Appendix A

Existing Minerals Management Service Geological and Geophysical Permit Stipulations for Oil and Gas Activities in Alaska OCS Waters.

STIPULATIONS

From http://www.mms.gov/alaska/re/permits/stips1-5/htm

In the performance of any operations under the Permit and Agreement for Outer Continental Shelf Exploration, the Permittee shall comply with the following Stipulations:

1. As part of the requirements of 30 CFR 251.7-3, the Permittee shall submit to the Regional Supervisor, Resource Evaluation (hereinafter referred to as the Supervisor) within 30 days after the completion of the survey authorized under this Permit and Agreement a map at the same scale as that used ordinarily for such maps and showing the coordinates of latitude and longitude. In addition, each Permittee shall submit one (1) one-half inch, nine-track, final edited navigation tape of all locations in latitude and longitude degrees. The tape is to be in an ASCII or EBCDIC 1600 BPI format with fixed record length and fixed block size. Record length, block size, density and whether the tape is ASCII or EBCDIC must be on a label affixed to the tape. The label must also specify the geodetic reference system (NAD27 or NAD83) used. A printed tape listing and format statement are to be included with the tape.

2. As part of the requirements of 30 CFR 251.3-5, if any operation under this Permit and Agreement is to be conducted in a leased area, the Permittee shall take all necessary precautions to avoid interference with operations on the lease and damage to existing structures and facilities. The lessee (or operator) of the leased area will be notified by letter before the Permittee enters the leased area or commences operations, and a copy of the letter will be sent to the Supervisor executing this Permit and Agreement.

3. (a) Solid or liquid explosives shall not be used except pursuant to written authorization from the Supervisor. Requests for the use of such explosives must be made in writing, giving the size of charges to be used, the depth at which they are to be suspended or buried, and the specific precautionary methods proposed for the protection of fish, oysters, shrimp, and other aquatic life, wildlife, or other natural resources.

   (b) The following provisions are made applicable when geophysical exploration on the Outer Continental Shelf using explosives is approved:

      (i) Each explosive charge will be permanently identified by markings so that unexploded charges may be positively traced to the Permittee and to the specific field party of the Permittee responsible for the explosive charge.

      (ii) The placing of explosive charges on the seafloor is prohibited. No explosive charges shall be detonated nearer to the seafloor than five (5) feet.

      (iii) No explosives shall be discharged within one thousand (1000) feet of any boat not involved in the survey.

4. Any serious accident, personal injury, or loss of property shall be immediately reported to the Supervisor.

5. All pipes, buoys, and other markers used in connection with work shall be properly flagged and lighted according to the navigation rules of the U.S. Corps of Engineers and the U.S. Coast Guard.

6. If the Permittee discovers any archaeological resource during geological and geophysical activities, the Permittee shall report the discovery immediately to the Supervisor. The Permittee shall make every reasonable effort to preserve the archaeological resource until the Supervisor has told the Permittee how to protect it.

7. In addition to the general provisions above, the following special provisions shall apply:

(a) This permit is applicable only to that portion of the program involving Federal OCS lands seaward of the submerged lands of the State of Alaska.

(b) The Permittee shall, on request of the Supervisor, furnish quarters and transportation for a Federal representative(s) or other designated observer to inspect operations.

(c) Operations shall be conducted in a manner to assure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions or unreasonably interfere with other uses of the area. Any difficulty encountered with other users of the area or any conditions which cause undue harm to aquatic life, pollution, or could create a hazardous or unsafe condition as a result of the operations under this permit shall be reported to the Supervisor. Serious or emergency conditions shall be reported without delay.

(d) A final summary report (one copy) shall be submitted to this office within 30 days of completion or cessation of operations.

This report shall include:

(i) Program commencement date.

(ii) Program completion date.

(iii) Field effort in crew weeks (actual work time based on 168-hour weeks).

(iv) Line miles of surveys completed.

(v) Summary of incidents or accidents from paragraph 4.

(vi) Date or reasonable estimation of date when data will be available for inspection or selection.

(e) The Permittee shall notify the Commander, U.S. Coast Guard and the Commander, 3rd Fleet as to the approximate time and place the work is to be conducted and to keep them informed:

Commander, U.S. Coast Guard 17th Coast Guard District Aids to Navigation Branch P.O. Box 25517 Juneau, AK 99801 (907)586-7365	COMTHIRD Pearl Harbor, HI 96860 (808)472-8242

8. Information to the Permittee

(a) Operations authorized under permit are subject to the Marine Mammal Protection Act of 1972 as amended (16 U.S.C. 1361 et seq), the Endangered Species Act as amended (16 U.S.C. 1531 et seq), regulations found in 50 CFR Part 18 (U.S. Fish and Wildlife Service), and 50 CFR Part 228 (National Marine Fisheries Service). Special attention should be given to the prohibition of the "taking" of marine mammals. "Taking" means to harass, hunt, capture, collect, or kill or attempt to harass, hunt, capture, collect, or kill any marine mammal. National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (F&WS) regulations allow, under certain conditions, the incidental taking by harassment of specific marine mammals. Such a taking of marine mammals is controlled through Letters of Authorization issued by NMFS or F&WS. Permittees are advised to consult the appropriate agencies regarding these laws and regulations. Further information may be obtained from

Regional Director
U.S. Fish and Wildlife Service
Alaska Region
1011 East Tudor Road
Anchorage, Alaska 99503
telephone (907) 786-3542

National Marine Fisheries Service
222 West 7th Avenue, Box 43
Anchorage, Alaska 99513
telephone (907) 271-5006

(b) It is recommended that you contact the appropriate Regional Supervisor, Commercial Fish Division, Alaska Fish and Game Department, or the National Marine Fisheries Service for information on the fisheries and fishing activities in the proposed area of operations in order to minimize potential conflict between your activities and fishing activities. We are attaching a list of the Fish and Game offices with addresses and telephone numbers and a map showing the boundaries of the fishing districts for your convenience.

In addition to the standard stipulations above, the following stipulation has been included in G&G permits for seismic surveys in the Alaska OCS Region since the 1980's:

- Operators must maintain a minimum spacing of 15 miles between the seismic source vessels for separate surveys. The MMS must be notified by means of the weekly report whenever shut down of operations occurs to maintain this minimum spacing.

THE FOLLOWING DOCUMENT PROVIDES INFORMATION TO THE PERMITTEE ON THE ENDANGERED SPECIES ACT OF 1973, AS IT MIGHT APPLY WHEN CONDUCTING FIELD OPERATIONS.

The Endangered Species Act prohibits harassment of endangered and threatened species whether the harassment occurs through an intentional or negligent act or omission. Harassment refers to conduct of activities that disrupt an animal's normal behavior or cause a significant change in the activity of the affected animal. In many cases the effect of harassment is readily detectible: a whale may rapidly dive or flee from an intruder to avoid the source of disturbance. Other instances of harassment may be less noticeable to an observer but will still have a significant effect on endangered whales.

The Permittee must be prepared to take all reasonable and necessary measures to avoid harassing or unnecessarily disturbing endangered whales. In this regard, the Permittee should be particularly alert to the effects of boat and airplane or helicopter traffic on whales.

In order to ensure that the Permittee may derive maximum benefits from their operations at a minimum cost to the health and well being of endangered whales, the following guidelines are offered to help avoid potential harassment of endangered whales:

(1) (a) Vessels and aircraft should avoid concentrations or groups of whales. Operators should, at all times, conduct their activities at a maximum distance from such concentrations of whales. Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 1,000 feet when within 500 lateral yards of groups of whales. Helicopters may not hover or circle above such areas or within 500 lateral yards of such areas.

(b) When weather conditions do not allow a 1,000-foot flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 1,000-foot altitude stipulated above. However, when aircraft are operated at altitudes below 1,000 feet because of weather conditions, the operator must avoid known whale concentration areas and should take precautions to avoid flying directly over or within 500 yards of groups of whales.

(2) When a vessel is operated near a concentration of whales, the operator must take every precaution to avoid harassment of these animals. Therefore, vessels should reduce speed when within 300 yards of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.

(3) Vessel operators should avoid multiple changes in direction and speed when within 300 yards of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.

(4) Small boats should not be operated at such a speed as to make collisions with whales likely. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to whales.

When any Permittee becomes aware of the potentially harassing effects of operations on endangered whales, or when any Permittee is unsure of the best course of action to avoid harassment of endangered whales, every measure to avoid further harassment should be taken until the National Marine Fisheries Service is consulted for instructions or directions. However, human safety will take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of endangered whales.

Permittees are advised that harassment of endangered whales may be reported to the National Marine Fisheries Service. For further information contact the National Marine Fisheries Service, Federal Building, Room C-554, Anchorage, Alaska, 99513, telephone (907) 271-5006.

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Appendix B

Profiles of the Families of Fish and Selected Species that Occur in the Alaska Arctic Ocean.

B.1 Fish Families.

Note: The information contained in this section is taken from Mecklenburg, Mecklenburg, and Thorsteinson (2002) except where noted. Where these authors cite other authors, those will be shown as, for example (citing Smith, 2001).

B.1.a. Petromyzontidae (Lampreys). Lampreys are eel-like fishes that live in cool regions of the world, mostly in the Northern Hemisphere. They can be restricted to freshwater for their entire lives or anadromous, spending part of their lives in saltwater but returning to freshwater to spawn. In either case, they die after spawning. There are five species occurring in Alaska; two of which occur in arctic Alaska (the Pacific lamprey and the Arctic lamprey).

There are two basic types of life cycle that occur in lampreys: parasitic and nonparasitic. The parasitic species include those that are anadromous and feed at sea before returning to freshwater to spawn, and others that do no leave freshwater. Nonparasitic species stay in their natal streams and adults are not only nonparasitic, they have a nonfunctional gut and do not feed at all. The adult phase is greatly abbreviated. The Pacific lamprey and the Arctic lamprey are of the parasitic life cycle. Adult lampreys spawn in pits they excavate in stream riffles by removing stones with their mouths and fanning away fine particles with vibrations of the body. The sexes are separate. The eggs are small, not yolky, and number in the thousands. Eggs hatch into blind larvae called ammocoetes. The ammocoetes burrow into the sand or mud of quiet pools and backwaters and feed by filtering microorganisms and fine debris from the water.

Ammocoetes metamorphose after 3-7 years, depending on species, into adults. Their transformation is radical. The parasitic lampreys, after metamorphosis but before reproducing, feed on the flesh or blood and other body fluids of other fish, sharks, and whales.

The Pacific lamprey occurs from southeastern Alaska into the Chukchi Sea and is one of the two most common lampreys in the State (the other is the Arctic lamprey). The Arctic lamprey is widespread in Alaska, except it is absent from the southeastern part of the State.

B.1.b. Dalatiidae (Sleeper Sharks). Sleeper sharks are sluggish and live close to the bottom, where they scavenge for food; they also swim toward the surface after prey. They consume a diverse array of both surface and bottom prey but fast-moving species, such as harbor seals and salmon, may be eaten as carrion rather than captured alive.

The Pacific sleeper shark inhabits the marine waters of Alaska from the Chukchi Sea to the Gulf of Alaska and is one of the three most abundant sharks in the region (the others being spiny dogfish, *Squalus acanthias*; and salmon shark, *Lamna ditropis*). Benz et al. (2004) describe a dead Pacific sleeper shark that was discovered in November 1998 along the shore at Point Hope, Alaska.

Sleeper sharks are assumed to be ovoviviparous, although little is known about their reproduction or other aspects of their life history. Females can carry several hundred large, yolky eggs, but embryos are unknown and the smallest sleeper shark on record measured 79 centimeters (cm) (31 inches [in]) (citing Eschmeyer and Herald, 1983).

B.1.c. Squalidae (Dogfish Sharks). Dogfish sharks inhabit boreal to tropical seas worldwide. They are sleek and fast-swimming, and travel in packs of hundreds to thousands of individuals. The spiny dogfish is possibly the most abundant and well-known living shark. Exhibiting wide salinity, temperature, and depth tolerances, spiny dogfish are the most widespread dogfish shark in the world's oceans. They mainly occur along coasts, both inshore and offshore. However, records of occurrence of immature and young adults in open ocean are not uncommon, and a few individuals tagged off the coasts of British Columbia and Washington have been recovered off Japan (citing Ketchen 1986; Nakano and Nagasawa, 1996). In Alaska, spiny dogfish are most abundant along the southern coasts. They are found there year-round, but most commonly in spring through fall.

The spiny dogfish is ovoviviparous and produces up to 20 young per litter. Gestation ranges from 18-24 months, and at the higher end of this range, it is longer than gestation in any other vertebrate. Recently obtained data from the Strait of Georgia, British Columbia, indicate a median age at maturity for female spiny dogfish of 35.5 years and length of 94 cm (citing Saunders and McFarlane, 1993).

B.1.d. Clupeidae (Herrings). Clupeids include herrings, shads, sardines, sprats, and other herring-like fishes. There are several freshwater and anadromous clupeids, but most are marine. They typically aggregate in schools and feed on plankton near the surface, usually in shallow coastal waters. The family contains about 56 genera and 180 species in five subfamilies. Three clupeid species occur in Alaska. The Pacific herring is the only clupeid occurring in arctic Alaska. The Pacific herring is distributed off all the coasts of Alaska and is seasonally and locally abundant.

B.1.e. Osmeridae (Smelts). Smelts are slender, silvery, shallow-water fishes found only in temperate and cold regions of the Northern Hemisphere. They occur in both fresh- and saltwater; usually in schools, and are important food and forage fishes. Some species congregate in huge numbers prior to spawning. Most species spawn on sand or gravel. Species that are entirely marine spawn on ocean beaches at high tide; in Alaska, these include capelin, surf smelt, and night smelt. Several species are anadromous or have anadromous populations and ascend freshwater streams to spawn, including three Alaskan species: rainbow smelt, eulachon, and longfin smelt. The family has seven recognized genera and 15 or 16 species, with the exact number of species depending on classification within the other genera. Alaska is home to four genera and seven species. Two species, capelin and rainbow smelt, occur in Arctic Alaska. Most smelts are extremely oily and have excellent flavor.

B.1.f. Salmonidae (Salmonids). The family includes about 70 species of whitefishes, graylings, salmons, trouts, and chars. They are some of the best known of the world's fishes. All salmonids spawn in freshwater and many are anadromous, spending part of their life at sea. They are fished for subsistence, commercial gain, and recreation both at sea and in freshwater, and farming of some species is successful. Salmonids are native to cool waters of the Northern Hemisphere, but several species have been transplanted outside their native ranges and a few now occur virtually worldwide.

B.1.g. Subfamily Coregoninae (Whitefishes). In North America, the name "whitefishes" applies to species in the subfamily Coregoninae. Whitefishes are found in Alaska in all river systems north of the Alaska Range, and the Copper, Susitna, and Alsek systems south of the Alaska Range. Eight to ten or more species are present in the region, with the number depending on how some forms are classified. Whitefishes of arctic Alaska include the inconnu, least cisco, Arctic cisco, Bering cisco, broad whitefish, and humpback whitefish.

Like Pacific salmons, some anadromous whitefishes show fidelity to their natal streams for spawning. Unlike Pacific salmons, whitefishes generally do not die after spawning and anadromous species do not spend most of their lives at sea. When at sea, anadromous whitefishes stay in estuarine coastal waters and do not make oceanic migrations.

Identifying whitefishes can be difficult. Hybridization among whitefishes is common and there are several hybrid studies for almost all pairs of whitefish crosses (citing e.g., Alt, 1971, Reist et al., 1992). Hybridization is believed not to result from intergeneric pairing but to occur when species spawn at the same time and in the same place, simultaneously broadcasting their reproductive products (gametes). Presence of hybrids can pose a challenge when attempting to identify species.

B.1.h. Subfamily Salmoninae (Trouts, Salmons, and Chars). The subfamily Salmoninae comprises seven extant genera and at least 30 species of trouts, salmons, and chars. A conservative classification of the forms found in Alaska recognizes 13 species in three genera. Salmonines of arctic Alaska include Arctic char, Dolly Varden, pink salmon, coho salmon, chinook salmon, chum salmon, and sockeye salmon.

Salmonines exhibit remarkable variation in sexual dimorphism, coloration, life history, and adaptability to local conditions. Like other salmonids, trouts and salmons inhabit freshwater or spend variable amounts of time at sea and migrate to freshwater to spawn. Pacific salmon, genus *Oncorhynchus*, spend most of their lives at sea and return to fresh water only to spawn. They migrate back to the same streams in which they hatched. During their ocean stay they undertake extensive migrations and are epipelagic, although some stocks can be found deep, to 200 meters (m) or more. Some populations of anadromous chars, genus *Salvelinus*, move between the sea and freshwater for other than reproductive purposes, and at sea generally stay close to shore and avoid high-salinity water.

B.1.i. Myctophidae (Lanternfishes). Lanternfishes, also called lampfishes or myctophids, have relatively large eyes and numerous discrete, round photophores which produce gold, orange, blue, green, red, and other colors of light. The photophores each having a light gland, reflecting layer, and lens, are arranged in distinct groups. Many species also have other luminous tissue, including glands on the caudal peduncle, organs around the eyes, patches on various parts of the body, and minute secondary photophores associated with each scale. Each species has its own photophore pattern. The location and number of photophores are critical for identifying the species. Some species have additional luminous organs but they are not always evident.

Myctophids are found in all oceans from near the surface to moderately great depths and occur in such tremendous schools their extent is measured in miles. Most species occur shallower than 1,000 m, and most migrate toward the surface at night to feed on plankton. They are the most speciose family of mesopleagic fishes, with about 235 valid species. Eight species occur in Alaskan water, primarily in the southern Bering Sea, Pacific Ocean south of the Aleutian Islands, and Gulf of Alaska, as well known from occasional to numerous catches. The glacier lanternfish is the only arctic lanternfish species in Alaska. Its presence in the region is substantiated by only one or two records.

In many regions of the world, including the basin waters of the Bering Sea and the Gulf of Alaska, the number of myctophids in each midwater-trawl catch far outnumbers species of other mesopelagic families. They are a potentially important commercial resource but, because of processing difficulties and low market price related to their small size, short duration of storage, presence of photophores, and a black film in the abdominal cavity, they currently are not heavily exploited.

Myctophids are important food for squids, larger fishes, and marine mammals, and constitute a critical part of the ocean ecosystem as they convert plankton to food for the next higher trophic level.

B.1.j. Gadidae (Cods). Cods are marine fishes except for the burbot, *Lota lota*, which exclusively inhabits fresh water. Most cod species inhabit continental shelves at coldwater latitudes in the North Atlantic Ocean. Relatively few are distributed in the Arctic and Pacific oceans. The family includes about 30 species with 9 occurring in Alaska. Walleye pollock and Pacific cod are the most abundant marine species in Alaska and are commercially important, while saffron cod, Pacific tomcod, and Arctic cod, are next abundant and sought by subsistence fishers. Burbot are sought by subsistence fishers but are not the target of a commercial fishery in Alaska, as they are in Russia. The presence of three Arctic marine cod species in Alaska is known from only one or a few records each: polar cod, collected northeast of Point Barrow in 1977; toothed cod; and ogac, recorded from the Alaskan sector of the Beaufort Sea in previous publications (e.g., citing Walters, 1955). Presence of ogac near Alaska in western Arctic Canada is well documented (e.g., citing Hunter et al., 1984), but vouchers are needed from Alaska.

B.1.k. Gasterosteidae (Sticklebacks). Sticklebacks inhabit coastal marine and freshwaters of the Northern Hemisphere, primarily in temperate to subarctic regions. There are marine, anadromous, and freshwater forms, and some species have both anadromous and strictly freshwater populations.

Although more than 60 species of sticklebacks have been described, less than a dozen, with some of them in "species complexes," are now considered valid. Their interesting behaviors, including nest building and guarding of eggs and fry by the males, wide range of salinity tolerance, phenotypic responsiveness to environmental factors, and recently evolved genetic diversity have made them famous among scientists, who have made sticklebacks the subject of several books and thousands of research papers. Recent studies indicate reproductive isolation may be established in some sympatric forms, and species-level differences are being suggested for some of them.

Two species occur in Alaska; the threespine stickleback and the ninespine stickleback. Both species are widely distributed in the State, except that the threespine stickleback is rarely found north of the Bristol Bay region or far inland, and the ninespine stickleback has not been recorded from southern Alaska east of the Kenai Peninsula.

B.1.l. Hexagrammidae (Greenlings). The family Hexagrammidae is a small group of marine scorpaeniform bottom fishes that is endemic to the North Pacific. Comprising four or five genera with 9-11 species, depending on classification employed, the family is the most speciose of the families occurring only in the North Pacific. Seven species of greenling occur in Alaska; however, the whitespotted greenling, has been found in the Chukchi and Beaufort seas. All of the greenlings are reported to have good flavor, but only lingcod and Atka mackerel are commercially important species.

B.1.m. Cottidae (Sculpins). The Cottidae are the largest family of sculpins, with, worldwide, about 70 genera and 300 species. They are primarily demersal inhabitants of cold, northern, marine coastal waters, with relatively few representatives in freshwater or, as adults, in offshore deepwater. Whereas the juveniles and adults are benthic, the larvae are planktonic and sometimes are found farther offshore. A few species are edible and good eating such as the Irish lords, genus *Hemilepidotus*, but they are not commercially important. For general discussion, these sculpins are called cottids to avoid confusion with other sculpins of the superfamily Cottoidea. Mecklenburg, Mecklenburg, and Thorsteinson (2002) include accounts of 87 cottid species in 35 genera. Cottids of arctic Alaska include the ribbed sculpin, butterfly sculpin, yellow Irish lord, spatulate sculpin, twohorn sculpin, Arctic staghorn sculpin, coastrange sculpin, antlered sculpin, belligerent sculpin, fourhorn sculpin, shorthorn sculpin, Arctic sculpin, plain sculpin, brightbelly sculpin, spinyhook sculpin, hamecon, hookhorn sculpin, and Okhotsk hookear sculpin.

B.1.n. Hemitripteridae (Sailfin Sculpins). The family Hemitripteridae comprises eight species of demersal marine fishes, which are closely related to and classified with the Cottidae in the superfamily Cottoidea. Seven hemitripterid species occur in Alaska and other regions of the North Pacific; two of these species, the crested sculpin and eyeshade sculpin, occur in arctic Alaska.

B.1.o. Psychroloutidae (Fathead Sculpins). The family Psychrolutidae includes about 30 species of loose-skinned, demersal marine cottoid fishes called fathead, soft, or blob sculpins. Their tadpole shape and movable skin over a clear, gelatinous layer gives them the general appearance of snailfishes (family Liparidae), except for lacking a pelvic disk. They are widely distributed in temperate to arctic regions from inshore shallow waters to depth as great as 2,800 m. Eight or nine species, possibly more, occur in Alaskan waters. Two of the described species may be synonymous, and there may be additional, undescribed species. The smoothcheek sculpin is documented occurring in the Chukchi Sea; whereas the Sadko sculpin is documented from the Beaufort Sea.

B.1.p. Agonidae (Poachers). Poachers are bottom-dwelling cottoid fishes with bodies completely covered by bony plates. The plates give poachers the appearance of being covered in alligator-like skin, for which some species are called alligatorfishes. The family occurs primarily in the North Pacific Ocean north of Japan and northern Mexico, the Bering Sea, and the Arctic Ocean. Poachers usually are found at moderate depths but occupy a wide range of habitats from tidepools to the continental slope at depths to nearly 1300 m. In the most recent revision of poacher taxonomy (citing Kanayama, 1991), the family comprises four subfamilies with 20 genera and 45 species. Twenty-two species occur and are well documented in Alaska, and one other has been reported but not confirmed in Alaska.

Of the 25 species in Mecklenburg, Mecklenburg, and Thorsteinson (2002), 12 are relatively abundant (with known range represented by solid black fill on their maps) off the coasts of Alaska, while 10 are less common or rare (records represented by dots) in the region. The fourhorn poacher, tubenose poacher, Bering poacher, Atlantic poacher, verteran poacher, Arctic alligatorfish, and alligatorfish are documented occurring in the Beaufort Sea, the Chukchi Sea, or both.

B.1.q. Cyclopteridae (Lumpsuckers). Lumpsuckers inhabit cold marine waters of the Northern Hemisphere. Most species live on the bottom on the continental shelf, while a few occur pelagically in deeper waters. Lumpsuckers occur from the Arctic Ocean to Puget Sound in the eastern Pacific and to the Koreas in the western Pacific.

The most recent revision to the family (citing Ueno, 1970) included 7 genera and 27 species. Mecklenburg, Mecklenburg, and Mecklenburg (2002) include accounts for 13 species. The occurrence of 10 species in Alaska has been confirmed; 3 others, known to be present in adjacent waters probably also occur in Alaska. The leatherfin lumpsucker occurs in the Beaufort Sea, whereas the pimpled lumpsucker occurs in the Chukchi Sea.

Pelagic lumpsuckers, like the smooth lumpsucker, *Aptocyclus ventricosus*, and Soldatov's lumpsucker, *Eumicrotremus soldatovi*, undergo extensive migration to reach their coastal spawning grounds (citing Il'inskii and Radcehnko, 1992, Orlov, 1994). Female lumpsuckers lay their eggs in a sticky, spongy mass on rocks and seaweed or in mollusk shells, and in some species the male guards the eggs.

Lumpsuckers exhibit considerable (morphological) variation with species. Sexes can be greatly different; for example, in some species the males may develop armor but not the females, and coloration can be different. There also may be great variability among individuals of a given age. Finally, lumpsuckers can inflate themselves, and this greatly changes their appearance.

B.1.r. Liparidae (Snailfishes). Snailfishes are marine cottid fishes that typically are tadpole-shaped, soft, and covered with gelatinous tissue. They are closely related to the lumpsuckers (Cyclopteridae), and like them, many snailfishes have a ventral sucking disk derived from the pelvic fins with which they attach themselves to rocks, algae, and other objects.

Snailfishes are distributed through a wide range of cold and temperate marine habitats from tidepools to depths of almost 8 km. Most species pursue benthic lifestyles, while relatively few are pelagic or benthopelagic. They have a bipolar distribution pattern, with more than half of the family's roughly 200 currently recognized species occurring in the Northern Hemisphere. The Liparidae are the richest and taxonomically most complex fauna in the North Pacific, which is generally considered to be the region of origin for this family. There are 56 liparid species known to occur in Alaska and 7 more have been reported from Alaska, but with some uncertainty, or are included from adjacent waters, making a total of 63 species—nearly a third of the world's total-addressed in Mecklenburg, Mecklenburg, and Thorsteinson (2002). Five species of snailfishes, genus *Liparis*, occur in arctic Alaska—the variegated snailfish, kelp snailfish, Bristol snailfish, gelatinous seasnail, and spotted snailfish.

Deepwater snailfishes, as well as eelpouts (family Zoarcidae), are different from most fishes because their eggs and larvae are more likely to develop at the same depths as inhabited by the adults. The eggs and larvae of most other fishes are produced in the surface waters, and maturing adults of deepwater species descend as they grow to maturity. This suggests that deep basins, submarine canyons, and other physiographic features could restrict distribution of deepwater snailfishes (and eelpouts). Opportunities for dispersion of deepwater *Careproctus* and *Paraliparis* are limited when compared to species of *Liparis* having planktonic larvae (citing Andriashev, 1990). At least one species of *Liparis* lays its eggs in scallops.

The horizontal distribution of many of the deepwater benthic species in Alaskan waters is unknown. Benthic snailfishes inhabiting shallow water, less than 200 m, generally are widespread in their geographic area of inhabitance, to the extent of limitations imposed by temperature or wide stretches of deepwater.

B.1.s. Zoarcidae (Eelpouts). Eelpouts are elongate, tapering fishes that inhabit the continental shelves to the abyss in tropical to polar seas and are found mostly on mud bottoms at moderate to great depths. They primarily are species of the North Pacific, North Atlantic, and Arctic oceans, although some are known from the Southern Hemisphere, including the Southern Ocean. Some of the benthic species, including those in the genus *Lycodes*, bury themselves in the mud tail first. A few eelpouts lead a midwater existence. Like deepwater snailfishes (family Liparidae), eelpouts produce their eggs and larvae at the same depths the adults inhabit and larvae are rarely collected in plankton nets. The juveniles of some bottom-dwelling eelpouts inhabit midwater.

In the most recent worldwide review of the family Zoarcidae (citing Anderson, 1994), about 200 valid species were recognized. Several new eelpout species have been described since that review, and others have been collected but not yet named. Many eelpouts are deep sea forms known from only a few specimens, and the taxonomy of some others is confused due to inaccurate descriptions and reliance on misunderstood or questionably useful characters. Fifty-eight of the species currently recognized as distinct species are treated by Mecklenburg, Mecklenburg, and Thorsteinson (2002). The taxonomy of some of them may change as knowledge of the group increases.

Gymnelus species inhabit continental shelf bottoms. Species known in Alaska inhabit the shallowest water areas from the intertidal to depths usually not greater than 80 m. *Lycodes* is the most speciose genus of eelpouts in Alaska and nearby waters, with 23 species included in Mecklenburg, Mecklenburg, and Thorsteinson (2002). *Lycodes* inhabit soft bottoms, mostly mud, at shallow to moderate depths on the continental shelf and upper slope. None inhabits the intertidal area, and not many frequent depths greater than about 400 m. *Lycodes* is the only eelpout genus other than *Gymnelus* to occur in the Arctic Ocean off Alaska. Eelpouts occurring in arctic Alaska include halfbarred pout, fish doctor, longear eelpout, saddled eelpout, estuarine eelpout, polar eelpout, marbled eelpout, threespot eelpout, archer eelpout, wattled eelpout, pale eelpout, scalebelly eelpout, doubleline eelpout, and ebony eelpout.

Range statements and maps for several similar-looking species of *Lycodes* may reflect taxonomic confusion and paucity of confirmed records. For example, it is odd that there are no records of shulupaoluk, from the Beaufort Sea off Alaska, and only one or a few records of threespot eelpout and saddled eelpout, whereas all of those species are represented by several records from Canada close to Alaska near Herschel Island and along the Mackenzie Delta.

B.1.t. Stichaeidae (Pricklebacks). Pricklebacks are elongate, compressed, slightly eel-like fishes of the Northern Hemisphere. They occur primarily in the North Pacific Ocean, with a few inhabiting the Arctic and North Atlantic oceans. Pricklebacks live on the bottom in a variety of habitats from shallow subtidal and intertidal areas to rocky reefs or gently sloping sandy or muddy seafloors. Comprising about 54 species, the family is represented by at least 23 species in Alaska. Pricklebacks of arctic Alaska include fourline snakeblenny, Arctic shanny, bearded warbonnet, daubed shanny, stout eelblenny, and slender eelblenny.

B.1.u. Pholidae (Gunnels). Gunnels are elongate, compressed, eel-like fishes of the littoral zone which, like some pricklebacks (family Stichaeidae), are often found under rocks or in tidepools. About 15 species of gunnels are known, and most of them are found only in the North Pacific. At least five species occur in Alaska, primarily along the southern shores of the State. Although five gunnel species occur in Alaska, only one species is documented occurring in the Chukchi Sea—the banded gunnel.

B.1.v. Anarhichadidae (Wolffishes). Wolffishes are elongate, carnivorous, demersal inhabitants of shallow to moderately deep waters of the North Pacific and North Atlantic oceans. Most of them feed primarily on hard-shelled benthic prey. Like most other marine carnivorous fishes, wolffishes typically occur as solitary individuals or in small groups, not in large schools. The wolffish family includes six species, two of them well known in Alaska.

The Bering wolffish, *Anarhichas orientalis*, inhabits boulder-strewn, sandy and pebbly bottoms along both Asiatic and American shores and in Alaska is known from the northcentral Gulf of Alaska through the Bering Sea and into the Arctic; it is a good food fish and historically was sough by Natives of western Alaska.

The northern wolffish, *Anarhichas denticulatus*, is a benthopelagic inhabitant of deeper waters, primarily of the North Atlantic where it is often taken as bycatch in the halibut fishery. It was listed from arctic Alaska (citing Wilimovsky, 1958). There was a record of the northern wolffish from the Canadian high Arctic not far from Alaska at Mould Bay (citing Walters, 1953b) and, since then, a specimen from the Amundsen Gulf area of the Canadian sector of the Beaufort Sea has been tentatively identified as belonging to this species (citing Smith, 1977). Northern wolffish have a diet that includes prey with relatively weak shells and tough skins such as crabs, sea urchins, and spiny lumpsuckers (family Cyclopteridae).

B.1.w. Ammodytidae (Sand Lances). Sand lances, including about 18 species in five or six genera, inhabit the Arctic, Pacific, Atlantic, and Indian oceans. The Pacific sand lance, *Ammodytes hexapterus*, occurs throughout the coastal marine waters of Alaska.

Sand lances occur in enormous schools containing millions of fish and are important as feed for other fishes, birds, and sea mammals. Adult sand lances typically occur in shallow water but can be found far from shore. When not schooling, they dive into the sand head first, aided by the pointed lower jaw, and come to rest with only the head protruding. Sometimes they are found buried in sandy beaches after the tide recedes.

B.1.x. Pleuronectidae (Righteye Flounders). In the Pleuronectidae, the eyes and color are almost always on the right side of the body. The left side is the blind side, which faces or rests on the seafloor. This family includes flounders, soles, turbots, dabs, and plaice. None of these names is restricted to any one taxonomic group, and the names are often used interchangeably for the same species. Most righteye flounders inhabit cold seas. A few occur in the tropics or in brackish and freshwaters. The family is represented in Alaska by 26 species. Righteye flounders occurring in arctic Alaska include the Pacific halibut, Bering flounder, Greenland halibut, starry flounder, Alaska plaice, Arctic flounder, longhead dab, yellowfin sole, and Sakhalin sole.

B.2. Selected Accounts of Better Known Arctic Fish Species.

B.2.a. Pacific Herring (*Clupea pallasii*) (Family Clupeidae; Herrings).

B.2.a(1) Distribution. Pacific herring migrate in schools and are found along both shores of the ocean, ranging from San Diego Bay to the Bering Sea and Japan. Pacific herring are not particularly abundant along the northern Chukchi and Beaufort coasts (Fechhelm et al., 1984). The bulk of the Pacific herring populations lies south of the Bering Strait, and the density of the Chukchi Sea is too low to develop a commercial fishery. Pacific herring occur in coastal waters of the northeastern Chukchi Sea (Fechhelm, et al., 1984) and southeastern Beaufort Sea in summer (Lawrence, Lacho, and Davies, 1984).

B.2.a(2) Abundance, Demography, and Population Trends. Fechhelm et al. (1984) found Pacific herring ranked fifth in abundance among all fish caught at Point Lay.

B.2.a(3) Life History and Important Habitat Areas. Pacific herring in Alaska move offshore in winter and onshore in spring for spawning. Spawning is observed in the eastern Bering Sea during May and June. Pacific herring spawn in high-energy, nearshore environments, depositing eggs on vegetation or on bottom substrate that is free from silting. There was some evidence by gonadal weights and egg sizes that herring may have spawned in Kasegaluk Lagoon in early summer of 1983; however, no trace of young-of-the-year herring was found throughout the end of the summer although young fish may have been too small for the sampling gear to have been effective or the young fish may have moved offshore from where sampling was conducted (Fechhelm et al., 1984).

Pacific herring spawning in the Mackenzie River estuary (and eastward) do so under the ice of early June to early July (Lawrence, Lacho, and Davies, 1984). Pacific herring were found to be abundant and widespread in coastal waters of the southeastern Beaufort Sea in August, and were most abundant during September. Juvenile herring were collected in September.

The eggs are adhesive, and survival is better for those eggs that stick to intertidal vegetation than for those that fall to the bottom. Milt released by the males drifts among the eggs and fertilizes them. Eggs hatch in about 2 weeks, depending on the temperature of the water.

Herring spawn every year after reaching sexual maturity at 3 or 4 years of age. The number of eggs varies with the age of the fish and averages 20,000 annually. Average life span for these fish is about 8 years in Southeast Alaska and up to 16 years in the Bering Sea.

Mortality of the eggs is high. Eggs may be lost as a result of tidal fluctuations. Young larvae drift and swim with the ocean currents and are preyed on extensively by other vertebrate and invertebrate predators. Following metamorphosis of the larvae to the juvenile form, they rear in sheltered bays and inlets and appear to remain segregated from adult populations until they are mature.

Herring are located in distinctly different ecosystems during different periods of the year. After spawning, most adults leave inshore waters and move offshore to feed primarily on zooplankton such as copepods and other crustaceans. They are seasonal feeders and accumulate fat reserves for periods of relative inactivity. Herring schools often follow a diel vertical migration pattern, spending daylight hours near the bottom and moving upward during the evening to feed.

B.2.a(4) Prey and Predators. Pacific herring collected at Point Lay were found to have consumed primarily mysids and, to a lesser extent, fish (Fechhelm et al. 1984). Opportunistic feeding patterns were evident when the diets of fish caught on the seaward side of the barrier islands were compared with those netted in the lower reaches of the Kokolik River. Calanoid copepods were prevalent in the river-caught fish, whereas mysids were the dominant prey in ocean-caught herring.

Pacific herring are preyed upon by a wide variety of marine fishes, birds, and marine mammals.

B.2.b. Capelin (*Mallotus villosus*) (Family Osmeridae; Smelts).

B.2.b(1) Distribution. Capelin has a circumpolar distribution and can be found in the northern regions of the Atlantic and the Pacific oceans. Off Alaska, capelin populations inhabit the Beaufort Sea, Chukchi Sea, Bering Sea, and Gulf of Alaska. The spatial distribution of capelin is poorly known along the northeastern Chukchi Sea. In coastal waters of the Beaufort Sea, Thorsteinson, Jarvela, and Hale (1991) found capelin nearly 8 km from the coast, but most were collected within 4 km at depths of less than 3 m. Capelin appeared most abundant at stations sampled along Collinson Point, Endicott, and West Dock. They also were common but less abundant in other coastal areas, where the net swept most of the water column. The average fish was determined probably to be yearling fish, although several smaller capelin could have been young-of-the-year fish.

B.2.b(2) Abundance, Demography, and Population Trends. Jarvela and Thorsteinson (1999) sampled epipelagic fishes in coastal waters of the Alaskan Beaufort Sea in the summers of 1988, 1990, and 1991. Arctic cod, capelin, and snailfishes were the most abundant marine fishes caught in their surveys. Noteworthy in their findings of capelin are: (1) a few large catches of capelin (and Arctic cod) during the late period constituted most of the annual catch in each year; (2) the species most aggregated of the fishes sampled; CPUE's in the west sector were larger than those in the east sector in all years; (3) differences appeared greater during heavy ice years (i.e., 1988 and 1991) than in the open-water year (i.e., 1990); and (4) age-0 capelin dominated marine fish catches in 1988 and 1991.

Fechhelm et al. (1984) reported capelin as the second most abundant species collected during their Point Lay summer study, where all but 2 of 3,360 specimens were taken within a 3-day period in early August.

B.2.b(3) Life History and Important Habitat Areas. Capelin spawn on beaches or in deeper water and are highly specific with regard to spawning conditions (Jangaard, 1974). Capelin generally prefer smooth sand and gravel beaches for spawning; they move up on the beach as far as possible, and then settle in one spot as the wave recedes, where spawning pairs scoop out a slight hollow in soft sand. They then spawn in the depression and, after separating, may attempt to return to the sea. Such spawning activity is brief, reportedly lasting less than 5 seconds (Jangaard, 1974). Capelin populations spawning elsewhere in the Arctic Ocean (e.g., the Barents Sea) spawn in March and April at depths of 10-70 m, although quantities of eggs have been found as deep as 175 m (Jangaard, 1974). In Iceland, capelin spawn in deeper water from March to June. Spawning in Greenland takes place in shallow water in fjords (Jangaard, 1974).

Little specific information is available on the life history, spawning, and habitat areas of capelin in northern Alaska. Capelin have been anecdotally reported spawning from early to mid-July along the sandy seaward beaches of barrier islands. On August 1-3, 1983, 3,358 capelin caught off Point Lay were apparently part of a spawning population (Fechhelm et al., 1984). Only two more capelin were caught during the rest of their study. Spawning may have been restricted to the seaward shoreline of the barrier island at Point Lay, as no capelin were taken in Kasegaluk Lagoon (Fechhelm et al., 1984). Near Point Barrow, capelin spawn in late July and August and are captured with hand nets by local residents for food (Bendock, 1977). Bendock (1977) only captured capelin during a 2-week period in mid-August, when spawning took place within the surf along exposed gravel beaches. Beaufort Sea coastal waters appear to be an important nursery area for age-0 capelin throughout the summer, whereas older fish seem to be present for comparatively brief periods during spawning runs (Jarvela and Thorsteinson, 1999).

At spawning grounds, capelin are segregated into schools of different sexes (Jangaard, 1974). The general pattern in Newfoundland seems to be that ripe males await opportunities to spawn near the beaches, while large schools, mainly composed of relatively inactive females, remain for several weeks off the beaches in slightly deeper water. As these females ripen, individuals proceed to the beaches to spawn. Thus, most males remain in attendance near the beaches and join successive small groups of females that spawn and depart from the area (Jangaard, 1974, citing Templeman, 1948).

During and following the spawning season, large numbers of dead capelin can be observed floating on the surface or stranded on the beach (Jangaard 1974). Hence, giving the impression that capelin are one-time spawners, however, spent fish in prime feeding condition have been caught at least a month postspawning (Jangaard, 1974, citing Winters 1969). Because of the great predominance of a single age-group (usually 3 year olds) in the spawning schools, Jangaard (1974) assumed that the overwhelming majority of capelin die after spawning, citing that most of the dead fish stranded on beaches are males.

Capelin eggs are demersal and attach to gravel on the beach or on the sea bottom (Jangaard, 1974). The incubation period varies with temperature, and hatching has been demonstrated to occur in about 55 days at 0 °C, 30 days at 5 °C, and 15 days at 10 °C (Jangaard, 1974, citing Jeffers 1931). Newly hatched larvae soon assume a pelagic existence near the surface, where they remain until winter cooling sets in, when they move closer to the sea bottom until waters warm again in spring.

Most capelin growth occurs during the second and third years of their lives. The availability of food, water temperatures, etc. can have a considerable effect on the size of mature specimens (Jangaard, 1974, citing Pitt 1958b; Prokhorov, 1965). Fechhelm et al. (1984) reported that capelin mature at an earlier age than almost any other fish species in the Arctic (presumably they are referring to the Alaskan Arctic). They found that the spawning population at Point Lay consisted almost entirely (94%) of Age 2 fish (otolith-based age), with the remaining 6% being Age 3. All but one male and one female were mature. In the Bering Sea, both age classes spawn, with 3 year olds being the most prevalent (Fechhelm et al., 1984, citing Paulke 1983). Elsewhere in the Arctic, a few capelin mature and spawn at 2 years of age, but it is not until the third year that mass (cohort) maturation occurs (Jangaard, 1974); hence, age at maturation appears to be a geographic characteristic. For example, 3- and 4-year old fish dominate the spawning schools of both Newfoundland and Barents Sea populations.

Thorsteinson, Jarvela, and Hale (1991) observed small differences in size of capelin, with distance captured from the Beaufort Sea coast. Fish captured within 2 km had average lengths of 67.0 millimeters (mm).

Between 2 and 5 km, the average length was 63.2 mm. Farther offshore at distances of between 5 and 8 km of the coast, the mean capelin size was 73.8 mm.

A trend of decreasing size with time was also observed (Thorsteinson, Jarvela, and Hale 1991). The length of capelin reported prior to August 15 average 70.8 mm. During the second half of August, the mean length decreased to 66.1 mm, and by early September it was 63.0 mm. For contrast, Fechhelm et al. (1984) reported Age 2 females (i.e., of spawning age) averaged 123.1 mm compared to 134.7 mm for males. The only Age 3 fish collected were a 133-mm female and two males, 147 and 152 mm.

B.2.b(4) Prey and Predators. Feeding activity in capelin is highly seasonal (Jangaard, 1974). Feeding intensity increases in the prespawning season in late winter and early spring but declines with the onset of spawning migration. Feeding ceases altogether during spawning season. Survivors of spawning resume feeding several weeks postspawning, and proceed at high intensity until early winter when it ceases. Stomach-content analysis revealed that capelin caught in nearshore waters of the northeastern Chukchi Sea consumed mysids (Fechhelm et al., 1984).

Capelin are important prey for other fish (e.g., cod, haddock, salmon, herring), marine mammals, and sea birds.

B.2.c. Arctic Cisco (*Coregonus autumnalis*) (Family Salmonidae/Coregoninae; Whitefishes).

B.2.c(1) Distribution. The arctic cisco is an anadromous species and occurs from Point Barrow, Alaska eastward to the Murchison River, Northwest Territories, Canada (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). They ascend the Mackenzie River (Canada) to Fort Simpson. Arctic cisco also occur in Arctic Siberia to the White Sea. In the western Beaufort, arctic cisco are anadromous, although there are landlocked, freshwater populations in rivers and lakes of the North Slope.

B.2.c(2) Abundance, Demography, and Population Trends. The Colville River is the only system west of the Mackenzie River that can support substantial overwintering populations of subadult and adult arctic cisco (Gallaway and Fechhelm, 2000). Moulton (1997) estimated that the number of arctic cisco greater than 250 mm that overwinter in the Colville system fluctuates between 200,000 and more than 1 million fish.

B.2.c(3) Life History and Important Habitat Areas. Arctic cisco found in the Alaskan Beaufort Sea are believed to originate from spawning grounds in the Mackenzie River system of Canada (Gallaway and Fechhelm, 2000, citing Gallaway et al., 1983, 1989). In spring, newly hatched young-of-the-year (age 0) are flushed downriver into ice-free coastal waters adjacent to the Mackenzie Delta. Some young-of-the-year are transported westward to Alaska by wind-driven coastal currents (Gallaway and Fechhelm, 2000). In summers with strong and persistent east winds, enhanced westward transport can carry fish to Alaska's Colville River until the onset of sexual maturity beginning at about age 7, at which point they migrate back to the Mackenzie River to spawn.

The Sagavanirktok River, 100 km east of the Colville River, is the third-largest Beaufort Sea drainage and, although it contains far less overwintering habitat than the Colville system, it does appear capable of supporting newly recruited, young-of-the-year fish for several years (Gallaway and Fechhelm, 2000). However, these juveniles eventually disappear from the Sagavanirktok system, typically by age 3. Although their fate is unknown, some fish probably survive by finding their way to the Colville River.

The meteorologically driven recruitment process plays a major role in determining the age structure of arctic cisco populations in Alaska (Gallaway and Fechhelm, 2000). Summers of strong, persistent east winds are associated with strong year-classes in the Colville/Sagavanirktok region. In contrast, few young-of-the-year fish arrive in central Alaska in years of weak east winds and correspondingly poor westward transport. The Alaskan arctic cisco population are, thus, characterized by strong and weak year-classes, the patterns of which are determined largely by summer wind patterns.

As a general rule, if there is no recruitment of young-of-the-year to the Colville/Sagavanirktok region, there is no appreciable recruitment of that year class (i.e., age cohort) in following summers (Gallaway and Fechhelm, 2000). If young-of-the-year fish are not transported far enough west in their first summer to overwinter in the Colville or Sagavanirktok rivers, they are forced to overwinter in mountain streams [to the east], where relatively few may survive.

Seasonal abundance of arctic cisco in Beaufort Sea coastal waters is a function of the fishes' foraging range during the open-water season (Gallaway and Fechhelm, 2000). Summer studies conducted along the coast [between the Mackenzie and Colville rivers] report collecting substantial numbers of large cisco. This coastwide distribution implies extensive dispersal from overwintering grounds. The ability to traverse large distances along the coast also is consistent with the premise that adults from the Colville River eventually migrate more than 600 km back to the Mackenzie River to spawn. The summer coastal dispersal of juvenile Arctic cisco is more localized around their overwintering drainages, perhaps because juveniles are too small to range as far as adults.

B.3. Prey and Predators.

B.3.a. Least cisco (*Coregonus sardinella*) (Family Salmonidae/Coregoninae; Whitefishes).

B.3.a(1) Distribution. The least cisco is an anadromous species and occurs in coastal and some freshwaters along the Alaskan coast from Bristol Bay north and eastward along the Arctic coast to Bathhurst Inlet and Cambridge Bay, Canada (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). It occurs in most streams and lakes north of the Alaska Range, in the Mackenzie River to Fort Simpson, and throughout the Yukon and Kuskokwim drainages. West of Alaska, least cisco is distributed in Russia from the Bering Strait northward along the Arctic coast of Siberia to the White Sea.

The least cisco has a discontinuous coastal Beaufort Sea distribution (Gallaway and Fechhelm, 2000). Western populations are associated with the Colville River and smaller tundra rivers to the west; eastern populations are associated primarily with the Mackenzie River drainage. The vast distance between these freshwater systems apparently isolates the two populations from each other.

B.3.a(2) Abundance, Demography, and Population Trends. There are population estimates for least cisco based upon Prudhoe Bay studies (1981-1996), as well as estimates from studies of the Colville River commercial fishery (Gallaway and Fechhelm, 2000). Population estimates for harvestable adult least cisco indicate "a generally stable population level between 200 and 400 thousand fish" (Gallaway and Fechhelm, 2000, citing Moulton, 1997).

B.3.a(3) Life History and Important Habitat Areas. Little is known about the westward dispersal of Colville River least cisco during summer, but adult fish that disperse eastward are known to travel considerable distances down the coast (Gallaway and Fechhelm, 2000). Substantial numbers of large least cisco are collected in the Prudhoe Bay/Sagavanirktok Delta region, and high abundance also has been found in Foggy Island Bay and as far as Mikkelsen Bay about 120 km east of the Colville River. Relatively few large least cisco reach Camden Bay about 200 km east of the Colville River.

The eastward dispersal distance of juvenile least cisco during summer is roughly half that of adults and appears to be a function of wind-driven coastal currents (Gallaway and Fechhelm, 2000). In summers of substantial west winds, large numbers of juvenile least cisco are collected in the Prudhoe Bay/Sagavanirktok Delta region. In years that lack substantial July west-wind events, few small least cisco reach the eastern end of Simpson Lagoon.

B.3.b. Broad Whitefish (*Coregonus nasus*) (Family Salmonidae/Coregoninae; Whitefishes).

B.3.b(1) Distribution The broad whitefish is an anadromous fish that occurs in drainages of the Alaskan Beaufort, Chukchi, and Bering seas to Kuskokwim Bay (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). In Canada, it occurs eastward to Perry River, Nunavut. In Russia, it occurs westward across Siberia to Pechora River, south to Korfa Bay, and to Pehzhina River on the Sea of Okhotsk.

The broad whitefish has two population centers in the Beaufort Sea region-the Colville River and adjacent coastal plain, and the Mackenzie River drainage (Gallaway and Fechhelm, 2000). The Sagavanirktok River supports a spawning and overwintering population of broad whitefish.

B.3.b(2) Abundance, Demography, and Population Trends. The broad whitefish population of the Sagavanirktok River fluctuates considerably in size (Gallaway and Fechhelm, 2000). During 9 years of continuous study, 1988-1996, population estimates for small fish based on mark-recapture data have ranged from 150,000 to more than 400,000 individuals, with the peak estimates occurring in 1990 and 1995. Gallaway et al. (1997) hypothesized that this pattern may reflect density-dependent responses to the limited overwintering area available to the fish. The population also may be affected by variations in the severity of individual winters, with milder winters having more overwintering space, thinner ice cover, and greater survivability.

B.3.b(3) Life History and Important Habitat Areas. Young fish (age 2 and younger) from the Sagavanirktok River population tend to remain near the low-salinity waters of the delta throughout much of the open-water season (Gallaway and Fechhelm, 2000). There has been speculation that salinity intolerance may be the reason for this limited summer distribution. Older broad whitefish (age 3 and older) disperse farther from their natal rivers, regularly moving between the Sagvanirktok and Colville rivers through Simpson Lagoon. Broad whitefish catches reported for the eastern Alaskan Beaufort Sea have been nominal to nil.

B.3.c. Arctic cod (*Boreogadus saida*) (Family Gadidae).

B.3.c(1) Distribution. Arctic cod are one of the most abundant and widely distributed circumpolar fishes of the Arctic. Off Alaska, they occur from the northern Bering Sea into the Chukchi Sea and eastward well into the Canadian Beaufort Sea (e.g., Alverson and Wilimovsky, 1966; Quast, 1974; Wolotira, Sample, and Morin, 1977; Craig et al., 1982; Frost and Lowry, 1983; Cannon, Glass, and Prewitt, 1991; Crawford and Jorgenson, 1993; Welch et al. 1993; Gillispie et al., 1997; Hop, Welch, and Crawford, 1997; Wyllie-Echeverria, Barber, and Wyllie-Echeverria, 1997; Gradinger and Bluhm, 2004).

B.3.c(2) Abundance, Demography, and Population Trends. In general, abundance of Arctic cod is higher in arctic waters than in the more southerly Bering Sea (Wolotira, Sample, and Morin, 1977). Gillispie et al. (1997) reported most recently on the distribution and abundance of Arctic cod in the northeastern Chukchi Sea, based on benthic trawls conducted in late summer of 1990 and 1991. In 1990, Arctic cod were present at all 48 stations sampled and ranged in numbers from 10-120,000 fish/km^2. They tended to be most abundant in the southern part of the sampling area (i.e., off Point Hope). Of the six stations where abundance was greater than 50,000 fish/km^2, four occurred in Bering shelf water and two in Alaska coastal water. In 1991, Arctic cod were present at 16 of the 17 stations and their abundance ranged from 394-15,700 fish/km^2. As in 1990, they also tended to most abundant off Point Hope. However, fish were generally present in few numbers at each station in the sampling area; there were no stations in which abundance was greater than 50,000 fish/km^2. Females and males were about equally represented in age classes 1 and 2 in 1990 and 1991, whereas fish in age classes 3 and 4 primarily were females in both years.

Gillispie et al. (1997) contrasted their results with those reported by Wolotira, Sample, and Morin (1977) who conducted a study in the southeastern Chukchi Sea in 1976 using the same net type. They found that the biomass in Wolotira, Sample, and Morin's northernmost stratum was considerably lower than that found in the northeastern Chukchi Sea, where the average biomass was 25 times greater in 1990 and 5 times greater in 1991. Average biomass for Alaska coastal water was 15 times greater in 1990 and 7 times greater in 1991. Gillispie et al. (1997) noted that the differences between the two studies, separated by 13 years, may be the result of extreme interannual differences, and that interannual differences in abundance and biomass were evident in their study between 1990 and 1991. They further explained that time of year may have influenced the abundance and biomass, particularly so if an annual migration hypothesis (i.e., fish move northward every spring and summer with the receding ice edge from the northern Bering Sea and southward in the fall with the advancing ice edge; Lowry and Frost, 1981) is accurate. They noted that Arctic cod may find environmental conditions in warmer years in the Chukchi Sea to be more favorable than cold years for their growth and abundance.

B.3.c(3) Life History and Important Habitat Areas. Arctic cod appear to have the shortest life span (8 years maximum) of the northern cods (e.g., walleye pollock, Pacific cod, Greenland cod, saffron cod) (Gillispie et al., 1997). Growth rates vary by area and by year (Lowry and Frost, 1981). Arctic cod exhibit the following life history traits: small body size, relatively short life span, early maturity, rapid growth, and large numbers of offspring (Craig et al., 1982). Data reported by a number of studies (e.g., those referenced in this account) all support aspects of Craig et al. (1982) characterization of these traits.

Arctic cod in the Beaufort Sea probably first spawn at 3 years of age, based on size at age data, (Frost and Lowry, 1984). Spawning occurs sometime between late November and early February (Craig et al., 1982) and in some instances as late as March (Gillispie et al., 1997, citing Rass, 1968). In Russian waters, Arctic cod spawn in midwinter, usually from the end of December to early February (Craig et al., 1982, citing Moskalenko, 1964). In November, potential spawners were found distributed throughout Simpson Lagoon and at several nearshore and offshore locations between the Colville and Sagavanirktok rivers; under-ice water depths at these sites were 1-12 m except at one station located 175 km offshore where the water depth was 2500+ m (Craig et al., 1982). However, 1 ripe and 19 recently spawned-out cod taken in February were all in Stefansson Sound (Craig et al., 1982). In general, few Arctic cod (spawning or otherwise) were collected in February at sites other than Stefansson Sound, although this may have been due to gear bias. Aronovich et al. (1975, as cited by Gillispie et al., 1997) found the incubation period of eggs could be prolonged by extended subzero winter water temperatures. An extended spawning and temperature-dependent development could lengthen the time period in which larval fish appear. Wyllie-Echeverria, Barber, and Wyllie-Echeverria (1997) sampled ichthyoplankton in the northeastern Chukchi Sea in 1989-1991 and caught larval Arctic cod in mid-July in 1991. Although Arctic cod are known to spawn in the winter under the ice, most of their spawning areas may be in nearshore waters (Craig et al., 1982), such as the one known in the nearshore waters of Stefansson Sound in the Beaufort Sea (Craig and Halderson, 1981). The warmer nearshore waters with more moderate salinity may be an essential nursery area for juvenile Arctic cod (Cannon, Glass, and Prewitt, 1991). It is reported that Arctic cod spawn only once (Nikolskii, 1961, as cited by Morrow, 1980).

Arctic cod young-of-the-year are normally found in the upper 50 m of water, in the same zone where the greatest abundance of their food (plankton) is found. Quast (1974) estimated that more than 46 million pounds of juvenile Arctic cod were present between Cape Lisburne and Icy Cape in 1970. They can also be found around ice (Andriyashev, 1970), which may provide shelter from predators and food in the form of ice-associated invertebrates (Gradinger and Bluhm, 2004). Arctic cod are often found around pressure ridges and rafted ice, where the undersurface of the ice is rough. Crevices, holes, caverns, and small ice cracks are commonly used. In many bottom trawls, adult Arctic cod are found in association with the bottom.

Migration patterns of Arctic cod in the region are essentially unknown. Lowry and Frost (1981) suggested that Arctic cod may move northward every spring and summer with the receding ice edge from the northern Bering Sea and southward in the fall with the advancing ice edge. Craig et al. (1982) noted that in late summer, some migrate into coastal waters. The large schools of fish that may form at this time have been described in the Russian literature as prespawning migrations toward coastal spawning areas. Welch, Crawford, and Hop (1993) reporting on Arctic cod in the Canadian High Arctic, noted in general, schools of Arctic cod tend to be found in bays and inlets where they pool in deep basins. When they occur on open coastlines or off points, they are moving along the shore in shallow water and end up in bays. Crawford and Jorgenson (1993) monitored aggregations of Arctic cod in a bay in the Canadian High Arctic and observed that when ice drifted into the bay, the schools of Arctic cod appeared to move under it. Later as the ice was leaving, the fish in the schools were found to be spread out, covering more area of the bay. They concluded that when under ice, Arctic cod become less aggregated and increased their nearest-neighbor distance.

Adults and juveniles are relatively abundant in both nearshore and neritic waters and contribute significantly to productivity in arctic coastal waters. The importance of nearshore habitat areas versus offshore habitat areas in the life cycle is still ambiguous. Juveniles occur in nearshore habitats such as Simpson Lagoon (Craig et al., 1982), but also commonly occur at least 50-150 km offshore in waters less than 100 m deep in summer (Lowry and Frost, 1981). Also, Arctic cod have been found to be more concentrated along the interface between the warmer nearshore water and colder marine water (Moulton and Tarbox, 1987; Cannon, Glass, and Prewitt, 1991). However, Gillispie et al. (1997) did not find a similar data trend relative to a transition layer, and suggested that Arctic cod may be more attracted to its food. It is possible that spawning and early life (larval) nursery areas are chiefly in nearshore waters, and that young cod rapidly expand their habitat use to include warm coastal waters and eventually offshore waters. It also may be that (a) young Arctic cod are relatively ubiquitous following their release in nearshore areas or that (b) spawning also occurs in neritic waters.

B.3.c(4) Prey and Predators. Food consumed vary both geographically and seasonally (Lowry and Frost, 1981). Copepods and amphipods are important prey of Arctic cod in offshore waters and while under ice (e.g., Craig et al., 1982; Frost and Lowry, 1984). Mysids were found to be the primary prey consumed of Arctic cod in nearshore waters of the Beaufort Sea (Bendock, 1979), but were a minor component in the stomach contents of fishes that Frost and Lowry (1984) examined from 40 m and deeper. Craig et al. (1982) noted that the dietary importance of the major groups of prey varied considerably among years; each was a major and minor dietary component at one time or another; they noted too that limited evidence indicates that Arctic cod prefer feeding on mysids rather than amphipods when both are available. Crawford and Jorgenson (1993) reported that aggregations of Arctic cod observed in a bay in the Canadian High Arctic were feeding primarily on amphipods, which were abundant. They noted that the distribution of loosely aggregated schools was patchy, and interpreted it to be a reflection of foraging behavior, where when foraging in open water, Arctic cod decreased their nearest-neighbor distance.

Arctic cod are a significant prey species in the diets of marine mammals, birds, and other fishes and, thus, have been described as a "key species in the ecosystem of the Arctic Ocean" (Quast, 1974; Craig et al., 1982). They are believed to be the most significant consumer of secondary production in the Alaskan Beaufort Sea (Frost and Lowry, 1983) and even to influence the distribution and movements of marine mammals and seabirds (Craig, 1984, citing Finley and Gibb, 1982).

B.3.d. Arctic Staghorn Sculpin (*Gymnocanthus tricuspis*) (Family Cottidae; Sculpins).

B.3.d(1) Distribution. The Arctic staghorn sculpin is a circumpolar species inhabiting continental shelves of the Arctic and subarctic oceans (Andriyashev, 1964). It is widespread in the Beaufort and Chukchi seas (Mecklenburg, Mecklenburg, and Thorsteinson, 2002) and reportedly common therein (Frost and Lowry, 1981). However, Smith et al. (1997a) found that the distribution of Arctic staghorn sculpin across the northeastern Chukchi Sea was not uniform. Replicate trawls at the same location did not necessarily agree with respect to the abundance or even the presence of this species.

B.3.d(2) Abundance, Demography, and Population Trends. Distribution, abundance, age, growth, and reproduction were examined for this species captured by trawls conducted in 1990 and 1991 in the northeastern Chukchi Sea (Smith et al., 1997a). High numbers generally occurred inshore and south of Icy Cape. Mean biomass and abundance were significantly higher in 1990 than in 1991. Also, the age structure changed dramatically from 1990 to 1991. In 1990, 42% of the population was greater than or equal to 4 years old; in 1991 that was true of only 9%. Data suggest that the 1987 year-class experienced poor recruitment and that this recruitment failure was widespread, possibly resulting from a large-scale environmental perturbation. Because Arctic staghorn sculpin exhibited interannual variability in distribution, abundance, and age structure, Smith et al. (1997a) suggested that the species exists in an unpredictable and dynamic habitat that may result in recruitment failures, mass mortalities, or dispersal of individuals.

B.3.d(3) Life History and Important Habitat Areas. The onset of maturity in females occurs at ages 3 and 4 (Smith et al., 1997a). All females are mature by age 6; males are mature by age 5. Smith et al. (1997a) reported absolute fecundity of Arctic staghorn sculpin in the northeastern Chukchi Sea as 3030-5414 eggs (per female); relative fecundity was 91-154 eggs/gram. The oldest female observed was 9 years old; the oldest male was 8 (Smith et al., 1997a).

B.3.d(4) Prey and Predators. Arctic staghorn sculpin exhibit considerable plasticity of prey species consumed across the northeastern Chukchi Sea, based data reported by Coyle et al. (1997). During summer surveys, sculpin were found to have consumed polychaetes, gastropods, benthic amphipods, cumaceans, isopods, bivalves, euphausiids, shrimp, and benthic amphipods. The relative importance of these prey taxa in the diet of sculpin varied considerably by sample station.

Arctic cod and Bering flounder forage on Arctic staghorn sculpin (Coyle et al., 1997), as also do estuarine eelpout (Walters, 1955). Pelagic larvae of sculpin may be preyed upon by planktivores during spring and early summer (Andriyashev, 1964). Age-0 sculpin taking up residency in benthic habitats in late summer (Andriyashev, 1964) become available as prey to benthophages (Smith et al., 1997a). Sculpins in general are occasional prey to ringed and bearded seals (Lowry, Frost, and Burns, 1980; Lowry and Frost, 1981).

B.3.e. Pacific Sand Lance (*Ammodytes hexapterus*) (Family Ammodytidae; Sand Lances).

B.3.e(1) Distribution. The Pacific sand lance is distributed in the eastern North Pacific from California to the Beaufort Sea and as far west as the Sea of Okhotsk and Hokkaido (Robards et al., 1999). Quast (1974) reported juvenile sand lance (and Arctic cod) as virtually the only fish species caught in surface and mid-depths during night-time trawls conducted in the northeastern Chukchi Sea during September and October of 1970. Sand lance was chiefly taken at the surface. Craig (1984) noted sand lance as present in brackish nearshore waters of the Alaskan Beaufort Sea. Other surveys in the northeastern Chukchi and western Beaufort seas have documented catches of Pacific sand lance (e.g., Fechhelm et al., 1984; Barber, Smith, and Weingartner, 1994; Jarvela and Thorsteinson, 1999), although in extremely low numbers.

B.3.e(2) Abundance, Demography, and Population Trends. Abundance, demography, and population trends are unstudied in the Arctic Alaska. Generally for sand lance populations, annual recruitment is highly variable (Robards et al., 1999). Large fluctuations in abundance are observed every few years. Recruitment of larvae to the spawning stock is highly dependent on juvenile survival, as they immediately recruit to the next-year spawning adults.

B.3.e(3) Life History and Important Habitat Areas. Sand lance use shallow nearshore areas ranging in depth to 100 m but are most common at depths less than 50 m (Robards et al., 1999). Juvenile and adult sand lance exhibit the habit of alternating between lying buried in the substrate and swimming pelagically in well-formed schools. They are typically associated with fine gravel and sandy substrates up to and including the intertidal zone. Their choice of substrates appears to be highly specific. Sand lance also avoid oil-contaminated sediments (Pinto, Pearson, and Anderson, 1984). Although wide ranging, sand lance preference for specific shallow substrates results in a patchy distribution of populations. Sand lance bury themselves within substrates during periods of low light, during dormant periods, or occasionally in response to predators. Generally, sand lance are abundant in preferred habitats from spring to late summer and uncommon during the remainder of the year. Sand lance are rarely caught in the water column during winter months (in more southerly waters of Alaska) and appear to remain inactive or in hibernation while buried in intertidal and shallow subtidal substrates.

Use of shallow intertidal substrates for refuge by sand lance can leave them exposed to air at extreme low tide (Robards et al., 1999). Sand lance can survive for at least 5.5 hours in damp exposed sand.

Schooling behavior is well documented from surface and subsurface observations, as well as from hydroacoustic surveys (Robards et al., 1999). Close, inshore schools usually include hundreds or low thousands of individuals, but offshore schools usually number in the thousands. During threatening situations or at spawning, schools tighten considerably in formation. Schools swimming normally become more or less stationary when feeding, and spread out vertically and radially, sometimes filling the entire water column.

Growth appears to be density and food dependent (Robards et al., 1999). Seasonal growth occurs mostly in spring and early summer. Most growth occurs during the first 2 years. In exeptionally unfavorable years, no growth may occur.

Within most populations, age-groups 0 and 1 are the numerically dominant age classes (Robards et al., 1999). Pacific sand lance mature in the second year. Females mature more slowly than males. Autumn-spawning sand lance require about three months to mature.

Normal sex ratios are about 1:1 or slightly in favor of females (Robards et al., 1999). Sand lance appear to be single batch spawners. Fecundity of females is proportional to length and range from 1468-16,081 eggs per female.

Spawning typically occurs in late September and October on fine gravel and sandy beaches, soon after the summer water temperatures being to decline (Robards et al., 1999). In the Chukchi Sea, sand lance spawn from November to February on sandy bottoms at depths of 50-75 m (Morris, 1981b). Adult fish, dominated in a 2:1 ratio by males, approach the intertidal zone at sites where spawning has sometimes taken place for decades. Spawning occurs in dense formations. Female sand lance burrow through the substrate while releasing eggs, resulting in the formation of scour pots in intertidal beach sediments. It is uncertain whether sand lance are obligate intertidal spawners. Pacific sand lance are presumed to spawn subtidally in other areas of Alaska (e.g., at inshore or offshore shallow banks at depths to 100 m).

Eggs are demersal and slightly adhesive (Robards et al., 1999). Eggs are deposited in the intertidal zone just below the waterline. Eggs are occasionally collected pelagically, presumably as waves and currents wash eggs up and off the substrate.

Incubation times are highly variable and depend on ambient temperatures and oxygen levels (Robards et al., 1999). Incubation times of permanently immersed eggs range from as much as 62 days at 2 °C to as little as 13 days at 15.7 °C. There is evidence that increased incubation times and time-to-hatch completion with decreasing temperatures (10-2 °C) (Robards et al., 1999, citing Smigielski et al., 1984).

Larvae hatch before the spring plankton bloom (Robards et al., 1999). Postyolk?-absorption sand lance larvae undergo marked diel vertical migrations, moving between shallow depths (5-30 m) during daylight to deeper depths (30-50 m) at night. The range of these migrations increases with larval size. Horizontal distribution, and possibly abundance of sand lance larvae, is strongly influenced by tidal currents, oceanography, and wind conditions (Robards, et al., 1999).

During the summer, large schools of Pacific sand lance are reported in Ledyard Bay, north of Cape Lisburne. Marine-bird-feeding studies suggest a major downcoast movement of these fish during late July and August (Roseneau and Springer, 1977).

B.3.e(4) Prey and Predators. Feeding occurs primarily in the water column, although epibenthic invertebrats occasionally appear in the diet (Robards et al., 1999). Feeding habits change with age. Larvae feed on phytoplankton, diatoms, and dinoflagellates. Juveniles greater than 10 mm feed on nauplii of copepods in summer and euphausiids in winter. Adult fish consume macrocopepods, chaetognatha, and fish larvae. Overall, copepods are the predominant prey for postlarval lifestages. Cannibalism appears rare.

Sand lance are a quintessential forage fish and possibly the most important taxon of forage fish in the Northern Hemisphere (Robards et al., 1999). Sand lance are preyed on by numerous species of seabird, marine mammal, and fish, as well as various land animals. Population fluctuations and distribution of these predators are frequently linked to sand lance abundance (e.g., Springer et al., 1984, 1987; Piatt et al., 1991; Robards et al., 1999).

B.3.f. Bering Flounder (*Hippoglossoides robustus*) (Family Pleuronectidae; Righteye Flounders).

B.3.f(1) Distribution. Generally, Bering flounder range from Tatar Strait in the west to the Chukchi Sea through the Bering Sea to the Aleutian Islands (Andriashev, 1955; Prueter and Alverson, 1962; Mecklenburg, Mecklenburg, and Thorsteinson, 2002) and possibly the Beaufort Sea (Mecklenburg, Mecklenburg, and Thorsteinson, 2002). Prueter and Alverson (1962) found Bering flounder to be the most abundant flatfish in the southeastern Chukchi Sea, most frequently occurring at depths ≥ 44 m. However, they also noted that Bering flounder occurred at extremely low population densities in the Chukchi Sea during the late 1950's.

More recently and in the northeastern Chukchi Sea, Smith et al. (1997b) found Bering flounder at 32 of 48 stations sampled in 1990 and at 8 of 16 stations sampled in 1991. Nineteen of 24 stations at which Bering flounder were missing was north of 70° N. Distribution of Bering flounder was not uniform.

B.3.f(2) Abundance, Demography, and Population Trends. Sampling data from 1990 show that where present, Bering flounder abundance ranged from 11-6436 fish/km^2 ;and in general, the highest abundance and biomass of Bering flounder occurred in the southernmost part of the study area (south of 69°30' N. and west of 167° W.) (Smith et al., 1997b). In 1991, far fewer Bering flounder were caught; where present, abundance was 12-100 fish/km^2. Smith et al. (1997b) noted considerable variability in abundance observed among stations and also between hauls at the same station. Mean abundance estimates for all stations sampled in 1990 and 1991 (995 and 429 fish/km^2, respectively) differed significantly ($U=785$; $P < 0.001$). Eight stations were sampled in both years. Mean abundance at these stations in 1990 (207 fish/km^2) was significantly higher ($U = 85$; $P < 0.001$) than the estimate for 1991 (19.7 fish/km^2). Reduced abundance in 1991 was associated with significantly lower temperatures in 1991. Comparing the eight station common to both years, Smith et al. (1997b) found mean bottom temperatures of 5.4 and 0.9 C ($U = 54$; $P < 0.05$).

Comparisons of 1990 and 1991 biomass and abundance values suggest considerable interannual variation in these biological parameters (Smith et al., 1997b). Moreover, Smith et al. (1997b) concluded that in considering abundance observations reported for Bering flounder of the Chukchi Sea by Prueter and Alverson (1962), Andriyashev (1964), Wolotira, Sample, and Morin (1977), Smith et al. (1997b), and Wyllie-Echeverria, Barber, and wyllie-Echeverria (1997), that Bering flounder may experience periodic population increases and also periodic mass mortalities resulting from either direct mortality, recruitment failure, or both.

Smith et al. (1997b) found all ages from 1-11 were represented, with age 5 dominating; about 75% of the population consisted of fish that were at least 5 years old. They also determined the maximum longevity of Bering flounder to be 11 years for females and 8 years for males. In contrast, Prueter and Alverson (1962; cited by Smith et al. 1997b) reported the ages of Bering flounder to range from 6-13 years with 7-, 8-, and 9-year olds constituting 90% of the population. Smith et al. (1997b) therefore noted that apparently, there are dramatic shifts in population age structure over time, as well as variability in abundance.

B.3.f(3) Life History and Important Habitat Areas. Relatively little is known regarding the life history and habitat areas of this species. Smith et al. (1997b) reported that mean length at age indicated that the first 3 years males and females grow at the same rate. By the end of the fourth year, however, females appear to be significantly larger.

The ecology of Bering flounder in the Chukchi Sea (and now possibly the Beaufort Sea) may be the result of environmental changes occurring in these large marine ecosystems, perhaps as early as 1933.

Andriashev (1955) noted that representatives of the genus in which Bering flounder are ordered had not been found north of Bering Strait prior to 1933, and were possibly absent in previous years. But in 1933 due to a noticeable increase of warm current through Bering Strait northward to the Chukchi Sea, eggs and pelagic larvae of Bering flatfish may have been passively transported there (with the aid of the current), thus expanding its distribution northward. Building upon this and other data, Prueter and Alverson (1962) added to the transport hypothesis, suggesting that the presence of Bering flounder in the southeastern Chukchi Sea largely depends upon trasport of eggs, larvae, and young fish into the Chukchi Sea by waters originating south of the Bering Strait. (Interestingly, recent authors have cited Prueter and Alverson [1962] as the source of the transport hypothesis, whereas a reading of Andriashev [1955] shows clearly that Andriashev first proposed the hypothesis in 1937.)

More recently, data collected by Wyllie-Echeverria, Barber, and Wyllie-Echeverria (1997) provides additional evidence supporting the transport hypothesis. These same authors reviewed evidence collected from another survey conducted in the southeastern Chukchi Sea in September and October of 1970 and, in combination with their data, concluded that populations of Bering flounder in the northeastern Chukchi Sea are maintained by the transport of larvae in the Alaska coastal water, and that the northern limit of Bering flounder is undoubtedly connected to the presence of resident Chukchi water. They further noted that although these fishes and others may be routinely advected into the northeastern Chukchi Sea by Alaska coastal water, resident Chukchi water may be a critical factor in limiting their northern distribution. If so, this information suggests that Bering flounder in the northeastern Chukchi Sea are of one or more sink populations that require northward emigration of individuals from source populations in the Bering Sea to sustain those in the Chukchi Sea (and perhaps Beaufort Sea). The dynamics of such population interactions may change if the Bering, Chukchi, and Beaufort seas continue warming due to climate change, allowing what were sink populations in the Chukchi Sea (and perhaps Beaufort Sea) to become source populations as water temperatures warm and become more favorable to Bering flounder habitat needs.

B.3.f(4) Prey and Predators. Bering flounder collected in surveys conducted in August-September 1990-1991 were examined for food habits (Coyle et al., 1997). Bering flounder was found to mainly consume fish; the most important identifiable fish was *Lumpenus* sp. Other fish prey identified to family included eelpouts, poachers, sculpins, and cods. Benthic and epibenthic crustaceans constituted most of the rest of the diet during the sampling period. An infaunal amphipod species (*Byblis* sp.) was important at one station sampled offshore Point Hope; pagurid crabs were important prey at a station sampled offshore Cape Lisburne.

The Bering flounder is preyed upon by Arctic cod (Coyle et al., 1997) and several species of marine mammals.

Appendix C

Subsistence-Harvest Activities in Inupiat Communities In and Adjacent to the Beaufort and Chukchi Seas Proposed Action Area.

C.1. INTRODUCTION

This section describes the subsistence-harvest patterns of the Inupiat communities in Kaktovik, Nuiqsut, Barrow, Atqasuk, Wainwright, Point Lay, and Point Hope. This community-by-community description provides general information on subsistence-harvest patterns, harvest information by resource and community, timing of the subsistence-harvest cycles, and harvest-area concentrations by resource and by community. This summary also includes any new Native stakeholder concerns as they relate to these topics, as well as traditional knowledge updates. The entire marine subsistence-harvest areas of each of these communities are included in the planning area.

Fundamentally, long-term subsistence-harvest practices and subsistence cycles have not changed since the assessment provided in the Beaufort Sea multiple-sale final EIS (USDOI, MMS, 2003a); nevertheless, harvest areas can be fluid and change from season to season, and there is increasing concern over the onset of global climate change and its effects on subsistence seasons and practices. The BLM's Alpine Satellite Development Plan draft EIS for potential expansion of Alpine field production near Nuiqsut (USDOI, BLM, 2004) has provided new information on contemporary harvest areas in some communities, particularly Nuiqsut. Some examples of the many other references used include: North Slope Borough Contract Staff (1979); ACI, Courtnage, and Braund (1984); Hoffman, Libbey, and Spearman (1988); Impact Assessment (1989); S.R. Braund and Assocs. and UAA, ISER (1993a,b); Alaska Natives Commission (1994); State of Alaska, Department of Fish and Game (ADF&G) (1995a); City of Nuiqsut (1995); Fuller and George (1997); Moulton (1997); North Slope Borough (1998); Brower et al. (2000); Kassam and Wainwright Traditional Council (2001); and the Community Profile Database [CPDB] ADF&G (2004).

Maps for the primary subsistence-harvest areas for Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, and Point Hope are shown on Map C-1. The primary subsistence-harvest areas for Point Hope are shown on Figures C-1 (all resources), C-2 (bowhead whales), C-3 (seals), C-4 (walrus), and C-5 (beluga whales).

C.2. COMMUNITY SUBSISTENCE PROFILES

C.2.a. Kaktovik. Kaktovik is situated on Barter Island off the Beaufort Sea coast with a 2004 population of 284 (State of Alaska, Dept. of Commerce, Community and Economic Development (DCCED), 2005). Major subsistence resources include bowhead and beluga whales, seals, polar bears, caribou, fishes, and marine and coastal birds. Kaktovik's subsistence-harvest areas are depicted in detail in maps included in MMS's Liberty final EIS (USDOI, MMS, 2002b), the Bureau of Land Management's (BLM's) Northwest National Petroleum Reserve-Alaska (NPR-A) final EIS (USDOI, BLM and MMS, 2003), and BLM's Alpine Satellite Development Plan draft EIS for potential expansion of Alpine field production near Nuiqsut (USDOI, BLM, 2004). Subsistence resources used by Kaktovik are listed in tables provided in these same documents. No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the MMS's 2003 Beaufort Sea multiple-sale EIS, the 2004 Beaufort Sea Lease Sale 195 Environmental Assessment, and the subsequent analyses mentioned herein. All of Kaktovik's marine subsistence-harvest area is within the Beaufort Sea portion of the proposed Arctic Seismic Programmatic Environmental Assessment (PEA) area.

Fuller and George (1999) harvest estimates for the 1992 harvest season in Kaktovik include:

- Three bowhead whales were harvested, representing 110,000 pounds (lb) of meat. Bearded seals and beluga whales were other important marine mammals taken. Also, five walruses were harvested, a rare occurrence in the eastern Beaufort Sea. Marine mammals represented 66.2% of the total edible pounds harvested.
- For terrestrial mammals, 136 caribou, 53 Dall sheep, and 6 muskoxen were harvested in 1992, 13.9 % of the total edible pounds harvested.
- For fish resources, 7, 900 arctic char (actually Dolly Varden), 7,100 arctic cisco, and 2,600

grayling were harvested, 18.3 % of the edible pounds harvested.
- Bird/waterfowl resources included 333 Pacific brant, 180 white-fronted geese, 11 snow geese, some Canada geese, and 11 Steller's eiders, 1.4 % of the edible pounds harvested.

Fifty percent of the households surveyed participated often in fall whaling, and more than 40% participated in caribou hunting, sheep hunting, and fishing (Fuller and George, 1999). Pedersen (2003) conducted surveys of the Kaktovik subsistence fishery in 2000-2001 and 2001-2002, and estimated community harvests of fish at 5,970.0 lb and 9,748.3 lb, respectively. Dolly Varden, lake trout, and arctic cisco were the only fishery resources reported to be harvested by Kaktovik households in this study. Dolly Varden was the most commonly harvested fish in terms of numbers harvested and estimated harvest weight, with arctic cisco and lake trout ranking second and third (Pedersen, 2003).

C.2.b. Nuiqsut. The Inupiat community of Nuiqsut is near the mouth of the Colville River, which drains into the Beaufort Sea, and had a 2004 population of 430 (State of Alaska, DCCED, 2005). For Nuiqsut, important subsistence resources include bowhead whales, caribou, fish, waterfowl, ptarmigan and, to a lesser extent, seals, muskoxen, and Dall sheep. Polar bears, beluga whales, and walruses are seldom hunted but can be taken opportunistically while in pursuit of other subsistence species. Nuiqsut has subsistence-harvest areas in and adjacent to the Arctic Seismic PEA area. Cross Island and vicinity is a crucially important region for Nuiqsut's subsistence bowhead whale hunting. Before oil development at Prudhoe Bay, the onshore area from the Colville River Delta in the west to Flaxman Island in the east and inland to the foothills of the Brooks Range (especially up the drainages of the Colville, Itkillik, and Kuparuk rivers) was historically important to Nuiqsut for the subsistence harvests of caribou, waterfowl, furbearers, fishes, and polar bears. Offshore, in addition to bowhead whale hunting, seals historically were hunted as far east as Flaxman Island. Nuiqsut's subsistence-harvest areas are depicted in detail in maps included in the Liberty final EIS (USDOI, MMS, 2002b), BLM's recent Northwest NPR-A final EIS (USDOI, BLM and MMS, 2003), and BLM's Alpine Satellite Development Plan draft EIS for potential expansion of Alpine field production near Nuiqsut (USDOI, BLM, 2004). Subsistence resources used by Nuiqsut are listed in tables provided in these same documents. See Appendix H in the Sale 195 EA, Evaluation of Potential Impacts on Subsistence Whaling from MMS Permitted Activities in the Cross Island and Smith Bay Areas (USDOI, MMS, 2004), for a discussion of subsistence-whaling activity in the Cross Island area. Also see Figures H-1 and H-2 in Appendix H that track Nuiqsut whaling crew voyages for the 2001 and 2002 whaling seasons. These data were gathered as part of the ongoing MMS Arctic Nearshore Impact Monitoring in Development Area monitoring effort in the region. No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the MMS's 2003 Beaufort Sea multiple-sale EIS, the 2004 Beaufort Sea Sale 195 EA, and the subsequent analyses mentioned herein.

For BLM's Alpine Satellite Development Plan draft EIS for potential expansion of Alpine field production near Nuiqsut (USDOI, BLM, 2004), S.R. Braund and Assocs. conducted 21 interviews in June and July 2003. These interviews included hunters of both genders and ranged in ages from young hunters to active elders. The subsistence-use area for all resources described in these interviews is similar in the most part to that described by Pedersen et al. (In prep.) for harvests conducted from 1973 thorough 1986. Some formerly used areas to the west and south were not described as presently used, although this could be due to the practices of the actual hunters interviewed. Areas in the vicinity of Prudhoe Bay are no longer used, because industrial development has rendered them inaccessible.

Interviews for BLM's Alpine draft EIS for potential expansion of Alpine field production near Nuiqsut (USDOI, BLM, 2004) also included additional traditional and local knowledge testimony. In her testimony at a 2003 public hearing for the Alpine Satellite Development Plan, Nuiqsut's Mayor Rosemary Ahtuangaruak related that villagers were seeing changes in caribou and fish that left them with tumors and lesions, and they believed this came from pollution from nearby gas flares. She also noted that helicopter activity was diverting caribou away from the community. Jimmy Nukapigak related that Alpine development had contributed to fewer arctic cisco in the Fish Creek area. Frank Long, Jr. believed that developing CD-6 would threaten fishing in Niqliq Channel and other Colville River channels.

C.2.c. Barrow. As with other communities adjacent to the Planning Area, Barrow residents (population 4,351 in 2004 (State of Alaska, DCCED, 2005) enjoy a diverse resource base that includes both marine and terrestrial animals. Barrow's location at the demarcation point between the Chukchi and Beaufort seas is unique among North Slope subsistence communities. This location offers superb opportunities for hunting a diversity of marine and terrestrial mammals and fishes. Barrow's subsistence-harvest areas are depicted in detail in maps included in MMS's Liberty final EIS (USDOI, MMS, 2002b) and BLM's recent Northwest NPR-A final EIS (USDOI, BLM and MMS, 2003) and Alpine Satellite Development Plan draft EIS for potential expansion of Alpine field production near Nuiqsut (USDOI, BLM, 2004). Subsistence resources used by Barrow are listed in tables provided in these same documents. See USDOI, BLM and MMS (2003:Map 75) for bowhead whale-harvest locations near Barrow. No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the MMS's 2003 Beaufort Sea multiple-sales EIS, the 2004 Beaufort Sea Sale 195 EA, and the subsequent analyses mentioned herein.

For BLM's Alpine draft EIS (USDOI, BLM, 2004), S.R. Braund and Assocs. conducted eight interviews in August 2003. These interviews were coordinated with the Inupiat Community of the Arctic Slope and included hunters who were known to travel to the east of Barrow for their subsistence harvests.

The use areas described in these eight interviews generally correlated with previously described subsistence land use areas to the east and southeast of Barrow. Some differences did surface with these hunters not going much farther east of the Itkillik River and many going father southeast than in the past to the Anaktuvuk River and into areas near the Titaluk and Kigalik rivers, 120 mi south of Barrow. Barrow hunters also described occasionally traveling to the Kalikpik-Kogru River areas for caribou, when animals are unavailable closer to Barrow. Winter snowmobile travel for caribou, wolf, wolverine, and fox as far east as Fish and Judy Creeks also was reported.

C.2.d. Atqasuk. Atqasuk's 2004 population was 247 (State of Alaska, DCCED, 2005) and the inland Inupiat community is approximately 50 mi south of Barrow. The marine-resource areas used by Atqasuk residents include those used by Barrow residents as explained in the Barrow discussion. Only a small portion of the marine resources used by Atqasuk residents is acquired on coastal hunting trips that are initiated in Atqasuk; most resources are acquired on coastal hunting trips initiated in Barrow or Wainwright with relatives or friends (ACI, Courtnage, and Braund, 1984). Nevertheless, the local connection with the coastal and marine resources is important to the community. As one resident observed: "We use the ocean all the time, even up here; the fish come from the ocean; the whitefish as well as the salmon migrate up here" (ACI, Courtnage, and Braund, 1984). Atqasuk's subsistence-harvest areas are depicted in detail in maps included in the BLM's Northwest NPR-A final EIS (USDOI, BLM and MMS, 2003), and the BLM's Alpine draft EIS (USDOI, BLM, 2004). Subsistence resources used by Atqasuk are listed in tables provided in these same documents. No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the EIS analyses mentioned above.

C.2.e. Wainwright. The community of Wainwright, with a population of 531 in 2004 (State of Alaska, DCCED, 2005), enjoys a diverse resource base that includes both terrestrial and marine resources. The city sits on the Chukchi Sea coast about 100 mi southwest of Barrow. Marine subsistence activities focus on the coastal waters from Icy Cape in the south to Point Franklin and Peard Bay in the north. The Kuk River lagoon system—a major marine estuary—is an important marine and wildlife habitat used by local hunters. Wainwright is situated near the northeastern end of a long bight that affects sea-ice conditions as well as marine-resource concentrations. Wainwright's subsistence-harvest areas are depicted in detail in maps included in the MMS's Chukchi Sea Oil and Gas Lease Sale 126 (USDOI, MMS, 1990) and the BLM's Northwest NPR-A final EIS (USDOI, BLM and MMS, 2003). No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the 2003 Northwest NPR-A final EIS.

Lydia Agnasagga in her testimony at a local public hearing in 1987 for MMS's Chukchi Sea Sale 109 related: "We live on subsistence, and everybody knows that...especially on the Arctic Coast. We live mainly on the animals from the sea and from the land, as well, and we can't very well live without those...our food because we didn't grow up with beef or anything like that, and I can say that everything costs so much nowadays. It's hard to try to live just by buying...store-bought food, and that's the reason why I'm concerned about this [lease sale]" (USDOI, MMS, 1987c).

At the same hearing, Jim Allen Aveoganna stated: "I was raised [by] hunting only. My dad had never been working, just hunting for a living. And I raised my family half the time just by hunting, which I can say. That's how we live. Us older people here...we have lived just for [the] hunt. We were raised just by hunting only. No money, nothing. My dad never had been employed; only time he start employ[ment] was the time he was [an] old age citizen. So, that's how we lived" (USDOI, MMS, 1987c).

C.2.f. Point Lay. With a population of 251 in 2004 (State of Alaska, DCCED, 2005), Point Lay has the smallest population of any of the communities in the North Slope Borough (NSB). About 90 mi southwest of Wainwright, the village sits on the edge of Kasegaluk Lagoon near the confluence of the Kokolik River with Kasegaluk Lagoon. As with other communities adjacent to the Chukchi portion of the Arctic Seismic PEA Planning Area, Point Lay residents enjoy a diverse resource base that includes both marine and terrestrial animals. However, Point Lay is unique among the communities; its dependence is relatively balanced between marine and terrestrial resources. Unlike the other communities discussed here, local hunters do not pursue the bowhead whale, although the community petitioned the Alaska Eskimo Whaling Commission (AEWC) for a bowhead whale quota in 2004 and a community initiative to resume its dormant bowhead hunt is continuing (AP, 2004). Beluga whale is the village's preferred and pivotal marine mammal resource. Barrier island shores, and the protected and productive lagoons they form, provide prime habitat for other sea mammals and birds, both important resources in the Point Lay subsistence round (USDOI, BLM, 1978d; Fuller and George, 1997). Point Lay's subsistence-harvest areas are depicted in detail in maps included in the MMS's Chukchi Sea Sale 126 EIS (USDOI, MMS, 1990) and the BLM's Northwest NPR-A final EIS (USDOI, BLM and MMS, 2003). No substantial changes to long-term subsistence-harvest practices, subsistence cycles, and types of resources harvested have occurred since the 2003 Northwest NPR-A final EIS.

Gregg Tagarook, hunter and elder from Wainwright, had this to say about weather and hunting conditions in Kasegaluk Lagoon:

> I grew up on Barter Island for a long while. I was at Wainwright and lived in Pt. Hope for 14 years. I know a little bit about how things travel, and I've been taught by different community elders, and one elder has said something I never forgot. I'm grateful that I understand a place called Kasegaluk. Our older generation has observed Kasegaluk and said the north wind would blow hard and the current would be strong but this would never change. I understand the hard times and the older generations would take their families out there for camping. When there is nothing dangerous there, I want to say in hunting in fall and mid-winter there would be some shallow spots and the upper part of it would be good. Around there it is dangerous. When the wind is coming from the west, the shore ice would come off from the shore. That is west of Wainwright. A place called Mikigealiak. When it was a west wind, we dared not be out there hunting because it is dangerous. We were saying that the oil industry should know about these conditions that occur when the west wind is blowing in that area because the ice is very strong. North northwest wind. That's that wind 90 miles west of here. (Alaska Traditional Knowledge and Native Foods Database, Northwest Arctic Regional Meeting, Sept. 1998 [UAA, ISER, No date]).

C.2.g. Point Hope. Point Hope residents, with a population of 726 in 2004 (State of Alaska, DCCED, 2005) enjoy a diverse resource base that includes both terrestrial and marine animals. The community, 330 mi southwest of Barrow, is located on a large gravel spit that forms the westernmost extension of the northwest Alaska coast. In the early 1970's, the community moved to its present location just east of the old settlement because of erosion and periodic storm-surge flooding. This spit of land juts out into the Chukchi Sea, offering superb opportunities for hunting a diversity of marine mammals, especially bowhead whales. The combination of caribou, bowhead whale, and fish has been identified as being the primary group of resources harvested; the lowest percentage for this combination occurred in Point Hope, where residents use the greatest variety of subsistence resources, which include beluga whales, walruses, polar bears, birds, marine fish, crab, and berries. Burch (1981) listed 60 species harvest by the village; a NSB subsistence survey in 1992 listed 59 species harvested (Pedersen, 1977; USDOI, MMS, 1987 [Beaufort Sea Sale 97 final EIS], 1990 [Chukchi Sea Sale 127 final EIS]; Fuller and George, 1997; U.S. Army Corps of Engineers, 2005 [Delong Mountain DEIS]). See Tables C-1 and C-2 for a summary of Point Hope's subsistence harvest resources for 1992.

The Point Hope annual subsistence round is shown in Figure C-6. Relative household subsistence consumption, participation, changes in subsistence activity, and expenditures on subsistence for Point Hope, as determined from the 1992 NSB subsistence survey and a NSB economic profile and census conducted in 2003 are displayed in Tables C-1, C-2, C-3, C-4, and C-5, and Figure C-3 (Pedersen, 1977; NSB, 2003; Fuller and George, 1997). The primary subsistence-harvest areas for Point Hope are shown on Figures C-1 (overall area), C-2 (bowhead whales), C-3 (seals), C-4 (walrus), and C-5 (beluga whales) included in this document.

Point Hope's strategic location close to the pack-ice lead makes it uniquely situated for hunting the bowhead. Beginning in late March or early April, the bowhead whale is available in the Point Hope area (see Figs. C-1 [overall area], C-6 [subsistence round], and C-2 [bowhead whales]). Approximately 15-18 whaling camps are located along the edge of the landfast ice. The actual harvest area varies from year to year, depending on where the open leads form. Camps as far south as Cape Thompson have been reported, but in recent years the camps tended to be closer to the community. In the recent past, the camps were situated south and southeast of the point. The intensive-use area delineated in Figure C-2 indicates the harvest-concentration areas over the past few years. The distance of the lead from shore varies from year to year. The lead is rarely more than 10-11 km offshore, but hunters have had to travel over the ice as far as 16 km away from the community to find the necessary open water for spring whaling. Table C-6 shows the annual bowhead whale subsistence harvest for Point Hope (Pedersen, 1977; ACI and Braund, 1984; USDOI, MMS, 1990; Fuller and George, 1997; Woody, 2003).

Point Hope generally has open water for the majority of the whaling season; but sometimes two narrow leads develop. This presents a problem for Point Hope hunters, because the whales may travel in the lead that is farther from shore and, thereby, become inaccessible to the whalers. The duration of the whaling season is limited by the International Whaling Commission's (IWC's) quota. Despite the limited nature of both the whaling season and the harvest area, no other marine mammal is harvested with the intensity and concentration of effort that is focused on the bowhead whale, the most important resource in Point Hope's subsistence economy. The harvest periods of all resources vary from year to year, and the bowhead season is no exception. In a 20-year period ending in 1982, the total annual number of bowheads landed varied from 0-14. In the recent memory of community residents, 1980 and 1989 were the only years in which a bowhead whale was not harvested. The last subsistence survey in the village was conducted by the NSB in 1992 and noted that two bowheads were landed that year—a poor harvest year (6.9% of the total subsistence harvest) due to onshore winds creating poor ice conditions (Pedersen, 1977; ACI and Braund, 1984; USDOI, MMS, 1990; Fuller and George, 1997).

Point Hope hunters actively harvest the beluga whale during the offshore spring bowhead-whaling season (late March-early June) and along the coast later in summer (July-late August/early September) (Fig. C-5). The first, and larger, harvest of belugas occurs coincidentally with the spring bowhead whale harvest. Hunters often use the beluga as an indicator for the bowhead. Although not as common as the bowhead, the beluga also is harvested in open water throughout the summer. During the summer season, hunters pursue belugas primarily near the southern shore of Point Hope in the southern Chukchi Sea, in close proximity to the beach, as well as in coastal areas on the northern shore as far north as Cape Dyer. Because belugas feed on the anadromous fishes of the Kukpuk River, hunters are particularly successful near Sinuk.

The beluga is harvested intensively at distances as far south as Cape Thompson (Fig. C-5). Although belugas are available in May and June, Point Hope residents generally do not pursue them because of deteriorating ice conditions along the landfast ice margins and the greater availability of bearded seal and walrus at this time (Pedersen, 1977; USDOI, MMS, 1990; Fuller and George, 1997).

The number of belugas harvested varies (Table C-7); according to Lowenstein (1981), each whaling crew harvests at least one beluga—and usually more—during the whaling season. The average annual beluga harvest (between 1962 and 1982) was estimated at 29, or 6.5% of the total annual marine-subsistence harvest. The 1992 NSB subsistence survey estimated a beluga harvest of 98 animals—40.3% of the total subsistence harvest (Pedersen, 1977; USDOI, MMS, 1990; Fuller and George, 1997).

Point Hope Inupiat have traditionally used walrus; however, the increasing importance of the walrus as a subsistence resource has been directly related to its fluctuating population, which also has increased over the past decade. Walruses are harvested during the spring marine mammal hunt, which is based along the southern shore of the point (Fig. C-4). The major walrus hunting effort coincides with the spring bearded seal harvest, and both species are harvested from the same camps that stretch from Point Hope to Akoviknak Lagoon. Although the walrus is hunted primarily during late May and early June, it also is hunted by boat during the rest of the summer along the northern shore, especially along the rocky capes and other points where they tend to haul out. The walrus harvest occurs in conjunction with other subsistence activities such as egg gathering, fishing, or traveling the shores in search of caribou. An estimated 10-30 animals are harvested during June (ACI, Courtnage, and Braund, 1984). The annual average harvest (from 1962-1982) was estimated at 15 walruses, or 2.9% of the total annual marine mammal subsistence harvest. Walrus harvest totals in Point Hope from 1982 through 2005, derived from the USDOI, Fish and Wildlife Service (FWS) Marking, Tagging, and Reporting Program (MTRP) are shown in Table C-8. Reported MTRP numbers are generally lower than actual harvests. The 1992 NSB subsistence survey estimated a walrus harvest of 72 animals—16.4% of the total subsistence harvest (Pedersen, 1977; USDOI, MMS, 1990; Fuller and George, 1997; Garlich-Miller, pers. com, 2006).

Point Hope residents hunt polar bears primarily from January to April concurrently with the winter seal-hunting season, and occasionally from late October to January. The polar bear is harvested mainly south of the community, generally in the area of intensive seal hunting (ACI, Courtnage, and Braund, 1984). The polar bear comprises a small portion of the Point Hope subsistence harvest with an annual average (from 1962-1982) of nine harvested, or only 1.1% of the total annual marine mammal subsistence harvest. The 1992 NSB subsistence survey showed that no polar bears were harvested that season but FWS data indicate 9 harvested during the 1991/92 season and 17 harvested during the 1992/93 season (Table C-9) (Pedersen, 1977; USDOI, MMS, 1990; Fuller and George, 1997; Schliebe, pers. com., 2006).

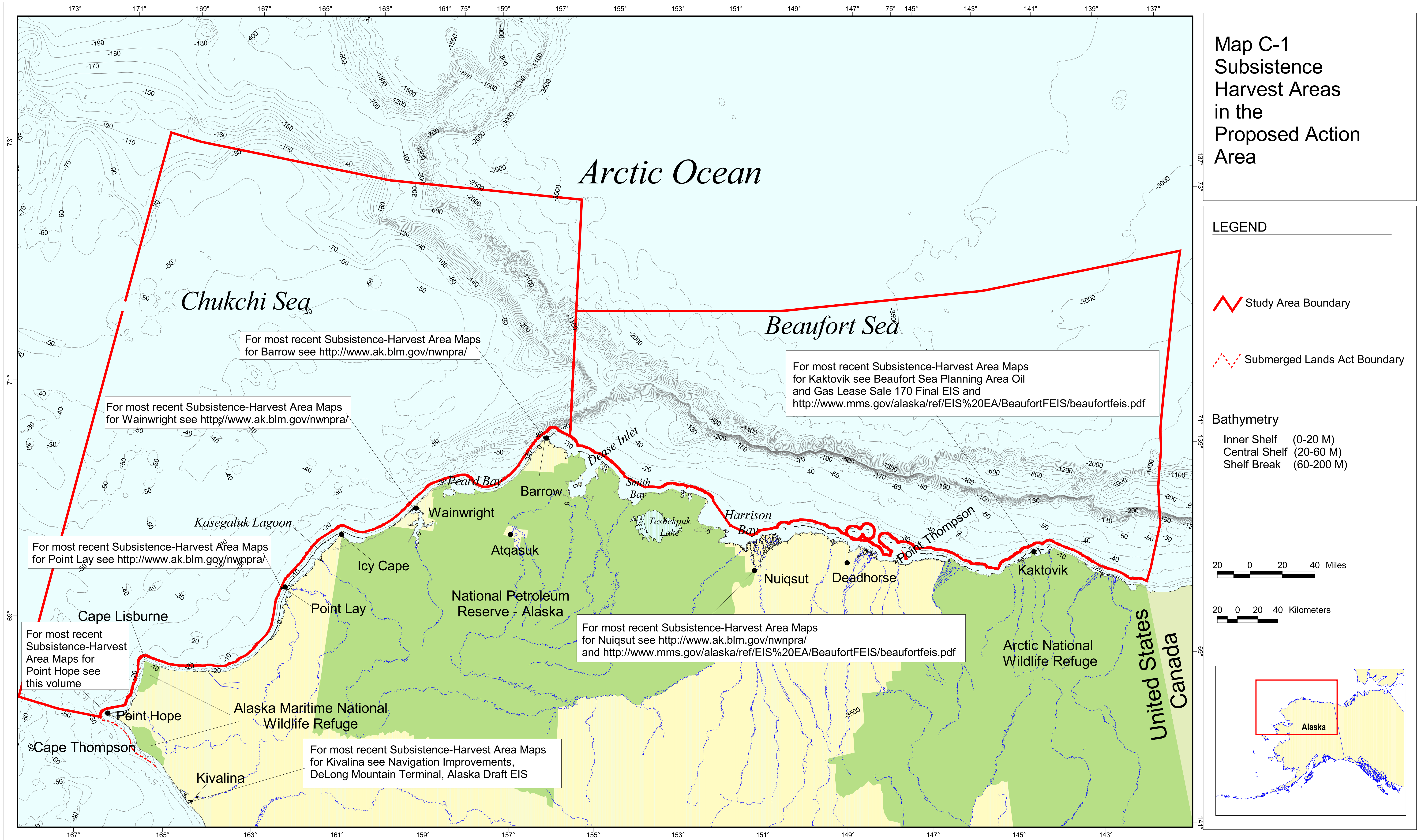
Seals are available to Point Hope residents from October through June; however, because of the availability of bowhead, bearded seal, and caribou during various times of the year, seals are harvested primarily during the winter months, from November through March. The ringed seal is the most common hair seal species harvested, and the month of February is the most concentrated harvest period for this species. Hair seals are hunted from south of Cape Thompson to as far north as Ayugatak Lagoon (Fig. C-3). The area south of Point Hope is safer and more advantageous for hunting seals. In good weather, it is safe for a hunter to travel 10-15 mi offshore of the southern side of the point; however, it is more common for residents to hunt seals closer to shore. The area north of the point is more dangerous for seal hunting because of the poor ice conditions. Seal hunting in this area occurs closer to shore and is most successful at Sinuk, near the mouth of the Kukpuk River, and at the numerous small points between Point Hope and Cape Lisburne, where open water is found (i.e., Kilkralik Point and Cape Dyer). South of the point, ringed seal hunting generally is concentrated within 5 mi of shore on the ice pack between Point Hope and Akoviknak Lagoon. Some hair seal hunting takes place directly off the point when the ice first forms in October and early November. From 1962-1982, the average annual harvest is estimated at 1,400 seals, or 14.8% of the total annual subsistence harvest. The 1992 NSB subsistence survey estimated that 265 ringed and 50 spotted seals were harvested that season (Pedersen, 1977; ACI, Courtnage, and Braund, 1984; Fuller and George, 1997).

Hunting of the bearded seal is an important subsistence activity in Point Hope; the meat is a preferred food and the skin is used to cover whaling boats. Most bearded seals are harvested during May and June, sometimes as late as mid-July, as the landfast ice breaks up into floes. More of the bearded seal than the smaller hair seal is harvested because of the former's larger size and use for skin-boat covers. Bearded seals, like hair seals, are hunted from Cape Thompson to Ayugatak Lagoon. The average annual fur seal harvest from 1962-1982 was 200 a year, or about 8.9% of the total annual subsistence harvest (ACI, Courtnage, and Braund, 1984; USDOI, MMS, 1990). The 1992 NSB subsistence survey showed that 160 bearded seals were harvested that season—8.3% of the total subsistence harvest (Table C-2) (Pedersen, 1977; Fuller and George, 1997).

Caribou is the primary source of meat for Point Hope residents. From 1962-1982 the annual average of 756 caribou harvested accounted for 29.5% of the total annual subsistence harvest (ACI, Courtnage, Braund, 1984). Although caribou are available throughout the year, peak harvest times occur from February-March and from late June through mid-November. The 1992 NSB subsistence survey showed that 225 caribou were harvested that season—7.7% of the total subsistence harvest (Table C-6) (Pedersen, 1977; USDOI, MMS, 1990; Fuller and George, 1997).

Point Hope residents harvest a variety of fish during the entire year. As the shorefast ice breaks free in mid- to late June, residents use setnets and beach seines to catch arctic char and pink, coho, and chum salmon. Fishing occurs from coastal fish camps (often converted from spring camps for hunting bearded seal and walrus) located along the shore from Cape Thompson north to Kilkralik Point. Some fishing may occur outside this area, but only in conjunction with other activities such as egg gathering or caribou hunting. The summer fishing season extends from mid- to late June through the end of August, with July the peak month. Other fishes harvested by Point Hope residents include whitefish, grayling, tomcod, and occasionally flounder. In the fall, residents harvest grayling and whitefish on the Kukpuk River during the October upriver fishing period. From December through February, residents fish for tomcod through the ice near the point (ACI, Courtnage, and Braund, 1984). From 1962-1982, an estimated annual average of 40,084 lb was harvested, accounting for 10.1% of the total subsistence harvest. The 1992 NSB subsistence survey showed that 30,589 lb of fish were harvested that season—9.0% of the total subsistence harvest (Table C-1) (Pedersen, 1977; ACI, Courtnage, and Braund, 1984; USDOI, MMS, 1990; Fuller and George, 1997).

Throughout the year, waterfowl and other migratory birds also provide a source of food for Point Hope residents. Eiders and other ducks, murres, brant, geese, and snowy owls are harvested at various times of the year. Eiders are hunted and harvested as they fly along the open leads during the whaling season, thereby providing a fresh meat source for the whaling camps. Murre eggs are harvested from the cliffs at Capes Thompson and Lisburne. Later in the spring, Point Hope residents harvest eiders, geese, brant, and other migratory waterfowl along both the northern and southern shores of the point and in the numerous lakes and lagoons. Geese are harvested from mid-May until mid-June, while brant are harvested at this time and during September, as they migrate from their summer breeding grounds. Snowy owls occasionally are trapped later in the fall, in October, as they migrate south. From 1962-1982, an estimated annual average of 12,527 lb of birds was harvested, accounting for about 3.2% of the total annual subsistence harvest. The 1992 NSB subsistence survey showed that 9,429 lb of birds were harvested that season—2.8% of the total subsistence harvest (Table C-1) (Pedersen, 1977; ACI, Courtnage, and Braund, 1984; USDOI, MMS, 1990; Fuller and George, 1997).



Map C-1 Subsistence Harvest Areas in the Proposed Action Area

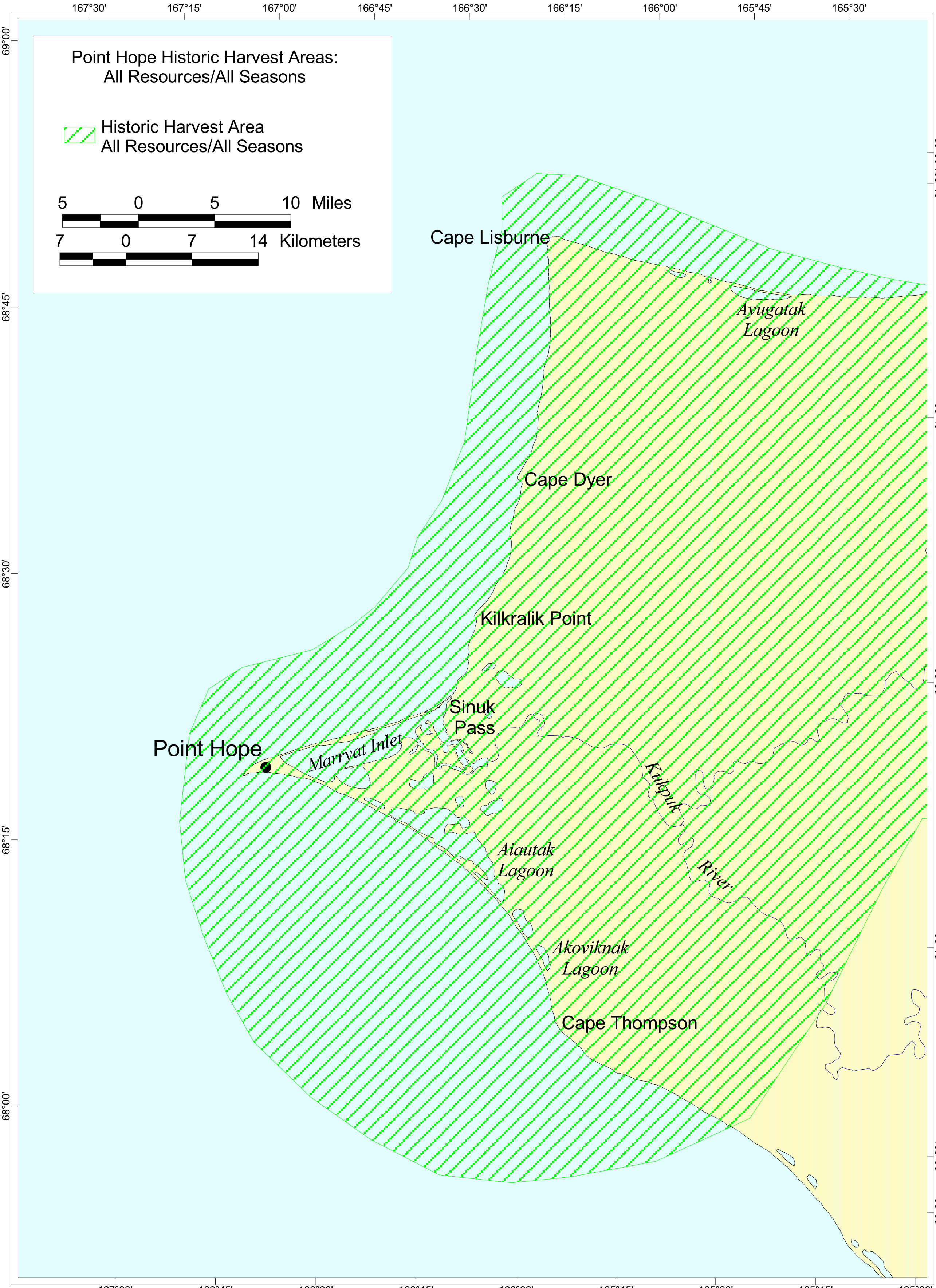


Figure C-1. Point Hope Historic Subsistence Harvest Areas: All Resources/All Seasons. From Braund & Burnham, 1984; Pedersen, 1977.

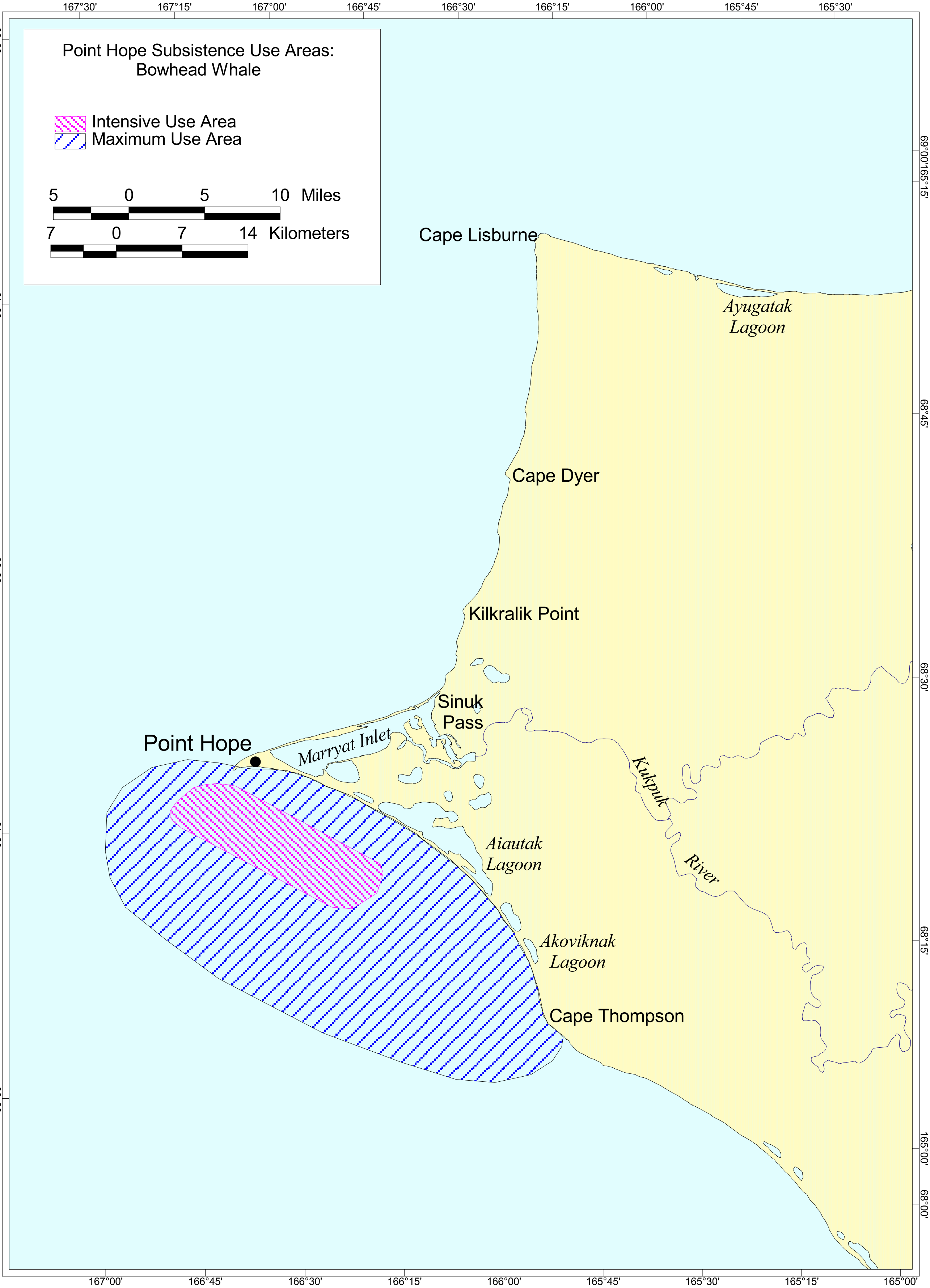


Figure C-2. Point Hope Subsistence Use Areas: Bowhead Whale. From Braund & Burnham, 1984.

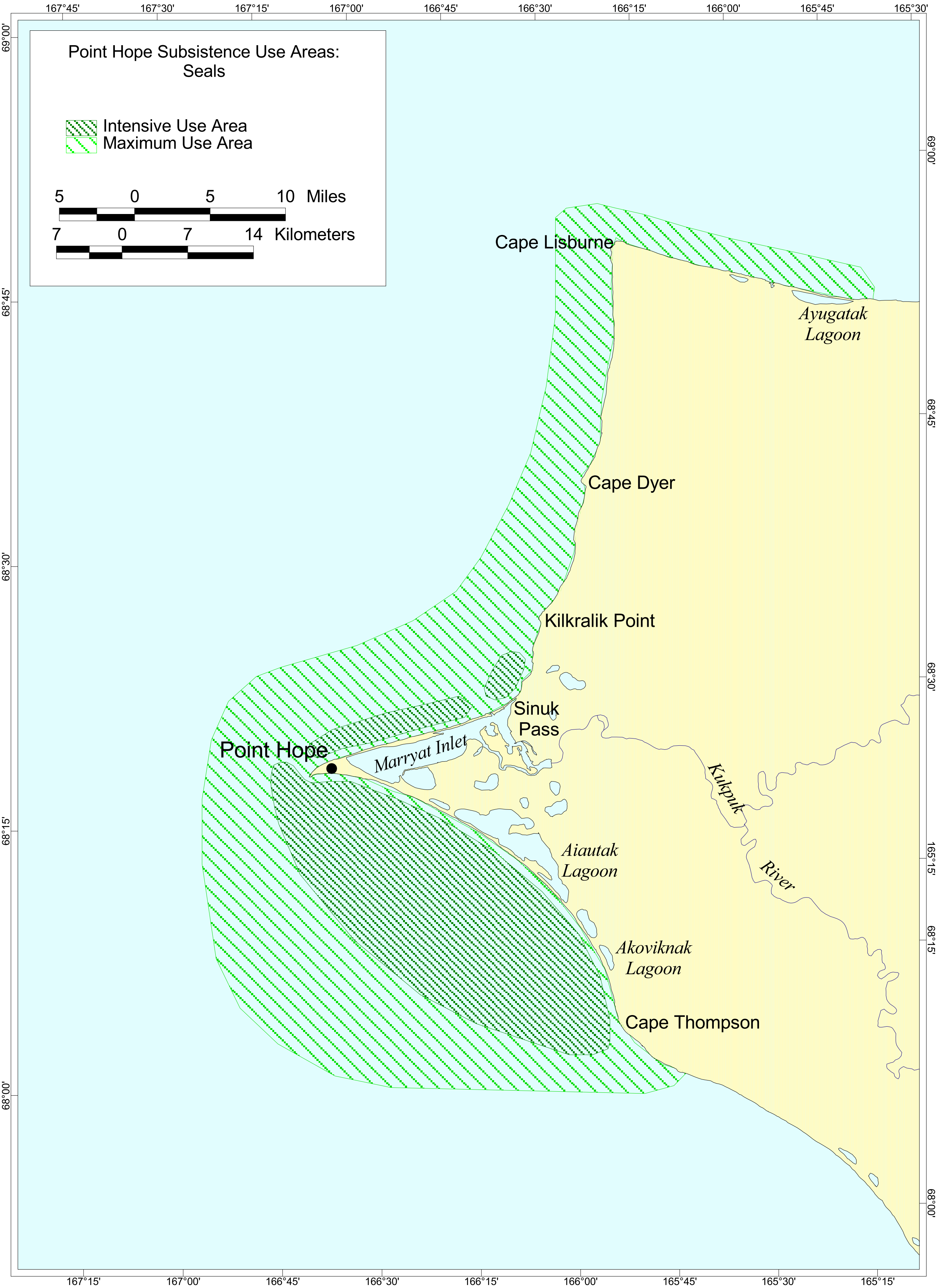


Figure C-3. Point Hope Subsistence Use Areas: Seals. From Braund & Burnham, 1984.

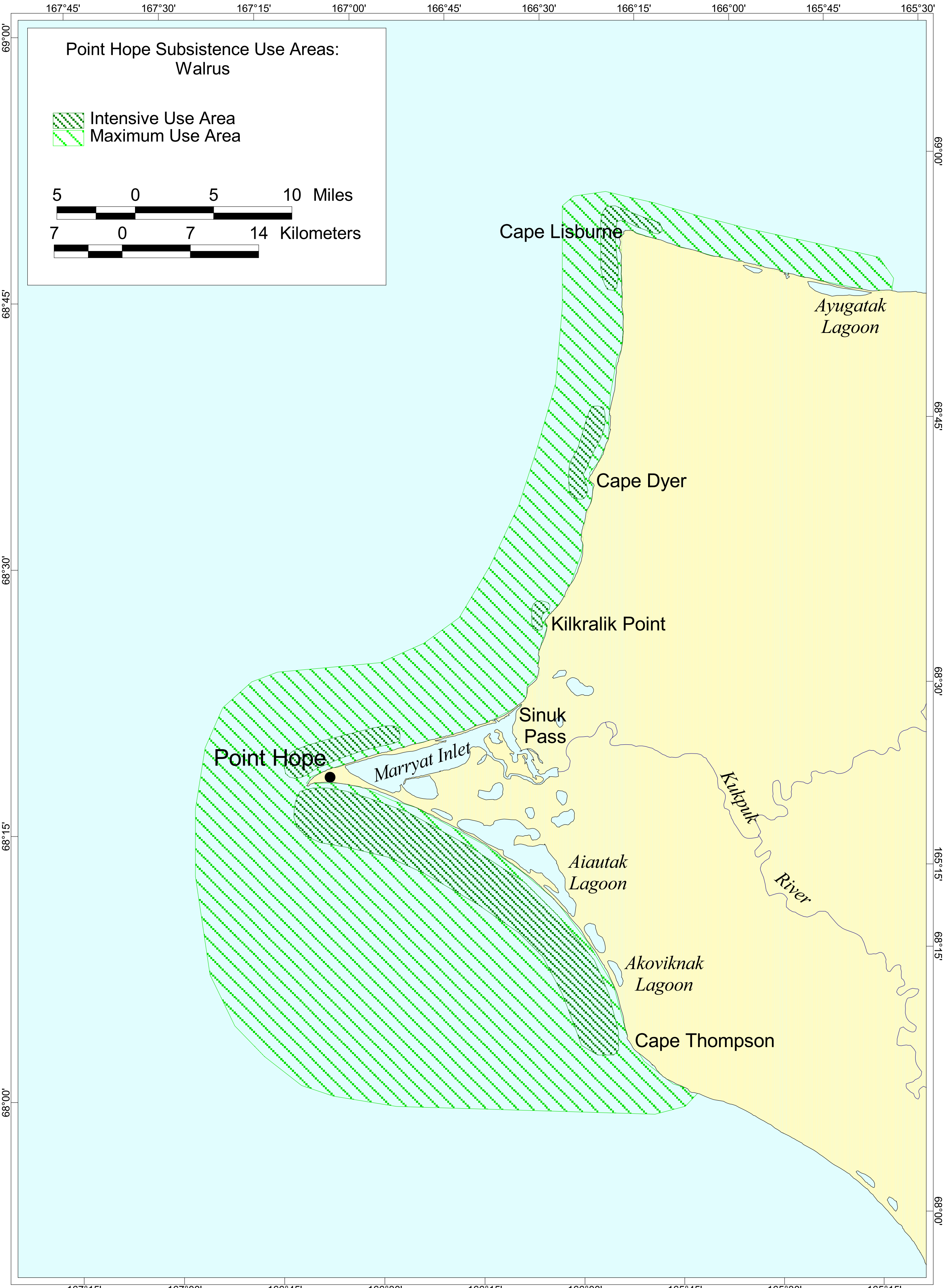


Figure C-4. Point Hope Subsistence Use Areas: Walrus. From Braund & Burnham, 1984.

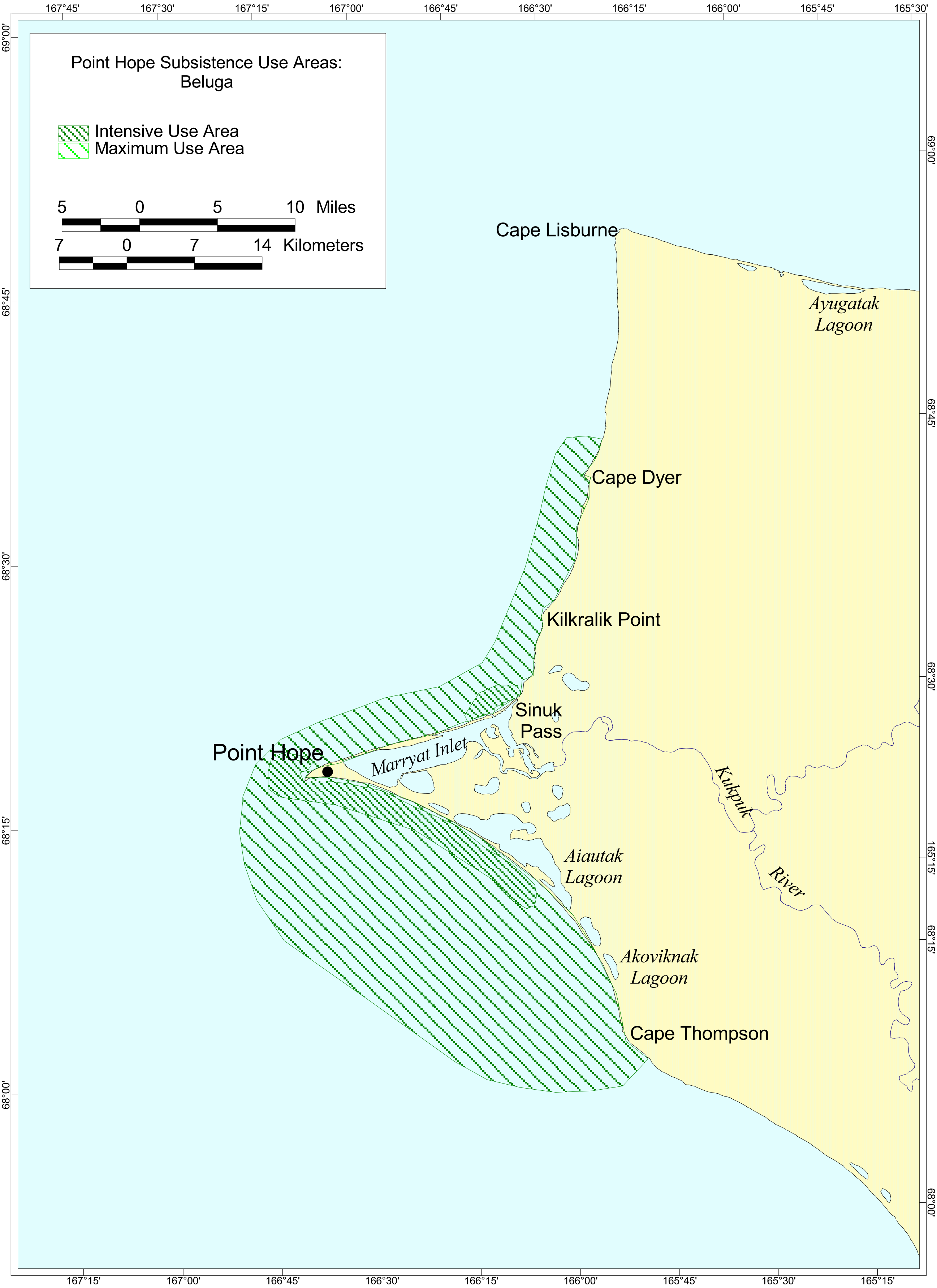
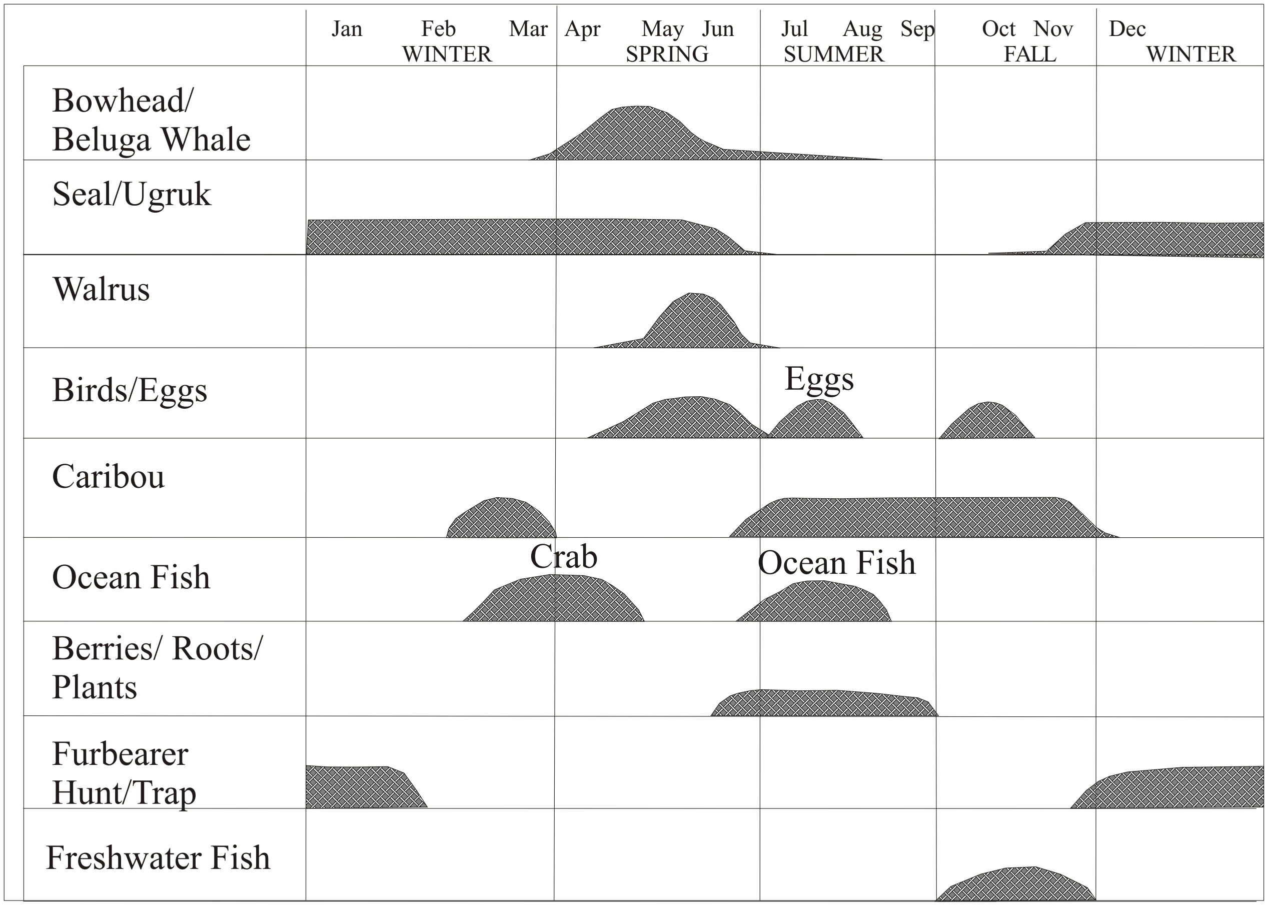


Figure C-5. Point Hope Subsistence Use Areas: Beluga. From Braund & Burnham, 1984.



Source: Pedersen, 1977.

Figure C-6. Point Hope Annual Subsistence Cycle.

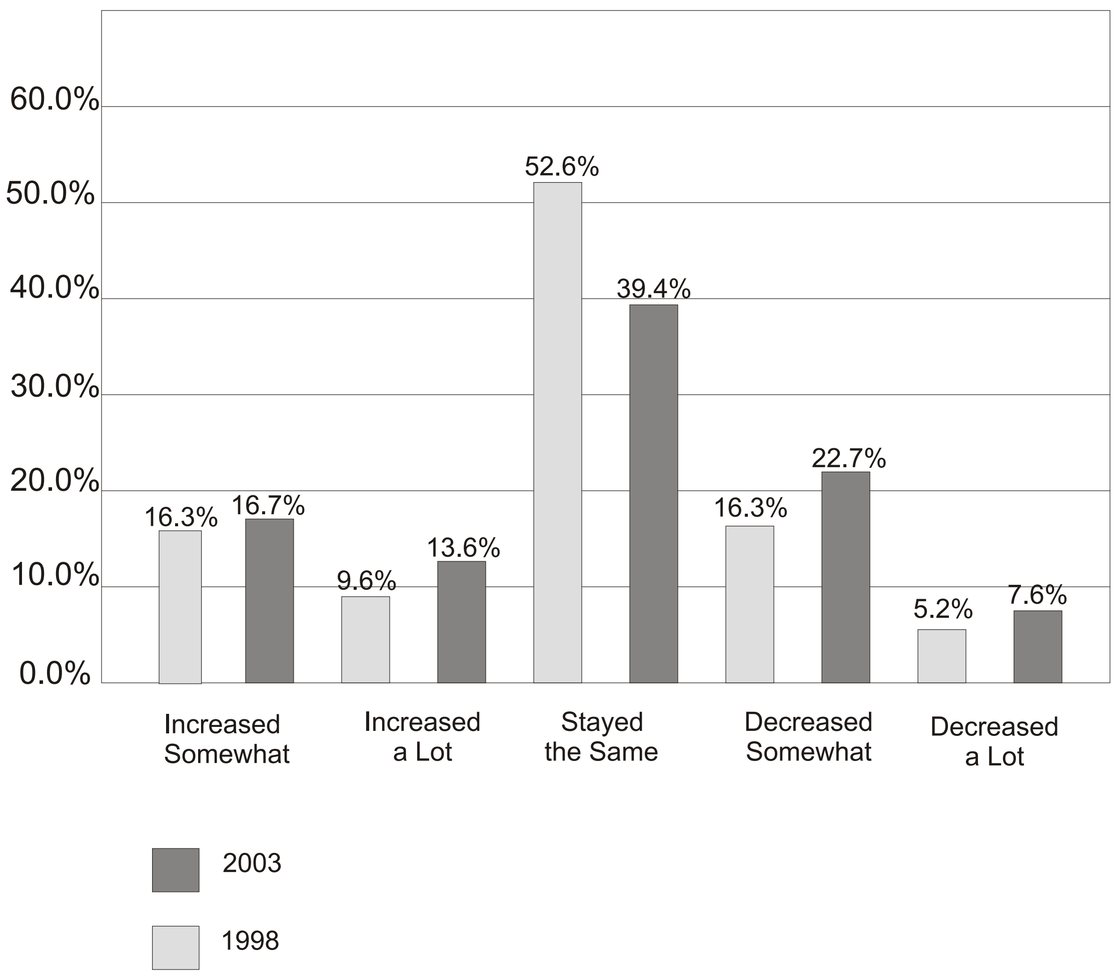


Figure C-7. Point Hope: Changes in Subsistence Activity. Fuller and George, 1997; North Slope Borough, 2004.

Table C-1.
Breakdown of Total Harvest by Subsistence-Harvest Category for Point Hope, Alaska, 1992.
The 1993 Population of Point Hope was 699; The Total Number of Households was 156.

Subsistence Harvest Category	Total Weight	Pounds Per Household	Pounds Per Capital
Birds	9,429	60	13
Fish	30,589	196	44
Invertebrates	88	I	0
Marine Mammals	262,009	1,680	375
Plants	2,720	17	4
Terrestrial Mammals	35,548	228	51
Total	340,383	2,182	487

Source:
Fuller and George, 1997.

Table C-2.
Top Five Species Harvested at Point Hope, Alaska during Calendar Year, 1992.

Top Five Species Harvested	Edible Pounds Harvested	Number Harvested	Pounds Per Household	Pounds Per Capita	Percent of Total Harvest
Beluga	137,172	98	879	196	40.3%
Walrus	55,797	72	358	80	16.4%
Bearded Seal	28,242	160	181	40	8.3%
Caribou	26,303	225	169	38	7.7%
Bowhead	23,365	3	150	33	6.9%

Source:
Fuller and George, 1997.

Table C-3.
Participation in Subsistence Harvest Activities, Point Hope, Alaska, 1992. of 156 Households, 142 Households Participated in This Survey.

Activity	Often	Sometimes	Sometime	Not at All	% Often	% Sometime	% Vacation	% Not at All
Fall Whaling	4	5	0	133	3%	4%	0%	94%
Fish	86	29	1	26	61%	20%	1%	18%
Helped Whaling Crew	92	27	2	21	65%	19%	1%	15%
Hunt Caribou	71	27	1	43	50%	19%	1%	30%
Hunt Moose, Bear, or Sheep	35	27	2	78	25%	19%	1%	55%
Hunt Seal	78	29	0	35	55%	20%	0%	25%
Hunt Walrus	70	33	0	39	49%	23%	0%	27%
Hunt Waterfowl & Eggs	81	27	1	33	57%	19%	1%	23%
Make Sleds or Boats	53	26	0	63	37%	18%	0%	44%
Pick Berries	81	39	1	21	57%	27%	1%	15%
Sew Skins, Make Parkas	49	35	0	58	35%	25%	0%	41%
Spring Whaling	98	16	4	24	69%	11%	3%	17%
Trap	14	22	0	106	10%	15%	0%	75%

Source:
Fuller and George, 1977.

Table C-4.
Point Hope, Amount of Food Consumed Harvested from Local Sources*

Amount	1998		2003	
	Number	Percent	Number	Percent
None	4	2.9%	10	7.0%
Very Little	11	8.2%	16	11.3%
Less Than Half	23	17.2%	23	16.2%
Half	34	25.4%	28	19.7%
More Than Half	34	25.4%	30	21.1%
Nearly All	19	14.2%	15	10.6%
All	9	6.7%	20	14.1%
Total	**134**	**100%**	**142**	**100%**

Note:
* Results include only those households responding to the census survey and the query about the amount of subsistence harvested by the household.
Source:
Fuller and George, 1997.

Table C-5.
Point Hope Money Spent on Subsistence Activities, 2003.

Amount	Number	Percent
$0 to $100	27	22.5%
$200 to 400	9	7.5%
$500 to 700	10	8.3%
$800 to1,200	11	9.2%
$1,200 to $3,000	22	18.3%
$3,100 to $9,500	22	18.3%
$9,600 to $20,000	18	15.1%
$21,000	1	0.8%
Total	**120**	**100%**

Note:
Results include only those households responding to the census and the questions about money spent on subsistence.
Source:
Fuller and George, 1997.

Table C-6
Annual Bowhead Whale Subsistence Harvest for Beaufort and Chukchi Sea Villages, 1982-2005

Year	Kaktovik	Nuiqsut	Barrow	Wainwright	Point Hope	Kivalina
1982	1	1	0	2	1	0
1983	1	0	2	2	1	0
1984	1	0	4	2	2	1
1985	0	0	5	2	1	0
1986	3	1	8	3	2	0
1987	0	1	7	4	5	1
1988	1	0	11	4	5	0
1989	3	2	10	2	0	0
1990	2	0	11	5	3	0
1991	2	1	12	4	6	1
1992	3	2	22	0	2	1
1993	3	3	23	5	2	0
1994	3	0	16	4	5	2
1995	4	4	19	5	1	1
1996	1	2	24	3	3	0
1997	4	3	30	3	4	0
1998	3	4	25	3	3	0
1999	3	3	24	5	2	0
2000	3	4	18	5	3	0
2001	4	3	27	6	4	0
2002	3	4	22	1	0	0
2003	3	4	16	5	4	0
2004	3	3	21	4	3	0
2005	3	1	29	3	7	0

Sources:
S.R. Braund and Assocs., 1984; Stoker and Krupnik, 1993; AEWC, 1993, 1994, 1995; Philo et al., 1994; Suydam et al., 1995; Stephen R. Braund & Associates 2002; S.R. Braund and Assocs. and North Slope Borough, Dept. of Wildlife Management, 2006.

Table C-7.
Annual Beluga Whale Harvest for Barrow, Wainwright, Point Lay, Point Hope, and Kivalina, 1980-2005

Year	Number of Whales				
	Barrow	Wainwright	Point Lay	Point Hope	Kivalina
1980	0	0	15-18	23-35	3-5
1981	5	0	29-38	4-7	10-15
1982	3-5	0	28-33	17	4-5
1983	3	0	18	20-31	24
1984	0	0	0	30	27
1985	0	0	18	30	120-200
1986	0	5	33	30	7
1987	0	47	22-35	40	4
1988	0	3	40	59	6
1989	1	0	16	17	0
1990	0	0	62	16	1
1991	1	5	35	39	1
1992	0	20	24	15	10
1993	2	0	77	79	3
1994	5	0	56	53	3
1995	0	0	31	40	3
1996	2	0	41	15	7
1997	8	4	3	32	1
1998	1	38	48	52	0
1999	1	3	47	33	1
2000	1	0	0	16	44
2001	1	23	34	24	0
2002	1	37	47	23	3
2003	2	38	36	34	0
2004	1	0	53	29	1
2005	7	1	41	?	2

Sources:
Alaska Beluga Whale Committee, 2002, 2006, Fuller and George, 1997; Lowry et al., 1989; Burns and Frost, 1989; Impact Assessment, 1989; Burns and Seaman, 1986; Braund and Burnham, 1984.

Table C.8.
Annual Walrus Harvest for Barrow, Wainwright, Point Lay, Point Hope, and Kivalina, 1985-2005.

Harvest Season	Number of Walrus				
	Barrow	Wainwright	Point Lay	Point Hope	Kivalina
1985	--	--	--	--	--
1986	--	--	--	--	--
1987	54	--	6	--	--
1988	1-62	0-59	0	--	--
1989	14	43	0	2	46
1990	7	0	0	5	0
1991	23	32	0	0	0
1992	26	48	0	5	1
1993	27	44	1	5	12
1994	16	68	1	6	16
1995	12	83	4	0	38
1996	13	24	4	0	13
1997	48	50	0	3	2
1998	24	69	7	5	0
1999	17	48	8	5	0
2000	19	36	6	6	0
2001	37	94	3	2	0
2002	39	119	11	16	0
2003	51	29	9	12	0
2004	52	47	5	20	0
2005	5	21	5	0	4

Source:
USDOI, FWS, 1997, 2002; USDOI, FWS, MTRP Tagging Database, 1989-2005; Braund, 1993; Braund and Burnham, 1984; CPDB, 1996; Fuller and George, 1997.

Table C-9.
Annual Polar Bear Harvest for Barrow, Nuiqsut, Wainwright, Point Lay, Point Hope, and Kivalina, 1983-2005.

Harvest Season*	Number of Bears					
	Barrow	Nuiqsut	Wainwright	Point Lay	Point Hope	Kivalina
1983/84	27	0	34	8	30	3
1984/85	33	1	18	0	18	3
1985/86	14	4	8	6	17	2
1986/87	18	2	13	4	13	1
1987/88	15	4	9	2	9	5
1988/89	29	4	14	2	9	1
1989/90	14	0	9	1	23	5
1990/91	14	0	6	3	18	3
1991/92	22	2	3	0	9	2
1992/93	26	0	8	3	17	1
1993/94	30	4	10	1	8	1
1994/95	11	1	7	1	20	2
1995/96	18	1	14	1	7	0
1996/97	40	0	9	6	14	0
1997/98	18	2	6	3	12	0
1998/99	16	3	2	0	18	3
1999/00	17	7	5	4	10	0
2000/01	28	5	10	1	15	1
2001/02	25	3	2	1	9	0
2002/03	20	3	5	1	12	1
2003/04	10	2	13	3	10	0
2004/05	2	2	5	4	9	2
2005/06***	?	?	?	?	?	?

Source:
Schliebe, Amstrup, and Garner, 1995; Schliebe, 2006.

Notes:
* Harvest runs from 1 July to 30 June.
** Atqasuk harvested 2 bears during the 1988/89 season.
*** Harvest season incomplete.