Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with Proposed Alaska Phase of the Quintillion Subsea Project, 2016

REVISED FINAL

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TABLE OF CONTENTS

Appendices

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1. DESCRIPTION OF SPECIFIC ACTIVITY

Quintillion Subsea Operations, LLC (Quintillion), is proposing to install a subsea fiber optic cable network (the Project) along the northern and western coasts of Alaska to provide high speed internet connectivity to six rural Alaska communities. The subsea fiber optic cable network will link with an existing North Slope terrestrial-based fiber optic line. The Quintillion Subsea Project will consist of 1,904 kilometers (km) (1,183 miles [mi]) of submerged fiber optic cable that includes a main trunk line and six branch lines to onshore facilities in Nome, Kotzebue, Point Hope, Wainwright, Barrow, and Oliktok Point (Figure 1-1). Alcatel-Lucent Submarine Networks (ASN) will conduct the work to lay the cable for the Nome to Oliktok Point system, which is the subject of this application.

The cable-lay ships, cable-lay barges, and support tugs proposed for the Project use thrusters for dynamic positioning and anchor handling during laying operations. The noises generated by these sources have a possibility of acoustically harassing marine mammals, a form of “take” as defined under the Marine Mammal Protection Act (MMPA), and thus are subject to governance under MMPA. Incidental and unintentional harassment takes are permitted with the issuance of an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS). MMPA identifies 14 specific items that must be addressed when applying for an IHA, which allow the NMFS to fully evaluate whether the proposed actions remain incidental and unintentional. The 14 items are addressed below relative to Quintillion Subsea Operation, LLC’s proposed 2016 cable laying project.

1.1. Overview of Activity

The planned fiber optic cable-lay project will occur in the offshore waters of the Bering, Chukchi, and Beaufort Seas between Nome and Oliktok Point (Figure 1-1). The main trunk line is 1,317 km (818 mi) in length, and will run from the tail of the Nome branching line to the tail of the Oliktok Point branching line (Table 1-1). The lengths of these branching lines range between 27 km (17 mi) and 233 km (145 mi). Branching lines connect to the main trunk line at the branching unit (BU), which is a piece of hardware that allows the interconnection of the branching cable from the main trunk line to the shore end facility. The cable signal is amplified through the use of a repeater that is attached to the cable approximately every 60 km (37 mi). Collectively, the cable, BUs, and repeaters make up the “submerged plant”. Depending on bottom substrate, water depth, and distance from shore, the cable will either lay on the ocean floor or will be buried using a plough or a remote operating vehicle (ROV) equipped for burial by water jetting. Specific project details follow.

1.2. Project Details

1.2.1. Cable Network

The location of all cable routes will be finalized after the cable route survey (CRS) and burial assessment survey (BAS) is completed (in fall of 2015) and reported. However, any changes in the planned routes (Figure 1-1) resulting from the CRS are expected to be minor, and would not appreciably affect the marine mammal assessment. The length of each cable segment (trunk line and branches) is found in Table 1-1.

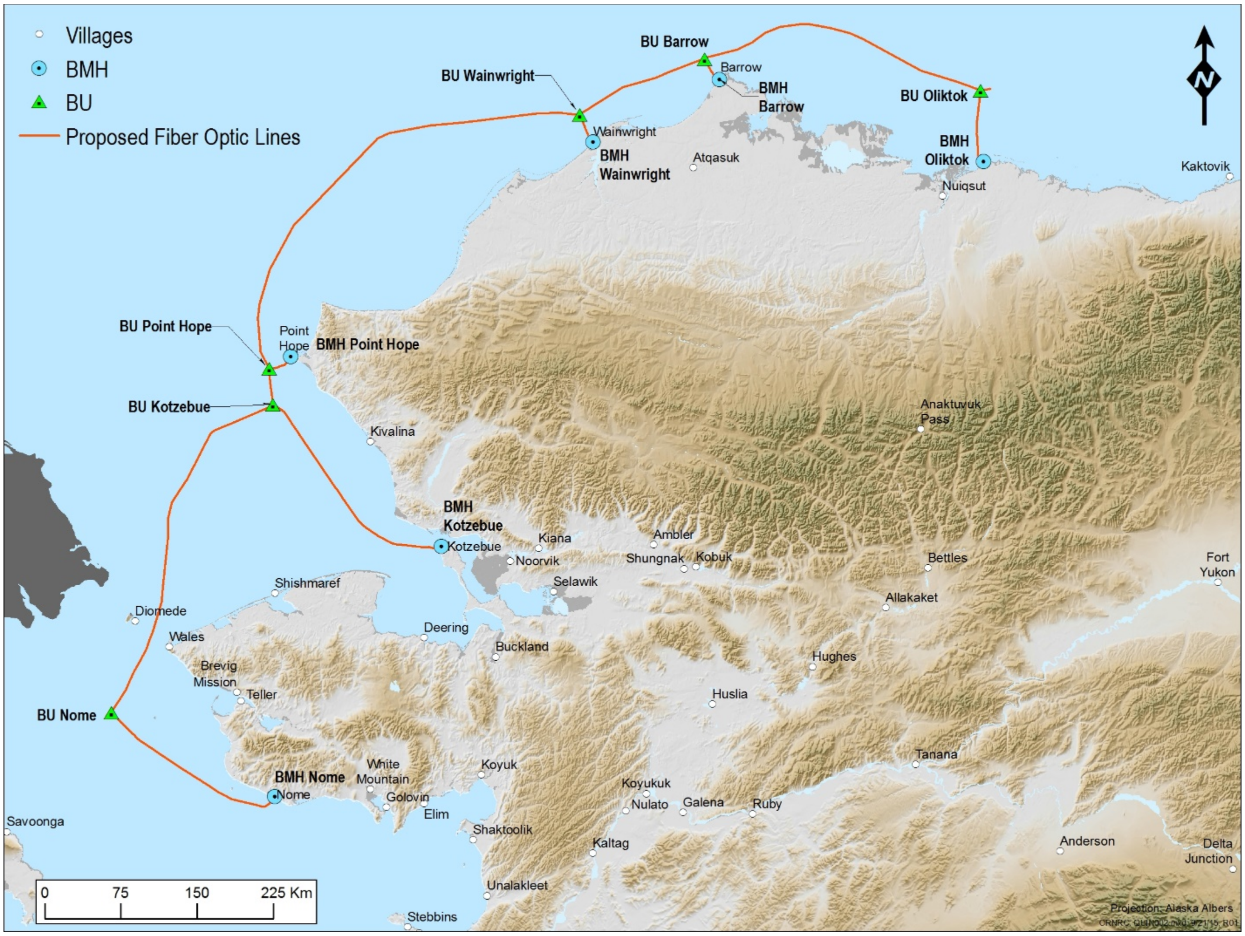

Figure 1-1. Quintillion Subsea Operations, LLC's proposed fiber optics cable network.

Table 1-1. 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**

1.2.2. Vessels

The offshore (waters >12 m deep) cable-lay operations will be conducted from the *Ile de Brehat* (Figure 2) and one or more of its sister ships (*Ile de Sein, Ile de Batz*). All three ships are 140 m (460 ft) in length 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. The full specifications of the ships are found in Appendix A. The ASN vessels and crew operate within the strictest compliance of all International, National, Local, and U.S. Coast Guard (USCG) territorial regulations. Support vessels include a tug and barge that will remain in the vicinity of the main lay vessels.

In order to maintain a flexible enough schedule to respond to the 2016 sea ice conditions, to respond to Bering Sea fisheries (cable-burying) and Beaufort Sea subsistence concerns, Quintillion plans to use two sister cable-laying ships, and possibly the third, operating at separate locations to ensure the project is completed during the 2016 open-water season.

During cable laying activities occurring in nearshore waters too shallow (<12 m deep) for the *Ile de Brehat* or other ships, an unpowered cable-lay barge will be used to lay the final shore ends of the cable. The cable-lay barge will slowly move along the cable route by winching along an anchor-spread. Two small (<3,000 hp) utility tug boats will be used to constantly maneuver the anchors into position. The utility tugs to be used have not been identified yet. The proposed barge is small and provides few accommodations for additional crew or supernumaries.

Figure 1-2. The proposed cable-lay ship *C/S Ile de Brehat*.

The branch line segment between and Oliktok Point and BU Oliktok (Figure 1-1) crosses a hard seafloor that poses a more unique challenge to burying the cable in the ice scour zone. For this segment the *CB Networker* (Figure 1-3), a 60-m (197-ft) powered cable-lay barge, will be used because it includes a vertical injector powerful enough to cut a cable trench through the hard sediments found off Oliktok Point. The *CB Networker* is also large enough to operate offshore and will lay the full 75 km cable length between Oliktok Point and BU Oliktok. This additional vessel will also facilitate completing the Beaufort Sea cable-routes before the start of the 2016 whaling season.

Figure 1-3. The proposed cable-lay barge *CB Networker*.

1.2.3. 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 to identify and clear any seabed debris (*e.g.*, wires, hawsers, fishing gear) which may have been deposited along the route. Any debris recovered during the PLGR 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 re-route will be planned to avoid the debris. The PLGR operation will be conducted to industry standards employing towed grapnels (the type of grapnel being determined by the nature of the seabed). The PLGR operation will be conducted by a local tug boat ahead of the cable-lay activities. The PLGR operation is similar to a fishing trawler operation, and there are no acoustical harassment concerns of consequence.

1.2.4. Cable Laying

The objective of the offshore surface cable-lay 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 will 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.

Cable-burying will occur in all waters south of Bering Strait to avoid conflicts with fisheries (snagging the cable). In water depths greater than about 12 m (about 40 ft) the cable will be buried using an SMD Heavy Duty HD3 Plough (Figure 1-4). 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 meters per hour (m/hr) (approximately 0.37 miles per hour [mph]).

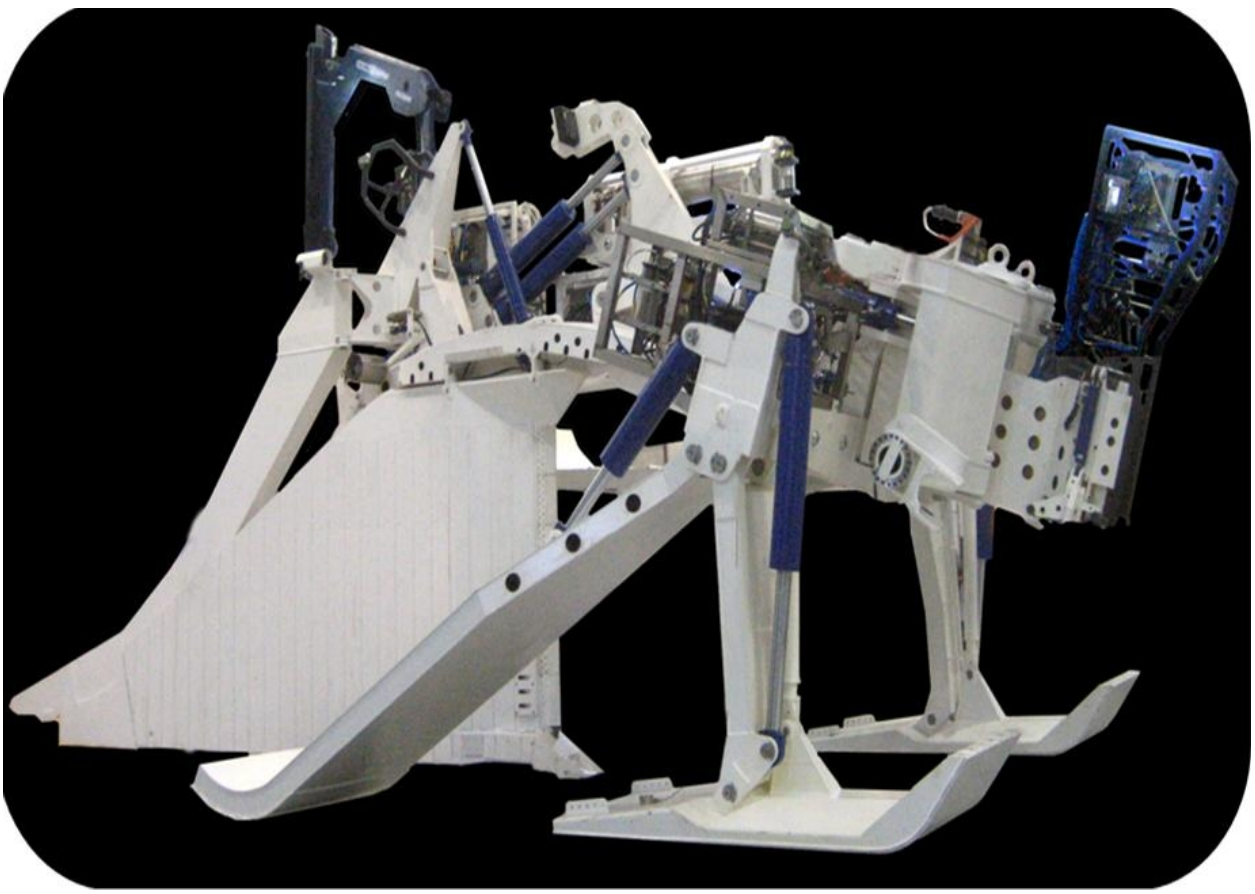

Figure 1-4. SMD HD3 plough.

In water depths less than 12 m (40 ft) cable burial will be by jet burial using a towed sled, tracked ROV, or by diver jet burial. Methods will be subject to seabed conditions in the area. The planned ROV (ROVJET 400 series, Figure 1-5) is 5.8 m (19.0 ft) long and 3.4 m (11.2 ft) wide and weighs 9.1 tonnes (10 tons), and has both a main and forward jet tool capable of trenching to 2 m (6.6 ft) depth.

Nearer to shore, where seasonal ice scouring occurs, the cable will be floated on the surface and then pulled through an existing HDD bore pipe to the BMH where it will 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.

Figure 1-5. ROVJET.

1.2.5. Post Lay Inspection and Burial

While it is expected that the cable trench will 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) will be conducted using the ROVJET 400 series mentioned above. It is expected that PLIB will be necessary for no more than about 10 km (6.2 mi) of the cumulative planned burial routes.

1.3. Acoustical Sources

There are a number of acoustical sources associated with cable-lay operations including thrusters, ploughs, jets, ROVs, echo sounders, and positioning beacons. The predominant noise source during cable-lay operations is the cavitation noise produced by thrusters during dynamic positioning of the vessel (Tetra Tech 2013). Cavitation is the random collapsing of bubbles produced by the blades. The C/S *Ile de Brehat* maintains dynamic positioning during cable-lay 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 (decibels relative to 1 microPascal root mean square at 1 m) (Nedwell *et al.* 2003, MacGillivary 2006, Samsung 2009, Hartin *et al.* 2011, Deepwater Wind 2013, Tetra Tech 2013).

Thruster noise represents a continuous sound source, and exceeds NMFS Level B harassment criteria when exceeding 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 km and 4.5 km (0.8 mi and 2.7 mi) (Samsung 2009, Deepwater Wind 2013, Tetra Tech 2013) for water depths similar to those where Quintillion will be operating in the Chukchi and Beaufort Seas. 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 Hertz (Hz) 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-lay operation will 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. However, a sound source verification of the C/S *Ile de Brehat* is planned to be conducted soon after it begins operations near Nome (see Appendix B Marine Mammal Monitoring and Mitigation Plan).

The proposed nearshore cable-lay barge would not be self-powered, but rather moves by winching along anchor lines and, thus, would not produce significant underwater noise. The most significant noise during these nearshore operations would come from the small utility tugs during anchor maneuvering activity. Source levels for large (45-83 m in length) anchor-handling tugs during anchor pulling operations have been measured at been 181 and 207 dB re 1 µPa (rms) (Laurinolli *et al*. 2005, Austin *et al*. 2013, LGL/JASCO/Greeneridge 2014). However, smaller (<35 m) tugs (of the size class proposed for this project) produce underwater noise levels <180 dB re 1 µPa (rms) when pulling (Richardson *et al*. 1995, Blackwell and Greene 2003). Blackwell and Greene (2003) measured the underwater noise levels from a tug maneuvering a large barge near the Port of Anchorage and recorded maximum sound pressure levels equating to 163.8 dB re 1 µPa (rms) at 1-m source when the tug was pushing the barge, which increased to 178.9 dB re 1 µPa (rms) when thrusters were additionally operated during docking maneuvers. It is assumed that the maximum noise levels from the proposed anchor-handling barges will produce underwater noise possibly reaching, but not exceeding, 180 dB re 1 µPa (rms). Tug sound pressure levels will be verified at the beginning of the cable-lay season (see Appendix B).

The larger *CB Networker* cable-lay barge that will operate off Oliktok Point is equipped with three (1,000 kW) main engines and four (420 kW) maneuvering thrusters to facilitate positioning, but once location is established, it will move by winching along a 4-point anchor-mooring system and, like the other nearshore barge, will be supported by small anchor-handling tugs. There is no sound source data on the *CB Networker*, but as with the other nearshore barging system, the expected dominate underwater noise will be small tugs during anchor-handling.

Other acoustical sources include the echo sounders, transceivers, and transponders that will be used to continually reference the water depth and the position of the plow and ROV that operate behind the vessel. Based on actual field measurements or manufacturer provided values, some these equipment produce noise levels exceeding the vessel thrusters. However, these equipment are impulsive, producing pulses every 1 to 3 sec, and the sound energy is focused downward in very narrow conical beams. There is very little horizontal propagation of the noise levels. Measured distances to the 160 dB isopleth for these or similar echo sounders and acoustical beacons ranged between 26 and 44 m (Ireland *et al.* 2007, Reider *et al.* 2013).

2. DATES, DURATION, AND SPECIFIC GEOGRAPHICAL REGION

The request for incidental harassment authorization is for the 2016 open water season (June through October). All associated activities, including mobilization, PLGR, cable-lay, PLIB, and demobilization of survey and support crews, would occur inclusive of the above seasonal dates. Operations would begin at Nome and generally follow the receding sea ice northward, although some vessels will be working at multiple locations to maximize completing the cable-lay within the open-water season. It is expected that the operations may last all season (approximately 150 days). The locations of the main trunk and branching lines are shown in Figure 1-1.

3. SPECIES AND NUMBERS OF MARINE MAMMALS

The proposed cable-lay activity will occur in three separate water bodies: the Bering, Chukchi, and Beaufort seas. The species of marine mammals that are most likely to be found in the Chukchi Sea activity area, at least seasonally, are the bowhead whale, gray whale, beluga whale, harbor porpoise, ringed seal, spotted seal, and bearded seal. (Pacific walrus and polar bear are also found here, but they fall under the jurisdiction of the U.S. Fish and Wildlife Service and are addressed in a separate IHA application.) Humpback whales, fin whales, minke whales, killer whales, and ribbon seals also seasonally occur in the Chukchi Sea, but in small numbers.

The primary species found in the Beaufort Sea include the bowhead whale, gray whale, beluga whale, ringed seal, spotted seal, and bearded seal. Gray whales are included in this list because they have been found penetrating deeper into the Beaufort Sea in recent years (Green and Negri 2005, Green *et al.* 2007).

A humpback whale cow/calf pair was observed in Smith Bay, inshore of the cable route between Barrow and Oilktok, but this is considered an extralimital sighting. Killer whales have been observed off Point Barrow in recent years (G. Green, pers. obs.), but there are no recent records.

A small portion of the network occurs within the Bering Sea (Norton Sound). The species most likely to occur there during the summer months include minke whales, beluga whales, harbor porpoises, and spotted seals. Small numbers of humpback whales and fin whales are expected to be found here. Bowhead whales and ice seals, including ribbon, ringed, and bearded seals, are found in the northern Bering Sea, but largely only during the winter months.

Table 3-1. Marine Mammals in the Alaskan Bering, Chukchi, and Beaufort Seas.

Species	Abundance	Comment
Bowhead Whale (*Balaena mysticetus*)	16,892	ESA-listed as Endangered
Fin Whale (*Balaenoptera physalus*)	1,652	Northeast Pacific Stock
Humpback Whale (*Megaptera novaeangliae*)	1,107	Western North Pacific Stock
Humpback Whale (*Megaptera novaeangliae*)	10,103	Central North Pacific Stock
Gray Whale (*Eschrichtius robutus*)	20,990	Common in Chukchi, Rare in Beaufort
Beluga Whale (*Delphinapterus leucas*)	39,258	Beaufort Sea Stock
Beluga Whale (*Delphinapterus leucas*)	3,710	Eastern Chukchi Sea Stock
Beluga Whale (*Delphinapterus leucas*)	19,186	Eastern Bering Sea Stock
Killer Whale (*Orcinus orca*)	2,347	Alaska Resident Stock
Harbor Porpoise (*Phocoena phocoena*)	48,215	Bering Sea Stock
Ringed Seal (*Phoca hispida*)	249,000	ESA-listed as Threatened
Spotted Seal (*Phoca largha*)	460,268	Alaska Stock
Ribbon Seal (*Histriophoca fasciata*)	49,000	Alaska Stock
Bearded Seal (*Erignathus barbatus*)	155,000	ESA-listed as Threatened

Source: Zerbini *et al*. (2006), Boveng *et al.* (2009), Cameron *et al.* (2010), Allen and Angliss (2014, 2015), Carretta *et al.* (2015)

4. STATUS AND DISTRIBUTION OF THE AFFECTED SPECIES

4.1. Bowhead Whale

The Western Artic stock of bowhead whale is one of five stocks recognized by the International Whaling Commission (IWC), and is currently the largest with an estimated population of 16,892 animals (Allen and Angliss 2015). This stock is currently listed as endangered under the Endangered Species Act (ESA) and "depleted" under the MMPA, although it has experienced significant growth in the past 30 years despite subsistence harvest.

This stock summers in the Canadian Beaufort Sea, migrate through the Alaskan Beaufort Sea, Chukchi Sea, and Bering Strait in the fall, and winter in the Bering Sea (Braham *et al.* 1984, Moore and Reeves 1993). The whales passing through the Chukchi often fall a route along the Siberian coast (Quakenbush 2007, Quakenbush *et al.* 2010). The whales follow open leads in the sea ice during their spring migration (March to mid-June) back to Canada (Braham *et al.* 1984, Moore and Reeves 1993). However, individual bowhead whales can be found throughout their range at almost any time of the year (Rugh *et al.* 2003, Moore *et al.* 2010), and they have been found summering near Point Barrow and Smith Bay (Green and Negri 2005, Green *et al.* 2007). Mocklin *et al.* (2012) have reported on bowheads feeding near Point Barrow.

Pre-whaling population estimates for bowhead whales range between 10,400 and 23,000 animals. This population was reduced to approximately 3,000 whales by commercial whaling (Woodby and Botkin 1993). From 1978 to 2011, the bowhead whale population has grown at an annual rate of approximately 3.7% (Givens *et al.* 2013).

Bowhead whales are hunted in the Bering Sea by whalers from Gambell, Savoonga, Little Diomede, and Wales, in the Chukchi Sea by whalers from Kivalina, Point Hope, Wainwright, and Barrow, and the Alaskan Beaufort Sea by hunters from Barrow, Kaktovik, and Nuiqsut. The Bering and Chukchi villages hunt in spring, the Beaufort villages in the fall, and Barrow during both seasons. The Nuiqsut hunters base from Cross Island, 70 km (44 mi) east of Oliktok Point. Fall migrating whales typically reach Cross Island in September and October (Brower 1996), although some whales might arrive as early as late August. Barrow is 260 km (162 mi) northwest of Oliktok Point. Because Barrow is located downstream of the bowhead whale migration, whaling from here often occurs a little later than at Cross Island. QSO's planned fall activities would occur between Barrow and Cross Island potentially at a time that the annual fall bowhead migration is underway. Cable-lay would occur well after the spring hunt.

Most bowheads fall migrate through the Alaskan Beaufort in water depths between 15 and 200 m (50 and 656 ft) deep (Miller *et al*. 2002), with annual variability depending on ice conditions (whales traveling farther offshore during heavy ice cover years). Hauser *et al.* (2008) conducted surveys for bowhead whales near the Colville River Delta (near Oliktok Point) during August and September 2008, and found most bowheads between 25 and 30 km (15.5 and 18.6 mi) north of the barrier islands (Jones Islands), with the nearest in 18 m (60 ft) of water about 25 km (16 mi) north of the Colville River Delta. No bowheads were observed inside the 18-m (60-ft) isobath.

Most of the cable-lay activity planned for the Beaufort Sea will occur in water deeper than 15 m (50 ft) where migrating bowhead whales could most likely be encountered. QSO will work with the Alaska Eskimo Whaling Commission (AEWC) and both the Barrow and Nuiqsut Whaling Captain's Associations, through the Plan of Cooperation process (Appendix C), to ensure that planned activities do not disrupt the annual bowhead whale hunt based from Barrow and Cross Island.

4.2. Fin Whale

North Pacific fin whales are cosmopolitan in their distribution in that they are found in all the oceans of the world, including polar regions, although they are rare in the tropics and the Arctic Ocean. They are found in both pelagic and shelf waters, and especially use shelf edge upwelling and mixing zones. The migratory pattern of eastern North Pacific fin whales is not fully understood although they are found in Alaska during summer (Mizroch *et al*. 2009) and off California all year (Clapham *et al*. 1997). Fin whales were listed as endangered under the Endangered Species Conservation Act in 1970 and the ESA in 1973, and received full protection from commercial whaling in 1976 under the International Whaling Commission. Between 1925 and 1975, nearly 48,000 fin whales were harvested in the North Pacific (Chapman 1976). No critical habitat has been designated for the North Pacific fin whale, although a recovery plan was developed in 1998.

Prior to commercial whaling, an estimated 25,000 to 27,000 fin whales seasonally inhabited the eastern North Pacific (Ohsuma and Wada 1974). By 1974, this stock was thought to have been reduced to between 38% and 50% of the original population (Rice 1974, Chapman 1976), although the methods used to estimate the decline may not be reliable (Barlow *et al.* 1994). Because this species occurs both in shelf edge and pelagic waters of the North Pacific, much of the population occurs outside nearshore marine mammal survey areas. Survey results from Moore *et al*. (2002) and Zerbini *et al*. (2006) were combined by Allen and Angliss (2014) to produce the current population estimate of 5,700 animals for western

Alaskan waters. Zerbini *et al*. (2006) also estimated that this stock has increased at an annual rate of 4.8% since 1987. The California/Oregon/Washington stock has been estimated at 3,044 (Carretta *et al*. 2013) based on the combined surveys by Forney (2007) and Barlow (2010). This stock is also thought to be increasing (Barlow *et al.* 1994, Barlow 1997).

Fin whales feed primarily on krill and schooling fish such as anchovies, Pacific herring (*Clupea pallasii*), and walleye pollock (*Theragra chalcogramma*) (Rice 1963, Clapham 1997). Euphausiids dominated the prey of fin whales taken from British Columbia whaling stations in the 1960s (Flinn *et al*. 2002).

It is assumed that North Pacific fin whales become sexually mature at about 10 years of age, although there is evidence that those in heavily exploited populations can mature in as little as 6 years (Gambell 1985, Ohsumi 1986). The calving interval may also vary depending on exploitation, with heavily hunted populations having intervals closer to 2 years (Christensen *et al*. 1992) and unhunted populations closer to 3 years (Agler *et al*. 1993).

Based on observations and passive acoustic detection (Delarue *et al.* 2010, 2012; Crance *et al.* 2011; Hannay *et al.* 2011) and direct observations from monitoring and research projects of fin whales from industry (Bisson *et al.* 2013, Funk *et al.* 2010, Hartin *et al.* 2013, Ireland *et al.* 2009) and government (Aerts *et al.* 2012, 2013; Clarke *et al.* 2011, 2013, 2014; Berchok *et al.* 2012), fin whales are considered to be in low densities, but regular visitors to the Alaska Chukchi Sea. COMIDA surveys between 2008 and 2010 reported only one fin whale sightings while the 2012 survey reported three sightings of five fin whales in the southern Chukchi Sea, south of Point Hope. Two of 2012 fin whales were calves – all adult fin whales were feeding. During the 2013 ASAMM aerial surveys there were three sightings of three fin whales sighted in the northern Chukchi Sea while the 2014 surveys reported 17 sightings totaling 36 animals during September and all in the southern Chukchi Sea. Daily reports from the 2015 ASAMM surveys report 16 sightings of 20 fin whales off Point Hope between August and October.

Fin whales may be found all along cable lay routes at least up to Point Barrow. However, while fin whale occurrence north and east of Barrow is possible it is not expected.

4.3. Humpback Whale

NMFS' Stock Assessment Reports recognize three "stocks" or populations of humpback whales in the North Pacific Ocean, based on genetic and photo-identification studies: (1) the California/Oregon/Washington and Mexico stock, (2) the Central North Pacific stock, and (3) the Western North Pacific stock (Baker et al., 1990; Calambokidis et al., 1997; Perry et al., 1999). Individuals from the Western Pacific stock and the Central North Pacific stock could occur in the Bering Sea with access to the Chukchi and Beaufort Seas.

There are numerous population estimates for North Pacific humpback whales depending on the survey and modeling techniques. An intensive 3-year (2004-2006) photo-identification study (Structures of Population, Levels of Abundance and Status of Humpback Whales; SPLASH) was conducted in an attempt to determine the population structure and abundance of North Pacific humpback whale populations (Calambokidis *et al*. 2008). The results of the study provided a best estimate overall abundance of 18,302 for the entire North Pacific, or an estimate higher than the pre-exploitation population estimated by Rice (1974). The SPLASH data (Calambokidis *et al*. 2008, Barlow *et al*. 2011) provided estimates for the three North Pacific humpback whale stocks occurring in the action area:

California/Oregon/Washington stock - 2,034; Central North Pacific stock - 10,103; and Western North Pacific stock - 1,107. Combined, these three stocks represent 72% of the current North Pacific population. Since protection in 1966, the North Pacific population has grown at an annual rate of about 6 to 7% (Caretta *et al*. 2012).

For the most part, humpback whales prey on krill and schooling fish with the composition dependent on the feeding location. The most important prey off California are anchovies and the krill species *E. pacifica* (Rice 1963). This and other species of krill are important in Alaska along with Pacific herring (Frost and Lowry 1981, Krieger and Wing 1984). Nemoto (1957) found stomachs of humpbacks taken during Japanese whaling in the North Pacific to contain almost entirely euphausiids.

Humpback whale calving and breeding occurs on the warmer-watered wintering grounds. The high population growth rate (average annual rate of 6-7%) since the 1960s is partially explained by a higher reproduction rate compared to other large whales. Females sexually mature at 4 to 6 years of age and gestation periods are less than 12 months (NMFS 1991). The calving interval is generally 2 to 3 years, but some whales have calved in consecutive years (NMFS 1991).

Humpback whale occurrence in the Chuckchi and Beaufort Seas has been documented with increased regularity during ice-free periods with most sightings occurring after September. However, there have been numerous sightings reported between 2007 and 2014 and vary in frequency and timing. Hashagen *et al.* (2009) reported a cow-calf pair approximately 87 km (54.1 mi) east of Barrow in the Beaufort Sea in August 2007. Other sightings include vessel- and aerial-based surveys from Nome to Barrow. Between 2007 and 2008 Ireland *et al.* (2008) and Hartin *et al.* (2013) both reported four and six humpback sightings, respectively (total of ten) in the eastern Chukchi Sea during vessel-based surveys. Aerts *et al.* (2012, 2013) has reported six humpback sightings between 2009 and 2012 during Chukchi Sea Environmental Studies Program (CSESP) vessel-based surveys – one sighting was several kilometers west of Barrow. The increase in sightings appears to be a recent change since COMIDA Surveys from 1982 through 1991 reported no humpback whale sightings in the Chukchi Sea (Clarke *et al.* 2011a) and ASAMM aerial surveys had only one sighting of a humpback prior to 2012 (Clarke *et al.* 2012, 2013, 2014). Most recently, ASAMM aerial surveys have reported numerous sightings of humpbacks in the northeastern Chukchi including four between July and August 2012 between Icy Cape and Pt. Barrow, and 24 south and east of Pt. Hope in September of the same year (Clarke *et al.* 2013). ASAMM surveys during 2013 reported two sightings totaling four humpback whales in the northeastern Chukchi Sea (Clarke *et al.* 2014). During 2014 ASAMM surveys there were 22 sightings of 48 humpbacks all focused south of Pt. Hope with greatest occurrence during September. Daily reports from 2015 ASAMM aerial surveys reported 10 sightings of 17 humpback whales off Point Hope, one of which was just north of Wainwright. Sightings occurred between July and October.

Given the recent increase in sightings, encounters with humpback whales is expected along the Nome to Point Hope cable lay route. Humpbacks may occur north to Barrow and into the western Beaufort Sea, but these events are not expected.

4.4. Gray Whale

The eastern North Pacific (or California) gray whale is one of two stocks inhabiting the Pacific Ocean (the other the endangered western North Pacific [or Korean] stock found along the Asian coast). The eastern North Pacific stock breeds in the warm-water lagoons of coastal Baja California and Mexico and winters in the shelf waters of the Bering and Chukchi seas (Jones *et al.* 1984), completing each year an annual round-trip migration of 16,000 to 22,500 km (9,900 to 14,000 mi). Not all whales complete the migration as some whales feed in the coastal waters of the Pacific Northwest (Calambokidis *et al.* 2002, 2010), and possibly elsewhere along the migration route. The most recent population estimate for the eastern North Pacific stock is 20,990 (Carretta *et al.* 2015).

A few gray whales are expected to occur along the main trunk line route through the north Bering and Chukchi seas. However, they are expected to be commonly observed along the nearshore segments of the branch lines, especially the Wainwright branch where they are commonly found in large feeding groups.

Prior to 1997, reports of gray whales in the Beaufort Sea were very rare. A single gray whale was killed at Cross Island in 1933 (Maher 1960), and small numbers were observed in the Canadian Beaufort Sea approximately 1,100 coastal km (~700 coastal mi) east of Point Barrow in 1980 (Rugh and Fraker 1981). Only one gray whale was observed during extensive aerial surveys conducted in the Beaufort Sea between 1979 and 2009 (Clarke and Ferguson 2010). Sightings in the Beaufort Sea became more common, although still occasional, from 1998 to 2004 (Miller *et al.* 1999, Treacy 2000, Williams and Coltrane 2002), and then regularly observed from 2005 on (Green and Negri 2005, Green *et al.* 2007; Jankowski *et al.* 2008; Lyons *et al.* 2009). Green and Negri (2005) observed feeding gray whales near Elson Lagoon (immediately east of Point Barrow) in 2005, and Green *et al.* (2007) at Smith's Bay (approximately 100 km east of Point Barrow) in 2007. Still, few gray whales have ever been reported in the Beaufort Sea as far east as Cape Halkett (approximately 160 km east of Point Barrow). Despite increased gray whale use in the Alaskan Beaufort Sea, their occurrence is not expected as far offshore as the Beaufort segment of the main trunk line or as far east as Oliktok Point.

4.5. Minke Whale

Minke whales are the smallest of the rorqual group of baleen whales reaching lengths of up to 11 m (35 ft). They are also the most common of the baleen whales. There are no population estimates for the North Pacific, although estimates have been made for some portions of Alaska. Zerbini *et al*. (2006) estimated the coastal population between Kenai Fjords and the Aleutian Islands at 1,233 animals.

Minke whales are distributed worldwide to the ice-edges, but sightings as far north as Point Barrow are rare (Leatherwood *et al*. 1982, Mizroch 1992), although sightings within the Chukchi Sea are not unusual (e.g. Miller *et al*. 1986). Few data are available on migratory behavior and apparent "home ranges" of the Alaska stock of minke whales (*e.g.,* Dorsey *et al*. 1990). In the central Bering Sea, an estimated 936 minke whales (95% CI 473-1,852, CV = 0.35) were observed during the summer of 1999 (Moore *et al*. 2000). However, this covers only a small portion of the Alaska stocks range. Seabird surveys around the Pribilof Islands indicated an increase in local abundance of minke whales between 1975-78 and 1987-89 (Baretta and Hunt 1994). No data exist on trends in abundance in Alaskan waters (Angliss *et al.* 2001).

Minke whales have a very catholic diet feeding on preferred prey most abundant at a given time and location (Leatherwood and Reeves 1983). Minke whales feed by side-lunging into schools of prey as well as gulping large amounts of water. Seabirds, attracted to the concentrated prey just below the surface, are sometimes associated with minke whale feeding and foraging. Minke whales opportunistically feed on crustaceans (*e.g.,* krill), plankton (*e.g.,* copepods), and small schooling fish (*e.g.,* anchovies, dogfish, capelin, coal fish, cod, eels, herring, mackerel, salmon, sand lance, saury, and wolfish) (Reeves *et al.* 2002). In the southern hemisphere, minkes feed largely on krill, while in the North Pacific they feed on schooling fish such as herring, sandlance, and walleye pollock (Reeves *et al.* 2002). There is no dietary information specific to Alaska although anecdotal observations of minke whales feeding on shoaling fish off Anchor Point within Cook Inlet have been reported to NMFS (Brad Smith, pers. comm.).

Minke whales in the northern hemisphere become sexually mature at around 3 to 8 years of age, which is about when they reach 7 m (23 ft) in size. Mating and calving most likely takes place during the winter season. After a gestation period of 10 to 11 months, females give birth to a single calf that is about 2.4 to 3.5 m (8-11.5 ft) in length and weighs 318 to 454 kg (700-1,000 lbs). The calf is weaned from lactation after 4 to 6 months. The reproductive interval for females is estimated at 14 months, but calving may occur annually (Shirihai and Jarrett 2006). Mother-calf pairs are usually sighted in the lower latitudes of the wintering grounds, but are much rarer in the higher latitude summer feeding grounds.

Minke whales are being sighted with greater frequency in the northeastern Chukchi Sea (Clarke *et al.* 2012). Prior to 2011, minke whales were not previously sighted in the northeastern Chukchi Sea study area during aerial surveys conducted in 1982 to 1991 (Moore and Clarke 1992), 2006 to 2010 (Thomas and Koski 2011), or 2008 to 2010 (Clarke *et al.* 2011). Minke whales were also sighted in summer 2009, summer and fall 2012, and fall 2013 in the northeastern Chukchi Sea during marine mammal aerial surveys and vessel-based oceanographic surveys conducted by the oil industry (Brueggeman 2010, Bisson *et al.* 2013, Smultea *et al.* 2014). Minke whale sightings have been reported as far north as Wainwright (Clarke *et al.* 2011). Daily reports from the 2015 ASAMM surveys reported six sightings of six minke whales south of Point Hope and as far north as offshore of Point Lay.

4.6. Beluga Whale

Three stocks of beluga whale inhabit the waters where cable-lay is planned to occur: Beaufort Sea, Eastern Chukchi Sea, and Eastern Bering Sea (O'Corry-Crowe *et al.* 1997). All three stocks winter in the open leads and polynyas of the Bering Sea (Hazard 1988). In spring, the Beaufort Sea stock migrates through coastal leads more than 2,000 km (1,200 mi) to their summering grounds in the Mackenzie River delta where they molt, feed, and calve in the warmer estuarine waters (Braham *et al.* 1977). In late summer, these belugas move into offshore northern waters to feed (Davis and Evans 1982, Harwood *et al.* 1996, Richard *et al.* 2001). In the fall, they begin their migration back to their wintering grounds generally following an offshore route as they pass through the western Beaufort Sea (Richard *et al.* 2001).

The most current population estimate for the Beaufort Sea stock is 39,258 animals (Allen and Angliss 2015). However, this estimate is based on aerial surveys conducted in 1992, and includes a smaller more conservative correction factor (to account for availability bias) than has been estimated for other aerial surveys of this species in Alaska (Frost and Lowry 1995, Allen and Angliss 2015). The current population trend is unknown, but subsistence harvest is probably well below the potential biological removal (Allen and Angliss 2015). Richard *et al.* (2001) tracked 12 satellite-tagged belugas and found them to pass relatively quickly (average 15 days) through the Alaskan Beaufort Sea during September. The westward routes ranged from coastal to more than 650 km (400 mi) offshore with all but one beluga passing at least 100 km (60 mi) north of the Beaufort shoreline. Based on the above and results from numerous aerial and boat-based marine mammal surveys in the Beaufort Sea, some belugas take a more coastal route during their fall migration, but compared to the vanguard of population and the survey effort expended, nearshore travel appears to be relatively rare. Most belugas recorded during aerial surveys conducted in the Alaskan Beaufort Sea in the last two decades were found more than 65 km (40 mi) from shore (Miller *et al.* 1999, Funk *et al.* 2008, Christie *et al.* 2010, Clarke and Ferguson 2010, Brandon *et al*. 2011). For the most part, beluga whales from this stock are expected to occur well north of the proposed cable route through the Beaufort Sea at the time of cable-lay activity.

The Eastern Chukchi Sea beluga whale stock summers in Kotzebue Sound and Kasegaluk Lagoon where they breed and molt, and then in late summer and fall they also move in the Beaufort Sea (Suydam *et al.* 2005). Suydam *et al.* (2005) satellite-tagged 23 beluga whales in Kasegaluk Lagoon and found nearly all the whales to move into the deeper waters of the Beaufort Sea post-tagging. However, virtually none of the whales were found in continental shelf waters (<200 m deep) of the Beaufort Sea, and all were in waters at least 65 km (40 mi) north of the northern Alaska coastline. The most recent stock estimate is 3,710 animals (Allen and Angliss 2015). The planned cable-lay activity is most likely to encounter this stock whale laying the Kotzebue and Wainwright branch lines, but the routes do avoid the Kasegaluk Lagoon breeding and molting area.

Eastern Bering Sea stock, estimated at 19,186 animals (Allen and Angliss 2015), summers within Norton Sound. There is little information on movements, although two whales that were satellite tagged in 2012 near Nome wintered in Bristol Bay (Allen and Angliss 2015). These whales might be encountered while laying the Nome branch line.

4.7. Killer Whale

Two different stocks of killer whales inhabit the coastal and oceanic regions of Alaska: the Alaska Resident Stock and the Gulf of Alaska, Aleutian Islands, Bering Sea Transient Stock (Allen and Angliss 2015). The resident stock is estimated at 2,347 animals and occurs from Southeast Alaska to the Bering Sea (Allen and Angliss 2015). The transient population inhabiting the Gulf of Alaska shares mitochondrial DNA haplotypes with whales found along the Aleutian Islands and the Bering Sea suggesting a common stock, although there appears to be some subpopulation genetic structuring occurring to suggest the gene flow between groups is limited (see Allen and Angliss 2015). For the three regions combined, the transient population has been estimated at 587 animals (Allen and Angliss 2015).

Killer whales feed on a variety of prey, from other marine mammals to fish depending on the killer whale type. Resident killer whale stocks feed almost exclusively on fish and squid (Scheffer and Slipp 1948, Ford and Ellis 2006) and are genetically distinct from transient whales (Saulitis *et al*. 2000). The transient whales feed primarily on marine mammals (Saulitis *et al*. 2000) and are known predators of larger prey including bowhead, gray, and humpback whales.

Killer whales are long-lived animals and reproduce slowly. Gestation appears to last 15 to 18 months. Calving interval is about 5 years and age at weaning is thought to about 1 to 2 years, but may occur sometime later. The maximum age which these animals can attain has not been determined but may be at least 50 years for males and 80 years for females (Jefferson et al. 2008). The annual birth rate has been estimated at 4 to 5% but may be higher following the deaths of several animals in a pod. In stable pods, some females may not breed at all. Much remains to be learned about the reproductive behavior of killer whales. Females are believed to become sexually active at 15 years of age, on average, yet that age can vary between 11 to 18 years. Young are born at intervals of three to eight years, although animals born in captivity have borne young 19 months apart. In the north Pacific, most births appear to occur between fall and spring.

Killer whales have been documented, sporadically, in the eastern Chukchi Sea as far north as Barrow. Hunters from Barrow and biologists from the North Slope Borough report that a few killer whales are seen each year in the Point Barrow area (George *et al*. 1994). Killer whales were acoustically detected by ARCWEST in the southcentral Chukchi Sea in September 2014 near the benthic hot spot (NMML/RACE/PMEL 2014), although none were seen. Killer whales were seen by ASAMM near Barrow and northwest of Point Hope in 2012 (Clarke *et al*. 2013), and detected acoustically at several recorders in the northeastern Chukchi Sea in summer 2010 (Delarue *et al.* 2011). Killer whales were not seen during aerial surveys conducted nearshore by industry from 2006 to 2010 (Thomas and Koski 2011) nor by CSESP marine mammal observers from 2008 to 2010 (Aerts *et al*. 2011). Killer whales are not expected to occur north or east of Barrow.

4.8. Harbor Porpoise

Harbor porpoise are small (1.5 m) inconspicuous odontocetes (Hobbs and Waite 2010). The Bering Sea stock, which is more management stock than a genetically distinct population, occurs throughout the Aleutian Islands, and the Bering and Chukchi seas (Allen and Angliss 2015). Sightings in the Beaufort Sea are also becoming more frequent (Funk *et al.* 2011). The most recent abundance estimate for the Bering Sea stock is 48,215 animals (Allen and Angliss 2015). They have been consistently seen in low numbers during marine mammal monitoring activities in the Chukchi Sea from 2006 to 2013 (Haley *et al.* 2010, Friday *et al.* 2013, Aerts *et al.* 2014). During intensive vessel-based monitoring in the northeastern Chukchi Sea by Aerts *et al.* (2014) from 2008 to 2013, 3 to 13 animals were observed each year.

Harbor porpoise are found primarily in coastal waters less than 100 m (328 ft) deep (Hobbs and Waite 2010) where they feed on Pacific herring, other schooling fishes, and cephalopods. Sexual maturity of harbor porpoise is usually reached by 3 to 4 years of age. Harbor porpoise give birth to one calf every year to every other year after a 10 to 11 month gestation period. Lactation lasts for approximately 9 months but calves will start to consume solid food at about 5 months of age (Jefferson *et al*. 2008).

Harbor porpoise might be encountered in low numbers during the cable-lay operation with primary occurrence south and west of Barrow, but with rare encounters in the western Beaufort Sea possible.

4.9. Ringed Seal

Ringed seals are the most common marine mammal in the Beaufort, Chukchi, and Bering seas. This Alaskan stock, a subpopulation of the Arctic subspecies (*P. h. hispida*), was most recently estimated at 300,000 animals, although the authors (Kelly *et al.* 2010) stated that this was likely an underestimate because it was based on surveys conducted within 40 km (25 mi) of shore, and historic estimates have ranged as high as 3.6 million (Frost *et al.* 1988). Some taxonomists have placed this seal in the genus *Pusa* following Rice (1998), but that usage is not universal. Ringed seals were recently (2012) listed under the ESA due to diminishing snow and ice from climate change. They survive the winter by digging multiple haul-out shelters and nursery lairs beneath the snow (Kelly 1988). A loss of snow cover, and ice coverage in general, poses a risk to long-term survival (Kelly *et al.* 2010).

Throughout most of their range, Arctic ringed seals do not come ashore and use sea ice as a substrate for resting, pupping, and molting (Kelly 1988, Kelly *et al*. 2010). Outside the breeding and molting seasons, they are distributed in waters of nearly any depth; their distribution is strongly correlated with seasonally and permanently ice-covered waters and food availability (*e.g.,* Simpkins *et al*. 2003, Freitas *et al*. 2008). The seasonality of ice cover strongly influences ringed seal movements, foraging, reproductive behavior, and vulnerability to predation. Three ecological seasons have been described as important to ringed seals: the "open-water " or "foraging" period when ringed seals forage most intensively, the subnivean period in early winter through spring when seals rest primarily in subnivean lairs on the ice, and the basking period between lair abandonment and ice break-up (Born *et al.* 2004, Kelly *et al*. 2010). During the open-water season, ringed seals are widely dispersed as single animals or in small groups and they are known to move into coastal areas (Smith 1987, Harwood and Stirling 1992, Moulton and Lawson 2002, Green *et al.* 2007). Also during the open-water period ringed seals shift from feeding on Arctic cod associated with sea ice to Saffron cod, shrimp, euphausiids, and amphipods. Ringed seals are harvested by coastal Alaska Natives and are a primary prey of polar bears and arctic foxes at some times of year.

Ringed seals are expected to be found within all cable-lay areas.

4.10. Spotted Seal

The spotted seal is found from the Beaufort Sea to the Sea of Japan and is most numerous in the Bering and Chukchi seas (Quakenbush 1988), although small numbers do range into the Beaufort Sea during summer (Rugh *et al.* 1997, Lowry *et al.* 1998, Green *et al.* 2007). The Bering Sea wintering population has been recently estimated at 460,268 (Conn *et al.* 2014) based on spring aerial surveys conducted in 2012 and 2013. This estimate suggests that spotted seals may be more in Alaska than ringed seals (although it is likely that ringed seals are underestimated). A status review of the species was completed in 2009 (Boveng *et al.* 2009) after the spotted seal was petitioned for listing under ESA relative to climate change and its effects on sea ice. The review found the listing as not warranted.

Pupping occurs along the Bering Sea ice front during March and April, followed by mating and molting in May and June (Quakenbush 1988). During the summer they follow the retreating ice north into the Chukchi and Bering seas, and then begin hauling out on lagoon and river delta beaches during the open water period. Several thousand use Kasegaluk Lagoon in the eastern Chukchi Sea. They begin their migration back to Bering Sea wintering grounds in October (Lowry *et al.* 1998). Spotted seals are expected to be encountered while laying cable along all the Bering and Chukchi branch lines, although no activity will occur near the Kasegaluk Lagoon breeding area.

A few spotted seals summer in the Beaufort Sea where they haulout at Oarlock Island, the Piasuk River, and the Colville River Delta (Green *et al.* 2007). The Colville River Delta and nearby Sagavanirktok River have supported as many as 400 to 600 spotted seals, but in recent times fewer than 20 seals have been seen at any one site (Johnson *et al.* 1999). Spotted seals were recorded during three years (2005-2007) of barging activities between Prudhoe Bay and Cape Simpson (Green and Negri 2005, 2006; Green *et al.* 2007). They observed between 23 and 54 seals annually, with the peak distributions found off the Colville and Piasuk rivers. Similarly, Savarese *et al.* (2010) surveyed the central Beaufort Sea from 2006 to 2008 and recorded 59 to 125 spotted seals annually. Summer use of the Beaufort Sea by spotted seals may be higher than haulout counts might indicate, although no haulout site surveys have been conducted in recent years.

Because the Colville River Delta haulout sites occur with a few kilometers of Oliktok Point, spotted seals are expected to be encountered during laying of the Oliktok branch. Lomac-MacNair *et al.* (2014a) reported more spotted seals than any other species of marine mammal in this area during monitoring of seismic activities off the point. Spotted seals appear to be much more common inside the barrier islands while ringed seals are more common in more offshore waters.

4.11. Ribbon Seal

Ribbon seals inhabit the North Pacific Ocean and adjacent parts of the Arctic Ocean. In Alaska waters, ribbon seals range northward from Bristol Bay in the Bering Sea into the Chukchi and western Beaufort Seas. From late March to early May, ribbon seals inhabit the Bering Sea ice front (Burns 1970, Burns 1981, Braham *et al.* 1984). They are most abundant in the northern part of the ice front in the central and western parts of the Bering Sea (Burns 1970, Burns *et al.* 1981). As the ice recedes in May to mid-July the seals move farther to the north in the Bering Sea, where they haul out on the receding ice edge and remnant ice (Burns 1970, Burns 1981, Burns *et al.* 1981). There is little known about the range of ribbon seals during the rest of the year. Recent sightings and a review of the literature suggest that many ribbon seals migrate into the Chukchi Sea for the summer (Kelly 1988).

Ribbon seals are listed as a species of concern. On July 10, 2013 The NMFS determined that the listing of ribbon seals as threatened or endangered under the ESA was not warranted (78 FR 41371). The main concern about the conservation status of the ribbon seal is associated with the loss of sea ice habitat associated with a warming climate and future warming.

A reliable abundance estimate for the Alaska stock of ribbon seals is currently not available. Burns (1981) estimated the worldwide population of ribbon seals at 240,000 in the mid-1970s, with an estimate for the Bering Sea at 90,000-100,000. Aerial surveys were conducted in portions of the eastern and central Bering Sea in spring of 2003 (Simpkins et al. 2003), 2007 (Cameron and Boveng 2007, Moreland *et al.* 2008), and 2008 (Cameron *et al.* 2008). Frequencies of sightings data from the 2007 surveys and information on ice distribution and the timings of seal haul-out behavior were analyzed to develop a population estimate of 61,100 (95% CI 35,200-189,300) ribbon seals in the areas surveyed in that year (Ver Hoef *et al.* 2014). In spring of 2012, NOAA researchers, in collaboration with Russian colleagues, conducted aerial abundance and distribution surveys of the entire Bering Sea (Moreland *et al.* 2012). Information from these surveys, and similar surveys planned for both the Bering and Okhotsk Seas in 2013, should provide the current range-wide estimates of ribbon seal abundance.

Adult ribbon seals consume about 9 kg (20 lbs) of food each day and feed on pelagic fish and invertebrates, (e.g., shrimp, crabs, squid, octopus, cod, sculpin, pollack, and capelin). Juveniles feed mostly on krill and shrimp.

Rates of reproduction are not well known, but ribbon seals are known to live 20 to 30 years. They reach sexual maturity at 1 to 5 years and are strongly associated with sea ice for mating, whelping pups and molting from mid-March through June. Adult females generally give birth to a single pup which is nursed for 3 to 4 weeks and abandoned (Boveng *et al*. 2013). Most of the rest of the year is spent at sea; they are rarely seen on land.

Ribbon seals in the northeastern Chukchi Sea are very rare (Aerts *et al.* 2013, Haley *et al.* 2010). In fact, no ribbon seal sightings have been reported as part of the BWASP surveys conducted in the Beaufort Sea or during seismic survey program monitoring. However, Savarese *et al.* (2010) did report three animals during a vessel-based marine mammal monitoring program near Prudhoe Bay in 2008.

There is a potential for ribbon seals to be present during the most northern reaches of the cable-lay activities.

4.12. Bearded Seal

The Alaska stock of bearded seals is seasonally found in the shelf waters of the Beaufort, Chukchi, and Bering seas. They are closely associated with ice, preferring to winter in the Bering Sea and summer along the pack ice edge in Chukchi Sea, although many summer in nearshore waters of the Beaufort Sea. Preferring areas of 70 to 90% ice coverage, but unlike ringed seals, few bearded seals overwinter in the Chukchi and Beaufort seas (Allen and Angliss 2014). Pupping occurs on ice floes primary in May in the Bering and Chukchi seas.

Bearded seals do not have any special status, but their seasonal dependence ice makes them vulnerable to declining ice conditions due to climate change. As a consequence, they were listed under ESA in December, 2012. There is no reliable population estimate for bearded seals. Cameron *et al.* (2010) provided a conservative estimate for the Beringia Distinct Population Segment (the population that winters in the Bering and Chukchi seas) of 155,000, based on data collected over the last four decades.

Bearded seals have been commonly observed along the proposed cable-lay routes. Aerial and vessel-based surveys associated with drilling, seismic programs, barging, and government research in these areas between 2002 and 2013 reported several sightings (Treacy 2002a, 2002b; Moulton *et al.* 2003; Green and Negri 2005, 2006; Green *et al.* 2007; Funk *et al.* 2008; Hauser *et al.* 2008; Savarese *et al.* 2010; Brandon *et al.* 2011; Reiser *et al.* 2011; Clarke *et al.* 2011, 2012, 2013, 2014, 2015). These seals are expected to be occasionally encountered during the cable-lay activity.

5. TYPE OF INCIDENTAL TAKING AUTHORIZATION REQUESTED

The incidental taking authorization requested is for Level B noise harassment associated with QSO’s proposed fiber optic cable-lay project in northern Bering, Chukchi, and Beaufort seas. The noise source of primary concern is the operation of ship thrusters during dynamic positioning and anchor handling. The actual Level B take will depend upon number of marine mammals occurring within the 120 dB Zone of Influence (ZOI) at the time of cable-lay activity. Level A harassment or injury is not of concern as thruster noise is not known to exceed 180 dB re 1 μPa (rms) at source.

6. HARASSMENT ESTIMATES FOR MARINE MAMMALS

Exposure to continuous sound levels greater than 120 dB re 1 μPa (rms) can elicit behavioral changes in marine mammals that might be detrimental to health and long-term survival where it disrupts normal behavioral routines, and is the Level B criteria for acoustical harassment under the MMPA. Exposure to sound levels greater than 180 dB re 1 μPa (rms) for cetaceans and 190 dB re 1 μPa (rms) for pinnipeds can lead to acoustical injury including temporary loss in hearing sensitivity and permanent hearing damage. These values are the MMPA Level A criterion. However, as ship thruster noise is not expected to exceed 180 dB re 1 μPa (rms) at source, Level A concerns are not addressed further.

The estimate of the numbers of each species of marine mammals that could be harassed (Level B) by exposure to thruster noise during cable-lay operations was determined by multiplying the maximum seasonal density of each species by the total area in 2016 that will be ensonified by greater than 120 dB re 1 μPa (rms).

6.1. Estimating Numbers of Level B Harassments

6.1.1. Ensonified Area

The acoustical footprint (total ensonified area) was determined by assuming that dynamic position would occur along all trunk and branch lines within the proposed fiber optics cable network, regardless of the cable-lay vessel used. The sum total of submerged cable length is 1,902.7 km (1,182.3 mi). Assuming that the radius to the 120 dB isopleth is 2.3 km (1.4 mi) (Hartin et al. 2011), then the total ensonified area represents a swath that is 1,902.7 km (1,182.3 mi) in length and 4.6 km (2.8 mi) in width (2 x 2.3 km) or 8,752.4 km^2 (3,379.3 mi^2). The Nome branch (194.7 km [121.0 mi]) and 87.1 km (54.1 mi) of the trunk line between BU Nome and BU Kotzebue fall within the Bering Sea (Figure 6-1). The combined length is 281.8 km (175.1 mi) and the total ensonified area is 1,296.3 km^2 (500.5 mi^2). The Oliktok branch (73.9 km [45.9 mi]) and 254.1 km (157.9 mi) of the trunk line between Barrow and Oliktok are found in the Beaufort Sea. Here the combined length is 328 km (203.8 mi) and total ensonified area is 1,508.8 km^2 (582.6 mi^2). The remaining area 5,947.3 km^2 (2,296.3 mi^2) falls within the Chukchi Sea.

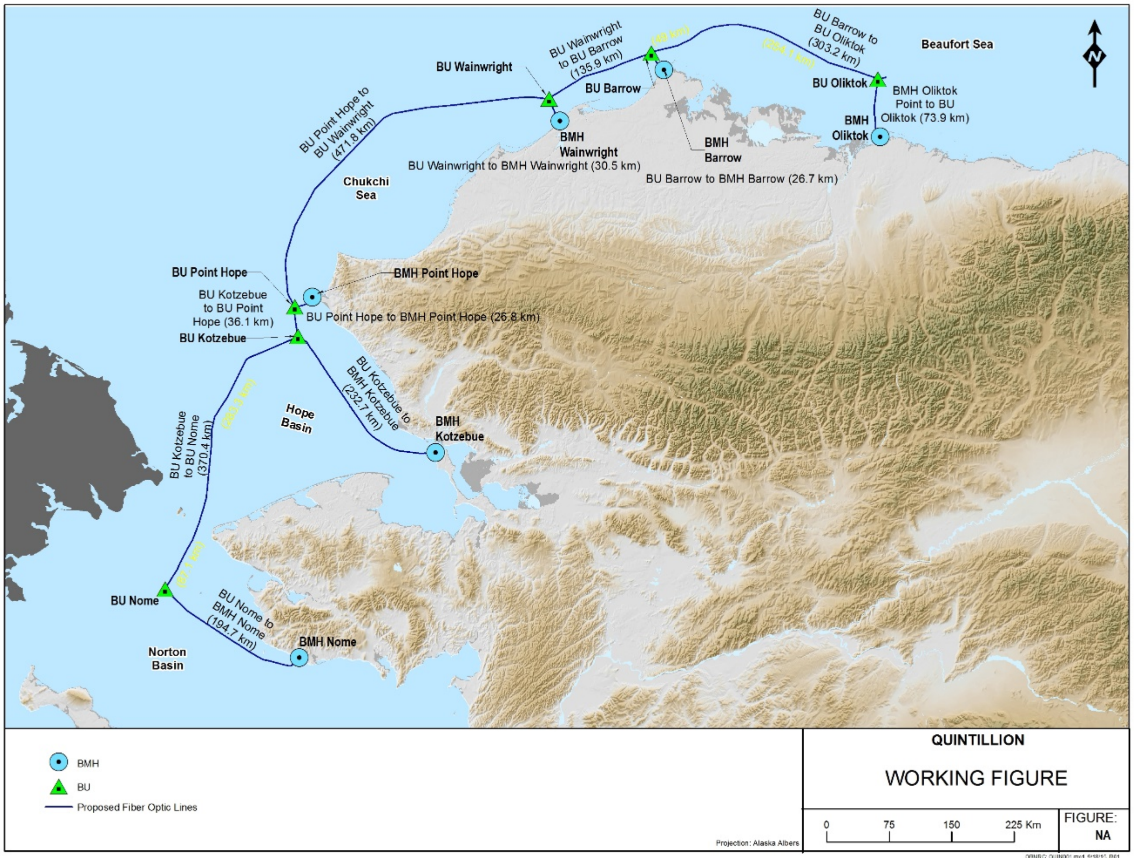

Figure 6-1. Segment lengths.

6.1.2. Marine Mammal Densities

Density estimates for bowhead, gray, and beluga whales were derived from aerial survey data collected in the Chukchi and Beaufort seas during the 2011 to 2014 Aerial Surveys of Arctic Marine Mammals (ASAMM) program (Clarke *et al.* 2012, 2013, 2014, 2015). The proposed cable routes cross ASAMM survey blocks 2, 11, and 12 in the Beaufort Sea, and blocks 13, 14, 18, 21, and 22 in the Chukchi Sea. Only data collected in these blocks were used to estimate densities for bowhead and gray whales. Beluga densities were derived from ASAMM data collected depth zones between 36 and 50 m (118 and 164 ft) within the Chukchi Sea between longitudes 157° and 169°W, and the depth zones between 21 and 200 m (68.9 and 656.2 ft) in the Beaufort Sea between longitudes 154° and 157°W. These depth zones reflect the depths where most of the cable-lay will occur. Harbor porpoise densities (Chukchi Sea only) are from Hartin *et al.* (2013), and ringed seal densities from Aerts *et al.* (2014; Chukchi Sea) and Moulton and Lawson (2002; Beaufort Sea). Spotted and bearded seal densities in the Chukchi Sea are also from Aerts *et al.* (2014), while spotted and bearded seal densities in the Beaufort Sea developed by assuming both represented 5% of ringed seal densities. Too few sightings have been made in the Chukchi and Beaufort seas for all other marine mammal species to develop credible density estimates.

The density estimates for the seven species are presented in Table 6-1 (Chukchi/Bering) and Table 6-2 (Beaufort) below. The specific parameters used in deriving these estimates are provided in the discussions that follow.

Table 6-1. Marine mammal densities (#/km^2) in the Chukchi and Bering seas.

Species	Summer	Fall
Bowhead Whale	0.0025	0.0438
Gray Whale	0.0680	0.0230
Beluga Whale	0.0894	0.0632
Harbor Porpoise	0.0022	0.0022
Ringed Seal	0.0846	0.0507
Spotted Seal	0.0423	0.0253
Bearded Seal	0.0630	0.0440

Table 6-2. Marine mammal densities (#/km^2) in the Beaufort Sea.

Species	Summer	Fall
Bowhead Whale	0.0444	0.0742
Gray Whale	0.0179	0.0524
Beluga Whale	0.0021	0.0142
Ringed Seal	0.3547	0.2510
Spotted Seal	0.0177	0.0125
Bearded Seal	0.0177	0.0125

6.1.2.1. Bowhead Whale

The summer density estimate for bowhead whales was derived from June, July, and August aerial survey data collected in the Chukchi and Beaufort Sea during the 2011 to 2014 ASAMM program (Clarke *et al.* 2012, 2013, 2014, 2015). Fall data were collected during September and October. Data only from the survey blocks that will be crossed by the proposed cable route were used in the calculations, and included blocks 3, 11, and 12 in the Beaufort Sea and 13, 14, 18, 21, and 22 in the Chukchi Sea. ASAMM surveys did not extend more than about 25 km (15.5 mi) south of Point Hope, and there are no other systematic survey data for bowhead whales south of the point. During these three years, 87 bowhead whales were recorded in the three Beaufort Sea blocks during 12,161 km (7,556mi) of summer survey effort (0.0072/km), and 201 whales during 16,829 km (10,457mi) of fall effort (0.0019/km). In the five Chukchi Sea survey blocks, 11 bowheads were recorded during 27,183 km (16,891 mi) of summer effort (0.0004/km), and 160 during 22,678 km (14,091 mi) of fall survey (0.0071/km). Applying an effective strip half-width (ESW) of 1.15 (Ferguson and Clarke 2013), and a 0.07 correction factor for whales missed during the surveys, results in corrected densities of 0.0444 (Beaufort summer), 0.0742 (Beaufort fall), 0.0025 (Chukchi summer), and 0.0438 (Chukchi fall) whales per km^2 (Tables 6-1 and 6-2).

6.1.2.2. Gray Whale

Gray whale density estimates were derived from the same ASAMM transect data used to determine bowhead whale densities. During the four years of aerial survey, 35 gray whales were recorded in the three Beaufort Sea blocks during 12,161 km (7,557 mi) of summer survey effort (0.0029/km), and 142 gray whales during 16,829 km (10,457 mi) of fall effort (0.0084/km). In the five Chukchi Sea survey blocks, 298 gray whales were recorded during 27,183 km (16,891 mi) of summer effort (0.0084/km), and 84 during 22,678 km (14,091 mi) of fall survey (0.0037/km). Applying an effective strip half-width (ESW) of 1.15 (Ferguson and Clarke 2013), and a correction factor of 0.07, results in corrected densities of 0.0179 (Beaufort summer), 0.0524 (Beaufort fall), 0.0680 (Chukchi summer), and 0.0230 (Chukchi fall) whales per km^2 (Tables 6-1 and 6-2).

6.1.2.3. Beluga Whale

Beluga whale density estimates were derived from the ASAMM transect data collected from 2011 to 2014 (Clarke *et al*. 2012, 2013, 2014, 2015). During the summer aerial surveys (June-August) there were 248 beluga whale observed along 3,894 km (2,420 mi) of transect in waters between 21 to 200 m (13-124 ft) deep and between longitudes 154°W and 157°W. This equates to 0.0637 whales/km of trackline and a corrected density of 0.0894 whales per km^2, assuming an ESW of 0.614 km and a 0.58 correction factor. Fall density estimates (September-October) for this region were based on 192 beluga whales seen along 4,267 km (2,651 mi). This equates to 0.0449 whales/km of trackline and a corrected density of 0.0632 whales per km^2, assuming an ESW of 0.614 km and a 0.58 correction factor.

During the summer aerial surveys (June-August) there were 30 beluga whale observed along 20,240 km (12,577 mi) of transect in waters less than 36 to 50 m (22-31 ft) deep and between longitudes 157°W and 169°W. This equates to 0.0015 whales/km of trackline and a corrected density of 0.0021 whales per km^2, assuming an ESW of 0.614 km and a 0.58 correction factor. Calculated fall beluga densities for the same region was based on 231 beluga whales seen during 22,887 km of transect (1,794 mi). This equates to 0.0101 whales/km and a corrected density of 0.142 whales per km^2, again assuming an ESW of 0.614 km and a 0.58 correction factor.

6.1.2.4. Harbor Porpoise

Although harbor porpoise are known to occur in low numbers in the Chukchi Sea (Aerts *et al.* 2014), no harbor porpoise were positively identified during COMIDA and ASAMM aerial surveys conducted in the Chukchi Sea from 2006 to 2013 (Clarke *et al*. 2011, 2012, 2013, 2014). A few small unidentified cetaceans that were observed may have been harbor porpoise. Hartin *et al*. (2013) conducted vessel-based surveys in the Chukchi Sea while monitoring oil and gas activities between 2006 and 2010 and recorded several harbor porpoise throughout the summer and early fall. Vessel-based surveys may be more conducive to sighting these small, cryptic porpoise than the aerial-based COMIDA/ASAMM surveys. Hartin *et al.*'s (2013) three-year average summer densities (0.0022/km^2) and fall densities (0.0021/km^2) were very similar, and are included in Table 6-1.

6.1.2.5. Ringed and Spotted Seal

Aerts *et al.* (2014) conducted a marine mammal monitoring program in the northeastern Chukchi Sea in association with oil & gas exploration activities between 2008 and 2013. For seal sightings that were either ringed or spotted seals, the highest summer density was 0.127 seals/km^2 (2008) and the highest fall density was 0.076 seals/km^2 (2013). Where seals could be identified to species, they found the ratio of ringed to spotted seals to be 2:1. Applying this ratio to the combined densities results in species densities of 0.0846 seals/km^2 (summer) and 0.0507 seals/km^2 (fall) for ringed seals, and 0.0423 seals/km^2 (summer) and 0.0253 seals/km^2 (fall) for spotted seals. These are the densities used in the exposure calculations (Table 6-1) and to represent ringed and spotted seal densities for both the northern Bering and Chukchi seas.

Moulton and Lawson (2002) conducted summer shipboard-based surveys for pinnipeds along the nearshore Alaskan Beaufort Sea coast, while the Kingsley (1986) conducted surveys here along the ice margin representing fall conditions. The ringed seal results from these surveys were used in the exposure estimates (Table 6-1). Neither survey provided a good estimate of spotted seal densities. Green and Negri (2005) and Green *et al.* (2006, 2007) recorded pinnipeds during barging activity between West Dock and Cape Simpson, and found high numbers of ringed seal in Harrison Bay, and peaks in spotted seal numbers off the Colville River Delta where a haulout site is located. Approximately 5% of all phocid sightings recorded by Green and Negri (2005) and Green *et al.* (2006, 2007) were spotted seals, which provide a suitable estimate of the proportion of ringed seals versus spotted seals in the Colville River Delta and Harrison Bay, both areas close to the proposed Oliktok branch line. Thus, the estimated densities of spotted seals in the cable-lay survey area were derived by multiplying the ringed seal densities from Moulton and Lawson (2002) and Kingsley (1986) by 5%.

Spotted seals are a summer resident in the Beaufort Sea and are generally found in nearshore waters, especially in association with haulout sites at or near river mouths. Their summer density in the Beaufort Sea is a function of distance from these haul out sites. Near Oliktok Point (Hauser *et al.* 2008, Lomac-McNair *et al.* 2014) where the Oliktok cable branch will reach shore, they are more common than ringed seals, but they are very uncommon farther offshore where most of the Beaufort Sea cable-lay activity will occur. This distribution of density is taken into account in the take authorization request.

6.1.2.6. Bearded Seal

The most representative estimates of summer and fall density of bearded seals in the northern Bering and Chukchi seas come from Aerts *et al.* (2014) monitoring program that ran from 2008 to 2013 in the northeastern Chukchi Sea. During this period the highest summer estimate was 0.063 seals/km^2 (2013) and the highest fall estimate was 0.044 seals/km^2 (2010). These are the values that were used in developing exposure estimates for this species for the northern Bering and Chukchi sea cable-lay areas (Table 6-1).

There are no accurate density estimates for bearded seals in the Beaufort Sea based on survey data. However, Stirling *et al.* (1982) noted that the proportion of eastern Beaufort Sea bearded seals is 5% that of ringed seals. Further, Clarke *et al.* (2013, 2014) recorded 82 bearded seals in both the Chukchi and Beaufort seas during the 2012 and 2013 ASAMM surveys, which represented 5.1% of all their ringed seal and small unidentified pinniped sightings (1,586). Bengtson *et al.* (2005) noted a similar ratio (6%) during spring surveys of ice seals in the Chukchi Sea. Therefore, the density values in Table 6-1 (/km^2) were determined by multiplying ringed seal density from Moulton and Lawson (2002) and Kingsley (1986) by 5% as was done with spotted seals

6.1.3. *Level B Exposure Calculations*

The estimated potential harassment take of local marine mammals by QSO's fiber optics cable-lay project was determined by multiplying the seasonal animal densities in Tables 6-1 and 6-2 with the seasonal area that would be ensonified by thruster noise greater than 120 dB re 1 µPa (rms). The total area that would be ensonified in the Chukchi Sea is 5,947 km^2 (2,296 mi^2), and for the Bering Sea 1,296 km^2 (500 mi^2). Since there are no marine mammal density estimates for the northern Bering Sea, the ensonified area was combined with the Chukchi Sea for a total ZOI of 7,243 km^2 (2,796 mi^2). The ensonified area for the Beaufort Sea is 1,509 km^2 (583 mi^2). The resulting exposure calculations are found in Tables 6-3 and 6-4.

Table 6-3. The estimated number of marine mammals potentially exposed to received sound levels greater than 120 dB in the Bering and Chukchi seas from operation of the cable-lay vessels.

Species	Seasonal ZOI (km^2)	Summer Density (#/km^2)	Summer Exposures	Fall Density (#/km^2)	Fall Exposures
Bowhead Whale	7,243	0.0025	***18***	0.0438	317
Gray Whale	7,243	0.0680	***493***	0.023	167
Beluga Whale	7,243	0.0894	***648***	0.0632	458
Harbor Porpoise	7,243	0.0022	***16***	0.0022	16
Ringed Seal	7,243	0.0846	***613***	0.0507	367
Spotted Seal	7,243	0.0423	***306***	0.0253	183
Bearded Seal	7,243	0.0630	***451***	0.0440	319

Table 6-4. The estimated number of marine mammals potentially exposed to received sound levels greater than 120 dB in the Beaufort Sea from cable-lay vessels.

Species	Seasonal ZOI (km^2)	Summer Density (#/km^2)	Summer Exposures	Fall Density (#/km^2)	Fall Exposures
Bowhead Whale	1,509	0.0444	67	0.0742	***112***
Gray Whale	1,509	0.1790	270	0.0524	***79***
Beluga Whale	1,509	0.0021	3	0.0142	***21***
Ringed Seal	1,509	0.3547	535	0.2510	***379***
Spotted Seal	1,509	0.0177	27	0.0125	***19***
Bearded Seal	1,509	0.0177	27	0.0125	***19***

Because the cable laying plan is to begin in the south as soon as ice conditions allow and work northward, the intention is to complete the Bering and Chukchi seas portion of the network (1,575 km, [979 mi]) during the summer (June to August), and Beaufort Sea portion (328 km [204 mi]) during the fall (September and October). Thus, summer exposure estimates apply for the Bering and Chukchi areas and the fall exposure estimates for the Beaufort (Table 6-5).

Table 6-5. The estimated number of Level B harassment exposures to marine mammals.

Species	Exposures Bering/Chukchi	Exposures Beaufort	Exposures Total
Bowhead Whale	18	112	***130***

Gray Whale	493	79	***572***
Beluga Whale	648	21	***669***
Harbor Porpoise	16	0	***16***
Ringed Seal	613	379	***992***
Spotted Seal	306	19	***325***
Bearded Seal	451	19	***470***

The requested take authorization is found in Table 6-6. The requested take is an upward adjustment of the exposure estimate to account for inherent population variation, but also includes requested authorization for species in which the estimated number of exposures were not calculated due to a lack of reasonably accurate density estimates, but for which records for the project area occur (*i.e.*, humpback whale, fin whale, minke whale, killer whale, and ribbon seal). The number of takes requested for these species is based on a combination of average group size (larger groups with higher takes requested) and site fidelity (exposing the same animal on consecutive days).

Table 6-6. The requested number of authorized takes of marine mammals.

Species	Take Authorization Request 2016
Bowhead Whale	130
Gray Whale	572
Beluga Whale	669
Ringed Seal	1,000
Spotted Seal	350
Bearded Seal	500
Humpback Whale	15
Fin Whale	15
Minke Whale	5
Killer Whale	5
Harbor Porpoise	25
Ribbon Seal	5

The estimated take as a percentage of the marine mammal stock is 3.5% or less in all cases, except for the Eastern Chukchi stock of beluga whale (Table 6-7). The 18% take estimate for this stock of beluga whales is unrealistic as it assumes that all takes would occur just from this stock of the three stocks present.

Table 6-7. Level B take request as percentage of stock.

Species	Abundance	Requested Take	Percent Population
Bowhead Whale	16,892	130	0.8%
Beluga Whale (Beaufort Stock)	39,258	669	1.7%
Beluga Whale (E. Chukchi Stock)	3,710	669	18.0%
Beluga Whale (E. Bering Stock)	19,186	669	3.5%
Killer Whale	2,347	5	0.2%
Ringed Seal	249,000	1,000	0.4%
Spotted Seal	460,268	350	0.1%

Species	Abundance	Requested Take	Percent Population
Bearded Seal	155,000	500	0.3%
Humpback Whale (West. North Pac.)	1,107	15	1.4%
Humpback Whale (Cent. North Pac.)	10,103	15	0.1%
Fin Whale	1,652	15	0.9%
Gray Whale	20,990	572	2.7%
Ribbon Seal	61,100	5	0.0%

Abundance sources: COSEWIC (2004), Zerbini (2006), Boveng *et al.* (2009), Cameron *et al.* (2010), Allen and Angliss (2015), Carretta *et al.* (2015)

7. ANTICIPATED IMPACT OF THE ACTIVITY ON THE SPECIES OR STOCK

7.1. Introduction

The primary impact of the proposed fiber optic cable-lay project to local marine mammals is acoustical harassment from the ship thrusters during continuous dynamic positioning. Noise generated from the thrusters could disrupt normal behaviors of marine mammals where received levels exceed 120 dB re 1 μPa (rms). What is known about behavioral responses to noise stimuli by the marine mammals that inhabit the cable-lay project area are discussed below.

7.2. Disturbance

Relative to marine mammals, man-made noise introduced into the marine environment can result in impaired hearing, disturbance of normal behaviors (*e.g.*, feeding, resting, social interactions), masking calls from conspecifics, disruption of echolocation capabilities, and masking sounds generated by approaching predators. Behavioral effects may be incurred at ranges of many miles, and hearing impairment may occur at close range (Madsen *et al*. 2006). Behavioral reactions may include avoidance of, or flight from, the sound source and its immediate surroundings, disruption of feeding behavior, interruption of vocal activity, and modification of vocal patterns (Watkins and Schevill 1975, Malme *et al*. 1984, Bowles *et al*. 1994, Mate *et al*. 1994). Long-term exposure can lead to fitness-reducing stress levels, and in some cases physical damage leading to death can occur (*e.g.*, Balcomb and Claridge 2001).

The hearing of baleen whales remains unmeasured, but anatomical analyses suggest they are low-frequency specialists with good sensitivity at less than 2 kilohertz (kHz) (Wartzok and Ketten, 1999). Odontocetes (toothed whales), however, are high-frequency specialists. For example, beluga have their best hearing sensitivity between 30 and 80 kHz (Finneran *et al*. 2005). Most pinnipeds have peak sensitivities between 1 and 20 kHz (NRC 2003), with phocids such as ringed and harbor seals peaking at over 10 kHz and showing good sensitivity to approximately 30 kHz (Wartzok and Ketten 1999). Also, pinniped sensitivity to underwater noise relates to their evolutionary adaptation to the underwater environment. Kastak and Schusterman (1998) found that northern elephant seals, which forage at great depths and spend prolonged periods underwater, have better underwater hearing sensitivity than in-air, while sea lions, which spend considerably more time at the surface or hauled out, exhibited the reverse.

7.2.1. Threshold Shift

When exposed to intense sounds, the mammalian ear will protect itself by decreasing its level of sensitivity (shifting the threshold) to these sounds. Stereocilia are the sound sensing organelles of the middle and inner ear. They are the “hairs” of the hair cells that convert sound wave energy to electrical signals. When sound intensity is low, the hairs will bend towards the incoming waves, thereby increasing sensitivity. If the sound intensity is high, the hairs will bend away in an effort to reduce wave energy damage to the sensitive organelles, which includes a reduction in sensitivity. If the sound levels are loud enough to damage the hairs, the reduction in sensitivity will remain, resulting in a shift in hearing threshold. These threshold shifts can be temporary (temporary threshold shift [TTS]) or permanent (permanent threshold shift [PTS]) (Weilgart 2007) depending on the recovery ability of the stereocilia and connecting hair cells. Over-activation of hair cells can lead to fatigue or damage that remains until cells are repaired or replaced.

Exposure to intense impulsive noises can disrupt and damage hearing mechanisms, leading to a threshold shift. However, these threshold shifts are generally temporary (TTS), as the hair cells have some ability to recover between and after the intermittent sound pulses. Long-term exposure to continuous (non-impulsive) noise, even noise of moderate intensity, can lead to a permanent threshold shift, or PTS. This is because the continuous wave energy does not allow hair cells to recover. If the exposure is long enough, the ability to replace damaged hair cells after the exposure has ceased is also reduced, and the threshold shift becomes permanent.

Anthropogenic sources of underwater impulsive noises that could lead to TTS include seismic surveys, pile driving, and blasting. However, Quintillion’s cable-lay operation will not produce impulsive noises, so these TTS concerns do not apply. The primary underwater noise associated with the proposed cable-lay operations is the continuous cavitation noise produced from cable-lay ship’s thrusters. Other noise sources include onboard diesel generators and the firing rate of the main engine, but both are subordinate to the blade rate harmonics (Gray and Greeley 1980). These continuous sounds for small ships have been measured at up to 171 decibels (dB) referenced at 1 micropascal in meters (μPa-m) root mean square (rms)) at 1-m source (broadband), and they are emitted at dominant frequencies of less than 5 kHz, and generally less than 1 kHz (Miles *et al*. 1987, Richardson *et al*. 1995, Simmonds *et al*. 2004). Measured cavitation noise from modern cargo ships have peak energies less than 100 Hz (Areveson and Vendittis 2000, McKenna *et al*. 2012), resulting from both the blade rate harmonics and the chaotic collapse of cavities (cavitation), with a rapid drop off of about 6 dB per octave on a constant-bandwith plot (Areveson and Vendittis 2000). Cavitation noise is a potential source for PTS depending on the received noise level (a function of the distance the animal is to the vessel) and duration (dependent on the period animal and vessel are in proximity). Since underwater hearing sensitivity in pinnipeds and odontocetes (*e.g.*, sperm, killer, and beluga whales) is greatest beyond 10 kHz, their effectiveness at hearing cavitation noise is already poor, and the potential for PTS is reduced. The cavitation noise does, however, fall within the effective hearing range of baleen whales (*e.g.*, right, blue, sei, fin, humpback, and gray whales), and PTS could occur if exposure duration was long enough. However, as the cable-lay ship is continually moving, there is no long-term exposure of a given marine mammal to continuous cavitation noise leading to PTS. Thus, hearing loss in marine mammals is not of concern from the proposed oceanic cable-lay operations.

7.2.2. Masking

Masking occurs when louder noises interfere with marine mammal vocalizations or their ability to hear natural sounds in the environment (Richardson *et al*. 1995), which limit their ability to communicate, detect prey, or avoid predation or other natural hazards. Masking is of particular concern with baleen whales because low-frequency anthropogenic noises, such as propeller noise, overlap with their communication frequencies. Some baleen whales have adjusted their communication frequencies, intensity, and call rate to limit masking effects. For example, McDonald *et al*. (2009) found that California blue whales have shifted their call frequencies downward by 31% since the 1960s, possibly in an attempt to communicate at frequencies below masking shipping noise frequencies. Melcon *et al*. (2012) found blue whales to increase their call rates in the presence of shipping noise, while Watkins (1986) found fin whales to reduce their calling rate in response to boat noise. Both killer whales (Holt *et al*. 2009) and beluga whales (Scheifele *et al*. 2005) were found to increase the amplitude of their calls (known as the Lombard effect) in response to loud vessel noise levels.

QSO's planned cable laying will have some limited, additive effect to the overall anthropogenic noise budget.

While odontocetes in general have poor sensitivity to low frequency sounds, the lower frequency component of discrete calls (frequency range of 1 to 10 kHz) in killer whales overlap the frequency range of propeller cavitation noise (Holt 2008). Based on this overlap, Crystal *et al*. (2011) studied commercial shipping noise in Southern Resident killer whale critical habitat and found that the western and eastern ends of the Strait of Juan de Fuca, Boundary Pass, Haro Strait, and the Strait of Georgia were subject to masking noise levels (at least masking of the lower frequency components of the calls) over 90% of the time. Considering noise levels as a function of vessel speed, Crystal *et al*. (2011) concluded that masking level noises could be eliminated completely by reducing commercial vessel speeds to 18.5 km/hr (10 kt). The cable-lay vessel travels at a speed of less than 1 km/hr.

Most auditory studies on pinnipeds to date indicate that pinnipeds can hear underwater sound signals (such as higher frequency calls) in noisy (low frequency) environments, a possible adaption to the noisy nearshore environment (due to wind, waves, and biologics) they inhabit (Southall *et al*. 2000). Southall *et al*. (2000) found northern elephant seals, harbor seals, and California sea lions lack specializations for detecting low-frequency tonal sounds in noise, but rather were more specialized for hearing broadband noises associated with schooling prey.

The extent of masking associated with QSO's cable-lay program is a function of the duration a cable-lay vessel is within hearing proximity of a marine mammal. Masking is not a concern to killer whales at least if, as Crystal *et al*. (2011) have suggested, masking effects are eliminated at speeds less than 18.5 km/hr. Whether this would apply also to other odontocetes such as beluga whales is unknown. Further, odontocetes compensate for masking effects from vessel noise by increasing call intensity (Lombard effect), although the fitness implications of doing so is unknown. Given the ability for pinnipeds to hear well in noisy backgrounds (Southall *et al*. 2000), combined with the short duration of exposure from the moving vessel, masking concerns are not particularly significant for these marine mammals.

Masking is of greater concern with large baleen whales. Although masking might increase the risk of large baleen whales to killer whale predation, the increased risk is probably slight and minimal given the overall low predation risk in the cable area. Communication masking is the primary issue, given the rate at which large baleen whales normally communicate. Communication masking is a function of the loss of communication space as a result of noise relative to the available communication space during quiet conditions (Clark *et al*. 2009). The size of communication space for a given species, in turn, is a function of call frequency range and call intensity. Clark *et al*. (2009) studied potential communication space loss from vessel traffic for singing fin and humpback whales and calling North Atlantic right whales. They found that for the source band (18-28 hertz) in which fin whales sing, source levels from a passing ship (181 dB) were essentially the same as the source level from the whale (180 dB), while for humpback source bands (224-708 hertz), ship source levels (167 dB) were much lower than whale source levels (170 dB). Thus, for both species there was little loss of communication space from the passing ship. However, because right whale call frequencies (71-224 dB) are well within the stronger frequency components from the ship, and right whales calls are relatively soft (160 dB), the source level from the ship (172 dB) is 12 dB higher than from the whale, resulting in nearly full masking of the communication space at the ships closest point. Right whales, however, do not occur in the cable-lay area.

7.2.3. Chronic Disturbance

Apart from any potential for damaging marine mammal hearing, loud vessels can disrupt normal behaviors of marine mammals either through auditory or visual harassment. Disturbed animals may quit feeding, move away from feeding areas, display overt reactions, or display other behaviors that expend undue energy potentially culminating in lowered fitness. Continued disturbance can lead to chronic stress exposure, further leading to stress-related responses such as immune system suppression, reproductive failure, and slowed growth, and an overall decline in fitness. Chronic stress is exposure to stressors that last for days or longer, and does not apply to a single passing ship. However, disturbance noise from a passing ship (acute stress) can add to the overall stress budget (known as the allostatic load; Romero *et al*. 2009) of an individual marine mammal contributing to general distress and deleterious effects.

In general, baleen whales seem less tolerant of continuous noise (Richardson and Malme 1993) and, for example, often detour around stationary drilling activity when received levels are as low as 119 dB re 1 μPa (rms) (Malme *et al*. 1983, Richardson *et al*. 1985, 1990). These studies are the basis for the threshold for harassment take from continuous noise defined at 120 dB re 1 μPa (rms). Humpback whales have been especially responsive to fast moving vessels (Richardson *et al*. 1995), and often react with aerial behaviors such as breaching or tail/flipper slapping (Jurasz and Jurasz 1979). Humpback whales have also shown a general avoidance reaction at distances from 2 to 4 km (1.2 to 2.5 mi) of cruise ships and tankers (Baker *et al*. 1982, 1983), although they have displayed no reactions at distances to 800 m (0.5 mi) when feeding (Watkins *et al*. 1981, Krieger and Wing 1986), and temporarily disturbed whales often remain in the area despite the presence of vessels (Baker *et al*. 1988, 1992). Odontocetes are probably less sensitive to acoustical disturbance from vessels because of their lower sensitivity to the low frequency noise generated by cavitating propellers. However, the presence of the cable-lay vessel could be disturbing to beluga whales and harbor porpoise if and when in close proximity. Williams *et al*. (2009) found that Southern Resident killer whales travel greater distances in the presence of vessels, presumably to avoid these vessels, leading to increased energy expenditure and reduced fitness.

Most information on the reaction of seals and sea lions to boats relate to disturbance of hauled out animals. None of the proposed barging routes will come within disturbance distance to pinniped haulouts.

There is little information on the reaction of these pinnipeds to ships while in the water other than some anecdotal information that sea lions are often attracted to boats (Richardson *et al*. 1995).

8. ANTICIPATED IMPACTS ON SUBSISTENCE USES

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 various 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 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 villages. 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 will occur in the summer after the spring bowhead and beluga whale hunts have ended, and will avoid the ice period when ringed seals are harvested. The Oliktok branch will 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. QSO will 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.

9. ANTICIPATED IMPACTS ON HABITAT

9.1. Habitat and Prey Resources

The cable-lay project will occur on the shelf regions of the northern Bering, Chukchi, and Beaufort seas. The physical habitat is characterized as flat with a bottom substrate of mud, sand, or gravel, or a combination of the three (Naidu 1987, Feder *et al.* 1989, Smith 2010). The portion of the cable network within the northern Bering Sea and the Chukchi Sea just north of the Bering Strait will cross sea floor substrate dominated by gravelly muddy sand, muddy sand, and muddy gravel. The main trunk line will also encounter mud and sandy mud substrates when crossing the Hope Basin. The cable routes for the rest of the Chukchi portion of the network will cross primarily gravelly mud, gravelly muddy sand, and mud substrates. The Beaufort Sea section of the network is primarily mud, sandy mud, and gravelly mud. There are no areas dominated by silt, clay, or rock.

These habitats support benthic and epibenthic fauna. Feder *et al*. (1989) identified four benthic fauna assemblages, based on grab sampling, in the Chukchi Sea that are a reflection of the relative presence and mix of gravel, sand, and mud. Areas of muddy-sandy-gravel were dominated in abundance by the tube-dwelling amphipod *Byblis gaimardi* and the juvenile barnacle *Balanus crenatus*. The muddy areas were dominated by the polychaete *Maldane glebifex* and the clams *Macoma* spp. and *Nucula bellotti*. The sandy area assemblage was dominated by barnacles (*B. crenatus*) and tube-dwelling amphipods including *Ampelisca macrocephala*. Finally, the sandy gravel areas included sand dollars (*Echinarachnius parma*) and the cockle *Cyclocardia rjabininae*. Feder *et al*. (1989) also conducted trawl surveys in the Chukchi to characterize communities the epifaunal communities and benthic fauna near the surface. Invertebrates they found to dominate abundance were brittle stars (*Ophiura sarsi*), Tanner crab (*Chionoecetes opilio*), and crangonid shrimp.

Very few fish caught in the trawls, although Arctic cod (*Boreogadus saida*) and flathead sole (*Hippoglossoides elassodon*) were must numerous. Trawl studies conducted in the Beaufort Sea have shown a clear dominance of the fish community by Arctic cod with locally high populations of capelin (*Mallotus villosus*) (Frost and Lowry 1983, Craig 1984, Cannon *et al.* 1987, Jarvela and Thorsteinson 1999, Logerwell *et al.* 2010). Other fish ranking in the community include eelpouts (*Lycodes* spp.), snailfish (*Liparis* spp.), and sculpins (Frost and Lowry 1983, Logerwell *et al.* 2010), with Arctic cisco (*Coregonus autumnalis*) common along the brackish shorelines (Jarvela and Thorsteinson 1999). Jarvela and Thorsteinson (1999) commented on the relatively low richness in fish species diversity in the Alaskan Beaufort Sea.

9.2. Marine Mammal Food Habits

In the Alaskan arctic waters, bowhead whales feed largely on euphausiid and calanoid copepod zooplankton (Moore *et al*. 2010). These resources are high near Point Barrow where feeding studies have been conducted, but much lower east of Barrow (Smith 2010) and in the Chukchi Sea. Most of the Alaskan bowhead whale population feeds in the Canadian Beaufort Sea during the summer months, and these whales are more likely to migrate through the cable-lay survey area than stop to feed. Based on stomach contents from whales harvested during the fall migration, bowheads don’t appear to feed during migration except near Point Barrow, where they feed on swarms of euphausiids, copepods, and mysids

(Moore *et al.* 2010). The prey species dominating the diets of humpback whales harvested during the fall varied annually (Sheffield and George 2013).

Both fin and humpback whales feed largely on krill, especially euphausiids. During studies of annual distribution of the krill-feeding short-tailed shearwater, Yamamoto *et al*. (2014) found shearwaters moving into the Chukchi Sea in response to high euphausiid densities, which they attributed to increasing sea surface temperatures. In association with the same study, Iwahara *et al*. (2015) found high densities of krill in the northern Bering Strait and off Icy Cape, Point Hope, and Point Barrow, and noted the presence of baleen whales (bowhead, humpback, and minke whales) at these locations.

Nelson *et al.* (1994) studied the feeding patterns of gray whales in the Chukchi Sea and found that they concentrated in the sandy substrate regions where Feder *et al.* (1989) found ampeliscid amphipods to dominate. These sandy regions are found in nearshore bands within approximately 40 km (25 mi) of Wainwright and Cape Lisburne. Gray whales feed by suctioning sediment and prey from the sea floor leaving behind elongated pits.

Beluga whales, harbor porpoise, ringed seals, and spotted seals feed primarily on fish. Quakenbush *et al.* (2015) analyzed stomach contents from 365 beluga whales from throughout Alaska and found Arctic and saffron (*Eleginus gracilis*) cod to dominate the diets of whales from the Beaufort, Eastern Chukchi, and Eastern Bering Sea stocks. The Bering Sea and Kotzebue Sound populations preyed on a much greater diversity of fish that included Pacific herring (*Clupea pallasii*), rainbow smelt (*Osmerus mordax*), and various eelblenny and sculpin species. Spotted seals and harbor porpoise have a diet (Wilkes and Kenyon 1952, Scheffer 1953, Boveng *et al.* 2009) very similar to beluga whale, while ringed seals feed also on invertebrates such as mysids (Kelly *et al.* 2010).

While bearded seals also feed on fish, their diet is largely dominated by invertebrates (Cameron *et al.* 2010). Carey *et al.* (1984) sampled the bivalve population in the Beaufort Sea (near Pingok Island) and found a relatively high abundance of about a dozen species of small clams. One species, *Macoma calcarea*, does grow to sizes exceeding 50 mm (2 in) and may be consumed by local bearded seals. Tanner crabs (*Chionoecetes opilio*) are also an important prey item (Cameron *et al.* 2010), especially so in the Bering and Chukchi seas where the abundance of these crabs are highest. Tanner crabs, however, are becoming increasingly abundant near Point Barrow (Logerwell *et al*. 2010) and may be expanding eastward in the Beaufort Sea.

9.3. Potential Project Impacts

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) critically 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.

Exactly where plough or jet trenching will occur will not be known until after the BAS is completed and reported. 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), (and it is likely that most cable-burying will occur in the Bering Sea where there are interactions with fishing gear concerns). 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-lay effects to marine mammal habitat and prey resources is negligible.

10. ANTICIPATED EFFECTS OF HABITAT IMPACTS ON MARINE MAMMALS

Based on the conclusions of Section 9 above, modification of marine mammal habitat is expected to be modest and temporary. Any impacts to prey resources is considered minor or negligible, and no long-term effects would occur.

11. MITIGATION MEASURES

The primary means of minimizing potential impacts from cable-lay to marine mammals is to design the routing to avoid marine mammal concentration areas or important prey habitat (BERR 2008). Most of the main trunk line will be laid 30 to 150 km (19 to 93 mi) offshore, thereby avoiding nearshore concentrations of gray whales, beluga whales, and spotted seals. Most of the work will also be conducted outside the bowhead migration period. The one exception is the planned work between Barrow and Oliktok Point, which might occur in September. QSO will work closely with AEWC and the various Whaling Captain's Associations during this period to ensure effects to migrating bowhead whales are avoided (see Appendix C – Plan of Cooperation). Reducing and mitigating potential acoustical impacts to local marine mammals during cable-lay activity is fully addressed in the Marine Mammal Monitoring and Mitigation Plan (4MP) attached as Appendix B.

12. PLAN OF COOPERATION

A Plan of Cooperation (POC) was POC was prepared specifically to address the following requirements:

- 50 CFR § 216.104 (a)(12), which requires a plan of cooperation to be submitted in support of a request for an Incidental Harassment Authorization (IHA) from the National Marine Fisheries Service (NMFS); and
- 50 CFR § 18.114, which requires a record of community consultation to be submitted in support of a request for a Letter of Authorization (LOA) from the U.S. Fish & Wildlife Service (USFWS).

The focus of the POC is to ensure that there are undue project impacts to local subsistence harvest of marine mammals. The POC can be found attached as Appendix C.

13. MONITORING AND REPORTING

Monitoring and reporting potential acoustical impacts to local marine mammals are fully addressed in the Marine Mammal Monitoring and Mitigation Plan attached as Appendix B.

14. SUGGESTED MEANS OF COORDINATION

Potential impacts of ship cavitation and other continuous noise activities on marine mammals have been studied, with the results used to establish the noise criteria for evaluating take and to support mitigation measures. However, all observations of marine mammals, including any observed reactions to the cable-lay operations will be recorded and reported in the 90-day report to the NMFS Office of Protected Species. Observation data will also be provided as requested to the NMFS National Marine Mammal Laboratory, the USFWS Office of Marine Mammal Management, the North Slope Borough Department of Fish and Wildlife, the Alaska Department of Fish and Game, the Alaska Eskimo Whaling Commission, the Alaska Beluga Whale Committee, and the Ice Seal Committee.

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APPENDIX A

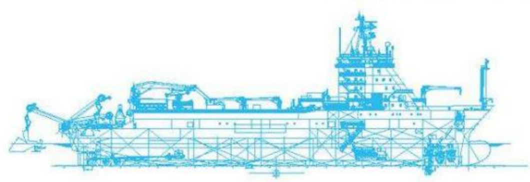
Cable-lay Vessel Specifications

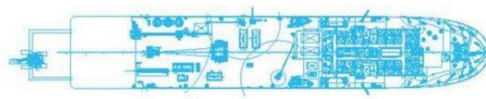
Ile de Brehat / Ile de Sein / Ile de Batz

Installation vessels

Technical Specifications

DESCRIPTION / POSITIONING	Three state-of-the-art vessels, highly powerful for long-haul cable installation and burying in the harshest conditions. Duplex DP and Integrated Control System
OWNER	ALDA MARINE
OPERATOR	ALDA MARINE S.A.S.
SHIP MANAGER	LOUIS DREYFUS ARMATEURS S.A.S.
FLAG	French
CONSTRUCTION YEAR	2002
LENGTH OVERALL	140.36 m
BREADTH	23.40 m
DRAFT	8.00 m (summer draft)
DEADWEIGHT	9820 mt
ACCOMMODATION	Single cabins: 60; double cabins: 5
CABLE TANK CAPACITY	Main cable tank: 2 x 2500 tonnes (max cap each tank: 3500 tonnes), 2 x 1500 m³ Spare cable tank: 2 x 250 tonnes, 2 x 150 m³
REPEATER STORAGE	2 x 100
CABLE MACHINERY	1 Linear Cable Engine – DOWTY 21 Wheel pairs, Drum Engine – DOWTY 6T DOHB / 28T Drum, 2 Transporter – DOWTY 2 Wheel Pairs, 1 Stern Hauler – DOWTY 2 Wheel Pairs
TYPE OF PLOUGH	1 SMD HD3 Plough – burial in all soils (including fractured rocks). Max burial: 3.00 m
CABLE LAYING SOFTWARE	MakaiLay
DYNAMIC POSITIONING	DP2 BV PDY MATAR ALSTOM
TRANSIT SPEED	15 knots
BOLLARD PULL	100 tonnes
POWER GENERATION	4 x 4320 kW MAK + 1 x 1360 kW MAK
THRUSTERS	2 x Lips 1500 kW Bow Thrusters, 1 x Lips 720 rpm - 1500 kW AZ Fore Thruster 2 x Lips 1500 kW Aft Thrusters
PROPULSION	2 electrically driven fixed pitch propellers. Output 4000 kW each. Propeller diameter: 3700 mm. Max propeller speed: 146 rpm





Alcatel·Lucent

Global Marine Systems

Networker is the first purpose-built cable-working barge in South East Asia. One of the largest vessels of her kind, she is specifically designed to provide shallow water expertise throughout the Asia Pacific Region.

Networker can overcome the most challenging seabed terrain, whilst her all-electric drive ensures maximum flexibility and control during narrow corridor cable installation operations. She is also equipped with an injector and rocksaw burial system which enables cable burial up to 10 metres.

Propulsion and Electric Power Generation

Main Engines:	3 x Cummins Model KTA 50-63 @ 1000kW each
Auxiliary Engines:	2 x Cummins Model KTA 19-DM
Thrusters:	4 x Schottel Thrusters @ 420kW each.
Switch boards:	380v A/C Main switchboard supplying 220v A/C and 110v A/C switchboards.
Emergency generator:	1

Fuel Consumptions , including tow tug:

Fuel Consumption in Port:	0.5t/day
Fuel Consumption Cable Laying:	10-14t/day
Fuel Consumption Economic:	8-10t/day
Fuel Consumption Transit:	12-16t/day
Fuel Consumption Max Speed:	12-16t/day
Maximum Bunker Capacity:	399t @ 0.86 SG

Capacity and Equipment

Cable Tanks

Main Cable Tanks:	2
Internal Diameter:	8.0m
Cone Outer Diameter:	3.8m
Tank Height:	4.0m
Cone Height:	4.0m
Volume of Each Cable Tank:	1 - 81.5 cubic metres 2 - 81.5 cubic metres
Maximum Load per Tank:	375 tonnes
Tank Top Loading:	10 tonnes/square metre
Spare Cable Tanks:	0

globalmarinesystems.com

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APPENDIX B

Marine Mammal Monitoring and Mitigation Plan

Attached Separately

APPENDIX C

Plan of Cooperation

Attached Separately