Final Environmental Assessment
For the Issuance of an Incidental Harassment Authorization for the Take of Marine Mammals by Harassment Incidental to the Alaska Phase of the Quintillion Subsea Project in the U.S. Arctic Ocean

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LOCATION:	U.S. Bering, Chukchi, and Beaufort Seas
ABSTRACT:	National Marine Fisheries Service proposes to issue an Incidental Harassment Authorization (IHA) to Quintillion Subsea Operations, LLC (Quintillion) for the take of marine mammals incidental to conducting the Alaska Phase of the subsea cable laying activities in the U.S. Arctic Ocean in 2016.

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Chapter 1 INTRODUCTION AND PURPOSE AND NEED

1.1 Description of Proposed Action

The Marine Mammal Protection Act of 1972, as amended (MMPA; 16 U.S.C. 1631 et seq.) prohibits the incidental taking of marine mammals. The incidental take of a marine mammal falls under three categories: mortality, serious injury or harassment (i.e., injury and behavioral effects). Harassment[1] is any act of pursuit, torment or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment) or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns (Level B harassment). Disruption of behavioral patterns includes, but is not limited to, migration, breathing, nursing, breeding, feeding or sheltering. However, there are exceptions to the prohibition on take in Section 101(a)(5)(D) of the MMPA that gives the National Marine Fisheries Service (NMFS) the authority to authorize the incidental but not intentional take of small numbers of marine mammals by harassment provided certain determinations are made and statutory and regulatory procedures are met. Refer to Chapter 2 for details regarding this exception and NMFS' incidental harassment authorization (IHA) criteria.

NMFS also promulgated regulations to implement the provisions of the MMPA governing the taking and importing of marine mammals, 50 Code of Federal Regulations (CFR) Part 216 and produced Office of Management and Budget (OMB)-approved application instructions (OMB Number 0648-0151) that prescribe the procedures necessary to apply for permits. All applicants must comply with these regulations and application instructions in addition to the provisions of the MMPA.

We propose to issue an IHA to the Quintillion Subsea Operations, LLC (Qunitillion) under the MMPA for the taking of small numbers of marine mammals, incidental to its Alaska Phase of the subsea cable laying activities in the U.S. Arctic Ocean during the 2016 Arctic open-water season. We do not have the authority to permit, authorize, or prohibit Quintillion's subsea cable laying activities.

1.1.1 Applicant's Incidental Take Authorization Request

Our proposed action is a direct outcome of Quintillion requesting an IHA under section 101(a)(5)(D) of the MMPA to take marine mammals, by harassment, incidental to conducting subsea cable laying activities. Underwater noises associated with the cable vessel's dynamic positioning thrusters have the potential to take, by harassment, marine mammals. Quintillion therefore requires an IHA for its incidental takes.

Our issuance of an IHA to Quintillion would be a major federal action under the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations in 40 CFR §§ 1500-1508, and NOAA Administrative Order (NAO) 216-6. Thus, we are required to analyze the effects of our proposed action.

[1] As defined in the MMPA for non-military readiness activities (Section 3 (18)(A)).

This Final Environmental Assessment (EA), titled "*Issuance of Incidental Harassment Authorizations for the Take of Marine Mammals by Harassment Incidental to the Alaska Phase of the Quintillion Subsea Project in the U.S. Arctic Ocean*," (hereinafter, EA) addresses the potential environmental impacts of two alternatives, namely:

- Issue the Authorization to Quintillion under the MMPA for Level B harassment of marine mammals during Quintillion's subsea cable laying activities, taking into account the prescribed means of take, mitigation measures, and monitoring requirements required in the proposed Authorization; or

- Not issue the Authorization to Quintillion, in which case, for the purposes of NEPA analysis only, we assume that Quintillion would forego the proposed respective subsea cable laying activities in the Arctic Ocean.

1.1.2 Background on Quintillion's MMPA Applications

On October 29, 2015, NMFS received an application from Quintillion for the taking of marine mammals incidental to conducting subsea cable laying activities in the U.S. Bering, Chukchi, and Beaufort seas. After receiving NMFS comments, Quintillion made revisions and updated its IHA application and marine mammal mitigation and monitoring plan on February 3, 2016.

Quintillion proposes to install a subsea fiber optic network along the northern and western coasts of Alaska in the U.S. Bering, Chukchi, and Beaufort seas during the 2016 Arctic open-water season. The proposed activity would occur between June 1 and October 31, 2016. Noise generated from the cable vessel's dynamic positioning thruster could impact marine mammals in the vicinity of the activities. Take, by Level B harassments, of individuals of 12 species of marine mammals is anticipated to result from the specified activity.

1.1.3 Marine Mammals in the Action Area

Quintillion has requested an authorization to take 12 marine mammal species by Level B harassment. These species are: beluga whale (*Delphinapterus leucas*), bowhead whale (*Balaena mysticetus*), gray whale (*Eschrichtius robustus*), killer whale (*Orcinus orca*), harbor porpoise (*Phocoena phocoena*), fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), bearded seal (*Erignathus barbatus*), ringed seal (*Phoca hispida*), spotted seal (*P. largha*), and ribbon seal (*Histriophoca fasciata*).

1.2 Purpose and Need

The MMPA prohibits "takes" of marine mammals, with a number of specific exceptions. The applicable exception in this case is an authorization for incidental take of marine mammals in section 101(a)(5)(D) of the MMPA.

Section 101(a)(5)(D) of the MMPA directs the Secretary of Commerce (Secretary) to authorize, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock, by United States citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if we make certain findings and

provide a notice of a proposed authorization to the public for review. Entities seeking to obtain authorization for the incidental take of marine mammals under our jurisdiction must submit such a request (in the form of an application) to us.

1.2.1 Purpose: The primary purpose of our proposed action—the issuance of an Authorization to Quintillion—is to authorize (pursuant to the MMPA) the take of marine mammals incidental to Quintillion's proposed activities. The IHA, if issued, would exempt Quintillion from the take prohibitions contained in the MMPA.

To authorize the take of small numbers of marine mammals in accordance with section 101(a)(5)(D) of the MMPA, we must evaluate the best available scientific information and determine the take would have a negligible impact on marine mammals or stocks and not have an unmitigable adverse impact on the availability of affected marine mammal species for certain subsistence uses. We cannot issue an IHA if it would result in more than a negligible impact on marine mammal species or stocks or if it would result in an unmitigable adverse impact on subsistence uses.

In addition, we must prescribe, where applicable, the permissible methods of taking and other means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat (i.e., mitigation), paying particular attention to rookeries, mating grounds, and other areas of similar significance. If appropriate, we must prescribe means of effecting the least practicable impact on the availability of the species or stocks of marine mammals for subsistence uses. Authorizations must also include requirements or conditions pertaining to the monitoring and reporting of such taking, in large part to better understand the effects of such taking on the species. Also, we must publish a notice of a proposed Authorization in the *Federal Register* for public notice and comment.

The underlying purpose of this action is therefore to determine whether the take resulting from Quintillion's subsea cable laying activities in the Bering, Chukchi, and Beaufort seas during the 2016 Arctic open-water season would have a negligible impact on affected marine mammal species or stocks and would not have an unmitigable adverse impact on the availability of marine mammals for taking for subsistence uses, and to develop mitigation and monitoring measures to reduce the potential impacts.

1.2.2 Need: U.S. citizens seeking to obtain authorization for the incidental take of marine mammals under NMFS jurisdiction must submit such a request (in the form of an application). On February 3, 2016, Quintillion submitted an adequate and complete application demonstrating both the need and potential eligibility for issuance of an IHA in connection with the activities described in section 1.1.1. We now have a corresponding duty to determine whether and how we can authorize take by Level B harassment incidental to the activities described in Quintillion's application. Our responsibilities under section 101(a)(5)(D) of the MMPA and its implementing regulations establish and frame the need for this proposed action.

Any alternatives considered under NEPA must meet the agency's statutory and regulatory requirements. Our described purpose and need guide us in developing reasonable alternatives for consideration, including alternative means of mitigating potential adverse effects.

1.3 Environmental Review Process

In accordance with the Council on Environmental Quality (CEQ) Regulations and Agency policies for implementing the National Environmental Policy Act (NEPA), NMFS, to the fullest extent possible, integrates the requirements of NEPA with other regulatory processes required by law or by agency practice so that all procedures run concurrently, rather than consecutively. This includes coordination within National Oceanic Atmospheric Administration (NOAA), (e.g., the Office of the National Marine Sanctuaries) and with other regulatory agencies (e.g., the U.S. Fish and Wildlife Service), as appropriate, during NEPA reviews prior to implementation of a proposed action to ensure that requirements are met. Regarding the issuance of IHAs, we rely substantially on the public process required by the MMPA for preparing proposed IHAs to develop and evaluate relevant environmental information and provide a meaningful opportunity for public participation when we prepare corresponding NEPA documents. We fully consider public comments received in response to the publication of proposed IHAs during the corresponding NEPA review process.

1.3.1 National Environmental Policy Act

NEPA requires federal agencies to examine the environmental impacts of their proposed actions within the United States and its territories. A NEPA analysis is a detailed public document that provides an assessment of the potential effects a major federal action may have on the human environment, which includes the natural and physical environment. Major federal actions include activities that federal agencies fully or partially fund, regulate, conduct or approve. Because our issuance of an Authorization would allow for the taking of marine mammals, consistent with provisions under the MMPA and incidental to the applicant's activities, we consider this as a major federal action subject to NEPA; therefore, NMFS analyzes the environmental effects associated with authorizing incidental takes of protected species and prepares the appropriate NEPA documentation.

Under the requirements of NAO 216-6 section 6.03(f)(2)(b), as preserved by NAO 216-6A, for incidental harassment authorizations, we prepared this EA to determine whether the direct, indirect and cumulative impacts related to the issuance of an IHA for incidental take of marine mammals during Quintillion's open-water subsea cable laying activities in the Bering, Chukchi, and Beaufort seas, could be significant. If we deem the potential impacts to be not significant, this analysis, in combination with other analyses incorporated by reference, may support the issuance of a Finding of No Significant Impact (FONSI) for the proposed Authorization.

1.3.1 Laws, Regulations, or Other NEPA Analyses Influencing the EA's Scope

We have based the scope of the proposed action and nature of the two alternatives considered in this EA on the relevant requirements in section 101(a)(5)(D) of the MMPA. Thus, our authority under the MMPA bounds the scope of our alternatives. We conclude that this analysis—when combined with the analyses in the following documents—fully describes the impacts associated with the proposed subsea cable laying activities with mitigation and monitoring for marine mammals. After conducting a review of the information and analyses for sufficiency and adequacy, we incorporate by reference the relevant analyses on Quintillion's proposed activities as well as discussions of the affected environment and environmental consequences within the following documents, per 40 CFR §1502.21 and NAO 216-6 § 5.09(d), as preserved by NAO 216-6A:

- *Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with Proposed Alaska Phase of the Quintillion Subsea Project, 2016* (Owl Ridge Natural Resource Consultants, Inc., 2016).

MMPA APPLICATION AND NOTICE OF THE PROPOSED AUTHORIZATION

The CEQ regulations (40 CFR § 1502.25) encourage federal agencies to integrate NEPA's environmental review process with other environmental reviews. We rely substantially on the public process for developing proposed Authorization and evaluating relevant environmental information and provide a meaningful opportunity for public participation as we develop the corresponding EA. We fully consider public comments received in response to our publication of the notice of proposed Authorization during the corresponding NEPA process.

We considered Quintillion's proposed mitigation and monitoring measures and determined that they would help ensure that the surveys would effect the least practicable impact on marine mammals. These measures include:

- Implementing vessel speed or course alteration during pre-cable-laying surveys and post-cable-laying inspection when a marine mammal appears likely to enter the exclusion zone, provided that doing so will not compromise operational safety requirements; and

- Eastablishing zones of influence surrounding the cable-laying vessel where the received level would be 120 dB (rms) re 1 μPa, and monitoring those zones for marine mammals during cable-laying activities through vessel-based visual monitoring by protected species observers.

Through the MMPA process, we determined that, provided that Quintillion implements the required mitigation and monitoring measures, the impact of the activities on marine mammals would be, at worst, a temporary modification in behavior of small numbers of certain species of marine mammals when exposed to certain received noise levels from the proposed subsea cable project.

We also prepared a *Federal Register* notice (81 FR 17666; March 30, 2016) on the proposed activity and request that the public submit comments, information, and suggestions concerning Quintillion's request, the content of our proposed IHA, and potential environmental effects related to the proposed issuance of the Authorization. During the 30-day public comment period, NMFS received comments from the Marine Mammal Commission (Commission) and the North Slope Borough (NSB). The Commission concurs with NMFS's preliminary finding and recommends that NMFS issue the incidental harassment authorization, subject to inclusion of the proposed mitigation, monitoring, and reporting measures. The NSB requests that Qunitillion continue working with subsistence communities and communicate with all villages to make sure that the proposed activities do not disrupt subsistence activities and to ensure the life, health and safety of Borough residents who may be out on the ocean. All relevant comments will be addressed in the *Federal Rigister* notice when NMFS makes a determination whether to issue an IHA.

In summary, the analysis referenced above supports our conclusion that, with the incorporation of the proposed monitoring and mitigation measures, the issuance of the IHA to Quintillion for the subsea cable laying activities would not result in any significant direct, indirect, or cumulative impacts. Based on our MMPA analysis, the limited harassment from the proposed subsea cable laying activities would allow adequate time for the marine mammals to recover from potentially adverse effects. Furthermore, the referenced analysis concluded that additive or cumulative effects of the project on its own or in combination with other activities, are not expected to occur. Finally, the environmental analysis did not identify any significant environmental issues or impacts.

1.3.2 Scope of Environmental Analysis

Given the limited scope of the decision for which we are responsible (*i.e.*, issue the IHA including prescribed means of take, mitigation measures, and monitoring requirements, or not issue the IHA), this EA provides more focused information on the primary issues and impacts of environmental concern related specifically to our issuance of the IHA. This EA does not further evaluate effects to the elements of the human environment listed in Table 1, because the issuance of an IHA for Quintillion's proposed activity would not significantly affect those components of the human environment. Moreover, those analyses are consistent with our MMPA analysis concluding that there would be no significant impacts to marine mammals.

Table 1. Components of the human environment not affected by our issuance of an IHA.

Biological	Physical	Socioeconomic / Cultural
Lower trophic organisms	Air Quality	Commercial Fishing
Fish	Essential Fish Habitat	Military Activities
Mammal species not under NMFS jurisdiction	Geography	Recreational Fishing
Seabirds	Oceanography	Shipping and Boating
		National Historic Preservation Sites
		Low Income Populations
		Minority Populations
		Indigenous Cultural Resources
		Public Health and Safety
		Historic and Cultural Resources

1.3.3 Scoping and Public Involvment

The NEPA process is intended to enable NMFS to make decisions based on an understanding of the environmental consequences of an action and take actions to protect, restore, and enhance the environment. An integral part of the NEPA process is public involvement. Early public involvement facilitates the development of an EA and informs the scope of issues to be addressed in the EA. Although agency procedures do not require public involvement prior to finalizing an EA, NMFS determined that the publication of the proposed IHA was the

appropriate step to involve the public in order to understand the public concerns for the proposed action, identify significant issues related to the proposed action and obtain the necessary information to complete a NEPA analysis.

NAO 216-6, as preserved by NAO 216-6A, established NOAA procedures for complying with NEPA and the implementing NEPA regulations issued by the CEQ. Consistent with the intent of NEPA and the clear direction in NAO 216-6 to involve the public in NEPA decision-making, we released the Draft EA for public comment on the potential environmental impacts of our issuance of an IHA, as well as comment on the activities described in Quintillion's MMPA application and in the *Federal Register* notice (81 FR 17666; March 30, 2016) of the proposed IHA. During the 30-day public comment period, NMFS received comments from the Marine Mammal Commission (Commission) and the North Slope Borough (NSB). The Commission recommends that NMFS issue the requested incidental harassment authorization, subject to inclusion of the proposed mitigation, monitoring, and reporting measures. The NSB requests that Qunitillion continue working with subsistence communities and communicate with all villages to make sure that the proposed activities do not disrupt subsistence activities and to ensure the life, health and safety of Borough residents who may be out on the ocean.

1.4 Other Permits, Licenses, or Consultation Requirements

NMFS must comply with all applicable federal environmental laws, regulations, and Executive Orders (EO) necessary to implement a proposed action. NMFS' evaluation of and compliance with environmental laws, regulations and EOs is based on the nature and location of the applicant's proposed activities and NMFS proposed action. Therefore, this section only summarizes environmental laws and consultations applicable to NMFS issuance of an IHA to Quintillion.

1.4.1 National Environmental Policy Act

Issuance of an Authorization is subject to environmental review under NEPA. NMFS may prepare an EA, an EIS, or determine that the action is categorically excluded from further review. While NEPA does not dictate substantive requirements for an Authorization, it requires consideration of environmental issues in federal agency planning and decision making. The procedural provisions outlining federal agency responsibilities under NEPA are provided in CEQ's implementing regulations (40 CFR §§ 1500-1508).

1.4.2 Marine Mammal Protection Act

The MMPA and its provisions that pertain to the proposed action are discussed above in section 1.2.

1.4.3 Endangered Species Act

The Endangered Species Act (ESA) established protection over and conservation of threatened and endangered species (T&E) and the ecosystems upon which they depend. An endangered species is a species in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the near future throughout

all or in a significant portion of its range. The U.S. Fish and Wildlife Service (USFWS) and NMFS jointly administer the ESA and are responsible for the listing of species (designating a species as either threatened or endangered) and designating geographic areas as critical habitat for (T&E) species. The ESA generally prohibits the "take" of an ESA-listed species unless an exception or exemption applies. The term "take" as defined in section 3 of the ESA means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." section 7(a)(2) requires each federal agency to ensure that any action it authorizes, funds or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species. When a federal agency's action may affect a listed species, that agency is required to consult with NMFS and/or the USFWS under procedures set out in 50 CFR Part 402. NMFS and USFWS can also be action agencies under section 7. Informal consultation is sufficient for species the action agency determines are not likely to be adversely affected if NMFS or USFWS concurs with the action agency's findings, including any additional measures mutually agreed upon as necessary and sufficient to avoid adverse impacts to listed species and/or designated critical habitat.

The bowhead, humpback, and fin whales are the only marine mammal species currently listed under the ESA that could occur in the vicinity of Quintillion's proposed subsea cable laying activity. NMFS' Permits and Conservation Division has consulted with NMFS' Alaska Regional Protected Resources Division (AKRO) under section 7 of the ESA on the issuance of the IHA to Quintillion under section 101(a)(5)(D) of the MMPA for this activity. In a biological opinion dated May 19, 2016, NMFS' Alaska Regional Office concluded that the issuance of the IHA is: (1) not likely to jeopardize the continued existence of the ESA-listed bowhead whales; and (2) not likely to adversely modify or destroy critical habitat, as the proposed subsea cable-laying areas are neither within nor nearby designated critical habitat for ESA-listed species.

1.4.4 Magnuson-Stevens Fishery Conservation and Management Act

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), "Essential Fish Habitat" (EFH) is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. § 1802(10)). The EFH provisions of the MSFCMA offer resource managers means to accomplish the goal of giving heightened consideration to fish habitat in resource management.

Federal agencies are required to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency which may adversely affect essential fish habitat (EFH) identified under the MSA.

1.4.5 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) encourages coastal states to develop comprehensive programs to manage and balance competing uses of and impacts to coastal resources. The CZMA emphasizes the primacy of state decision-making regarding the coastal zone. Section 307 of the CZMA (16 U.S.C. § 1456), called the federal consistency provision, is a major incentive for states to join the national coastal management program and is a powerful tool that states use to manage coastal uses and resources and to facilitate cooperation and coordination with federal agencies.

Federal consistency is the CZMA requirement where federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources and coastal effects) must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally-approved coastal management program. On July 1, 2011, the federally-approved Alaska Coastal Management Program expired, resulting in a withdrawal by Alaska from participation in CZMA's National Coastal Management Program. The federal CZMA consistency provision in section 307 no longer applies in Alaska.

Chapter 2 ALTERNATIVES

2.1 Introduction

NEPA and the CEQ implementing regulations (40 CFR §§ 1500-1508) require consideration of alternatives to proposed major federal actions and NAO 216-6, as preserved by NAO 216-6A, provides NOAA policy and guidance on the consideration of alternatives to our proposed action. An EA must consider all reasonable alternatives, including the Preferred Alternative. It must also consider the No Action Alternative, even if that alternative does not meet the stated purpose and need. This provides a baseline analysis against which we can compare the other alternatives.

To warrant detailed evaluation as a reasonable alternative, an alternative must meet our purpose and need. In this case, as we previously explained in Chapter 1 of this EA, an alternative only meets the purpose and need if it satisfies the requirements under section 101(a)(5)(D) the MMPA. We evaluated each potential alternative against these criteria; identified one reasonable action alternative along with the No Action Alternative; and carried these forward for evaluation in this EA. This chapter describes the alternatives and compares them in terms of their environmental impacts and their achievement of objectives.

As described in Section 1.2, the MMPA requires that we must prescribe the means of effecting the least practicable impact on the species or stocks of marine mammals and their habitat. In order to do so, we must consider Quintillion's proposed mitigation measures, as well as other potential measures, and assess how such measures could benefit the affected species or stocks and their habitat. Our evaluation of potential measures includes consideration of the following factors in relation to one another: (1) the manner in which, and the degree to which, we expect the successful implementation of the measure to minimize adverse impacts to marine mammals; (2) the proven or likely efficacy of the specific measure to minimize adverse impacts as planned; and (3) the practicability of the measure for applicant implementation.

Any additional mitigation measure proposed by us beyond what the applicant proposes should be able to or have a reasonable likelihood of accomplishing or contributing to the accomplishment of one or more of the following goals:

- Avoidance or minimization of marine mammal injury, serious injury, or death, wherever possible;
- A reduction in the numbers of marine mammals taken (total number or number at biologically important time or location);
- A reduction in the number of times the activity takes individual marine mammals (total number or number at biologically important time or location);
- A reduction in the intensity of the anticipated takes (either total number or number at biologically important time or location);
- Avoidance or minimization of adverse effects to marine mammal habitat, paying special attention to the food base; activities that block or limit passage to or from biologically

important areas; permanent destruction of habitat; or temporary destruction/disturbance of habitat during a biologically important time; and

- For monitoring directly related to mitigation, an increase in the probability of detecting marine mammals, thus allowing for more effective implementation of the mitigation.

Alternative 1 (the Preferred Alternative) includes a suite of mitigation measures intended to minimize potentially adverse interactions with marine mammals.

2.2 Description of Quintillion's Proposed Activities

Quintillion plans to conduct subsea cable-laying activity during the 2016 Arctic open-water season in the Bering, Chukchi, and Beaufort seas.

2.2.1 Dates and Duration

Quintillion's proposed subsea cable laying activity is planned for the 2016 open-water season (June through October, 2016). All associated activities, including mobilization, pre-lay grapnel run (PLGR), cable-laying, post lay inspection and burial (PLIB), and demobilization of survey and support crews, would occur inclusive of the above seasonal dates. It is expected that the operations may last all season (approximately 150 days).

2.2.2 Specific Geographic Region

The planned fiber optic cable-laying project will occur in the offshore waters of the Bering, Chukchi, and Beaufort seas between Nome and Oliktok Point (the latter located 260 km [162 mi] southeast of Barrow) (Figure 1).

2.2.3 Detailed Description of the Activity

I. Cable Network

The proposed subsea cable network is shown in Figure 1. The main trunk line is 1,317 km (818 mi) in length, and will run from the tail of the Nome branch line to the tail of the Oliktok Point branch line (Table 1). The branch lines range between 27 km (17 mi) and 233 km (145 mi). The branch lines connect to the main trunk line at the branching unit (BU), which is a piece of hardware that allows the interconnection of the branch cable from the main trunk line to the shore end facility. The cable is also "repeatered" in that approximately every 60 km (37 mi) a repeater is attached to the cable that amplifies the signal. Collectively, the cable, branch units (Bus), and repeaters make up the "submerged plant." Depending on bottom substrate, water depth, and distance from shore, the cable would either lay on the ocean floor or be buried using a plough or a remote operating vehicle (ROV) equipped for burial jetting.

II. Vessels

The cable-laying operations will be conducted from the *Ile de Brehat* or one of its sister ships (*Ile de Sein*, *Ile de Batz*). All three ships are 140 m (460 ft) in length and 23 m (77 ft) in breadth, with berths for a crew of 70. The ships are propelled by two 4,000 kW fixed-pitch propellers. Dynamic positioning is maintained by two 1,500 kW bow thrusters, two 1,500 kW aft thrusters, and one 1,500 kW fore thruster.

Support vessels include a tug and barge that will remain in the vicinity of the main lay vessel. During cable laying activities occurring in nearshore waters too shallow for the *Ile de Brehat*, the tug and barge (using a dive team) will lay the final shore ends of the cable.

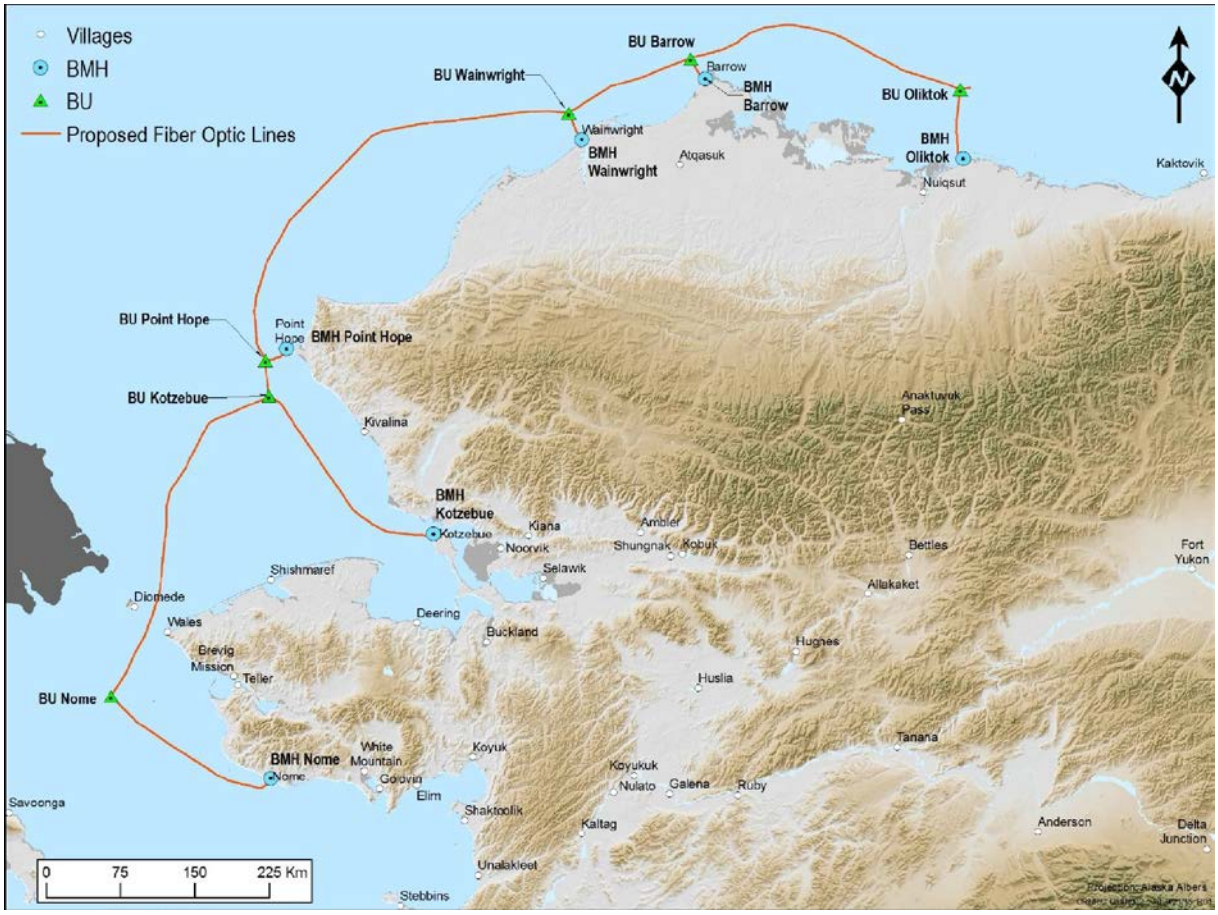

Figure 1. Quintillion Subsea Operations, LLC's proposed fiber optics cable network.

Table 2. Network route lengths for each segment.

	Segment (km)							
	Main	Branch Lines						Total
		Oliktok	Barrow	Wainwright	Point Hope	Kotzebue	Nome	
Route Length	1,317	74	27	31	27	233	195	1,904

III. Pre-Lay Grapnel Run

Before cable is laid, a pre-lay grapnel run (PLGR) will be carried out along the proposed cable route where burial is required. The objective of the PLGR operation is the identification and clearance of any seabed debris, for example wires, hawsers, wrecks, or fishing gear, which may have been deposited along the route. Any debris recovered during these operations would be discharged ashore on completion of the operations and disposed of in accordance with local regulations. If any debris cannot be recovered, then a local reroute would be planned to avoid the debris. The PLGR operation would be to industry standards employing towed grapnels; the type of grapnel being determined by the nature of the seabed. The PLGR operation would be conducted by a local tug boat ahead of the cable-laying.

IV. Cable-Laying

The objective of the surface laying operation is to install the cable as close as possible to the planned route with the correct amount of cable slack to enable the cable to conform to the contours of the seabed without loops or suspensions. A slack plan would be developed that uses direct bathymetric data and a catenary modeling system to control the ship and the cable pay out speeds to ensure the cable is accurately placed in its planned physical position.

The cable would be buried to depth using various methods. In water depths greater than about 12 m (about 40 ft), the cable would be buried using an SMD Heavy Duty HD3 Plough. The plough has a submerged weight of 25 tonnes (27.6 tons). The plough is pulled by the tow wire and the cable fed through a cable depressor that pushes it into the trench. Burial depth is controlled by adjusting the front skids. The normal tow speed is approximately 600 m/hr (approximately 0.37 mph).

In water depths less than 12 m (40 ft), burial would be by jet burial using a towed sled, tracked ROV, or by diver jet burial, subject to seabed conditions in the area. The ROV would be used in areas accessible to the main lay vessel. The planned ROV, the ROVJET 400 series, is 5.8 m (19.0 ft) long and 3.4 m (11.2 ft) wide and weighs 9.1 tonnes (10 tons) in air, and has both a main and forward jet tool cable of trenching to 2 m (6.6 ft) depth.

Nearer to shore, where seasonal ice scouring occurs, the cable would be floated on the surface and then pulled through an existing horizontal directional drilling (HDD) bore pipe to the beach man hole (BMH) where it would be anchor-clamped and spliced to the terrestrial cable. The floated cable portion is then lowered to the seabed by divers and buried (using a post-lay burial method as described above) from the HDD Bore pipe seaward.

V. Post Lay Inspection and Burial

While it is expected that the cable trench would fill back in by natural current processes, it is important to ensure that cable splices and BUs are fully buried, and that there are no unnecessary plough skips at locations where burial is critical. To ensure proper burial, a post lay inspection and burial (PLIB) would be conducted using the ROVJET 400 series mentioned above. It is expected that PLIB would be necessary for no more than about 10 km (6.2 mi) of the cumulative planned burial routes.

2.2.4 Underwater Noise from the Activity

The proposed cable-laying activity is expected to generate underwater noises from several sources, including thrusters, plows, jets, ROVs, echo sounders, and positioning beacons. The predominant noise source and the only underwater noise that would affect marine mammals during cablelaying operations is the cavitating noise produced by the thrusters during dynamic positioning of the vessel (Tetra Tech 2014). Cavitation is random collapsing of bubbles produced by the blades. The *C/S Ile de Brehat* maintains dynamic positioning during cable-laying operations by using two 1,500 kW bow thrusters, two 1,500 kW aft thrusters, and one 1,500 kW fore thruster. Sound source measurements have not been conducted specific to the *C/S*

Ile de Brehat but other acoustical studies have shown thruster noise measurements ranging between 171 and 180 dB re 1 μPa (rms) at 1 m (Nedwell et al. 2003, MacGillivary 2006, Samsung 2009, Hartin et al. 2011, Deepwater Wind 2013, Tetra Tech 2014).

Thruster noise is a non-impulse sound source, and exceeds NMFS Level B harassment criteria when its received levels are above 120 dB re 1 μPa (rms). Various acoustical investigations in the Atlantic Ocean have modeled distances to the 120 dB isopleth with results ranging between 1.4 and 3.575 km (Samsung 2009, Deepwater Wind 2013, Tetra Tech 2014) for water depths similar to where Quintillion would be operating in the Arctic Ocean. However, all these ranges were based on conservative modeling that included maximum parameters and worst-case assumptions.

Hartin et al. (2011) physically measured dynamic positioning noise from the 104-m (341-ft) Fugro Synergy operating in the Chukchi Sea while it was using thrusters (2,500 kW) more powerful than those used on the *C/S Ile de Brehat* (1,500 kW). Measured dominant frequencies were 110 to 140 Hz, and the measured (90^{th} percentile) radius to the 120-dB isopleth was 2.3 km (1.4 mi). Because this radius is a measured value from the same water body where Quintillion's cable-laying operation would occur, as opposed to a conservatively modeled value from the Atlantic Ocean, it is the value used in calculating marine mammal exposure estimates. Sound source levels from the Fugro Synergy during dynamic positioning did not exceed 180 dB, thus there are no Level A harassment or injury concerns.

2.3 Description of Alternatives

2.3.1 Alternative 1 – Issuance of an Authorization with Mitigation Measures (Preferred Alternative)

Under this alternative, NMFS would issue an IHA under section 101(a)(5)(D) of the MMPA to Quintillion, allowing the take, by Level B harassments, of small numbers of marine mammal species incidental to its subsea cable laying activity in the Bering, Chukchi, and Beaufort seas during the 2016 open-water season. In order to reduce the incidental harassment of marine mammals to the lowest level practicable, Quintillion would be required to implement the mitigation, monitoring, and reporting measures described below.

2.3.1.1 Proposed Mitigation Measures

In its Marine Mammal Mitigation and Monitoring Plan (4MP), Quintillion proposed a suite of mitigation measures to minimize any adverse impacts associated with the subsea cable laying operation in the Bering, Chukchi, and Beaufort seas. These include: (1) establishing and monitoring disturbance zones; and (2) vessel movement to minimize potential marine mammal impacts. The following is a summary of mitigaiton measures proposed for Quintillion:

(a) Establishing Zone of Influence (ZOI)

- (i) Establish a ZOI where the received level is 120 dB.

(b) Vessel Movement Mitigation during Pre- and Post-cable-laying Activities :

- (i) Avoid concentrations or groups of whales by all vessels under the direction of Quintillion.
- (ii) If any vessel approaches within 1.6 km (1 mi) of observed bowhead whales, except when providing emergency assistance to whalers or in other emergency situations, the vessel operator will take reasonable precautions to avoid potential interaction with the bowhead whales.
- (iii) When weather conditions require, such as when visibility drops, adjust vessel speed accordingly, but not to exceed 5 knots, to avoid the likelihood of injury to whales.

2.3.1.2 Proposed Monitoring Measures

(1) Protected Species Observers

Vessel-based monitoring for marine mammals would be done by trained protected species observers (PSOs) throughout the period of subsea cable-laying operation. The observers would monitor the occurrence of marine mammals near the cable-laying vessel during all daylight periods during operation. PSO duties would include watching for and identifying marine mammals; recording their numbers, distances, and reactions to the survey operations; and documenting "take by harassment."

A sufficient number of PSOs would be required onboard each survey vessel to meet the following criteria:

- 100% monitoring coverage during all periods of cable-laying operations in daylight;
- Maximum of 4 consecutive hours on watch per PSO; and
- Maximum of 12 hours of watch time per day per PSO.

PSO teams will consist of Inupiat observers and experienced field biologists. Each vessel will have an experienced field crew leader to supervise the PSO team. The total number of PSOs may decrease later in the season as the duration of daylight decreases.

(2) Observer Qualifications and Training

Lead PSOs and most PSOs would be individuals with experience as observers during marine mammal monitoring projects in Alaska or other offshore areas in recent years. New or inexperienced PSOs would be paired with an experienced PSO or experienced field biologist so that the quality of marine mammal observations and data recording is kept consistent.

Resumes for candidate PSOs would be provided to NMFS for review and acceptance of their qualifications. Inupiat observers would be experienced in the region and familiar with the marine mammals of the area. All observers would complete a NMFS-approved observer training course designed to familiarize individuals with monitoring and data collection procedures.

(3) Specialized Field Equipment

The PSOs shall be provided with Fujinon 7 X 50 or equivalent binoculars for visual based monitoring onboard all vessels.

Laser range finders (Leica LRF 1200 laser rangefinder or equivalent) would be available to assist with distance estimation.

(4) Sound Source Verification

Quintillion plans to conduct a sound source verification (SSV) on one of the cable-lay ships and the anchor-handling tugs when both are operating near Nome (early in the season).

Monitoring Plan Peer Review

The MMPA requires that monitoring plans be independently peer reviewed "where the proposed activity may affect the availability of a species or stock for taking for subsistence uses" (16 U.S.C. 1371(a)(5)(D)(ii)(III)). Regarding this requirement, NMFS' implementing regulations state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan" (50 CFR 216.108(d)).

NMFS has established an independent peer review panel to review Quintillion's 4MP for their proposed open-water subsea cable laying activities. The panel met in early March 2016, and provided recommendations to NMFS in mid-April. These recommendations include contributing funding to acoustic monitoring in offshore waters and analysis of existing data from passive acoustic monitors deployed in 2013-2015 near Kotzebue, which Quintillion has agreed to provide.

Reporting Measures

(1) Final Report

The results of Quintillion's subsea cable laying activities monitoring reports would be presented in the "90-day" final report, as required by NMFS under the proposed IHA. The initial final report is due to NMFS within 90 days after the expiration of the IHA (if issued). The report will include:

- Summaries of monitoring effort (e.g., total hours, total distances, and marine mammal distribution through the study period, accounting for sea state and other factors affecting visibility and detectability of marine mammals);

- Summaries that represent an initial level of interpretation of the efficacy, measurements, and observations, rather than raw data, fully processed analyses, or a summary of operations and important observations;

- Analyses of the effects of various factors influencing detectability of marine mammals (e.g., sea state, number of observers, and fog/glare);

- Species composition, occurrence, and distribution of marine mammal sightings, including date, water depth, numbers, age/size/gender categories (if determinable), group sizes, and ice cover;

- Estimates of uncertainty in all take estimates, with uncertainty expressed by the presentation of confidence limits, a minimum-maximum, posterior probability distribution, or another applicable method, with the exact approach to be selected based on the sampling method and data available;

- A clear comparison of authorized takes and the level of actual estimated takes; and

- A complete characterization of the acoustic footprint resulting from various activity states.

The "90-day" report will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS.

(2) Notification of Injured or Dead Marine Mammals

Quintillion will be required to notify NMFS' Office of Protected Resources and NMFS' Stranding Network of any sighting of an injured or dead marine mammal. Based on different circumstances, Quintillion may or may not be required to stop operations upon such a sighting. Quintillion would provide NMFS with the species or description of the animal(s), the condition of the animal(s) (including carcass condition if the animal is dead), location, time of first discovery, observed behaviors (if alive), and photo or video (if available). The specific language describing what Quintillion must do upon sighting a dead or injured marine mammal can be

found in the "Proposed Incidental Harassment Authorization" section of their specific proposed IHA.

2.3.2 Alternative 2 – No Action Alternative

Under the No Action Alternative, NMFS would not issue the requested IHA to Quintillion for the potential take of marine mammals, by harassment, incidental to conducting subsea cable-layng operations in the Bering, Chukchi, and Beaufort seas during the 2016 Arctic open-water season. The MMPA prohibits all takings of marine mammals unless authorized by a permit or exemption under the MMPA. The consequences of not authorizing incidental takes are (1) the entity conducting the activity may be in violation of the MMPA if takes do occur, (2) mitigation and monitoring measures cannot be required by NMFS, and (3) mitigation measures might not be performed voluntarily by the applicant. By undertaking measures to further protect marine mammals from incidental take through the authorization program, the impacts of these activities on the marine environment can potentially be lessened. While NMFS does not authorize the subsea cable laying operations, NMFS does authorize the unintentional, incidental take of marine mammals (under its jurisdiction) in connection with these activities and prescribes, where applicable, the methods of taking and other means of effecting the least practicable impact on the species and stocks and their habitats. If an IHA is not issued, Quintillion would effectively be precluded from engaging in subsea cable laying activity in the Bering, Chukchi, and Beaufort seas during the 2016 Arctic open-water season, as any takes of marine mammals under such activities would be violations of the MMPA. Although the No Action Alternative would not meet the purpose and need to allow incidental takings of marine mammals under certain conditions, the CEQ's regulations require consideration and analysis of a No Action Alternative for the purposes of presenting a comparative analysis to the action alternatives.

2.3.5 Alternatives Considered but Rejected from Further Consideration

NMFS considered whether other alternatives could meet the purpose and need and support Quintillion's proposed activities.

Issuance of IHA with No Required Mitigation, Monitoring, or Reporting Measures

An alternative that would allow for the issuance of an IHA with no required mitigation or monitoring was considered but eliminated from consideration, as it would not be in compliance with the MMPA and therefore would not meet the purpose and need. For that reason, this alternative is not analyzed further in this document.

Use of Alternative Technologies

An alternative that would require Quintillion to use alternative technologies to conduct subsea cable laying activity in the Bering, Chukchi, and Beaufort seas was considered but eliminated from further consideration. NMFS is unaware of any alternative techniques currently available that would allow Quintillion to conduct the proposed subsea cable laying activities in the Arctic Ocean.

Chapter 3 AFFECTED ENVIRONMENT

This chapter describes existing conditions in the proposed action areas. Complete descriptions of the physical, biological, and social environment of the action area are contained in the documents listed in Section 1.3.1 of this EA. We incorporate those descriptions by reference and briefly summarize or supplement the relevant sections for marine mammals in the following subchapters.

3.1 Physical Environment

We are required to consider impacts to the physical environment under NAO 216-6, as preserved by NAO 216-6A. As discussed in Chapter 1, our proposed action and alternatives relate only to the authorization of incidental take of marine mammals and not to the physical environment. Certain aspects of the physical environment are not relevant to our proposed action (see subchapter 1.3.2 - Scope of Environmental Analysis). Because of the requirements of NAO 216-6, we briefly summarize the physical components of the environment here.

3.1.1 Marine Mammal Habitat

The Proposed Action areas in the Bering, Chukchi, and Beaufort seas cover a large continental shelf adjacent to the Arctic Ocean. Water depths within the proposed subsea cable laying operation in the Bering, Cbukchi, and Beaufort seas are less than 200 m.

3.2 Biological Environment

The primary component of the biological environment that would be impacted by the proposed action and alternatives would be marine mammals, which would be directly impacted by the authorization of incidental take. We briefly summarize this component of the biological environment here.

3.2.1 Marine Mammals

The Bering, Chukchi, and Beaufort seas support a diverse assemblage of marine mammals, including: bowhead, gray, beluga, killer, minke, humpback, and fin whales; harbor porpoise; ringed, ribbon, spotted, and bearded seals; narwhals; polar bears; and walruses. Both the walrus and the polar bear are managed by the U.S. Fish and Wildlife Service (USFWS) and are not considered further in this proposed IHA notice.

Only beluga, bowhead, and gray whales, and ringed, spotted, and bearded seals are likely to occur in the proposed activity area. The remaining cetacean species are rare and not likely to be encountered during Quintillion's subsea cable laying activity, due to their extralimital distribution in the proposed survey areas. Therefore, these species are not further discussed.

The bowhead whale is listed as "endangered" under the Endangered Species Act (ESA) and as depleted under the MMPA. Certain stocks or populations of gray, beluga, and spotted seals are listed as endangered under the ESA; however, none of those stocks or populations occur in the proposed activity area.

Quintillion's IHA application contains information on the status, distribution, seasonal distribution, abundance, and life history of each of the species under NMFS jurisdiction mentioned in this document. When reviewing the application, NMFS determined that the species descriptions provided by Quintillion correctly characterized the status, distribution, seasonal distribution, and abundance of each species. Please refer to the application for that information. Additional information can also be found in the NMFS Stock Assessment Reports (SAR) (Allen and Anglyss, 2015). The Alaska 2013 SAR is available at: http://www.nmfs.noaa.gov/pr/sars/pdf/ak2013_final.pdf.

Table 5 lists the twelve marine mammal species under NMFS jurisdiction with confirmed or possible occurrence in the proposed project area.

Table 5. Marine mammal species and stocks that could be affected by Quintillion's subsea cable laying activities in the Beaufort Sea.

Common Name	Scientific Name	Status	Occurrence	Seasonality	Range	Abundance
Odontocetes Beluga whale (Beaufort Sea stock)	*Delphinapterus leucas*	-	Common	Mostly spring and fall with some in summer	Mostly Beaufort Sea	39,258
Beluga whale (eastern Chukchi Sea stock)		-	Common	Mostly spring and fall with some in summer	Mostly Chukchi Sea	3,710
Beluga whale (eastern Bering Sea stock)		-	Common	Year round	Bering Sea	19,186
Killer whale (Alaska resident stock)	*Orcinus orca*	-	Occasional/ Extralimital	Mostly summer and early fall	California to Alaska	2,347
Harbor porpoise (Bering Sea stock)	*Phocoena phocoena*	-	Occasional/ Extralimital	Mostly summer and early fall	California to Alaska	48,215

Mysticetes *Bowhead whale (W. Arctic stock)	*Balaena mysticetus*	Endangered ; Depleted	Common	Mostly spring and fall with some in summer	Russia to Canada	19,534
Gray whale (E. North Pacific stock)	*Eschrichtius robustus*	-	Somewhat common	Mostly summer	Mexico to the U.S. Arctic Ocean	20,990
*Fin whale (N. East Pacific)	*Balaenoptera physalus*	Endangered ; Depleted	Rare	Mostly summer	N.E Pacific Ocean	1,650
Minke whale	*Balaenoptera acutorostrata*	-	Rare	Mostly summer	N.E. Pacific Ocean	810
*Humpback whale (Central North Pacific stock)	*Megaptera novaeangliae*	Endangered ; Depleted	Rare	Mostly summer	North Pacific Ocean	10,103
*Humpback whale (western North Pacific stock)		Endangered ; Depleted	Rare	Mostly summer	North Pacific Ocean	1,107
Pinnipeds Bearded seal (Alaska stock)	*Erigathus barbatus*	-	Common	Spring and summer	Bering, Chukchi, and Beaufort Seas	155,000
Ringed seal (Alaska stock)	*Phoca hispida*	-	Common	Year round	Bering, Chukchi, and Beaufort Seas	249,000
Spotted seal (Alaska stock)	*Phoca largha*	-	Common	Summer	Japan to U.S. Arctic Ocean	460,268

Ribbon seal (Alaska stock)	*Histriophoca fasciata*	-	Occasional	Summer	Russia to U.S. Arctic Ocean	49,000

3.3 Socioeconomic Environment

3.3.1 Subsistence

Subsistence hunting continues to be an essential aspect of Inupiat Native life, especially in rural coastal villages. The Inupiat participate in subsistence hunting activities in and around the Bering, Chukchi, and Beaufort seas. The animals taken for subsistence provide a significant portion of the food that will last the community through the year. Marine mammals represent on the order of 60-80% of the total subsistence harvest. Along with the nourishment necessary for survival, the subsistence activities strengthen bonds within the culture, provide a means for educating the younger generation, provide supplies for artistic expression, and allow for important celebratory events.

The main species that are hunted include bowhead and beluga whales, ringed, spotted, and bearded seals, walruses, and polar bears. (As mentioned previously in this document, both the walrus and the polar bear are under the USFWS' jurisdiction.) The importance of each of these species varies among the communities and is largely based on availability.

Chapter 4 ENVIRONMENTAL CONSEQUENCES

This chapter of the EA analyzes the impacts of the two alternatives and addresses the potential direct, indirect, and cumulative impacts of our issuance of an IHA. Quintillion's IHA application and other related environmental analyses identified previously facilitate this analysis.

Under the MMPA, we have evaluated the potential impacts of Quintillion's subsea cable laying activity in order to determine whether to authorize incidental take of marine mammals. Under NEPA, we have determined that an EA is appropriate to evaluate the potential significance of environmental impacts resulting from the issuance of the IHA.

4.1 Effects of Alternative 1— Issuance of an IHA with Mitigation Measures

Under this alternative, NMFS would issue an IHA to Quintillion for the proposed subsea cable laying activity in the Bering, Chukchi, and Beaufort seas during the 2016 Artic open-water season, with required mitigation, monitoring, and reporting requirements as discussed in Chapter 2 of this EA. As part of NMFS' action, the mitigation and monitoring would be undertaken as required by the MMPA, and, as a result, no serious injury or mortality of marine mammals is expected and correspondingly no impact on the reproductive or survival ability of affected species would occur. These analyses are provided in detail in the proposed IHA for the issuance of the IHA to Quintillion. Potentially affected marine mammal species under NMFS' jurisdiction include: bowhead, fin, minke, humpback, gray, beluga, and killer whales; harbor porpoise; and bearded, spotted, ringed, and ribbon seals.

4.1.1 Effects on Marine Mammals

Acoustic Impacts

When considering the influence of various kinds of sound on the marine environment, it is necessary to understand that different kinds of marine life are sensitive to different frequencies of sound. Based on available behavioral data, audiograms have been derived using auditory evoked potentials, anatomical modeling, and other data, Southall *et al.* (2007) designate "functional hearing groups" for marine mammals and estimate the lower and upper frequencies of functional hearing of the groups. The functional groups and the associated frequencies are indicated below (though animals are less sensitive to sounds at the outer edge of their functional range and most sensitive to sounds of frequencies within a smaller range somewhere in the middle of their functional hearing range):

- Low frequency cetaceans (13 species of mysticetes): functional hearing is estimated to occur between approximately 7 Hz and 25 kHz;

- Mid-frequency cetaceans (32 species of dolphins, six species of larger toothed whales, and 19 species of beaked and bottlenose whales): functional hearing is estimated to occur between approximately 150 Hz and 160 kHz;

- High frequency cetaceans (eight species of true porpoises, six species of river dolphins, Kogia, the franciscana, and four species of cephalorhynchids): functional hearing is estimated to occur between approximately 200 Hz and 180 kHz;

- Phocid pinnipeds in Water: functional hearing is estimated to occur between approximately 75 Hz and 100 kHz; and

- Otariid pinnipeds in Water: functional hearing is estimated to occur between approximately 100 Hz and 48 kHz.

As mentioned previously in this document, twelve marine mammal species (eight cetaceans and four phocid pinnipeds) may occur in the proposed seismic survey area. Of the eight cetacean species, four are classified as low-frequency cetaceans (i.e., bowhead, gray, humpback, and fin whales), two are classified as mid-frequency cetaceans (i.e., killer and beluga whales), and one is classified as a high-frequency cetacean (i.e., harbor porpoise) (Southall *et al.*, 2007). A species' functional hearing group is a consideration when we analyze the effects of exposure to sound on marine mammals.

The proposed Quintillion subsea cable laying activity could adversely affect marine mammal species and stocks by exposing them to elevated noise levels in the vicinity of the activity area. Marine mammals exposed to high intensity sound repeatedly or for prolonged periods can experience hearing threshold shift (TS), which is the loss of hearing sensitivity at certain frequency ranges (Kastak *et al*. 1999; Schlundt et al. 2000; Finneran *et al*. 2002; 2005). TS can be permanent (PTS), in which case the loss of hearing sensitivity is unrecoverable, or temporary (TTS), in which case the animal's hearing threshold will recover over time (Southall *et al*. 2007). Since marine mammals depend on acoustic cues for vital biological functions, such as orientation, communication, finding prey, and avoiding predators, marine mammals that suffer from PTS or TTS will have reduced fitness in survival and reproduction, either permanently or temporarily. Repeated noise exposure that leads to TTS could cause PTS.

In addition, chronic exposure to excessive, though not high-intensity, noise could cause masking at particular frequencies for marine mammals that utilize sound for vital biological functions (Clark *et al*. 2009). Acoustic masking can interfere with detection of acoustic signals such as communication calls, echolocation sounds, and environmental sounds important to marine mammals. Therefore, under certain circumstances, marine mammals whose acoustical sensors or environment are being severely masked could also be impaired from maximizing their performance fitness in survival and reproduction.

Masking occurs at the frequency band which the animals utilize. Therefore, since noise generated from dynamic positioning (DP) using thrusters is mostly concentrated at low frequency ranges, it may have less effect on high frequency echolocation sounds by odontocetes (toothed whales). However, lower frequency man-made noises are more likely to affect detection of communication calls and other potentially important natural sounds such as surf and prey noise. It may also affect communication signals when they occur near the noise band and thus reduce the communication space of animals (e.g., Clark *et al*. 2009) and cause increased stress levels (e.g., Foote *et al*. 2004; Holt *et al*. 2009).

Unlike TS, masking can potentially affect the species at population, community, or even ecosystem levels, as well as individual levels. Masking affects both senders and receivers of the

signals and could have long-term chronic effects on marine mammal species and populations. Recent science suggests that low frequency ambient sound levels have increased by as much as 20 dB (more than 3 times in terms of sound pressure level (SPL)) in the world's ocean from pre-industrial periods, and most of these increases are from distant shipping (Hildebrand 2009). All anthropogenic noise sources, such as those from vessel traffic and cable laying activity while operating DP thrusters contribute to the elevated ambient noise levels, thus increasing potential for or severity of masking.

Finally, exposure of marine mammals to certain sounds could lead to behavioral disturbance (Richardson *et al*. 1995), such as: changing durations of surfacing and dives, number of blows per surfacing, or moving direction and/or speed; reduced/increased vocal activities; changing/cessation of certain behavioral activities (such as socializing or feeding); visible startle response or aggressive behavior (such as tail/fluke slapping or jaw clapping); avoidance of areas where noise sources are located; and/or flight responses (e.g., pinnipeds flushing into water from haulouts or rookeries).

The biological significance of many of these behavioral disturbances is difficult to predict, especially if the detected disturbances appear minor. However, the consequences of behavioral modification are expected to be biologically significant if the change affects growth, survival, and/or reproduction.

The onset of behavioral disturbance from anthropogenic noise depends on both external factors (characteristics of noise sources and their paths) and the receiving animals (hearing, motivation, experience, demography) and is also difficult to predict (Southall *et al*. 2007). Currently NMFS uses 160 dB re 1 μPa (rms) at received level for impulse noises (such as impact pile driving) as the onset of marine mammal behavioral harassment, and 120 dB re 1 μPa (rms) for non-impulse noises (such as operating DP thrusters). No impulse noise is expected from the Quintillion's subsea cable laying activity. For the Quintillion's subsea cable laying operation, only the 120 dB re 1 μPa (rms) threshold is considered because only non-impulse noise sources would be generated.

4.1.2 Effects on Marine Mammals Habitat

Project activities that could potentially impact marine mammal habitats include acoustical injury of prey resources and trenching associated with laying cable on sea bottom. Regarding the former, however, acoustical injury from thruster noise is unlikely. Previous noise studies (e.g., Greenlaw *et al*. 1988, Davis *et al*. 1998, Christian *et al*. 2004) with cod, crab, and schooling fish found little or no injury to adults, larvae, or eggs when exposed to impulsive noises exceeding 220 dB. Continuous noise levels from ship thrusters are generally below 180 dB, and do not create great enough pressures to cause tissue or organ injury.

Nedwell *et al*. (2003) measured noise associated with cable trenching operations offshore of Wales, and found that levels (178 dB at source) did not exceed those where significant avoidance reactions of fish would occur. Cable burial operations involve the use of ploughs or jets to cut trenches in the sea floor sediment. Cable ploughs are generally used where the substrate is cohesive enough to be "cut" and laid alongside the trench long enough for the cable to be laid at

depth. In less cohesive substrates, where the sediment would immediately settle back into the trench before the cable could be laid, jetting is used to scour a more lasting furrow. The objective of both is to excavate a temporary trench of sufficient depth to fully bury the cable. The plough blade is 0.2 m (0.7 ft) wide producing a trench of approximately the same width. Jetted trenches are somewhat wider depending on the sediment type. Potential impacts to marine mammal habitat and prey include 1) crushing of benthic and epibenthic invertebrates with the plough blade, plough skid, or ROV track, 2) dislodgement of benthic invertebrates onto the surface where they may die, and 3) and the settlement of suspended sediments away from the trench where they may clog gills or feeding structures of sessile invertebrates or smother sensitive species (BERR 2008). However, the footprint of cable trenching is generally restricted to 2 to 3 m (7-10 ft) width (BERR 2008), and the displaced wedge or berm is expected to naturally backfill into the trench. Jetting results in more suspension of sediments, which may take days to settle during which currents may transport it well away (up to several kilometers) from source. Suspended sand particles generally settle within about 20 m (66 ft). BERR (2008) reviewed the effect of offshore wind farm construction, including laying of power and communication cables, on the environment. Based on a rating of 1 to 10, they concluded that sediment disturbance from plough operations rated the lowest at 1, with jetting rating from 2 to 4, depending on substrate. Dredging rated the highest (6) relative sediment disturbance.

The maximum amount of trenching possible is about 1,900 km (1,180 mi), but the width of primary effect is only about 3 m (10 ft). Thus, the maximum impact footprint is less than 6 km^2 (2.3 mi^2), an insignificantly small area given the Chukchi Sea area alone is 595,000 km^2 (230,000 mi^2). Overall, cable-laying effects to marine mammal habitat and prey resources is negligible.

4.1.3 Effects on Subsistence

4.1.3.1 Subsistence Activities in the Action Area

NMFS has defined "unmitigable adverse impact" in 50 CFR 216.103 as: "an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met."

Noise and general activity during Quintillion's proposed subsea cable-laying operation has the potential to impact marine mammals hunted by Native Alaskans. In the case of cetaceans, the most common reaction to anthropogenic sounds (as noted previously) is avoidance of the ensonified area. In the case of bowhead whales, this often means that the animals divert from their normal migratory path by several kilometers. Additionally, general vessel presence in the vicinity of traditional hunting areas could negatively impact a hunt. Native knowledge indicates that bowhead whales become increasingly "skittish" in the presence of anthropogeinc noise. Whales are more wary around the hunters and tend to expose a much smaller portion of their back when surfacing, which makes harvesting more difficult. Additionally, natives report that bowheads exhibit angry behaviors, such as tail-slapping, in the presence of seismic activity,

which translate to danger for nearby subsistence harvesters.

The proposed cable-lay activities will occur within the marine subsistence areas used by the villages of Nome, Wales, Kotzebue, Little Diomede, Kivalina, Point Hope, Wainwright, Barrow, and Nuiqsut. Subsistence use varies considerably by season and location. Seven of the villages hunt bowhead whales (Suydam and George 2004). The small villages of Wales, Little Diomedes, and Kivalina take a bowhead whale about once every five years. Point Hope and Nuiqsut each harvest three to four whales annually, and Wainwright five to six. Harvest from Barrow is by far the highest with about 25 whales taken each year generally split between spring and fall hunts. Point Hope and Wainwright harvest occurs largely during the spring hunt, and Nuiqsut's during the fall. Nuiqsut whalers base from Cross Island, located 70 km (44 mi) east of Oliktok.

Beluga are also annually harvested by the above villages. Beluga harvest is most important to Point Hope. For example, the village harvested 84 beluga whales during the spring of 2012, and averaged 31 whales a year from 1987 to 2006 (Frost and Suydam 2010). Beluga are also important to Wainwright village. They harvested 34 beluga whales in 2012, and averaged 11 annually from 1987 to 2006 (Frost and Suydam 2010). All the other villages - Nome, Kotzebue, Wales, Kivalina, Little Diomede, and Barrow - averaged less than 10 whales a year (Frost and Suydam 2010).

All villages utilize seals to one degree or another as well. Ringed seal harvest mostly occurs in the winter and spring when they are hauled out on ice near leads or at breathing holes. Bearded seals are taken from boats during the early summer as they migrate northward in the Chukchi Sea and eastward in the Beaufort Sea. Bearded seals are a staple for villages like Kotzebue and Kivalina that have limited access to bowhead and beluga whales (Georgette and Loon 1993). Thetis Island, located just off the Colville River Delta, is an important base from which villagers from Nuiqsut hunt bearded seals each summer after ice breakup. Spotted seals are an important summer resource for Wainwright and Nuiqsut, but other villages will avoid them because the meat is less appealing than other available marine mammals.

The proposed cable-lay activity would occur in the summer after the spring bowhead and beluga whale hunts have ended, and would avoid the ice period when ringed seals are harvested. The Oliktok branch would pass within 4 km (2 mi) of Thetis Island, but the laying of cable along that branch would occur in late summer or early fall, long after the bearded seal hunt is over.

Based on the proposed cable-lay time table relative to the seasonal timing of the various subsistence harvests, cable-lay activities into Kotzebue (bearded seal), Wainwright (beluga whale), and around Point Barrow (bowhead whale) could overlap with important harvest periods. Quintillion would work closely with the AEWC, the Alaska Beluga Whale Committee (ABWC), the Ice Seal Committee (ISC), and the North Slope Borough (NSB) to minimize any effects cable-lay activities might have on subsistence harvest.

4.2 Effects of Alternative 2—No Action Alternative

Under the No Action Alternative, NMFS would not issue an IHA to Quintillion for the proposed subsea cable-laying activities in the Bering, Chukchi, and Beaufrot seas. Therefore, the No

Action Alternative would effectively preclude Quintillion from engaging in these activities in the Bering, Chukchi, and Beaufort seas during the 2016 Arctic open-water season, as any takes of marine mammals under such activities would be violations of the MMPA. If this alternative were selected, the impact on the environment from not conducting the proposed subsea cable-laying activities in the 2016 open-water season means that:

1) Adverse impacts on marine mammals, principally bowhead whales, would not be expected, as the associated noise generated from these activities would not exist; and

2) Adverse impacts on the Inupiat subsistence hunts would not occur, as marine mammals would not be affected and would not have cause to temporarily vacate the area due to underwater noises from the subsea cable-laying operation.

4.3 Estimation of Takes

For purposes of evaluating the potential significance of the "takes" by harassment, estimations of the number of potential takes are discussed in terms of the populations present. The specific number of takes considered for the authorizations is developed via the MMPA process, and the analysis in this EA provides a summary of the anticipated numbers that would be authorized to give a relative sense of the nature of impact of NMFS' proposed action. The methods to estimate take by harassment and present estimates of the numbers of marine mammals that might be affected during Quintillion's proposed subsea cable laying activities are described in detail in the applicant's IHA application and the *Federal Register* notice of proposed IHA, which can be accessed at NMFS website at: http://www.nmfs.noaa.gov/pr/permits/incidental/oilgas.htm.

Table 6. The estimated Level B harassments and requested take of marine mammals by Quintillion.

Species	Stock Abundance	Level B Take Requested	% Request Level B Take by Stock
Bowhead whale	19,534	130	0.8%
Beluga whale (Beaufort Sea stock)	39,258	669	1.7%
Beluga whale (E. Chukchi Sea stock)	3,710	669	18.0%
Beluga whale (E. Bering Sea stock)	19.186	669	3.5%
Gray whale	20,990	572	2.7%
Humpback whale (W.N. Pacific stock)	1,107	15	1.36%
Humpback whale (Cent. N. Pacific stock)	10,103	15	0.14%
Fin whale	1,652	15	0.91%
Minke whale	1,233	5	0.40%
Killer whale	2,347	5	0.21%
Harbor porpoise	48,215	16	0.03%
Ringed seal	249,000	992	0.49%
Spotted seal	460,268	325	0.07%
Bearded seal	155,000	470	0.08%
Ribbon seal	61,100	5	0.01%

Estimates of the takes of marine mammals by Level B harassment from Quintillion's proposed subsea cable-laying operation are presented in Table 6. Detailed descriptions of take estimates are presented in the *Federal Register* notice for the proposed IHA for the proposed action.

4.4 Cumulative Effects

Cumulative effect is defined as "the impact on the environment which results 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" (40 CFR §1508.7). Cumulative impacts may occur when there is a relationship between a proposed action and other actions expected to occur in a similar location or during a similar time period, or when past or future actions may result in impacts that would additively or synergistically affect a resource of concern. In other words, the analysis takes into account the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions (40 CFR §1508.7). These relationships may or may not be obvious. Actions overlapping within close proximity to the proposed action can reasonably be expected to have more potential for cumulative effects on "shared resources" than actions that may be geographically separated. Similarly, actions that coincide temporally will tend to offer a higher potential for cumulative effects.

Actions that might permanently remove a resource would be expected to have a potential to act additively or synergistically if they affected the same population, even if the effects were separated geographically or temporally. Note that the proposed action considered here would not be expected to result in the removal of individual cetaceans or pinnipeds from the population or to result in harassment levels that might cause animals to permanently abandon preferred feeding areas or other habitat locations, so concerns related to removal of viable members of the populations are not implicated by the proposed action. This cumulative effects analysis considers these potential impacts, but more appropriately focuses on those activities that may temporally or geographically overlap with the proposed activity such that repeat harassment effects warrant consideration for potential cumulative impacts to the potentially affected 12 marine mammal species and their habitats.

Cumulative effects may result in significant effects even when the Federal action under review is insignificant when considered by itself. The CEQ guidelines recognize that it is not practical to analyze the cumulative effects of an action on the universe but to focus on those effects that are truly meaningful. This section analyzes the addition of the effects of the proposed action (i.e., the issuance of IHA to Quintillion for the take of marine mammals incidental to subsea cable-laying activities in the Bering, Chukchi, and Beaufort seas) to the potential direct and indirect effects of other factors that may, in combination with the proposed action, result in greater effects on the environment than those resulting solely from the proposed action. Cumulative effects on affected resources that may result from the following activities— past commercial whaling, subsistence harvest activities, climate change, seismic survey activities, oil and gas exploration and development in Federal and state waters, and vessel traffic —within the proposed project area are discussed in the following subsections.

4.6.1 Past Commercial Whaling

Commercial hunting between 1848 and 1915 caused severe depletion of the bowhead population(s) that inhabits the Bering, Chukchi, and Beaufort (BCB) Seas. This hunting is no longer occurring and is not expected to occur again. Woodby and Botkin (1993) estimated that the historic abundance of bowheads in this population was between 10,400 and 23,000 whales in 1848, before the advent of commercial whaling. Woodby and Botkin (1993) estimated between 1,000 and 3,000 animals remained in 1914, near the end of the commercial-whaling period. Data indicate that what is currently referred to as the BCB Seas stock of bowheads is increasing in abundance.

Similar to bowhead whales, most stocks of fin whales were depleted by commercial whaling (Reeves *et al*., 1998) beginning in the second half of the mid-1800s (Schmitt *et al*., 1980; Reeves and Barto, 1985). In the 1900s, hunting for fin whales continued in all oceans for about 75 years (Reeves *et al*., 1998) until it was legally ended in the North Pacific in 1976. Commercial hunting for humpback whales resulted in the depletion and endangerment of this species. Prior to commercial hunting, humpback whales in the North Pacific may have numbered approximately 15,000 individuals (Rice, 1978). Unregulated hunting legally ended in the North Pacific in 1966.

The end of commercial whaling has resulted in an increase in whale numbers in the Arctic, particularly for bowhead and gray whales, despite increased industrial and commercial activities in the region. Since the proposed subsea cable-laying activity will not have lethal takes of marine mammals, therefore, there are no potential additive or cumulative effects on marine mammal population levels with the proposed action.

4.6.2 Subsistence Hunting

4.6.2.1 Bowhead Whales

Indigenous peoples of the Arctic and Subarctic have been hunting bowhead whales for at least 2,000 years (Stoker and Krupnik, 1993). Thus, subsistence hunting is not a new contributor to cumulative effects on this population. There is no indication that, prior to commercial whaling, subsistence whaling caused significant adverse effects at the population level. However, modern technology has changed the potential for any lethal hunting of this whale to cause population-level adverse effects if unregulated. Under the authority of the IWC, the subsistence take from this population has been regulated by a quota system since 1977. Federal authority for cooperative management of the Eskimo subsistence hunt is shared with the AEWC through a cooperative agreement between the AEWC and NMFS.

The sustainable take of bowhead whales by indigenous hunters represents the largest known human-related cause of mortality in this population at the present time. Available information suggests that it is likely to remain so for the foreseeable future. While other potential effectors primarily have the potential to cause, or to be related to, behavioral or sublethal adverse effects to this population, or to cause the deaths of a small number of individuals, little or no evidence exists of other common human-related causes of mortality. Subsistence take, which all available evidence indicates is sustainable, is monitored, managed, and regulated, and helps to determine the resilience of the population to other actions that could potentially cause lethal takes. The sustained growth of the BCB Seas bowhead population indicates that the level of subsistence

take has been sustainable. Because the quota for the hunt is tied to the population size and population parameters (IWC, 2003; NMFS, 2003), it is unlikely this source of mortality will contribute to a significant adverse effect on the recovery and long-term viability of this population.

Currently, Native Alaskan hunters from 11 communities harvest bowheads for subsistence and cultural purposes under a quota authorized by the IWC. Chukotkan Native whalers from Russia also are authorized to harvest bowhead whales under the same authorized quota. Bowheads are hunted at Gambell and Savoonga on St. Lawrence Island, and along the Chukotkan coast. On the northward spring migration, harvests may occur by the villages of Wales, Little Diomede, Kivalina, Point Lay, Point Hope, Wainwright, and Barrow. During their westward migration in autumn, whales are harvested by Kaktovik, Nuiqsut, and Barrow. At St. Lawrence Island, fall migrants can be hunted as late as December (IWC, 2004). The status of the population is closely monitored, and these activities are closely regulated.

There are adverse impacts of the hunting to bowhead whales in addition to the death of animals that are successfully hunted and the serious injury of animals that are struck but not immediately killed. Available evidence indicates that subsistence hunting causes disturbance to the other whales, changes in their behavior, and sometimes temporary effects on habitat use, including migration paths. Modern subsistence hunting represents a source of noise and disturbance to the whales during the following periods and in the following areas: during their northward spring migration in the Bering Sea, the Chukchi Sea in the spring lead system, and in the Beaufort Sea spring lead system near Barrow; their fall westward migration in subsistence hunting areas associated with hunting from Kaktovik, Cross Island, and Barrow; hunting along the Chukotka coast; and hunting in wintering areas near St. Lawrence Island. Lowry et al. (2004) reported that indigenous hunters in the Beaufort Sea sometimes hunt in areas where whales are aggregated for feeding. When a subsistence hunt is successful, it results in the death of a bowhead. Data on strike and harvested levels indicate that whales are not always immediately killed when struck, and some whales are struck but cannot be harvested. Whales in the vicinity of the struck whale could be disturbed by the sound of the explosive harpoon used in the hunt, the boat motors, and any sounds made by the injured whale.

Noise and disturbance from subsistence hunting serves as a seasonally and geographically predictable source of noise and disturbance to which other noise and disturbance sources, such as shipping and oil and gas-related activities, add additional stressors to marine mammals. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

4.6.2.2 Beluga Whales

The subsistence take of beluga whales within U.S. waters is reported by the Alaska Beluga Whale Committee (ABWC). The annual subsistence take of the Beaufort Sea stock of beluga whales by Alaska Natives averaged 25 belugas during the 5-year period from 2002-2006 (Allen and Angliss, 2011). The annual subsistence take of Eastern Chukchi Sea stock of beluga whales

by Alaska Natives averaged 59 belugas landed during the 5-year period 2002-2006 based on reports from ABWC representatives and on-site harvest monitoring. Data on beluga that were struck and lost have not been quantified and are not included in these estimates (Allen and Angliss, 2011). As with bowhead whale subsistence hunts, noise during the hunts may disturb other animals not struck and taken for subsistence purposes. Again, the disturbance occurs during specific time periods in specific locations to which other activities could add. To the extent such activities occur in the same habitats during the period of whale migration, even if the activities (for example, hunting and shipping) themselves do not occur simultaneously, cumulative effects from all noise and disturbance could affect whale habitat use. Subsistence hunting attaches a strong adverse association to human noise for any whale that has been in the vicinity when other whales were struck.

4.6.2.3 Ice Seals

The Division of Subsistence, Alaska Department of Fish and Game (ADF&G) maintains a database that provides additional information on the subsistence harvest of ice seals in different regions of Alaska (ADF&G 2000a,b). Information on subsistence harvest of bearded seals has been compiled for 129 villages from reports from the Division of Subsistence and a report from the Eskimo Walrus Commission (Sherrod, 1982). Data were lacking for 22 villages; their harvests were estimated using the annual per capita rates of subsistence harvest from a nearby village. As of August 2000, the subsistence harvest database indicated that the estimated number of bearded, ribbon, ringed, and spotted seals harvested for subsistence use per year are 6,788; 193; 9,567; and 244, respectively (Allen and Angliss, 2011).

At this time, there are no efforts to quantify the current level of harvest of bearded seals by all Alaska communities. However, the USFWS collects information on the level of ice seal harvest in five villages during their Walrus Harvest Monitoring Program. Results from this program indicate that an average of 239 bearded seals were harvested annually in Little Diomede, Gambell, Savoonga, Shishmaref, and Wales from 2000 to 2004, 13 ribbon seals from 1999 to 2003, and 47 ringed seals from 1998 to 2003 (Allen and Angliss, 2010). Since 2005, harvest data are only available from St. Lawrence Island (Gambell and Savoonga) due to lack of walrus harvest monitoring in areas previously monitored. There were 21 bearded seals harvested during the walrus harvest monitoring period on St. Lawrence Island in 2005, 41 in 2006, and 82 in 2007. There were no ringed seals harvested on St. Lawrence Island in 2005, 1 in 2006, and 1 in 2007. The mean annual subsistence harvest of spotted seals in north Bristol Bay from this stock over the 5-year period from 2002 through 2006 was 166 seals per year. No ribbon seal was harvested between 2005 and 2007 (Allen and Angliss, 2010).

4.6.2.4 Contributions of the Alternatives to Cumulative Effects of Subsistence Hunting

Alternative 2 would not contribute any additional effects beyond those already analyzed to the cumulative effects from subsistence hunting, as the IHA would not be issued. Alternative 1 would allow for the issuance of an IHA for the take of marine mammals incidental to conducting subsea cable laying activities in the Beaufort Sea during the open-water season. However, the proposed action is not anticipated to result in serious injury or mortality of any marine mammals; therefore, there would not be additional deaths beyond those from subsistence hunting activities. While both activities (i.e., the proposed surveys and subsistence hunting) can disturb marine

mammals, NMFS considers the contribution of such disturbance to overall cumulative effects to be minimal because of the mitigation measures that would be required under the IHA, which are included to reduce impacts to the lowest level practicable.

4.6.3 Climate Change

Section 3.1.4.4 in NMFS' Draft EIS on the Effects of Oil and Gas Activities in the Arctic Ocean (NMFS, 2011) describes changes to climate in the Arctic environment. That information is summarized here and incorporated herein by reference. Evidence of climate change in the Arctic has been identified and appear to generally agree with climate modeling scenarios of greenhouse gas warming. Such evidence suggests (NSIDC, 2011a):

- Air temperatures in the Arctic are increasing at an accelerated rate;
- Year-round sea ice extent and thickness has continually decreased over the past three decades;
- Water temperatures in the Arctic Ocean have increased;
- Changes have occurred to the salinity in the Arctic Ocean;
- Rising sea levels;
- Retreating glaciers;
- Increases in terrestrial precipitation;
- Warming permafrost in Alaska; and
- Northward migration of the treeline.

Concurrent with climate change is a change in ocean chemistry known as ocean acidification. This phenomenon is described in the IPCC Fourth Assessment Report (IPCC, 2007a), a 2005 synthesis report by members of the Royal Society of London (Raven et al., 2005), and an ongoing Bureau of Ocean Energy Management (BOEM)-funded study (Mathis, 2011). The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This amplified scenario in the Arctic is due to the effects of increased freshwater input from melting snow and ice and from increased CO_2 uptake by the sea as a result of ice retreat (Fabry et al., 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrate that over 11 years, melting sea ice forced changes in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater. At this time, we do not know the precise timeframe, or the series of events that would need to occur before an adverse population level effect on the marine mammals or other resources in the Arctic would be realized. However, this information is unobtainable at this time due to the fact that such conditions do not exist to conduct studies.

Bowhead and other Arctic whales are associated with and well adapted to ice-covered seas with leads, polynyas, open water areas, or thin ice that the whales can break through to breathe. Arctic coastal peoples have hunted bowheads for thousands of years, but the distribution of bowheads in relation to climate change and sea ice cover in the distant past is not known. It has been suggested that a cold period 500 years ago resulted in less ice-free water near Greenland, forcing bowheads to abandon the range, and that this in turn led to the disappearance of the Thule culture. However, it is not clear if larger expanses and longer periods of ice-free water would be beneficial to bowheads. The effect of warmer ocean temperatures on bowheads may

depend more on how such climate changes affect the abundance and distribution of their planktonic prey rather than the bowheads' need for ice habitat itself.

Climate change associated with Arctic warming may also result in regime change of the Arctic Ocean ecosystem. Sighting of humpback whales in the Chukchi Sea during the 2007 Shell seismic surveys (Funk et al., 2008), 2009 Chukchi Offshore Monitoring in Drilling Area (COMIDA) aerial survey (Clarke *et al*., 2011c), and south of Point Hope in 2009 while transiting to Nome (Brueggeman, 2010) may indicate the expansion of habitat by this species as a result of ecosystem regime shift in the Arctic. These species, in addition to minke and killer whales, and four pinniped species (harp, hooded, ribbon, and spotted seals) that seasonally occupy Arctic and subarctic habitats may be poised to encroach into more northern latitudes and to remain there longer, thereby competing with extant Arctic species (Moore and Huntington, 2008).

In the past decade, geographic displacement of marine mammal population distributions has coincided with a reduction in sea ice and an increase in air and ocean temperatures in the Bering Sea. Continued warming is likely to increase the occurrence and resident times of subarctic species such as spotted seals and bearded seals in the Beaufort Sea. The result of global warming would significantly reduce the extent of sea ice in at least some regions of the Arctic (ACIA, 2004).

Ringed seals, which are true Arctic species, depend on sea ice for their life functions, and give birth to and care for their pups on stable shorefast ice. The reductions in the extent and persistence of ice in the Beaufort Sea almost certainly could reduce their productivity (NRC, 2003b). Ongoing and projected changes in sea ice habitat pose significant therats to the Alaska ringed seal stock. In addition, spotted seals and bearded seals would also be vulnerable to reductions in sea ice, although insufficient data exist to make reliable predictions of the effects of Arctic climate change on these two species (Allen and Angliss, 2010).

The implications of the trends of a changing climate for bowheads and other Arctic cetaceans are uncertain, but they may be beneficial, in contrast to affects on ice-obligate species such as ice seals, polar bears, and walrus (ACIA, 2004). There will be more open water and longer ice-free seasons in the arctic seas, which may allow them to expand their range as the population continues to recover from commercial whaling. However, this potential for beneficial effects on bowheads and other whales will depend on their ability to locate sufficient concentrations of planktonic crustaceans to allow efficient foraging. Since phytoplankton blooms may occur earlier or at different times of the season, or in different locations, the timing of zooplankton availability may also change from past patterns. Hence, the ability of bowheads to use these food sources may depend on their flexibility to adjust the timing of their own movements and to find food sources in different places (ACIA, 2004). In addition, it is hypothesized that some of the indirect effects of climate change on marine mammal health would likely include alterations in pathogen transmission due to a variety of factors, effects on body condition due to shifts in the prey base/food web, changes in toxicant exposures, and factors associated with increased human habitation in the Arctic.

With the large uncertainty of the degree of impact of climate change to Arctic marine mammals, NMFS recognizes that warming of this region which results in the diminishing of ice could be a

concern to ice dependent seals, walrus, and polar bears. Nonetheless, NMFS considers the effects of the proposed action and the specified activity proposed by Quintillion during 2016 on climate change to be too remote and speculative at this time to conclude definitively that the issuance of an MMPA IHA for the 2016 open-water subsea cable-laying activities would contribute to climate change, and therefore a reduction in Arctic sea ice coverage. More research is needed to determine the magnitude of the impact, if any, of global warming to marine mammal species in the Arctic and subarctic regions.

4.6.4 Oil and Gas Exploration and Development

4.6.4.1 Marine and Seismic Surveys

BOEM-permitted seismic surveys have been conducted in the Federal waters of the Beaufort Sea since the late 1960's/early 1970's (MMS 2007a). For activities since July 2010, NMFS issued an IHA to Shell to take 8 species of marine mammals by Level B behavioral harassment incidental to conducting site clearance and shallow hazards surveys in the Beaufort and Chukchi Seas on August 6, 2010 (75 FR 49710; August 13, 2010). No seismic surveys were conducted in the Beaufort Sea in 2011. In 2012, NMFS issued an IHA to BP Exploration (Alaska), Inc. (BPXI) and ION Geophysical (ION) to take small numbers of marine mammals by harassment incidental to conducting open-water 3D OBC seismic surveys in the Simpson Lagoon of the Beaufort Sea (77 FR 40007; July 6, 2012) and in-ice 2D seismic surveys in the Beaufort and Chukchi Seas (77 FR 65060; October 24, 2012), respectively. In 2013, NMFS issued an IHA to Shell for its open-water marine surveys in the Chukchi Sea (78 FR 47496; August 5, 2013), and to ION for its 2D seismic survey in the Chukchi Seas (78 FR 51147; August 20, 2013). In 2014, NMFS issued an IHA to BP for its 3D seismic survey in the Beaufort Sea (79 FR 36730; June 30, 2014) and its geohazard survey in the Beaufort Sea (79 FR 36769; June 30, 2014), and to SAE for its marine seismic survey in the Beaufort Sea (79 FR 51963; September 2, 2014). In 2015, NMFS issued an IHA to SAE for its marine seismic survey in the Beaufort Sea (80 FR 40016; July 13, 2015), and to Hilcorp for its geohazard survey in the Beaufort Sea (80 FR 39062; July 8, 2015).

However, the proposed subsea cable-laying operation by Quintillion would not generate as intense underwater noise as those from marine seismic and shallow hazard surveys.

4.6.4.2 Oil and Gas Development and Production

Oil and gas exploration and production activities have occurred on the North Slope since the early 1900's, and production has occurred for more than 50 years. Since the discovery and development of the Prudhoe Bay and Kuparuk oil field, more recent fields generally have been developed not in the nearshore environment, but on land in areas adjacent to existing producing areas. Pioneer Natural Resources Co. is developing its North Slope Oooguruk field, which is in the shallow waters of the Beaufort Sea approximately 8 mi northwest of the Kuparuk River unit.

BPXA is currently producing oil from an offshore development in the Northstar Unit, which is located between 3.2 and 12.9 km (2 and 8 mi) offshore from Point Storkersen in the Beaufort Sea. This development is the first in the Beaufort Sea that makes use of a subsea pipeline to transport oil to shore and then into the Trans-Alaska Pipeline System. The Northstar facility was built in State of Alaska waters on the remnants of Seal Island ~9.5 km (6 mi) offshore from Point

Storkersen, northwest of the Prudhoe Bay industrial complex, and 5 km (3 mi) seaward of the closest barrier island. The unit is adjacent to Prudhoe Bay, and is approximately 87 km (54 mi) northeast of Nuiqsut, an Inupiat community. To date, it is the only offshore oil production facility north of the barrier islands in the Beaufort Sea.

On November 6, 2009, BPXI submitted an application requesting NMFS issue regulations and subsequent LOAs governing the taking of marine mammals, by both Level B harassment and serious injury and mortality, incidental to operation of the Northstar development in the Beaufort Sea, Alaska. Construction of Northstar was completed in 2001. The activities for 2012-2017 include a continuation of drilling, production, and emergency training operations but no construction or activities of similar intensity to those conducted between 1999 and 2001. NMFS published a notice of proposed rulemaking in the *Federal Register* on July 6, 2011, requesting comments and information from the public (76 FR 39706). NMFS is currently working on the final rulemaking governing BP's marine mammal take authorizations for operating its Northstar facility.

In addition, Shell conducted two exploratory drilling activities at exploration wells in the Beaufort (77 FR 27284; May 9, 2012) and Chukchi (77 FR 27322; May 9, 2012) Seas, Alaska, during the 2012 Arctic open-water season (July through October). In December 2012, Shell submitted two additional IHA applications to take marine mammals incidental to its proposed exploratory drilling in Beaufort and Chukchi Seas during the 2013 open-water season. However, Shell withdrew its application in February 2013. In 2015, NMFS issued an IHA to Shell for its exploration drilling in the Chukchi Sea (80 FR 35744; June 22, 2015).

4.6.4.3 Vessel Traffic

Vessel traffic in the Alaskan Arctic generally occurs within 12.4 mi (20 km) of the coast and usually is associated with fishing, hunting, cruise ships, icebreakers, Coast Guard activities, and supply ships and barges. No extensive maritime industry exists for transporting goods. Traffic in the Beaufort and Chukchi Seas, at present, is limited primarily to late spring, summer, and early autumn.

For cetaceans, the main potential for effects from vessel traffic is through vessel strikes and acoustic disturbance. Regarding sound produced from vessels, it is generally expected to be less in shallow waters (i.e., background noise only by 6.2 mi [10 km] away from vessel) and greater in deeper waters (traffic noise up to 2,480 mi [4,000 km] away may contribute to background noise levels) (Richardson *et al*., 1995). Aside from the drillships and other vessels associated with the drilling programs, seismic-survey vessels, barging associated with activities such as onshore and limited offshore oil and gas activities, fuel and supply shipments, and other activities contribute to overall ambient noise levels in some regions of the Beaufort and Chukchi Seas. Whaling boats (usually aluminum skiffs with outboard motors) contribute noise during the fall whaling periods in the Alaskan Beaufort Sea. Fishing boats in coastal regions also contribute sound to the overall ambient noise. Sound produced by these smaller boats typically is at a higher frequency, around 300 Hz (Richardson *et al*., 1995a).

Overall, the level of vessel traffic in the Alaskan Arctic, either from oil and gas-related activities or other industrial, military, or subsistence activities, is expected to be greater than in the recent past. With increased ship traffic, there could potentially be deep water port construction in the region.

Ships using the newly opened waters in the Arctic likely will use leads and polynyas to avoid icebreaking and to reduce transit time. Leads and polynyas are important habitat for belugas, especially during winter and spring, and heavy shipping traffic could disturb polar bears and belugas during these times.

The proposed subsea cable-laying activities proposed by Quintillion would employ up to three cable laying vessels and a few support vessels in limited geographic regions. Therefore, these activities would not contribute to a noticeable increase in the total number of vessels already operating in the Arctic Ocean.

4.7.6 Conclusion

Based on the analyses provided in this section, NMFS has determined that Quintillion's proposed subsea cable-laying activities in the Bering, Chukchi, and Beaufort seas during the 2016 Arctic open-water season would not be expected to add significant impacts to overall cumulative effects on marine mammals from past, present, and future activities. The potential impacts to marine mammals and their habitat are expected to be minimal based on the limited noise footprint, and temporal or spatial separation from the activities analyzed above. In addition, mitigation and monitoring measures described in Chapter 2 are expected to further reduce any potential adverse effects.

Chapter 5 List of Preparers and Agencies Consulted

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Agencies Consulted
NMFS Office of Protected Resources consulted with NMFS Alaska Regional Office on potential effects on species lised under the Endangered Species Act.

Chapter 6 LITERATURE CITED

ACIA. 2004. Arctic Climate Impact Assessment: Impacts of a Warming Arctic. Cambridge University Press; 2004. Available from: http://www.acia.uaf.edu/

ACIA. 2005. Arctic Climate Impact Assessment. Cambridge University Press, 1042 p.

Allen, B.M. and R.P. Angliss. 2015. Alaska Marine Mammal Stock Assessments. 2014. NOAA Technical Memorandum NMFS-AFSC-301. Seattle, Washington, National Marine Fisheries Service. 304 pp.

Austin, M., A. McCrodan, C. O'Neill, Z. Li, and A. MacGillivray. 2013. Underwater Sound Measurements. (Chapter 3) In: Bisson, L.N., H.J. Reider, H.M. Patterson, M. Austin, J.R. Brandon, T. Thomas, and M.L. Bourdon. 2013. Marine mammal monitoring and mitigation during exploratory drilling by Shell in the Alaskan Chukchi and Beaufort seas, July–November 2012: Draft 90-Day Report. Editors: D.W. Funk, C.M. Reiser, and W.R. Koski. LGL Rep. P1272D–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, USA, and JASCO Applied Sciences, Victoria, BC, Canada, for Shell Offshore Inc, Houston, TX, USA, Nat. Mar. Fish. Serv., Silver Spring, MD, USA, and U.S. Fish and Wild. Serv., Anchorage, AK, USA. 266 pp, plus appendices.

BERR. 2008. Review of cabling techniques and environmental effects applicable to the offshore wind farm industry. Technical Report. 159 pp.

Bisson, L.N., H.J. Reider, H.M. Patterson, M. Austin, J.R. Brandon, T. Thomas, and M.L. Bourdon. 2013. Marine mammal monitoring and mitigation during exploratory drilling by Shell in the Alaskan Chukchi and Beaufort seas, July–November 2012: Draft 90-Day Report. Editors: D.W. Funk, C.M. Reiser, and W.R. Koski. LGL Rep. P1272D–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, USA, and JASCO Applied Sciences, Victoria, BC, Canada, for Shell Offshore Inc, Houston, TX, USA, Nat. Mar. Fish. Serv., Silver Spring, MD, USA, and U.S. Fish and Wild. Serv., Anchorage, AK, USA. 266 pp, plus appendices.

Blackwell, S.B. and C.R. Greene, Jr. 2003. Acoustic measurements in Cook Inlet, Alaska, during August 2001. Greeneridge Rep. 271-2, Rep. from Greeneridge Sciences Inc., Santa Barbara, CA, for National Marine Fisheries Service, Anchorage, AK, 43 pp.

Brower, H., Jr. 1996. Observations on locations at which bowhead whales have been taken during the fall subsistence hunt (1988 through 1995) by Eskimo hunters based in Barrow, Alaska. North Slope Borough Dept. Wildl. Manage., Barrow, AK. 8 p. Revised 19 Nov. 1996.

Burns, J. J. 1970. Remarks on the distribution and natural history of pagophilic pinnipeds in the Bering and Chukchi Seas. J. Mammal. 51:445-454.

Burns, J. J. 1981. Ribbon seal-Phoca fasciata. Pp. 89-109 In S. H. Ridgway and R. J. Harrison (eds.), Handbook of marine mammals. vol. 2. Seals. Academic Press, New York.

Burns, J. J., L. H. Shapiro, and F. H. Fay. 1981. Ice as marine mammal habitat in the Bering Sea. Pp. 781-797 In D. W. Hood and J. A. Calder (eds.), The eastern Bering Sea shelf: oceanography and resources. vol. 2. U.S. Dep. Commer., NOAA, Off. Mar. Pollut. Assess., Juneau, Alaska.

Clark, C.W., W.T. Ellison, B.L. Southall, L. Hatch, S.M. van Parijs, A. Frankel, and D. Ponikaris. 2009. Acoustic masking in marine ecosystems: intuitions, analyses and implication. Mar Ecol Prog Ser. 395:201–222.

Deepwater Wind. 2013. Block Island Wind Farm and Block Island Transmission System Underwater Acoustic Report, Revision 1.

Feder, H. M., Naidu, A.S., Hameedi, J.W., Jewett, S.C., and Johnson, W.R. 1989. The Chukchi Sea continental shelf: benthos-environmental interactions: U.S. Dep. Comer., NOAA, OCSEAP, Final Rep. 68, p. 25-311.

Ferguson, M. C., and J. T. Clarke. 2013. Estimates of detection probability for BWASP bowhead whale, gray whale, and beluga sightings collected from Twin Otter and Aero Commander aircraft, 1989 to 2007 and 2008 to 2011. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-261, 52 pp.

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. J. Acoust. Soc. Am. 118(4):2696-2705.

Flinn, R. D., A. W. Trites, E. J. Gregr, and I. R. Perry. 2002. Diets of fin, sei, and sperm whales in British Columbia: An analysis of commercial whaling records, 1963- 1967. Marine Mammal Science 18(3):663-679.

Funk, D., D. Hannay, D. Ireland, R. Rodrigues and W.R. Koski, eds. 2008. Marine mammal monitoring during open water seismic exploration by Shell Offshore, Inc. in the Chukchi and Beaufort Seas, July–November 2007: 90 day report. Prep. By LGL Alaska Research Assoc., Inc., Anchorage, AK; LGL Limited environmental research associates, King City, Ont. Canada; and Greenridge Sciences and JASCO Applied Sciences for Shell Offshore, Inc., NMFS and USFWS.

Funk, D.W., D.S. Ireland, R. Rodrigues, and W.R. Koski, eds. 2010. Joint Monitoring Program in the Chukchi and Beaufort Seas, Open Water Seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 506 p. plus appendices.

Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2011. Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Draft Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Gambell, R. 1985. Fin Whale Balaenoptera physalus (Linnaeus, 1758). In: Handbook of Marine Mammals. S.H. Ridgway and R. Harrison, eds. Vol. 3. London, UK: Academic Press, pp. 171–192.

Georgette, S. and H. Loon. 1993. Subsistence use of fish and wildlife in Kotzebue, a Northwest Alaska regional center Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 167. Juneau.

Givens, G. H., et al. 2013. Estimate of 2011 Abundance of the Bering-Chukchi-Beaufort Seas Bowhead Whale Population. Presented to the 65th International Whaling Commission. SC/65a/BRG01.

Gray, L.M. and D.S. Greeley. 1980. Source level model for propeller blade rate radiation for the world's merchant fleet. Journal of the Acoustical Society of America 67:516–522.

Green, G.A., and S. Negri. 2005. Marine Mammal Monitoring Program: FEX Barging Project, 2005. Unpublished report prepared for ASRC Lynx Enterprises, Inc., Anchorage, Alaska, by Tetra Tech EC, Inc., Bothell, Wash.

Green, G.A., and S. Negri. 2006. Marine Mammal Monitoring Program: FEX Barging Project, 2006. Unpublished report prepared for ASRC Lynx Enterprises, Inc., Anchorage, Alaska, by Tetra Tech EC, Inc., Bothell, Wash.

Green, G.A., K. Hashagen, and D. Lee. 2007. Marine mammal monitoring program, FEX barging project, 2007. Report prepared by Tetra Tech EC, Inc., Bothell, WA, for FEX L.P., Anchorage, AK.

Greenlaw, C.F., D.V. Holliday, R.E. Pieper and M.E. Clark. 1988. Effects of airgun energy releases on the northern anchovy. J. Acoust. Soc. Am. 84:S165.

Haley, B., J. Beland, D.S. Ireland, R. Rodrigues & D.M. Savarese. 2010. Chukchi Sea vessel-based monitoring program. (Chapter 3) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research , Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 499 p. plus Appendices.

Hannay, D.E., J. Delarue, B. Martin, X. Muoy, and, J.Vallarta. 2011. Joint Studies 2009 Chukchi Acoustics Monitoring Program. Version 2.1. Technical report prepared by JASCO Applied Sciences for Olgooonik-Fairweather LLC. 14 April 2011.

Hartin K.G., L.N. Bisson, S.A. Case, D.S. Ireland, and D. Hannay. (eds.) 2011. Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August–October 2011: 90-day report. LGL Rep. P1193. Rep. from LGLAlaska Research Associates Inc., LGL Ltd., and JASCO Research Ltd. for Statoil USA E&P Inc., National Marine Fisheries Service, and U.S. Fish and Wildlife Service, 202 pp, plus appendices.

Hartin, K.G., C.M. Reiser, D.S. Ireland, R. Rodrigues, D.M.S. Dickson, J. Beland, and M. Bourdon. 2013. Chukchi Sea vessel-based monitoring program. (Chapter 3) In: Funk, D.W., C.M. Reiser, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2013. Joint Monitoring Program in the Chukchi and Beaufort seas, 2006–2010. LGL Alaska Final Report P1213-1, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and Other Industry Contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. 592 p. plus Appendices.

Hashagen, K.A., G.A. Green, and B. Adams. 2009. Observations of humpback whales, Megaptera novaeangliae, in the Beaufort Sea, Alaska. Northwestern Naturalist, 90:160–162.

Hauser, D.D.W., V.D. Moulton, K. Christie, C. Lyons, G. Warner, C. O'Neill, D. Hannay, and S. Inglis. 2008. Marine mammal and acoustic monitoring of the Eni/PGS open-water seismic program near Thetis, Spy and Leavitt islands, Alaskan Beaufort Sea, 2008: 90-day report. LGL Rep. P1065-1. Rep. from LGL Alaska Research Associates Inc. and JASCO Research Ltd., for Eni US Operating Co. Inc., PGS Onshore, Inc., NMFS, and USFWS. 180 pp.

Holt, M.M. 2008. Sound exposure and Southern Resident killer whales (Orcinus orca): A review of current knowledge and data gaps. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-89, 59 p.

Holt M.M., D.P. Noren, V. Veirs, C. Emmons, S. Veirs. 2009. Speaking up: killer whales (Orcinus orca) increase their call amplitude in response to vessel noise. J Acoust Soc Am 125:EL27–EL32.

Jarvela L.E. and L.K. Thorsteinson. 1999. The epipelagic fish community of Beaufort Sea coastal waters, Alaska. Arctic 52:80-94.

Johnson, C.B., B.E. Lawhead, J.R. Rose, M.D. Smith, A.A. Stickney, and A.M. Wildman. 1999. Wildlife studies on the Colville River Delta, Alaska, 1998. Rep. from ABR, Inc., Fairbanks, AK, for ARCO Alaska, Inc., Anchorage, AK.

Kastak, D. and R.J. Schusterman. 1998. Low-frequency amphibious hearing in pinnipeds: Methods, measurements, noise, and ecology. J Acoust Soc Am 103:2216-2228.

Laurinolli, M.H. and N.A. Cochrane. 2005. Hydroacoustic analysis of marine mammal vocalization data 6 from ocean bottom seismometer mounted hydrophones in the Gully. Pages 89-95 in K. Lee, H. Bain 7 and G.V. Hurley, eds. Acoustic Monitoring and Marine Mammal Surveys in The Gully and Outer 8 Scotian Shelf Before and During Active Seismic Surveys. Environmental Studies Research Funds 9 Report 151.

LGL Alaska Research Associates, Inc., JASCO Applied Sciences, Inc., and Greeneridge Sciences, Inc., 2013. Joint Monitoring Program in the Chukchi and Beaufort Seas, 2012. LGL Alaska Draft Report P1272-2 for Shell Offshore, Inc. ION Geophysical, Inc., and Other Industry Contributors, National Marine Fisheries Service, and U.S. Fish and Wildlife Service, 320 p. plus Appendices.

Lomac-MacNair, K., C. Thissen, and M.A. Smultea. 2014. Draft NMFS 90-Day Report for Marine Mammal Monitoring and Mitigation during SAExploration's Colville River Delta 3D Seismic Survey, Beaufort Sea, Alaska, August to September 2014. Submitted to SAE, Prepared by Smultea Environmental Sciences, P.O. Box 256, Preston, WA 98050.

MacGillivray, A.O. 2006. Acoustic Modelling Study of Seismic Airgun Noise in Queen Charlotte Basin. Master of Science Thesis. University of Victoria, British Columbia.

Madsen, P.T., Wahlberg, M., Tougaard, J., Lucke, K. and Tyack, P. (2006). Wind turbine underwater noise and marine mammals: implications of current knowledge and data needs. Mar. Ecol. Progr. Ser. 309, 279-295.

Maher, W.J. 1960. Recent records of the California gray whale (Eschrichtius glaucus) along the north coast of Alaska. Arctic 13(4):257-265.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird. 1983. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior (BBN Report No. 5366; NTIS PB86-174174). Report from Bolt Beranek and Newman Inc. for U.S. Minerals Management Service, Anchorage, AK.

Malme, C.I., P.R. Miles, C.W. Clark, P. Tyack and J.E. Bird. 1984. Investigations of the potential effects of underwater noise from petroleum industry activities on migrating gray whale behavior/Phase II: January 1984 migration. BBN Rep. 5586. Rep. from Bolt Beranek & Newman Inc., Cambridge, MA, for U.S. Minerals Manage. Serv., Anchorage, AK. NTIS PB86-218377.

Mate, B.R., K.M. Stafford and D.K. Ljungblad. 1994. A change in sperm whale (Physeter macrocephalus) distribution correlated to seismic surveys in the Gulf of Mexico. Journal of the Acoustical Society of America 96(2):3268-3269.

McDonald, M.A., Hildebrand J.A., Mesnick S. 2009. Worldwide decline in tonal frequencies of blue whale songs. Endang. Species Res. 9:13-21.

McKenna, M.F., D. Ross, S.M. Wiggins, and J.A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. Journal of the Acoustical Society of America 131:92-103.

Melcon, M.L., Cummins A.J., Kerosky S.M., Roche L.K., Wiggins S.M., et al. 2012. Blue whales respond to anthropogenic noise. PLoS ONE 7(2):e32681. doi:10.1371/journal.pone.0032681

Miles, P.R., C.I. Malme, and W.J. Richardson. 1987. Prediction of drilling site-specific interaction of industrial acoustic stimuli and endangered whales in the Alaskan Beaufort Sea. Report prepared by BBN Laboratories Inc., Cambridge, MA and LGL Ltd., King City, ON for the U.S. Department of the Interior Minerals Management Service, Alaska OCS Office, Anchorage, AK.

Miller, R.V., D. J. Rugh, and J. H. Ohnson. 1986. The distribution of bowhead whales, Balaena mysticetus, in the Chukchi Sea. Marine Mammal Science 2(3):214-222.

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, G.W., R.E. Elliot, T.A. Thomas, Moulton, V.D. and W.R. Koski. 2002. Distribution and numbers of bowhead whales in the eastern Alaska Beaufort Sea during late summer and autumn, 1979-2000. In: Richardson, W.J. and D.H. Thomson (eds). 2002. Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information. OCS Study MMS 2002-012; LGL Rep. TA2196-7. 697 pp. 2 vol.

National Marine Fisheries Service (NMFS). 1991. Recovery plan for the humpback whale (Megaptera novaeangliae). Prepared by the humpback recovery team for the National Marine Fisheries Service, Silver Spring, Maryland. 105 pp.

National Research Council (NRC). 2003. Ocean Noise and Marine Mammals. National Academies Press, Washington, D.C. 192 pp.

Nedwell, J.R., J. Langworthy, and D. Howell. 2003. Assessment of sub-sea acoustic noise and vibration from offshore wind turbines and its impact on marine wildlife; initial measurements of underwater noise during construction of offshore wind farms, and comparison with background noise. Subacoustech Report ref: 544R0423, published by COWRIE.

Nelson, C.H., R.L. Phillips, J. McRea Jr., J.H. Barber Jr., M.W. McLaughlin, and J.L. Chin. 1994. Gray whale and Pacific walrus benthic feeding grounds and sea floor interaction in the Chukchi Sea. U.S. Geological Survey, Menlo Park, California. Technical report for minerals management service / IA No. 1417. OCS Study MMS 93–0042. 51 pp.

Nemoto, T. 1957. Foods of Baleen Whales in the North Pacific. Scientific Report 12. Tokyo, Japan: Whales Research Institute, pp. 33–89.
Ohsumi, S. and S. Wada. 1974. Status of whale stocks in the North Pacific, 1972. Rep. Int. Whal. Commn. 24:114–126.
Perry, S.L., D.P. DeMaster, and G.K. Silber. 1999. The great whales: History and status of six species listed as endangered under the U.S. Endangered Species Act of 1973. Mar. Fish. Rev. 61(1):1–74.9
Reider, H.J., L.N. Bisson, M. Austin, A. McCrodan. J. Wladichuk, C.M. Reiser, K.B. Matthews, J.R. Brandon, K. Leonard, and H.M. Patterson. 2013. Marine mammal monitoring and mitigation during Shell's activities in the Chukchi Sea, July–September 2013: Draft 90-Day Report. LGL Report P1272D–2. Report from LGL Alaska Research Associates Inc., Anchorage, AK, USA, and JASCO Applied Sciences, Victoria, BC, Canada, for Shell Gulf of Mexico, Houston, TX, USA, National Marine Fisheries Service, Silver Spring, MD, USA, and U.S. Fish and Wildlife Service, Anchorage, AK, USA. 198 pp, plus appendices.
Reiser, C.M, D.W. Funk, R. Rodrigues, and D. Hannay. (eds.) 2011. Marine mammal monitoring and mitigation during marine geophysical surveys by Shell Offshore, Inc. in the Alaskan Chukchi and Beaufort seas, July–October 2010: 90-day report. LGL Rep. P1171E–1. Rep. from LGL Alaska Research Associates Inc., Anchorage, AK, and JASCO Applied Sciences, Victoria, BC for Shell Offshore Inc, Houston, TX, Nat. Mar. Fish. Serv., Silver Spring, MD, and U.S. Fish and Wild. Serv., Anchorage, AK. 240 pp, plus appendices.
Richardson, W.J. and C.I. Malme. 1993. Man-Made Noise and Behavioral Responses. In: The Bowhead Whale, J.J. Burns, J.J. Montague, and C.J. Cowles, eds. Society for Marine Mammalogy Special Publication of The Society for Marine Mammalogy, 2. Lawrence, KS: The Society for Marine Mammalogy; pp. 631–700.
Richardson, W.J., M.A. Fraker, B. Würsig, and R.S. Wells. 1985. Behaviour of bowhead whales, Balaena mysticetus, summering in the Beaufort Sea: Reactions to industrial activities. Biological Conservation 32:195-230.
Richardson, W.J., B. Würsig, and C.R. Greene Jr. 1990. Reactions of bowhead whales, Balaena mysticetus, to drilling and dredging noise in the Canadian Beaufort Sea. Marine Environmental Research, 29:135-160.
Richardson, W.J., C.R. Greene, Jr., C.I. Malme and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, San Diego. 576 pp.
Romero, L.M., M.J. Dickens, and N.E. Cyr. 2009. The reactive scope model – a new model integrating homeostasis, allostasis and stress. Horm. Behav. 55:375–389.
Samsung 2009. Underwater noise measurements for HN1688 145,000 m³ LNG SRV. Report by Samsung Ship Model Basin, Daejeon, Korea for Neptune LNG Project, Boston, MA. 29 p.
Savarese, D.M., C.M. Reiser, D.S. Ireland & R. Rodrigues. 2010. Beaufort Sea vessel-based monitoring program. (Chapter 6) In: Funk, D.W, D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open water seasons, 2006–2008. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, LGL Ltd., Greeneridge Sciences, and JASCO Research for Shell Offshore, Inc. and Other Industry Contributors, and NMFS, USFWS, 506 pp, plus Appendices.
Scheffer, V. B., and J. W. Slipp. 1948. The whales and dolphins of Washington State with a key to the cetaceans of the west coast of North America. Am. Midl. Nat. 39:257−337.
Scheffer, V. B. 1953. Measurements and stomachs contents of 11 delphinids from the northeast Pacific. Murrelet 34:27–30.
Scheifele, P.M., S. Andrew, R.A. Cooper, M. Darre, F.E. Musiek, and L. Max. 2005. Indication of a Lombard vocal response in the St. Lawrence River beluga. Journal of Acoustics Society of America 117:1486-1492.
Sheffield, G., and C. George. 2013. Diet studies. Section VB. In: Shelden, K.E.W., and J.A. Mocklin, eds. 2013. Bowhead Whale Feeding Ecology Study (BOWFEST) in the western Beaufort Sea. Final

Report, OCS Study BOEM 2013-0114. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115-6349.
Simmonds, M., S. Dolman, and L. Weilgart. 2004. Ocean of noise – A WDCS Science report. Whale and Dolphin Conservation Society. 164 pp.
Simpkins, M. A., L. M. Hiruki-Raring, G. Sheffield, J. M. Grebmeier, and J. L. Bengtson. 2003. Habitat selection by ice-associated pinnipeds near St. Lawrence Island, Alaska in March 2001. Polar Biol. 26:577-586.
Southall, B.L., R.J. Schusterman, and D. Kastak. 2000. Masking in three pinnipeds: Underwater, low-frequency critical ratios. J. Acoust. Soc. Am. 108, 1322–1326.
Stirling, I., M. Kingsley, and W. Calvert. 1982. The Distribution and Abundance of Seals in the Eastern Beaufort Sea, 1974-79. Can. Wildl. Serv. Occas. Pap. 47. 25 pp.
Suydam, R.S., and J.C. George. 2004. Subsistence harvest of bowhead whales (Balaena mysticetus) by Alaskan Eskimos, 1974-2003. Presented to the 56th International Whaling Commission. SC/56/BRG12.
Tetra Tech. 2013. Block Island Transmission System: Scarborough Beach Underwater Acoustic Assessment. 8 pp.
Ver Hoef, J. M., M. F. Cameron, P. L. Boveng, J. M. London, and E. E. Moreland. 2014. A spatial hierarchical model for abundance of three ice-associated seal species in the eastern Bering Sea. Stat. Methodol. 17:46 66. DOI: 10.1016/j.stamet.2013.03.001.
Wartzok, D. and D.R. Ketten. 1999. Marine mammal sensory systems. Pages 117-148 in J.E. Reynolds III and S.A. Rommel (eds), Biology of Marine Mammals. Washington D.C.: Smithsonian Institution Press.
Williams, M.T. and J.A. Coltrane (eds.). 2002. Marine mammal and acoustical monitoring of the Alaska Gas Producers Pipeline Team's open water pipeline route survey and shallow hazards program in the Alaskan Beaufort Sea, 2001. LGL Rep. P643. Rep. from LGL Alaska Res. Assoc. Inc., Anchorage, AK, for BP Explor. (Alaska) Inc., ExxonMobil Production, Phillips Alaska Inc., and Nat. Mar. Fish. Serv. 103 pp.
Williams, R., D.E. Bain, J.C. Smith, and D. Lusseau. 2009. Effects of vessels on behaviour patterns of individual southern resident killer whales Orcinus orca. Endangered Species Research 6:199-209.
Woodby, D.A. and Botkin, D.B. 1993. Stock sizes prior to commercial whaling. pp. 387-407. In: J.J. Burns, J.J. Montague and C.J. Cowles (eds.) Special Publication. No. 2. The Bowhead Whale. 1st. Edn. Society for Marine Mammology, Lawrence, Kansas. 787pp.
Yamamoto, T., Hoshina, K., Nishizawa, B., Meathrel, C. E., Phillips, R. A., and Watanuki, Y. 2015. Annual and seasonal movements of migrating short-tailed shearwaters reflect environmental variation in sub-Arctic and Arctic waters, Mar. Biol., 162, 413–424, doi:10.1007/s00227-014-2589-1.
Zerbini, A. N., J. M. Waite, J. L. Laake, and P. R. Wade. 2006. Abundance, trends and distribution of baleen whales off western Alaska and the central Aleutian Islands. Deep-Sea Res. Part I:1772-1790.