. Gowan, and D.H. Ito. 1978. A biological report on eight species of rockfish (Sebastes spp.) from Puget Sound, Washington, Northwest and Alaska Fisheries Center Processed Report. Seattle, WA: U.S. Dept. of Commerce, Northwest and Alaska Fisheries Center.

Watson, J.W., and D.J. Pierce. 1998. Bald eagle ecology in western Washington with an emphasis on the effects of human activity. Final Report. Washington Department of Fish and Wildlife, Olympia, WA.

WDF, Washington Department of Wildlife, and Western Washington Treaty Indian Tribes. 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Washington Department of Fisheries, Olympia, WA. 212 pp.

WDFW (Washington Department of Fish and Wildlife). 2001. Washington and Oregon Eulachon Management Plan. WDFW, ODFW. Olympia, Washington.

WDFW. 2002. Salmonid stock inventory (SaSI). Maps and stock assessments. http://wdfw.wa.gov/fish/sasi/

WDFW. 2004. Washington State salmonid stock inventory. Bull trout/Dolly Varden. Washington Department of Fish and Wildlife, Olympia, WA. 449 pp. http://wdfw.wa.gov/fish/sassi/bulldolly.pdf.

WDFW. 2007a. Puget Sound clam and oyster FAQs. Frequently asked questions about clam and oyster regulations and management. http://wdfw.wa.gov/fish/shelfish/beachreg/faqs.htm (Accessed August 16, 2007).

WDFW. 2007b. Marine density of marbled murrelet in northern Hood Canal. Density maps, created by Dave Nysewander of WDFW, January 24, 2007.

WDFW. 2007c. Priority habitats and species data request for the project area, at NAVBASE Kitsap Bangor. April 18, 2007. WDFW, Priority Habitats and Species, Olympia, WA.

WDFW. 2007d. Washington State Status Report for the Bald Eagle. WDFW Wildlife Program, Olympia, WA. 86 + viii pp.

WDFW and PNPTT (Point No Point Treaty Tribes). 2000. Summer chum salmon conservation initiative: An implementation plan to recover summer chum in the Hood Canal and Strait of Juan de Fuca Region. Report for WDFW and Point-No-Point Treaty Tribes. Washington Department of Fish and Wildlife, Olympia, WA. http://wdfw.wa.gov/fish/chum/chum.htm.

WDNR (Washington State Department of Natural Resources). 2006. Washington State shorezone inventory shapefiles (electronic vector data). February 2001. Rev. December 2006. Washington State Department of Natural Resources, Nearshore Habitat Program, Aquatic Resources Division., Olympia, WA.

WDOE. 1991. Net shore-drift in Washington State Volume 4: Hood Canal Region. Ecology Report 00-06-03. Shorelands and Environmental Assistance Program. Washington Department of Ecology, Olympia, WA. http://www.ecy.wa.gov/pubs/93520.pdf

WDOE. 1998. Marine sediment monitoring program: II. Distribution and structure of benthic communities in Puget Sound 1989-1993. Roberto Llansó, Sandra Aasen, Kathy Welch, authors. September 1998.

WDOE. 2005. Washington State's Water Quality Assessment for 2002/2004. Final submittal approved by the U.S. Environmental Protection Agency on November 4, 2005. http://www.ecy.wa.gov/programs/wq/303d/2002/2002-index.html.

WDOE. 2007. Relationships between benthos, sediment quality, and dissolved oxygen in Hood Canal. Prepared by Maggie Dutch, Ed Long, Sandy Aasen, Kathy Welch, and Valerie Partridge.

WDOE. 2009a. *Washington State's Water Quality Assessment for 2008. Final 2008 Section 303(d) map for NAVBASE Kitsap Bangor waterfront. (User-generated map and listings.)*. http://www.ecy.wa.gov/programs/wq/303d/index.html (Accessed March 24, 2009).

WDOH (Washington State Department of Health). 2006. 2005 annual inventory: Commercial and recreational shellfish areas of Washington State. WDOH Office of Food Safety and Shellfish. http://www.doh.wa.gov/ehp/sf/Pubs/2005annual-inventory.pdf

WDOH. 2008. Summary of Shellfish Growing Areas Water Quality Study Results: Hood Canal #2. Subset of data for stations located along NBK-Bangor waterfront, provided by Greg Combs, WDOH.

Weitkamp, D., G. Ruggerone, L. Sacha, J. Howell, and B. Bachen. 2000. Factors affecting Chinook populations. Background report. Prepared by Parametrix Inc., Natural Resources Consultants, and Cedar River Associates. Prepared for City of Seattle, Seattle, WA.

Weston. 2006. Benthic community assessment in the vicinity of the Bangor Naval Facility, Hood Canal, Draft report, June 2006. Prepared by Weston Solutions, Inc., Port Gamble, WA. Prepared for Science Applications International Corporation, Bothell, WA.

Whitmus, C.J. 1985. The influence of size on the early marine migration and mortality of juvenile chum salmon (*Oncorhynchus keta*). M.S. thesis, University of Washington, Seattle, WA.

Wiles, G. J. 2004. Washington State status report for the killer whale. Washington Department Fish and Wildlife, Olympia. 106 pp. http://wdfw.wa.gov/science/articles/orca/final_orca_status.pdf

Williams, G.D., and R.M. Thom. 2001. White Paper: Marine and estuarine shoreline Modification Issues. Prepared by Battelle Marine Laboratories for Washington Department of Ecology, Sequim, WA.

Willis, P.M., B.J. Crespi, L.M. Dill, R.W. Baird, and M.B. Hanson. 2004. Natural hybridization between Dall's porpoises (Phocoenoides dalli) and harbour porpoises (Phocoena phocoena). *Canadian Journal of Zoology 82*, 828-834.

Wilson, S.C. 1978. Social organization and behavior of harbor seals, Phoca vitulina concolor, in Maine. Final report to the U.S. Marine Mammal Commission. Washington, D.C.: Smithsonian Institution Press.

Wilson, U.W., and D.A. Manuwal. 1986. Breeding biology of the rhinoceros auklet in Washington. *Condor. 88*, 143-155.

Wilson, O.B.J., S.N. Wolf, and F. Ingenito. 1985. Measurements of acoustic ambient noise in shallow water due to breaking surf. *The Journal of the Acoustical Society of America, 78*(1), 190-195.

Wolski, L.F., R.C. Anderson, A.E. Bowles, and P.K. Yochem. 2003. Measuring hearing in the harbor seal (*Phoca vitulina*): Comparison of behavioral and auditory brainstem response techniques. *Journal of the Acoustical Society of America 113*(1), 629-637.

WSDOT. 2005. Hydroacoustic Measurements during Pile Driving at the Hood Canal Bridge, September through November 2004.

WSDOT. 2007. Underwater sound levels associated with driving steel and concrete piles near the Mukilteo Ferry Terminal. March 2007.

WSDOT. 2008. *Advanced Training Manual, Biological Assessment Preparation for Transportation Projects*. Version 7. Washington State Department of Transportation, Environmental Affairs Office, Olympia, WA.

WSDOT. 2010. Keystone Ferry Terminal – vibratory pile monitoring technical memorandum. May 2010.

Wyllie Echeverria, T. 1987. Thirty-four species of California rockfish: maturity and seasonality of reproduction. *Fishery Bulletin. 85*, 229-240.

Yelverton, J.T., D.R. Richmond, E.R. Fletcher, and R.K. Jones. 1973. Safe distances from underwater explosions for mammals and birds. Lovelace Foundation, Albuquerque, DNA 3114T. http://stinet.dtic.mil/cgibin/GetTRDoc?AD=AD766952&Location=U2&doc=GetTRDoc.pdf.

Yoklavich, M.M., H.G. Greene, G.M. Cailliet, D.E. Sullivan, R.M. Lea, and M.S. Love. 2000. Habitat associations of deep-water rockfishes in a submarine canyon: An example of a natural refuge. *Fishery Bulletin. 98*(3), 625-641.

Yurk, H., L. Barrett-Lennard, J.K.B. Ford, and C.O. Matkin. 2002. Cultural transmission within maternal lineages: Vocal clans in resident killer whales in southern Alaska. *Animal Behaviour 63*, 1103- 1119.

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APPENDIX A

Coastal Consistency Determination

COASTAL CONSISTENCY DETERMINATION FOR THE TEST PILE PROGRAM – NBK BANGOR WATERFRONT NAVAL BASE KITSAP BANGOR SILVERDALE, KITSAP COUNTY, WA

This document provides the State of Washington with the U.S. Department of Navy's (Navy) Consistency Determination under Section 307 (c)(1) of the federal Coastal Zone Management Act (CZMA) of 1972, as amended, for the proposed Test Pile Program for NBK Bangor Waterfront at Naval Base Kitsap-Bangor.

Proposed Federal Action:

As part of the U.S. Navy's sea-based strategic deterrence mission, the Navy Strategic Systems Programs (SSP) directs research, development, manufacturing, test, evaluation, and operational support of the TRIDENT Fleet Ballistic Missile (TRIDENT) program. The proposed action (also called the Test Pile Program) is to install and remove up to 29 test and reaction piles, conduct testing on select piles, and measure in-water noise propagation during pile installation and removal. Geotechnical and noise data collected during pile installation and removal will be integrated into the design, construction, and environmental planning for the Navy's proposed second Explosives Handling Wharf (EHW-2). The Navy proposes to install the test piles in the location planned for EHW-2 (south of the existing Explosives Handling Wharf); however, other future projects can also benefit from the geotechnical and noise propagation data gathered from driving the test piles.

The Test Pile Program will involve driving 18 steel piles, ranging in size from 30 inches in diameter to 60 inches in diameter, at predetermined locations within the proposed footprint of EHW-2. Some piles will be installed more than one time. Eleven additional piles will be installed to perform lateral load and tension load tests on the original 18 test piles. The pile lengths will range from 100 feet to 197 feet. All piles will be driven to an initial embedment depth with a vibratory hammer, and select piles will be driven an additional 10-15 feet (approximate) with an impact hammer. Noise attenuation measures will be used during all impact hammer operations and some vibratory hammer operations. The proposed action would also include the removal of all test piles. Hydroacoustic monitoring will be accomplished to assess effectiveness of noise attenuation measures. The presence of marine mammals and marbled murrelets will also be monitored during pile installation and removal.

Project Location:

NBK Bangor is located on Hood Canal and utilizes various piers and docks. The proposed location for the Test Pile Program is immediately south of Explosive Handling Wharf #1 (EHW-1). Two restricted areas are associated with NBK Bangor, Naval Restricted Areas 1 and 2 (33 CFR 334.1220). Naval Restricted Area 1 covers the area north and south along the Hood Canal encompassing the NBK Bangor waterfront. The regulations associated with Naval Restricted Area 1 state that no person or vessel shall enter this area without permission from the

Commander, Naval Submarine Base Bangor, or his/her authorized representative. Naval Restricted Area 2 encompasses the waters of Hood Canal within a circle of 1,000 yards diameter centered at the north end of NBK Bangor and partially overlapping Naval Restricted Area 1. The regulations associated with Naval Restricted Area 1 state that navigation will be permitted within that portion of this circular area not lying within Area No. 1 at all times except when magnetic silencing operations are in progress. Figure 1 depicts a plan view of the study area location and Figure 2 indicates the restricted areas associated with NBK Bangor.

PERMITTING AND ENVIRONMENTAL ASSESSMENT

Prior to implementation of the proposed action, the Navy will obtain all appropriate permits and authorizations applicable to the proposed action including:

- Federal Coastal Consistency Determination concurrence by the State of Washington Department of Ecology, Coastal Zone Management Program in accordance with the CZMA.

- Permit from the US Army Corps of Engineers (USACOE), Seattle District in accordance with Section 10 of the Rivers and Harbors Appropriation Act of 1899.

- Section 106 consultation with the Washington State Historic Preservation Officer (SHPO).

- Government to government consultations with federally recognized American Indian Tribes.

- Coordination with the U.S. Fish and Wildlife Service (USFWS) on Endangered Species Act (ESA) and Migratory Bird Treaty Act (MBTA).

- Consultation with National Marine Fisheries Service (NMFS) on ESA, Marine Mammal Protection Act (MMPA), and Magnuson-Stevens Fisheries Conservation and Management Act (MSFCMA).

PROGRAM AND POLICY ANALYSIS

The CZMA, enacted in 1972, created the National Coastal Management Program for management and control of the uses of and impacts on coastal zone resources (16 USC 1451-1465). The program is implemented through federally approved state coastal management programs (CMPs). Washington was the first state to receive federal approval of a Coastal Zone Management Program in 1976. The Department of Ecology's Shorelands and Environmental Assistance Program is responsible for implementing Washington's Program.

Federal approval of a state CMP triggers the CZMA Section 307 federal consistency determination requirement. Section 307 mandates that federal actions within a state's coastal zone be consistent to the maximum extent practicable with the enforceable policies of the state

CMP. The CZMA applies to lands within the coastal zone, which includes Hood Canal. However, the CZMA excludes "…lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents" (16 USC 1453 definition of coastal zone). The consistency determination for these federal properties is then conducted to determine if project-related impacts to the neighboring properties would be consistent under CZMA regulations.

Washington's Coastal Zone Management Program (CZMP) defines Washington State's coastal zone to include the 15 counties with marine shorelines: Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Mason, Pacific, Pierce, San Juan, Skagit, Snohomish, Thurston, Wahkiakum, and Whatcom. The CZMP applies to activities within the 15 counties, as well as activities outside these counties, which may impact Washington's coastal resources. Most, but not all, activities and development outside the coastal zone are presumed to not impact coastal resources.

Under the program, activities that impact any land use, water use, or natural resource of a coastal zone must comply with six laws, or "enforceable policies". These include:

- Shoreline Management Act;
- State Environmental Policy Act;
- Clean Air Act;
- Clean Water Act;
- Ocean Resources Management Act; and,
- Energy Facility Site Evaluation Council

CONSISTENCY DETERMINATION

Statutes addressed as part of the Washington Coastal Management Program consistency review and considered in the analysis of the proposed action are noted in the following table.

Statute	Scope	Consistency
Shoreline Management Act	Designated preferred uses for protected shorelines. Provides for the protection of shoreline natural resources and public access to shoreline areas. Protected shorelines include the following: • Marine waters; • Streams with greater than 20 cubic feet per second of mean annual flow; • Lakes 20 acres or larger; • Upland areas e.g., shorelands, that extend 200 feet landward from the edge of these waters; and, • Wetlands and floodplains associated with any of the above waters. Under the Shoreline Management Act, each city and county adopts a shoreline master program based on state guidelines but tailored to the specific needs of the city or county. Kitsap County has developed a Shoreline Management Master Program under Title 22 of the Kitsap County Code. Among the exemptions included is an exemption for any activity that "does not interfere with the normal public use of surface water."	**CONSISTENT** The Test Pile Program will be conducted along the east shoreline of the Hood Canal in the NBK Bangor Waterfront area. Naval Restricted Area 1 covers the area along the Hood Canal encompassing the NBK Bangor waterfront. The regulations associated with Naval Restricted Area 1 state that no person or vessel shall enter this area without permission from the Commander, Naval Submarine Base Bangor, or his/her authorized representative. The proposed action will be conducted entirely within this designated Naval Restricted Area. As a result, "the activity does not interfere with the normal public use of surface water" and is thus exempt from substantial development permitting requirements in accordance with Wash. Rev. Code Chapter 90.58 and the Kitsap County Master Shoreline Management Master Program (Kitsap County Code Chapter 22).

Statute	Scope	Consistency
State Environmental Policy Act (SEPA)	Requires state and local agencies to consider likely environmental consequences of a proposal before approving or denying the project.	**NOT APPLICABLE** The proposed action is a Federal action subject to the National Environmental Policy Act (NEPA), and is exempt from SEPA.
State Clean Air Act	Addresses the state's policy concerning air quality.	**CONSISTENT** Both temporary construction total annual emissions and projected annual operating emissions are below the 250 ton per year (tpy) significance threshold for all criteria pollutants. Potential impacts on air quality are discussed further in the EA (air section included).
State Clean Water Act	Addresses the state's policy concerning water quality and wetlands.	**CONSISTENT** The project review by the USACE is being made pursuant to Section 10 of the Rivers and Harbors Act. Section 401 of the Clean Water Act requires an applicant for a federal permit to obtain water quality certification from the State before commencing work in waters of the U.S. Water quality certification for the proposed placement of 29 test piles in the Hood Canal south of Explosive Handling Wharf #1 (EHW-1) will be initiated upon submittal of the JARPA and completed as part of the permitting process.

Statue	Scope	Consistency
Ocean Resources Management Act	Establishes the state's policy for leasing tidal or submerged coastal lands from Cape Flattery to Cape Disappointment.	**NOT APPLICABLE** The proposed action does not affect ocean uses involving renewable and/or non renewable resources that occur on Washington's coastal waters.
Energy Facility Site Evaluation Council	Addresses the state's policy for permitting the development of new energy-generating facilities.	**NOT APPLICABLE** The proposed action does not include the construction of any energy-generating facilities.

CONCLUSION

The proposed action will be undertaken in a manner is consistent to the maximum extent practicable with the enforceable policies of Washington's approved coastal zone management program

Figure 1 Study Area

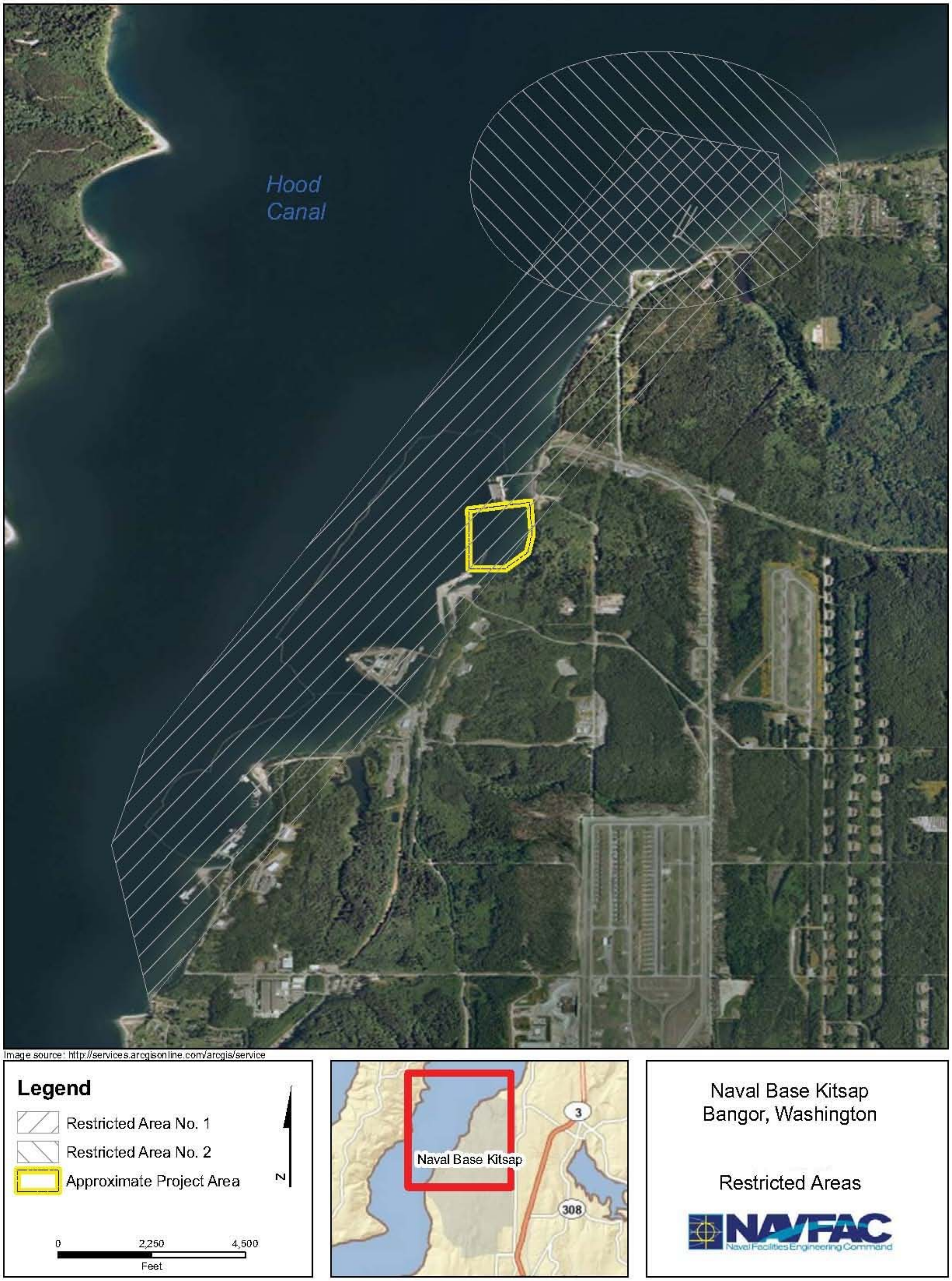

Figure 2 NBK Bangor Restricted Areas

APPENDIX B

Air Quality Calculations

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Test Piles emissions calculations for boat (From EPA AP-42)

E=A*EF

E=emissions
A=activity rate
EF=emissions factor

Assumptions
internal combustion diesel engine with 600 HP or less for the vibratory hammer and the pile driver
50.75 hours total for vibratory hammer & pile driver
no emissions control reductions
A=50.75 hours
boat operates 100% of the time the vibratory hammer and/or pile driver are operating
approximately 60 year old 44-foot tugboat

Calculations explanations

NOx	where A=50.75 hours per year, E=0.031 lbs./hp-hr
CO	where A=50.75 hours per year, E=6.68 E-03 lbs./hp-hr
SOx	where A=50.75 hours per year, E=2.05 E-03 lbs./hp-hr
PM10	where A= 50.75 hours per year, E=2.20 E-03 lbs./hp-hr
CO2	where A= 50.75 hours per year, E=1.15 lbs./hp-hr

NOx	**943.95 lbs.**	**0.47 tons**	emissions for activity	EF=0.031
CO	**203.41 lbs.**	**0.10 tons**	emissions for activity	EF=6.68 E-03
SOx	**62.42 lbs.**	**0.03 tons**	emissions for activity	EF=2.05 E-03
PM10	**66.99 lbs.**	**0.03 tons**	emissions for activity	EF=2.20 E-03
CO2	**35017.50 lbs.**	**17.51 tons**	emissions for activity	EF=1.15
	36249.00 lbs.	**18.15 tons**	SUM emissions for activity	
	72589.00 lbs	**36.29 tons**	**SUM TOTAL for boat, pile driver and vibratory hammer**	

Test Piles emissions calculations for vibratory hammer and pile driver combined (Action Alternative only, no emissions associated with the No Action Alternative), From EPA AP-42

E=A*EF

E=emissions
A=activity rate
EF=emissions factor

Assumptions
internal combustion diesel engine with 600 HP or less for the vibratory hammer and the pile driver
50.75 hours total for vibratory hammer & pile driver
no emissions control reductions
A=50.75 hours
boat operates 100% of the time the vibratory hammer and/or pile driver are operating
approximately 60 year old 44-foot tugboat

Calculations explanations

NOx	where A=50.75 hours per year, E=0.031 lbs./hp-hr
CO	where A=50.75 hours per year, E=6.68 E-03 lbs./hp-hr
SOx	where A=50.75 hours per year, E=2.05 E-03 lbs./hp-hr
PM10	where A=50.75 hours per year, E=2.20 E-03 lbs./hp-hr
CO2	where A=50.75 hours per year, E=1.15 lbs./hp-hr

NOx	**943.95**	**lbs.**	**0.47**	**tons**	emissions for activity	EF=0.031
CO	**203.41**	**lbs.**	**0.10**	**tons**	emissions for activity	EF=6.68 E-03
SOx	**62.42**	**lbs.**	**0.03**	**tons**	emissions for activity	EF=2.05 E-03
PM10	**66.99**	**lbs.**	**0.03**	**tons**	emissions for activity	EF=2.20 E-03
CO2	**35017.50**	**lbs.**	**17.51**	**tons**	emissions for activity	EF=1.15
	36294.00	**lbs.**	**18.15**	**tons**	**SUM emissions for activity**	
			36.29	**tons**	**SUM TOTAL for boat, pile driver and vibratory hammer**	

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APPENDIX C

Tribal Consultations

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APPENDIX D

SHPO Concurrence Letter

STATE OF WASHINGTON

DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION

1063 S. Capitol Way, Suite 106 • Olympia, Washington 98501
Mailing address: PO Box 48343 • Olympia, Washington 98504-8343
(360) 586-3065 • Fax Number (360) 586-3067 • Website: www.dahp.wa.gov

June 28, 2010

Captain M. J. Olson
Naval Base Kitsap
120 South Dewey Street
Bremerton, Washington 98314-5020

Re: Pile Testing at Explosives Handling Wharf Project
Log No: 022210-11-USN

Dear Captain Olson:

Thank you for contacting our department. We reviewed the materials you provided for the proposed Pile Testing at Explosives Handling Wharf Project at Naval Base Bangor, Kitsap County, Washington.

We concur with your determination of No Historic Properties Affected.

We would appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

These comments are based on the information available at the time of this review and on the behalf of the State Historic Preservation Officer in conformance with Section 106 of the National Historic Preservation Act and its implementing regulations 36CFR800. Should additional information become available, our assessment may be revised.

In the event that archaeological or historic materials are discovered during project activities, work in the immediate vicinity must stop, the area secured, and the concerned tribes and this department notified. Thank you for the opportunity to comment and a copy of these comments should be included in subsequent environmental documents.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: rob.whitlam@dahp.wa.gov

DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION
Protect the Past, Shape the Future

APPENDIX E

Essential Fish Habitat Assessment

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