Bering Strait Region Case Study

Contributors
L. Brigham (USARC), M. Cerne (USCG), K. Cole (NOAA, NWS), N. Durham (USNA), A. Fish (NOAA, NWS), C. Johnson (USARC), M. McCammon (AOOS), R. Meehan (USFWS), S. Montoya (USCG), T. Newbury (USMMS), J. Overland (NOAA), R. Pawlowski (AFDF), G. Sheffield (ADF&G), M. Wang (NOAA).

I. Introduction

Separating the Asian and North American continents, the Bering Strait is a narrow international strait that connects the North Pacific Ocean to the Arctic Ocean and forms the major corridor between northern and southern transportation routes (Figure 1). At the strait's narrowest point, Alaska's Cape Prince of Wales and Russia's Cape Dezhnev are just 90 km apart. Seasonally dynamic sea ice conditions of all types are to be found in this natural bottleneck, including shorefast ice, pan ice, and moving pack ice that can be either newly formed ice or older, multi-year ice.

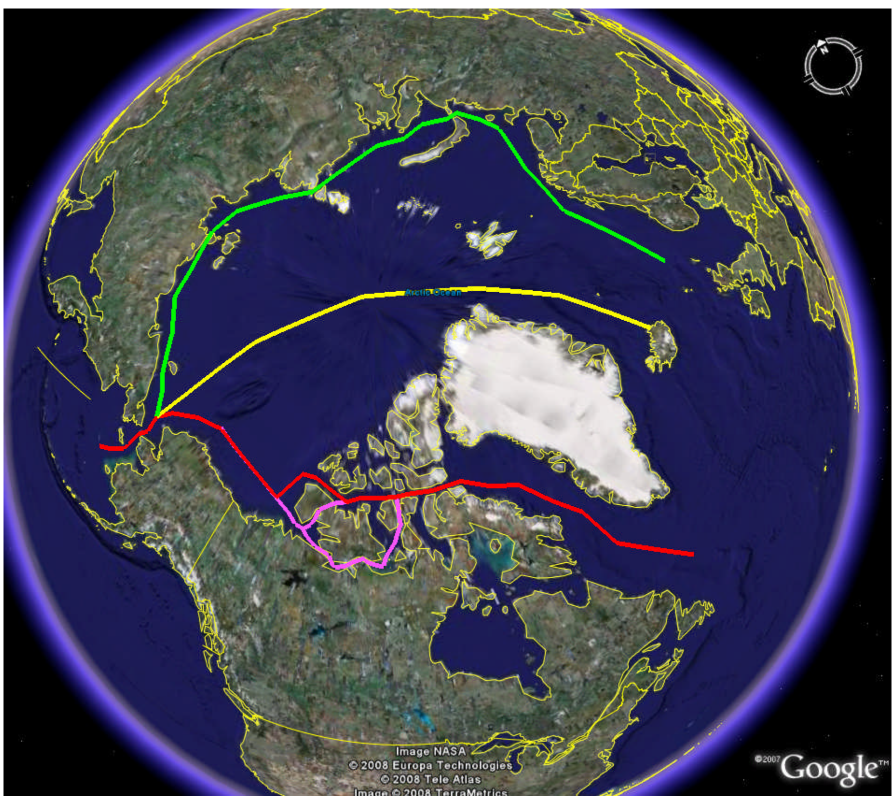


Figure 1. Potential shipping routes that pass through the Bering Strait.

The closest towns of any size are Nome, Alaska on the southern side of the Seward Peninsula and Alyatki, Russia on the northern edge of the Chukchi Peninsula. A pair of islands, the Diomedes, lies in the middle of the strait with Russia claiming Big Diomede Island and the United States claiming Little Diomede Island with less than 4 km separating the two islands. The International Dateline also slices through the center of the Bering Strait dividing the Diomede Islands, and possibly complicating navigation. The average water depths in the strait range from 30 to 50 meters.

Figure 2. Vessel traffic in the Bering Strait Region during Summer 2004.

This case study focuses on the current and future (until 2020) use of the Bering Strait region. The strait is a bottleneck that connects two unique, but globally significant large marine ecosystems: the Bering Sea, part of the North Pacific Ocean, and the Chukchi Sea, part of the Arctic Ocean. The strait is international, bordered by the United States on one side and Russia on the other and ringed by numerous small communities with a large indigenous population.

Like the rest of the Arctic, it is a dynamic region, with current climate change amplifying all its complexities. The Bering Strait region is defined by the presence or absence of sea ice and by local oceanographic conditions as described below. Those conditions and the region's biological communities are changing quickly and in unpredictable ways, making the region more vulnerable to human and natural perturbations. Although the environmental impacts from increased marine shipping in the Arctic are described in Chapter 6, the potential damage from an oil spill in this region would be great, especially given that a spill in ice conditions would be nearly impossible to clean up given current technology.

II. Description of the study area

Geography

For the purposes of this review, the Bering Strait region is considered bounded by 63°N to 67°N. The geography of the Bering Strait presents a choke point between the two oceans as the continental land masses and the ocean bottom converge creating a shallow, narrow opening. The bottom profile of the region presents a uniformly shallow and gently sloping floor with the eastern region being slightly shallower (30-40m) compared to the deeper (40-50m) western edge toward Russia. There are several islands in the Bering Strait region with St. Lawrence Island to the south being the largest. St. Lawrence Island stretches 145km east to west with a width of 13-26km and covers over 4,600km². Other islands of note are the two Diomede Islands in the middle of the strait, Fairway Rock to the south-east of Little Diomede, and King Island south of Cape Prince of Wales. All of these islands are characterized with high, rocky cliffs. St. Lawrence Island and the two Diomedes support year around indigenous populations.

To the south in the Bering Sea, there are two large embayments, the shallow (20m) Norton Sound to the east and the deep (70-90m) Gulf of Anadyr to the west. A 50m deep channel runs between the Chukotka Peninsula and the western side of St. Lawrence Island. St. Lawrence Island presents a noticeable effect on the northerly currents through the Bering Strait by diverting flow to both sides and creating a northerly lee for 150km. It also effects tidal and wave energy pushing north from the Bering Sea. Channeled winds typically blow either north or south through the strait due to the high, mountainous capes that rise up from both peninsulas.

Ocean currents and characteristics

The Bering Strait creates a convergence zone of different currents and temperature and salinity gradients. The currents are broadly well mapped and known as shown in Figure 3. Throughout the year, the water flows predominately to the north due to the wind-driven northerly sloping sea surface. The northward current transports many nutrients, algae, and zooplankton into the southwestern Chukchi Sea. The ocean waters in the Bering Strait region are some of the most biologically productive waters in the world ocean, especially due to the nutrient-rich Anadyr water that flows northward on the western side of the Bering Sea. The flow speeds are not uniform across or along the strait. Flows are almost always swifter within the strait than away from this geographically and bathymetrically constricted area. The flow rates also vary by region with the eastern side experiencing fast to intermediate velocities and the deeper western side experiencing slower and more uniform velocities with a strong velocity sheer between the two sides. Several shoals have formed from these current disparities with one large shoal extending 100km from Cape Prince of Wales.

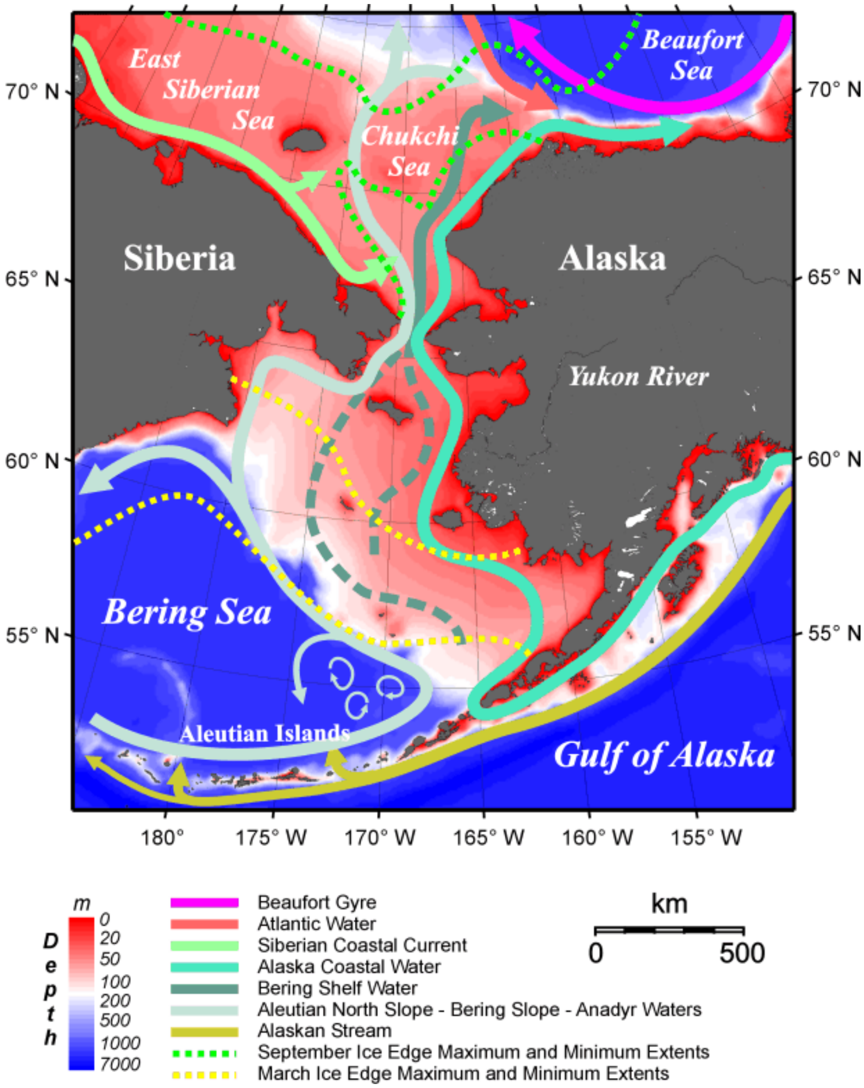


Figure 3. Water masses that flow through the Bering Strait (from Weingartner et al., 1999)

The oceanography of the Bering Straits region is dominated by the Anadyr Current which moves through Anadyr Strait and then northward through Bering Strait. The Anadyr Current results in high primary production over the northern shelf and through the Bering Strait. The strength of the Anadyr Current is related to the magnitude of flow through the Bering Strait. This net northward flow is driven by the difference between sea level in the North Pacific and Arctic Oceans (0.4–0.5 m). On short time scales, this northward flow is modified by wind-generated coastal changes in sea level. During the weak winds of summer, northward transport is greatest and provides the strong flux of nutrients for primary production.

Flow along the Alaskan coast of the northern Bering Sea is a combination of river runoff (mainly the Yukon River) and a continuation of the Bering Coastal Current of the southeastern Bering Sea. Production here has been identified as typical of shallow shelves elsewhere: once nutrients are exhausted during an initial bloom, production is low and only ~10% of that for the Chirikov Basin and the Gulf of Anadyr. The east-west gradient in water properties, nutrients, primary production and fauna (transported in the Anadyr Current) result in two different community structures, a rich benthic system to the west and a less productive eastern system

Seasonal changes in salinity and temperature when combined with winds are significant in determining the formation and strength of sea ice. Salinity differs across the strait with greater salinity in the west. In the eastern region, a distinct pycnocline separates the warmer, lower salinity surface layer at 10 to 15m from the colder and more saline water toward the bottom. Several freshwater sources including the Yukon River on the eastern edge significantly affect the salinity during the summer months. The western edge of the strait remains relatively uniform with cold, saline water. The temperature difference between the surface and the bottom rarely exceeds 8°C.

Bathymetry

The continental shelf of the Bering Strait case study area is recognized as a broad generally featureless shelf with 3 major islands and several small islands or rocks. With depths less than 200 meters over the shelf and a gradient of 0.24m/km, it is one of the gentlest gradients of the world's continental shelves. The geology of the Bering Sea and Bering Strait regions is well described as a shallow epicontinental sea. Surface sediments west of 169^{o}W are thought to be of glacial and marine origin, while surface sediments east of 169^{o}W are underlain by river deposits. The deposition of sediment is largely influenced by geologic and oceanographic processes. Where relief is measurable, it reflects either tectonic uplift with evidence of modification with sea level change and glacial activity at St. Lawrence Island and the Seward Peninsula or coastal scouring associated with strong currents in the vicinity of Cape Prince of Wales. This scouring extends far into the Chukchi Sea, creating a significant shallow area northeast of the Bering Strait.

The mapped bathymetry of the Bering Strait case study area reflects the compilation of soundings collected by national interests and shared through scientific and technical agreement. The United States side of the international border has been adequately surveyed to produce bathymetric maps of 1:250,000 scale and contoured to 5 meter levels. This compilation is based on the soundings by the National Ocean Service, NOAA and its predecessor, the United States Coast and Geodetic Survey from 1900 to 1971. Bathymetric multi-beam data collected during US EEZ surveys of the 1980's and USGS "Gloria" seabed side scan sonar profiles are available, but have not been compiled into an overall bathymetric map. Surveys of the Russian side of the border are much less available, with the accuracy of available data at 1:1,000,000. These data have been merged with the United States surveys to provide a continuous bathymetric profile across the area. A summary of these surveys is provided by the USGS Alaska Science Center with data sets maintained online through the USGS: http://alaska.usgs.gov/science/biology/walrus/bering/bathy/index.html.

The Bering Strait bathymetric maps are adequate for understanding the general structure of the seabed and the shoals in the vicinity of St. Matthew, St. Lawrence, King, and the Diomede Islands, Fairway Rock and extending north of Cape Prince of Wales. However, chart coverage is poor with the area best displayed on Chart 514, Bering Sea Northern Part at 1:3,500,000. A modern harbor chart is available only at Nome, Alaska at 1:20,000 reflecting recent harbor construction. Deep draft navigation information is available for the mineral loading port at the Red Dog Dock. All other navigation in the area is based on local knowledge and experience.

Coastal shoreline and erosion

The coastal topography has been influenced by periodic rising and lowering of the sea levels and emergence of the Bering land bridge. Today the coastal topography varies from low coastal relief of barrier islands and inshore lagoons generally associated with river deltas to significant coastal bluffs ending the coastal ranges of the Seward Peninsula. The low coastal relief of St Matthew and St Lawrence Islands reflect sedimentary processes associated with glacial moraines while the sheer cliffs of King and the Diomede Islands reflect uplift eroded by coastal processes and arctic maritime climate. The topography on the islands offers no significant harbors of refuge for other than shallow draft vessels. The only relatively deep harbor close to the Bering Strait exists at Port Clarence, where a 4 mile wide channel offers a passage free of dangers with depths of 42 to 48 feet. This natural embayment is sheltered by the low spit at Point Spencer to the west, Point Jackson and to the north and the mainland of the Seward Peninsula to the east and south.

Formation of offshore and landfast sea ice during the early fall months have historically provided a protective barrier to the coast from the impacts of waves and storm surges. However, with later freeze-ups in the fall, the coast has recently experienced increased exposure to the impacts of wave action. This, combined with thawing permafrost throughout Alaska's Arctic, has resulted in increased coastal erosion and shoreline instability.

Water levels

Water level information is limited for the area with long term measurements at Nome Alaska (1992-present) and more recently, the Red Dog dock (2004-present) in Kotzebue Sound. Predictive models by the National Ocean Services show co-tidal and co-range contours for the area reflecting a complex tidal regime of diurnal and semi-diurnal tides with ranges of less than 1 meter change. No predictions are available for the Bering Strait or north into the Chukchi Sea, other than directly in Kotzebue Sound. Storm surge is the dominant force in coastal inundation.

Tide coordinated shoreline in the Bering Strait area is limited to a 2003 aerial survey by NOAA's National Geodetic Survey in Kotzebue Sound in the vicinity of Kivalina (north shore) and Shishmaref (south shore) for establishing an erosion baseline and comparison with the 1952 and 1949-1950 surveys. This was the first set of 1:12,000 tide coordinated data in the Chukchi Sea since the 1959-1953 1:40,000 USGS coastal photogrammetry. The shoreline of the Bering Strait and the islands of St. Matthew and St. Lawrence are mapped and maintained from analog data as derived from the USGS mapping efforts from 1949-1952, with an update only to the south shore of Kotzebue Sound. Norton Sound and the Yukon delta remain unmapped.

Sea ice

Seasonally dynamic sea ice conditions of all types are to be found in this natural bottleneck separating the Bering and Chukchi seas and include shorefast ice, polynyas, pack ice, and pan ice. Seasonally, this sea ice serves as a habitat for small fauna, birds, and marine mammals. Ice in the Chukchi Sea to the north and the Bering Sea to the south of the strait is seasonal following the north-south movement of the sun with a lag of about 3 months). The sea ice summer minimum extent typically occurs in late September when the ice edge lies across the northern Chukchi Sea or further north in the Arctic Ocean. Sea ice reaches it maximum in April when it stretches across the Bering Sea from the Alaskan Peninsula to the Kamchatka Peninsula. Typically, ice begins to develop along the Bering Strait coasts in October and fills the strait in November. The ice transition periods for the Bering Strait are October and November for advancing ice and May through July for retreating ice). The variability of these events is shown in the analyses of ice edge location at the beginning of the months May through July and October through December for the odd years from 1997 to 2007 (Figures 4-9).

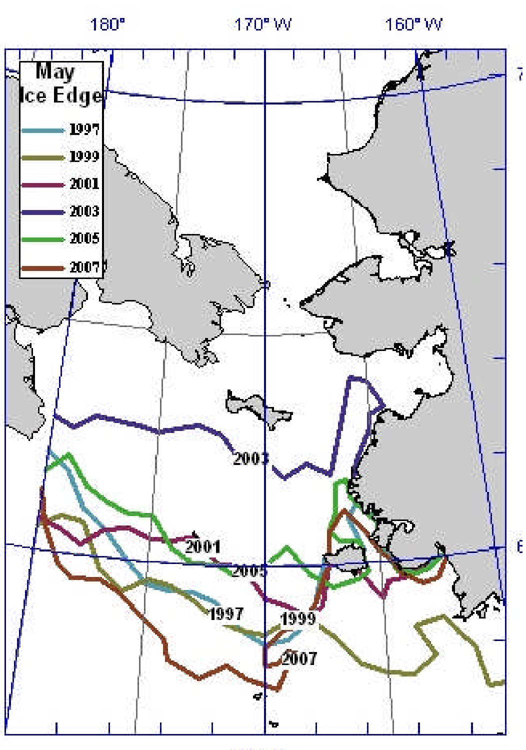


Figure 4 First of May Ice Edge Location

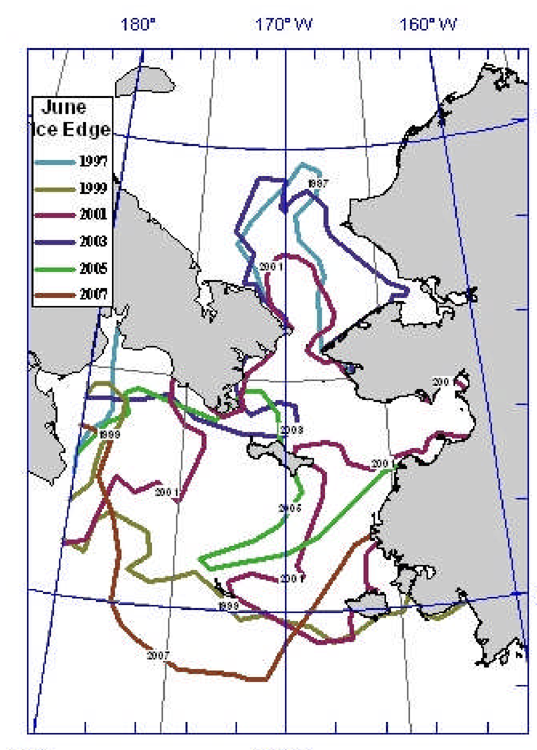


Figure 5 First of June Ice Edge Location

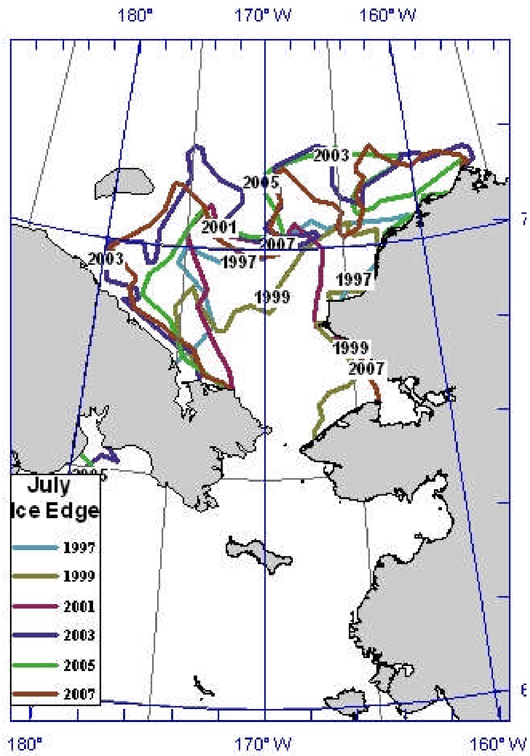


Figure 6 First of July Ice Edge Location

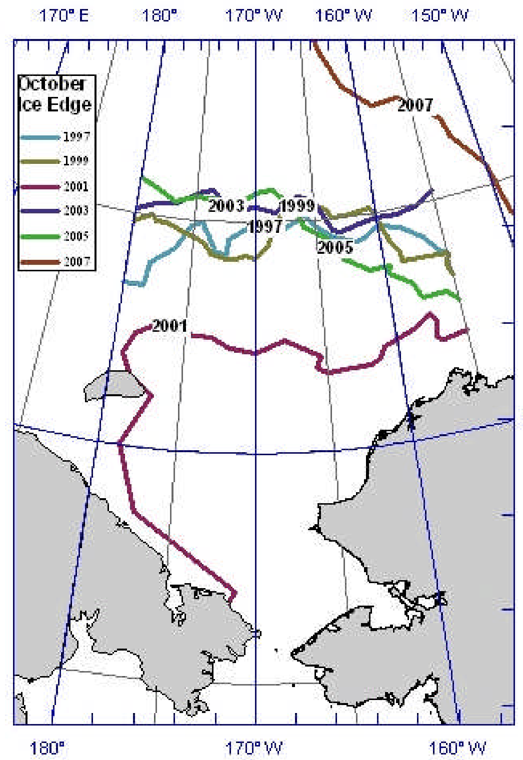


Figure 7 First of October Ice Edge Location

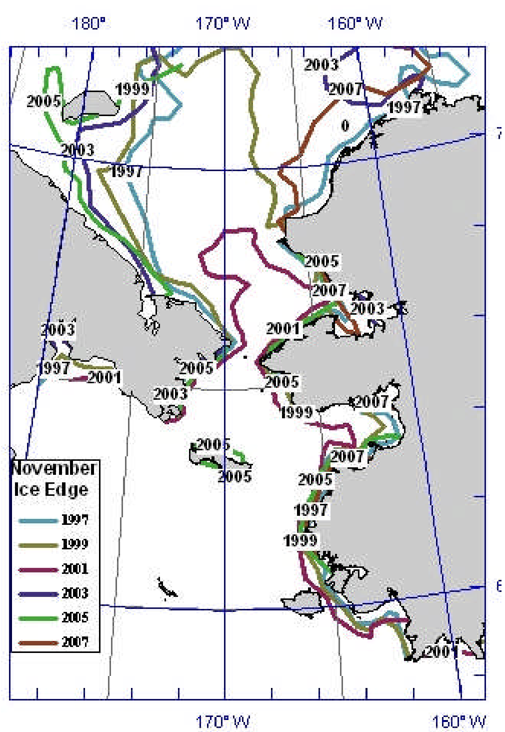


Figure 8 First of November Ice Edge Location

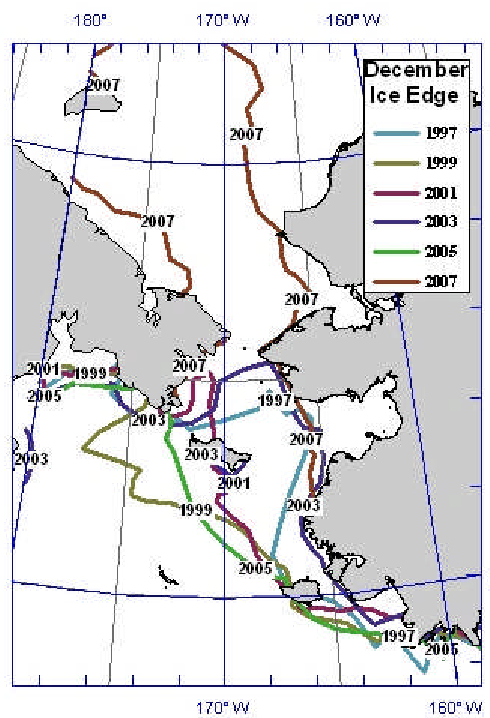


Figure 9 First of December Ice Edge Location

The ice that develops yearly in the Chukchi and Bering Seas grows to thicknesses greater than 4 feet. The ice is not stationary and flows between the Chukchi and Bering driven by winds and currents. Ice is known to move through the Bering Strait at rates close to 27 nautical miles per day. Wind driven polynyas, large areas of open water within the ice field, are typical near St. Lawrence and St. Matthew islands. The seasonal ice field never contains ice bergs, ice calved from land-based ice fields. Multiyear ice from the Arctic ice pack has been known to flow through the strait and into the Bering Sea (Figure 8). This old ice is thicker and denser than first year ice and, when present, slows the summer melting process.

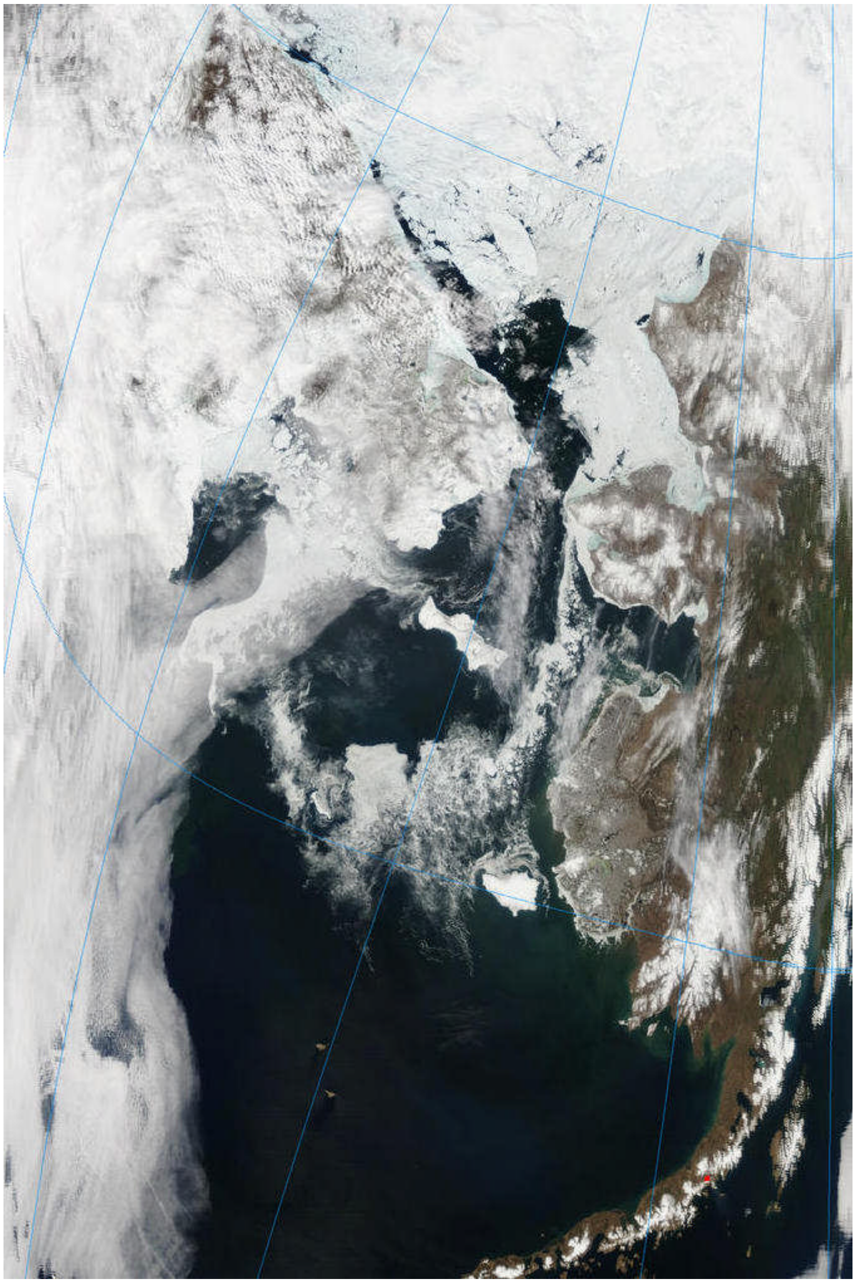


Figure 10 - 2006 MODIS image of multi-year ice among seasonal ice in the Bering Strait Region

Several programs currently provide sea ice forecasts and products. The National Ice Center (NIC) provides strategic and tactical ice information to government agencies. The National Weather Service (NWS) through the Alaska Region Ice Program provides information to the general public, state and local officials, Alaska Native groups and various commercial marine interests for sea ice in and near Alaska waters. The Alaska sea ice forecaster prepares routine Sea Ice Advisory text products three days per week that are accompanied by a graphical sea ice analysis and five day sea ice forecast. Sea surface temperature analyses are produced twice per week. The graphic products are GIS based and available in many formats. The Alaska ice program responds to oil spills, search and rescue operations and other threatening situations whenever sea ice is a factor.

An analysis of sea ice is made using a combination of surface and satellite data. Surface data includes ship observations, local observations, digital photos and small plane over-flights. Satellite data includes visible and infrared (IR) images from geostationary and polar orbiting platforms, high resolution visible MODIS images from NASA and Synthetic Aperture Radar (SAR) from satellites owned by several nations (the United States does not own a SAR platform system). Visible and IR images are limited by cloud cover. SAR imagery is not impacted by clouds and has become a significant tool in ice analysis, although the availability of SAR data was severely decreased when the Canadian satellite RADARSAT-1 was decommissioned on May 2, 2008.

Projected Changes in the sea-ice Cover

Comprehensive Atmosphere-Ocean General Circulation Models (AOGCMs) are the major objective tool used to account for the complex interaction of processes and feedbacks which determine future climate. Such model projections formed the basis of the Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC AR4) and are now archived as part of the CMIP3 Project. Using 17 of the CMIP3 models Wang and Overland projected that the future sea ice extent in the vicinity of the Bering Strait will not change dramatically in spring (April and May). For example, by the middle of this century, a reduction to about 90% of current ice coverage is likely. However, a significant reduction (later freeze-up) is projected in November and December. The average ice extent is 30% of today's area by 2050 (relative to a 1979-1999 mean) in November and 60% of today's area in December.

People

The Bering Strait region is a relatively small, but vastly dynamic and strategic, area that includes approximately 9,000 vibrant indigenous Russian and American citizens. The region is home to three distinct linguistic and cultural groups of Eskimo peoples; Inupiaq, Central Yupik, and Saint Lawrence Island Yupik. There is documented evidence of human habitation dating as far back as 10,000 years. Alaska Native people make up 75% of the population. There are 15 year-round villages outside of Nome that range in population from 161 to 798. For each group/tribe there are socio-economic, cultural, and political differences and similarities to be considered unique to each group within the region. Nome is the largest community in the region with approximately 3,700 people. It is the transportation and service hub for the region. Residents of the region use and rely upon a multitude of marine resources from shared animal populations for their nutritional, economic, and cultural needs.

The main communities on the Russian side are just south of the Bering Strait, as they are on the U.S. side, and include Provideniya, Egvekinot, and Anadyr. Provideniya is a former Soviet military port with a 2002 population of about 2,500, mainly Yupik. Anadyr is a port on the Gulf of Anadyr, and the eastern-most town in Russia. The population was about 11,000 in 2002. Egvekinot is a small town with a population of about 2,500 in 2002. The locations of these communities are illustrated in Figure 2.

III. Ecosystem and Bio-resource Considerations

The Bering Strait region is a highly productive area extensively used by many species (including several species listed under the federal Endangered Species Act) of marine mammals, seabirds and fishes. The highly productive continental shelf seasonally supports a rich array of benthic feeders, such as gray whales, Pacific walrus and spectacled eiders. Ice-dependent species seasonally move through the region as sea ice retreats and advances. Many species depend upon primary productivity associated with sea ice, and the juxtaposition of the seasonal ice and productive benthos serves to support a unique diversity and density of marine life. It is also a dynamic region and the physical constraints of the Bering Strait serve to seasonally concentrate species associated with the ice edge. The Bering Strait region is the only migration corridor for many species (including several federally listed species) of fishes, birds, and marine mammals. Potential conflicts between increased ship traffic and large marine pinnipeds and cetaceans in the Bering Strait region include an increased amount of ambient and underwater ship noise, ship strikes, entanglement in marine debris, and pollution including oil spills. This ecosystem information on the Bering Strait supplements the information on the Bering Strait in Chapter 6 on the arctic environment. Chapter 6 includes detailed information on arctic straits in particular, including the Bering Strait and Unimak Pass.

III.A Marine Mammals

The Bering Sea and Bering Strait region is home to, or seasonally used by, a large number of marine mammals. Polar bears and ice-dependent pinnipeds (Pacific walrus, ribbon seal, bearded seal, spotted seal and ringed seal) seasonally move through the Straits as they follow seasonal ice movements. Other pinnipeds seasonally use the area during the ice-free season (Steller sea lion, Northern fur seal). Some cetaceans use the region as they move into summer feeding areas in the Chukchi and Beaufort seas (*e.g.* Bowhead and gray whales) while others (*e.g.* Beluga) are residents. Particularly for the ice-dependent species, the Bering Strait area is a key movement corridor with seasonally high concentrations of marine mammals in the spring and fall typically tied to ice retreat and reformation. It is also a highly productive area and therefore an important feeding area.

Cetaceans

Bowhead Whale: Western Arctic bowhead whales are distributed in seasonally ice-covered waters of the Arctic and near-Arctic, generally north of 60N and south of 75N in the western Arctic Basin. The largest population, and the only stock that is found within U.S. waters, is the Western Arctic stock, also know as the Bering-Chukchi-Beaufort stock or Bering Sea stock. The majority of the Western Arctic stock migrates annually from wintering areas (November to March) in the northern Bering Sea, through the Chukchi Sea in the spring (March through June), to the Beaufort Sea where they spend much of the summer (mid May through September) before returning again to the Bering Sea in the fall (September through November) to overwinter. Most of the year, bowhead whales are closely associated with sea ice. The bowhead spring migration follows fractures in the sea ice around the coast of Alaska, generally in the shear zone between the shore-fast ice and the mobile pack ice. During the summer most of the population is in relatively ice-free waters in the southern Beaufort Sea. During the autumn migration, bowheads select shelf waters in all but "heavy ice" conditions, when they select slope habitat. Sightings of bowhead whales do occur in the summer near Barrow and are consistent with suggestions that certain areas near Barrow are important feeding grounds. Some bowheads are found in the Chukchi and Bering seas in summer, and these are thought to be a part of the expanding Western Arctic stock.

Gray Whale: Most of the Eastern North Pacific stock spends the summer feeding in the northern Bering and Chukchi seas. Each fall, the whales migrate south along the coast of North America from Alaska to Baja California, in Mexico. Most of them begin migrating in November or December. The Eastern North Pacific stock winters mainly along the west coast of Baja California, using certain shallow, nearly landlocked lagoons and bays, and calves are born from early January to mid February. The northbound migration generally begins in mid February and continues through May, with cows and newborn calves migrating northward primarily between March and June along the U.S. west coast. While most North Pacific gray whales spend the summer in the shallow waters of the northern and western Bering Sea and Arctic Ocean, some animals feed along the Pacific coast. Photo-identification studies of these animals indicate that they move widely within and between areas on the Pacific coast, are not always observed in the same area each year, and may have several year gaps between re-sightings in studied areas.

Beluga Whale: Beluga whales are distributed throughout seasonally ice-covered Arctic and sub Arctic waters of the Northern Hemisphere, and are closely associated with open leads and polynyas in ice-covered regions. Depending on season and region, beluga whales may occur in both offshore and coastal water of the Strait, with concentrations in Norton Sound and Kasegaluk Lagoon. It is assumed that most beluga whales from these summering areas overwinter in the Bering Sea, excluding those found in the northern Gulf of Alaska. Seasonal distribution is affected by ice cover, tidal conditions, access to prey, water temperature, and human interaction. During the winter, beluga whales occur in offshore waters associated with pack ice. In the spring, they migrate to warmer coastal estuaries, bays, and rivers for molting and calving. Annual migrations may cover thousands of kilometers.

Minke Whale: In the North Pacific, minke whales occur from the Bering and Chukchi Seas to the south near the equator. Minke whales are relatively common in the Bering and Chukchi Seas and the inshore waters of the Gulf of Alaska, but are not considered abundant in any other part of the eastern Pacific. Minke whales are known to penetrate loose ice during the summer, and some individuals venture north of the Bering Strait. Ship surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 resulted in new information about the distribution and relative abundance of minke whales in these areas. Minke whale abundance estimates were similar in the central-eastern Bering Sea and the southeastern Bering Sea. Minke whales occurred throughout the area surveyed, but most sightings of minke whales in the central-eastern Bering Sea occurred along the upper slope in waters 100-200 m deep; sightings in the southeastern Bering Sea occurred along the north side of the Alaska Peninsula and were associated with the 100 m contour near the Pribilof Islands. In the northern part of their range, minke whales are believed to be migratory, whereas they appear to establish home ranges in the inland waters of Washington and along central California.

Killer Whale: Killer whales have been observed in all oceans and seas of the world. Although reported from tropical and offshore waters, killer whales occur at higher densities in colder and more productive waters of both hemispheres, with the greatest densities found at high latitudes. Killer whales are found throughout the North Pacific and occur along the entire Alaskan coast. Seasonal and year-round occurrences have been noted for killer whales throughout Alaska.

Humpback Whale: The humpback whale is distributed worldwide in all ocean basins, though in the North Pacific it does not occur in Arctic waters. In winter, most humpback whales occur in the subtropical and tropical waters of the northern and southern hemispheres. Humpback whales in the high latitudes of the North Pacific are seasonal migrants that feed on euphausiids and small schooling fishes. The historic feeding range of humpback whales in the North Pacific encompassed coastal and inland waters around the Pacific Rim from Point Conception, California, north to the Gulf of Alaska and the Bering Sea, and west along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk. The humpback whale population in much of this range was considerably reduced as a result of intensive commercial exploitation during the 20th century. Recent surveys in the central-eastern and southeastern Bering Sea in 1999 and 2000 resulted in new information about the distribution of humpback whales in these areas. The only sightings of humpback whales in the central-eastern Bering Sea occurred southwest of St. Lawrence Island; animals co-occurred with a group of killer whales and a large aggregation of Arctic cod. A few sightings occurred in the southeast Bering Sea, primarily outside Bristol Bay and north of the eastern Aleutian Islands. However, a survey conducted in 2005 found numerous humpback whales north of the central Aleutian Islands, reinforcing the idea that the Bering Sea is an important feeding area.

North Pacific Right Whale: Whaling records indicate that right whales in the North Pacific ranged across the entire North Pacific north of 35N and occasionally as far south as 20N. Before right whales in the North Pacific were heavily exploited by commercial whalers, concentrations were found in the Gulf of Alaska, eastern Aleutian Islands, south-central Bering Sea, Sea of Okhotsk, and Sea of Japan. Aerial and vessel surveys for right whales have occurred in recent years in a portion of the southeastern Bering Sea where right whales have been observed each summer since 1996. North Pacific right whales are observed consistently in this area, although it is clear from historical and Japanese sighting survey data that right whales often range outside this area and occur elsewhere in the Bering Sea. Bottom-mounted acoustic recorders were deployed in the southeastern Bering Sea and the northern Gulf of Alaska starting in 1999 to document the seasonal distribution of right whale calls. Preliminary analysis of the data from the recorders indicates that right whales remain in the southeastern Bering Sea from May through November with peak call detection in September. Right whale calls were rarely detected in the northwestern Gulf of Alaska in the late summer. Right whales have not been observed outside the localized area in the southeastern Bering Sea during surveys conducted for fishery management purposes which covered a broader area of Bristol Bay and the Bering Sea. In 2004, a right whale was successfully tagged with a satellite-monitored transmitter for 40 days, during which time the animal moved over a large part of the southeastern Bering Sea including the outer shelf area. In September 2004, information from the tag was used with acoustic detections to find the largest aggregation of right whales observed in the eastern North Pacific since Soviet whaling. A minimum of 17 individuals were identified by photo identification and genotyping from skin biopsies. In 2006, the National Marine Fisheries Service (NMFS) issued a final rule designating two areas as northern right whale critical habitat, one in the Gulf of Alaska and one in the Bering Sea (71 FR 38277, 6 July 2006).

Harbor Porpoise: In the eastern North Pacific Ocean, the harbor porpoise ranges from Point Barrow, along the Alaska coast, and down the west coast of North America to Point Conception, California. The harbor porpoise primarily frequents coastal waters. The average density of harbor porpoises in Alaska appears to be less than that reported off the west coast of the continental U.S.

Dall's Porpoise: Dall's porpoises are widely distributed across the entire North Pacific Ocean. They are found over the continental shelf adjacent to the slope and over deep (2,500+ m) oceanic waters. They have been sighted throughout the North Pacific as far north as 65°N, and as far south as 28°N in the eastern North Pacific. Throughout most of the eastern North Pacific they are present during all months of the year, although there may be seasonal onshore-offshore movements along the west coast of the continental U.S.

Polar Bears

Polar bears in the Bering Strait region are subject to the movements and coverage of the pack ice and annual ice. They are dependent on the ice as a platform for hunting and resting, and giving birth. Ringed seals are their primary prey. Historically, polar bears of the Chukchi Sea have spent most of their time on the annual ice in near-shore, shallow waters over the productive continental shelf, which is associated with the shear zone and the active ice adjacent to the shear zone. Sea ice and food availability are two important factors affecting the distribution of polar bears. During the ice-covered season, bears use the extent of the annual ice. The most extensive north–south movements of polar bears are associated with the spring and fall ice movement. For example, during the 2006 ice-covered season, six bears radio collared in the Beaufort Sea were located in the Chukchi and Bering Seas as far south as 59^{o} latitude, which was the farthest extent of the annual ice.

Polar bear distribution during the open-water season is dependent upon the location of the ice edge. The summer ice pack can be quite patchy and segments can be driven by wind great distances carrying polar bears with them. For example, bears from both the Southern Beaufort and Bering/Chukchi stocks overlap in their distribution around Point Barrow and can move into surrounding areas depending on ice conditions. Recent telemetry movement data are lacking for bears in the Chukchi Sea; however, an increased trend by polar bears to use coastal habitats in the fall during open-water and freeze-up conditions has been noted since 1992. Recently, the minimum sea ice extent in 2005 and 2007 suggest that bears will most likely be found during the open-water periods on the sea ice or along the Chukotka coast.

Ice-dependent Pinnipeds

Pacific Walrus: Pacific walruses inhabit the shallow continental shelf waters of the Bering and Chukchi seas and their distribution often varies markedly with the seasons. During the late winter breeding season, walruses are found in areas of the Bering Sea where open leads, polynyas, or areas of broken pack-ice occur. Significant winter concentrations are normally found in the Gulf of Anadyr, the St. Lawrence Island polynya, and in an area south of Nunivak Island. In the spring and early summer, most of the population follows the lead systems that form along the coastlines of Alaska and Chukotka and stay with the retreating pack ice northward into the Chukchi Sea; however, several thousand animals, primarily adult males, remain in the Bering Sea, using coastal haul-outs in Bristol Bay during the ice-free season. During the summer months, walruses are widely distributed either on Russian coastal haulouts or on sea ice across the shallow continental shelf waters of the Chukchi Sea. Significant summer concentrations are normally found in the unconsolidated pack ice west of Point Barrow, and along the northern coastline of Chukotka Russia, near Wrangel Island. As the ice edge advances southward in the fall, walruses reverse their migration and re-group in large aggregations on the Bering Sea pack ice.

Walruses rely on floating pack ice as a substrate for resting and giving birth and usually occupy areas with natural openings. Walruses are not adapted to a strictly pelagic existence and therefore are seldom found in areas of extensive, unbroken ice. Their concentrations in winter tend to be in areas of divergent ice flow or along the margins of persistent polynyas. Concentrations in summer tend to be in areas of unconsolidated pack ice, usually within 100 km of the leading edge of the ice pack. When suitable pack-ice is not available, walruses haul out to rest on land. Isolated sites, such as barrier islands, points, and headlands, are most frequently occupied. Traditional walrus haul-out sites in the eastern Chukchi Sea include Cape Thompson, Cape Lisburne, and Icy Cape. In recent years, the Cape Lisburne haul-out site has seen regular use in late summer.

Numerous haul-outs also exist along the northern coastline of Chukotka, as well as on Wrangel and Herald islands, which are considered important hauling grounds in late summer especially in years when the pack ice retreats beyond the continental shelf.

Although capable of diving to deeper depths, walruses are for the most part found in waters of 100 m or less, possibly because of the higher productivity of benthic foods in shallow waters. The juxtaposition of ice over appropriate depths for feeding is especially important for females with dependent calves that are not capable of deep diving or long exposure in the water. The mobility of the pack ice is thought to help prevent walruses from overexploiting their prey resource.

In May and June walruses migrate through the Bering Strait region along lead systems that form along the coastlines of Alaska and Chukotka. During the summer months walruses are widely distributed along the southern margin of the seasonal pack ice both in U.S. and Russian waters. During August, the edge of the pack ice generally retreats northward to about 71 ^{o}N, but in light ice years, the ice edge can retreat beyond 76 ^{o}N. The sea ice normally reaches its minimum (northern) extent in September. It is unclear how walruses respond in years when the sea ice retreats beyond the relatively shallow continental shelf waters. In recent years several tens of thousands of walruses have been reported congregating at coastal haulouts along the Russian coast in late summer. Russian biologists attribute the formation of these coastal aggregations to diminishing sea ice habitats in offshore regions. In 2007 a new sea ice minima record was established. Sea ice had completely retreated from the continental shelf waters of the Chukchi Sea by mid-August. Anecdotal reports from Russia indicate that as many as 100,000 walruses congregated at coastal haulouts along the northern Chukotka coastline. An estimated 2-5 thousand walruses were also observed along the northwestern Alaska coast. The pack ice usually advances rapidly southward in October, and most walruses are thought to have moved into the Bering Sea by mid to late November where they winter in large aggregations on the ice.

Spotted Seal: Spotted seals are distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk Seas south to the northern Yellow Sea and western Sea of Japan. Satellite tagging studies have provided considerable insight into the seasonal movements of spotted seals. Those studies indicate that spotted seals migrate south from the Chukchi Sea in October and pass through the Bering Strait in November. Seals overwinter in the Bering Sea along the ice edge and make east-west movements along the edge. During spring they tend to prefer small floes (i.e., < 20 m in diameter), and inhabit mainly the southern margin of the ice, with movement to coastal habitats after the retreat of the sea ice. In summer and fall, spotted seals use coastal haulouts regularly, and may be found as far north as 69-72N in the Chukchi and Beaufort Seas. To the south, along the west coast of Alaska, spotted seals are known to occur around the Pribilof Islands, Bristol Bay, and the eastern Aleutian Islands. Of eight known breeding areas, three occur in the Bering Sea.

Bearded Seal: Bearded seals are circumpolar in their distribution, extending from the Arctic Ocean (85N) south to Hokkaido (45N) in the western Pacific. They generally inhabit areas of shallow water (less than 200 m) that are at least seasonally ice covered. During winter they are most common in broken pack ice and in some areas also inhabit shorefast ice. In Alaskan waters, bearded seals are distributed over the continental shelf of the Bering, Chukchi, and Beaufort Seas. Bearded seals are evidently most concentrated from January to April over the northern part of the Bering Sea shelf. Recent spring surveys along the Alaskan coast indicate that bearded seals tend to prefer areas of between 70% and 90% sea ice coverage, and are typically more abundant 20-100 nm from shore than within 20 nmi of shore, with the exception of high concentrations nearshore to the south of Kivalina. Many of the seals that winter in the Bering Sea migrate north through the Bering Strait from late April through June, and spend the summer along the ice edge in the Chukchi Sea. The overall summer distribution is quite broad, with seals rarely hauled out on land, and some seals do not migrate but remain in open water areas of the Bering and Chukchi Seas. An unknown proportion of the population migrates southward from the Chukchi Sea in late fall and winter, away from shore during that season as well.

Ringed Seal: Ringed seals are found throughout the Beaufort, Chukchi, and Bering Seas. as far south as Bristol Bay in years of extensive ice coverage. During late April through June, ringed seals are distributed throughout their range from the southern ice edge northward. Preliminary results from recent surveys conducted in the Chukchi Sea in May-June 1999 and 2000 indicate that ringed seal density is higher in near shore ice and lower in offshore pack ice. It is believed there is a net movement of seals northward with the ice edge in late spring and summer. Thus, ringed seals occupying the Bering and southern Chukchi Seas in winter apparently are migratory, but details of their movements are unknown.

Ribbon Seal: Ribbon seals inhabit the North Pacific Ocean and adjacent parts of the Arctic Ocean. In Alaska waters, ribbon seals are found in the open sea, on the pack ice, and only rarely on shorefast ice. They range northward from Bristol Bay in the Bering Sea into the Chukchi and western Beaufort seas. From late March to early May, ribbon seals inhabit the Bering Sea ice front. They are most abundant in the northern part of the ice front in the central and western parts of the Bering Sea. As the ice recedes in May to mid-July the seals move farther to the north in the Bering Sea, where they haul out on the receding ice edge and remnant ice. There is little known about the range of ribbon seals during the rest of the year. Recent sightings and a review of the literature suggest that many ribbon seals migrate into the Chukchi Sea for the summer.

Overall, the hazards of ship noise and disturbance on marine mammals near the Bering Strait, and in Arctic waters in general, need to be addressed further through relevant international organizations.

III.B Seabirds

The Bering Strait area is a prolific location for colonial nesting seabirds (Figure 9). Many colonies are clustered around the Bering Strait area, making it a vulnerable location for ecological disruptions such as human disturbance, boat traffic, oil spills, commercial fisheries (bycatch) and other negative environmental impacts due to the amount of birds nesting, foraging, and resting there.

Colony Summary

Seabird colony information from the US Fish and Wildlife Service's (USFWS) North Pacific Seabird Colony Catalog indicates that the majority of birds nesting in the Bering Strait area are alcids (11,839,095 out of the 12,558,990 total nesting seabirds in the Bering Strait colonies). Alcids are diving seabirds which forage offshore for prey, making them vulnerable to oil spills and boat traffic. *Aethia* species (auklets) comprise the majority of alcids present in Bering Strait colonies (9,820,027) with least auklets being the most abundant (7,250,194) followed by crested and parakeet auklets (2,415,457 and 154,376 respectively). Auklets nest in talus areas either in rock crevices or earth and rock burrows. *Uria* species (murres) are the next most numerous alcids with 1,345,414 birds in the Bering Strait colonies followed by puffins, guillemots and a scattering of dovekies.

Outside of the alcids, Northern fulmars comprise 417,957 of the individuals in the Bering Strait colonies. The *Laridae* family, consisting of gulls and terns, composes 283,090 of the total colonial nesting seabirds in the Bering Strait colonies. Finally, cormorants (*Phalacrocorax spp.*) compose almost 19,000 of the colonial nesting seabirds in the Bering Strait colonies.

At Sea Observations

Information from the USFWS North Pacific Pelagic Seabird Observer Program (funded by the North Pacific Research Board and USFWS, with NOAA-Fisheries and NSF-funded studies providing survey platforms) document extensive use of the Bering Strait region by sea birds. Information summarized below is from surveys conducted by USFWS in 2006 and 2007.

> During spring and early summer, we see low numbers of circumpolar or Russian species (slaty-backed gull, Ross's gull, ivory gull, black guillemot, glaucous gull). Once ice breaks up, we see more auklets (mainly crested and least), common and thick-billed murres, black-legged kittiwakes, eiders). By summer, with ice gone from the Chirikov Basin, we found <u>very</u> high densities of auklets, plus kittiwakes, murres, shearwaters, and a variety of other species (up to ~ 50 spp). Of note, on 23 March 2008, during surveys being conducted from the USCGC *Healy*, observers found the wintering spot for spectacled eiders, with estimates ranging from 250,000 -350,000, about 80 km off of SW Cape on St. Lawrence Island.
>
> We observed several species of interest in the Arctic in 2007 including Dovekies, Kittlitz's murrelets, black guillemots, loons, and eiders. In October 2007, 60

Kittlitz's murrelets were counted on transect off of Pt. Barrow and several were observed south of Pt. Hope, suggesting this is a fall staging or migration area. In spring & early summer of 2006, parakeet, crested & least auklets (*Aethia spp*) were near colonies on St. Lawrence Is (above). In later summer, once ice retreated, they were abundant farther north in the Chirikov Basin (below). Ancient murrelets and dovekies were also observed in low numbers in the Bering Strait region.

Short-tailed shearwaters are abundant throughout the Bering Sea during summer, when they come to Alaska to feed during their non-breeding season (shearwaters breed in the southern hemisphere, near New Zealand and Australia). However, during the fall of 2007, we also observed shearwaters throughout the Bering Strait region, indicating that this region may be an important final feeding area before shearwaters migrate south.

During a Canadian cruise with seabird observers conducting surveys from the CCGS *Sir Wilfrid Laurier* in 2007 between Dartmouth, NS and Victoria, BC, the Bering Strait had among the highest densities of birds encountered throughout the Canadian and U.S. arctic and the Bering Sea (Gjerdrum et al., 2008).

Spectacled and Steller's Eiders

As species listed as threatened under the U.S. Endangered Species Act, Spectacled and Steller's eiders are of particular interest. These sea ducks spend a considerable amount of time at sea. In the late summer and fall after breeding in northern and western Alaska and Arctic Russia, spectacled eiders gather in flocks in coastal waters to molt. During molting, the birds become flightless as their old, worn feathers are replaced with new ones. Four principle molting areas have been identified. Two molting areas on the coast of Alaska are eastern Norton Sound and Ledyard Bay, between Cape Lisburne and Point Lay. On the coast of Russia, eiders molt in Mechigmenskiy Bay on the Chukotka Peninsula and an area between the Indigirka and Kolyma river deltas. Eastern Norton Sound appears to be the primary molting area for females nesting on the Yukon-Kuskokwim Delta in Alaska, while females nesting in northern Alaska migrate to either Ledyard Bay or Mechigmenskiy Bay to molt. Males from all three breeding areas have been found molting in Ledyard Bay, Mechigmenskiy Bay, and in the area between the Indigirka and Kolyma river deltas. Molting areas are typically less than 36 meters deep. By late October, spectacled eiders follow coastal and offshore migration corridors through the Bering and Chukchi seas to offshore wintering areas. The primary wintering area is in the central Bering Sea south and southwest of St. Lawrence Island. Critical habitat has been identified for spectacled eiders in Ledyard Bay, Norton Sound and south of St. Lawrence Island, as shown in the following web site: http://alaska.fws.gov/media/SpecEider.htm.

Steller's eiders breed in northern Russia and northern and western Alaska. Although formerly considered locally common at a few sites on both the Yukon-Kuskokwim Delta and the arctic coastal plain of Alaska, they have nearly disappeared from most nesting areas in Alaska. The current primary nesting range in Alaska consists of a portion of the central arctic coastal plain between Wainwright and Prudhoe Bay, primarily near Barrow. In Russia, Steller's eiders nest along the Arctic coast from the Chukotka Peninsula west to the Taimyr, Gaydan, and Yamal peninsulas. Most Steller's eiders breeding in Alaska and Russia migrate south after breeding to molt along the coast of Alaska from Nunivak Island to Cold Bay, primarily in Izembek Lagoon, Nelson Lagoon, and near the Seal Islands. At least 150,000 Steller's eiders, the majority of the world population, winter in Alaska from the eastern Aleutian Islands to Lower Cook Inlet. During their northward spring migration from wintering areas in Alaska, Steller's eiders can be found in large flocks close to shore from northern Bristol Bay to Hooper Bay. Critical habitat has been identified for Steller's eider along the Yukon/Kuskokwim delta, as shown in the following web site: http://alaska.fws.gov/media/StellEider.htm.

III.C Fish and shellfish

South of the Bering Strait, the Bering Sea contains some of the largest groundfish populations in the world and freshwater rivers are home to millions of spawning salmon. North of the Bering Strait, the Arctic is not nearly as productive, although the combination of more time with open water and far higher nutrient inputs into the Chukchi Sea relative to the Beaufort Sea generates much higher biological productivity in the Chukchi.

Although a 1990 Arctic fish survey obtained catches of 119 "species," many of these are species considered to be at the "tails" of their respective geographic distributions, others appear to have very small, and possibly not self-sustaining, populations, and others have no commercial, subsistence or recreational value. Based on very minimal data, it appears that relatively abundant species in federal waters include snow crab (which are taken in large numbers in the adjoining Eastern Bering Sea and are a prized commercial species in that region), Arctic cod and saffron cod (not significant commercial species in the Bering Sea but targets of commercial fisheries elsewhere in the world), and sculpins (not a significant commercial species in the Eastern Bering Sea although they are abundant in that region).

Some research indicates that primary production in shallow Arctic Seas may not convert directly to fish biomass. In the Chukchi Sea, some authors suggest that the close coupling of primary production with benthic invertebrate biomass results from short food chains and little grazing in the pelagic zone, thus leaving little energy for high fish biomass, but considerable energy for large benthic foraging mammals, such as walruses, bearded seals and gray whales. In the Beaufort Sea, the total annual fish production estimated here corresponds closely to the estimated fish consumption of vertebrate predators in that ecosystem. An estimated 123,000 tons of Arctic cod were required to feed late 1970's populations of Belugas, ringed seals, marine birds, and Arctic cod themselves in the Beaufort Sea. Belugas and ringed seals in particular were dependent on Arctic cod for a majority of their consumption, and birds for half their consumption.

It is unknown what stock of red king crab, for which there is a small fishery in state waters, occurs in the southeastern Chukchi Sea. It is possible this stock is related to the

Norton Sound red king crab that occurs south of Bering Strait in the northern Bering Sea, but additional research and stock identification work is required to obtain this information. The fishery has occurred infrequently, and so little information is available. When it does occur, it is prosecuted during the open water season from small vessels, or in winter using snow machines or dog sleds on ice-covered waters. The fishery uses pot gear, and fishermen involved are primarily based in Kotzebue. The lack of information about some fish and shellfish stocks near the Bering Strait adds to the difficulty of assessing the effects of possible invasive species in ballast water discharges near the strait.

Small salmon populations in Northwest Arctic rivers support a small commercial fishery for chum salmon, although other fish species are incidentally harvested, in the Kotzebue Sound region, and are an important component of subsistence fishing in the region. All 5 species of salmon have been seen in Arctic waters, although only chum salmon in any significant quantities. Subsistence fishing is an important part of the economic, nutritional, and cultural lifestyle of local residents of the Arctic and occurs near coastal communities and also in nearshore areas during open water seasons and some activities occur to a limited extent in this area during winter. In winter fishing is generally conducted by gill nets threaded through holes in the ice or by jigging. In summer, rod and reel, gill net, and jigging are techniques used to capture fish. Species harvested for subsistence purposes include Dolly Varden char, whitefishes, Arctic and saffron cod, and sculpins.

IV. Indigenous Marine Use

The Bering Strait region is home to three distinct linguistic and cultural groups of Eskimo people in Alaska; the Inupiaq, Central Yupik, and Siberian Yupik on Saint Lawrence Island. The coastline of the Bering Strait region has been continually occupied by indigenous peoples for several thousand years. Human populations (>10,000) in this region have been dependent on marine resources, including mammals, fish, birds, macro algae, as well as shellfish and other invertebrates. The hunting of large marine mammals has been the primary adaptive subsistence strategy of Bering Strait human populations for over 1,000 years.

Currently, the population of the Bering Strait region is >10,000 people with Alaska Natives comprising more than $3/4^{th}$ the population. There are 15 year-round villages outside of Nome that range in population from approximately 150 up to >750.

The use of different marine resources occurs throughout the year, but changes seasonally with the resource migrations and life history stages. Regions where marine resources are gathered are not limited to beachcast, coastal waters, and nearshore waters, but may include offshore waters. For example, to adapt to the rapidly changing accessibility and availability of sea ice, hunting of large marine mammals (ex. walruses) can take place up to 50-80 miles offshore. Travel to these offshore locations is typically done in small open boats and a hunt can span several days before a vessel returns to its port of origin.

Marine resources are of vital and critical importance to peoples of the Bering Strait region. Not surprisingly, all present day communities in the Bering Strait region, except White Mountain, are situated on the shore of the Bering or Chukchi seas and are strongly tied to subsistence uses. This maritime reliance for subsistence in the Bering Strait region is very significant and for marine mammal species such as walruses, whales, and seals, comprises a significant portion of the total U.S. harvest. Additional marine-based resources are obtained through beachcombing, clamming, gathering seabird eggs, fishing, birding, gathering greens, etc.

For each group/tribe in the Bering Strait region, there are socio-economic, cultural, and political differences and similarities to be considered unique to each within the region. All the coastal communities exhibit similarities in terms of broad utilization of all available marine resources for, but not limited to, nutritional reliance, cultural customs, and economic dependence (ex. clothing, equipment, handicrafts, commercial fishing and hunting, and limited ecotourism). The general patterns of large marine mammal hunting and reliance on other marine resources (ex. fishes, crabs, birds, beachcast invertebrates, macro algae) persist to the present time, despite technological changes.

The most recent description of traditional subsistence use of the U.S. side of the Bering Strait region is included in Kawerak's January 2008 North Pacific Research Board report "A Comprehensive Subsistence Use Study of the Bering Strait Region," with additional funding provided by the Alaska Department of Fish and Game (ADF&G). The comprehensive harvest survey was approved by the Tribes of Shishmaref, Wales, Brevig Mission, Teller, White Mountain, Golovin, Elim, Koyuk, Unalakleet, Gambell, Savoonga, Stebbins, & Saint Michael. The community of Shaktoolik did not want to be involved in the survey. Due to logistics and timing, the community of Diomede did not participate. Nome was not included in the survey because of the large size of the population was cost-prohibitive. The locations of these communities are illustrated in Figure 2.

Figure 11 graphically demonstrates the maritime reliance for subsistence in the Bering Strait region with over 85% of the harvested resources being marine-derived. The regional reliance on marine mammals is very significant. For species such as walruses, whales, and seals, the Bering Strait region comprises a significant portion of the total U.S. harvest of marine mammals.

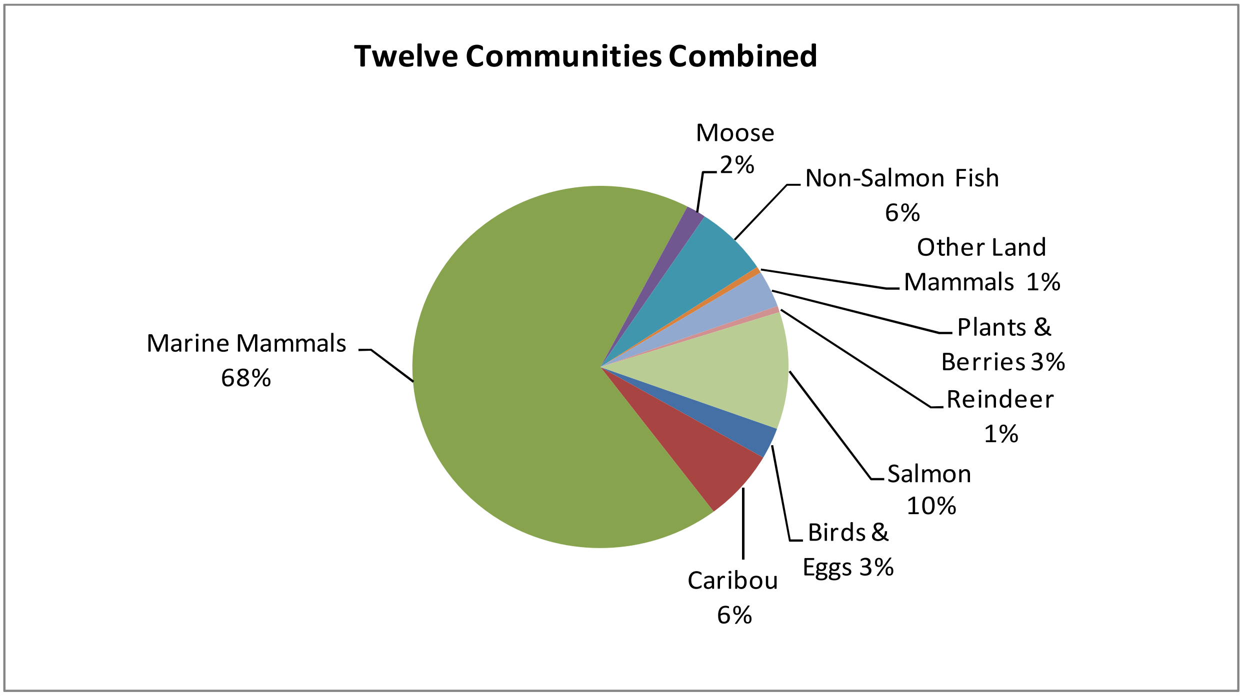


Figure 11. Harvest Composition of Resources, 2005-2006, Twelve Communities Combined. Source: Kawerak, Inc., et al. 2007.

Table 1 illustrates the high reliance the communities closest to proposed vessel traffic in the Bering Strait (Gambell, Savoonga, Shishmaref, and Wales) have to ocean-based resources. St. Lawrence Island communities (i.e. Gambell and Savoonga) were most dependent on marine resources with the marine mammal harvest totaling over one million kilograms. (The location of these coastal communities is shown in Figure 2.) Over 95% of their total subsistence harvests were marine-based resources (ex. Seabirds, eggs, fishes, and marine mammals). Shishmaref (on Sarichef Island) and Wales (on the mainland) demonstrated a high reliance on marine resources with over 75% of their total harvest derived from the sea. In contrast, the coastal communities of southern Norton Sound, especially Stebbins and Unalakleet demonstrated a higher reliance on fishes, especially salmon, which is indicative of the highly productive river influences.

Though future predictions and current environmental patterns indicate a profound and long term ecosystem change to the Bering Strait region, human reliance on marine resources for subsistence remain essential. The central importance of the cooperative hunting of large marine mammals and the use of all available marine resources for nutritional, cultural, and economic needs will persist in the Bering Strait. Given the ecosystem changes and increasing vessel traffic around the Bering Strait, information on traditional marine use could be collected and compiled again, and shared with coastal communities.

Potential conflicts between increased ship traffic and indigenous marine resource uses of the Bering Strait region include but are not limited to an increased amount of:

- Ambient and underwater ship noise - recognized as one of the primary concerns to marine mammal populations, especially within the narrow and shallow migration corridor;
- Ship strikes on large marine mammals;
- Entanglement of large marine mammals from commercial fishing gear;
- Potential for collision between coastal and offshore large ship traffic and small open boats using marine resources;
- Pollution affecting the availability and quality of offshore, coastal, and beachcast marine resources due in part but not limited to:
    - lack of navigational and rescue infrastructure in an extremely challenging physical and marine environment;
    - lack of infrastructure to secure a large vessel in distress;
    - lack of infrastructure to assess and respond to an oil and/or chemical spill;
    - language (ex. English, Russian, Siberian Yupik) and cultural communication barriers; and
    - lack of a communication protocol between Russia and the United States.

Table 1. Estimated Kilograms Harvested by Community and Resource in the Bering Strait Region during 2005-2006.

	Estimated Total Kilograms Harvested by Community and Resource									
	Resource									
Community	Salmon	Non-Salmon Fish	Caribou	Moose	Other Land Mammals	Marine Mammals	Birds & Eggs	Plants & Berries	Reindeer	Total Kilograms
Brevig Mission	9,394.7	721.0	2,646.6	1,935.8	609.4	4,607.0	519.0	3,740.3	-	24,173.9
Elim	17,656.5	12,861.8	9,262.8	6,029.3	158.3	31,230.0	840.0	6,101.7	-	84,140.5
Gambell	15,816.7	2,642.9	0.0	0.0	64.2	476,009.3	6,753.5	3,062.2	-	504,348.7
Koyuk	14,116.2	3,506.1	27,559.8	6,911.3	27.5	8,460.4	1,180.8	5,165.9	-	66,928.1
Savoonga	6,232.2	25,466.9	0.0	0.0	0.0	551,271.7	24,476.1	5,709.6	11,349.5	624,505.9
Shishmaref	11,300.7	13,547.2	51,028.9	3,879.8	5,815.9	182,817.5	5,857.2	11,612.2	-	285,859.4
St. Michael	13,127.7	9,637.3	1,073.4	4,262.0	24.4	14,411.7	3,909.4	5,792.1	-	52,237.9
Stebbins	41,805.7	14,663.5	1,302.0	6,462.2	1,602.4	41,773.6	8,321.3	9,393.4	-	125,324.2
Teller	14,675.9	3,508.5	0.0	1,106.8	46.1	21,180.7	539.9	1,975.0	-	43,033.0
Unalakleet	57,181.4	36,982.5	34,161.8	762.0	477.2	28,320.2	3,656.0	11,301.2	-	172,842.4
Wales	3,857.6	890.5	454.0	772.5	1,704.3	14,689.9	238.9	1,672.7	-	24,280.4
White Mountain	8,507.3	4,871.0	3,095.6	2,939.3	924.8	14,307.0	679.2	1,983.1	-	37,307.3
Total	213,672.7	129,299.2	130,584.8	35,061.0	11,454.6	1,389,079.1	56,971.3	67,509.4	11,349.5	2,044,981.6

Source: Kawerak, Inc., North Pacific Research Board, Alaska Department of Fish & Game, 2005-2006 Comprehensive Subsistence Harvest Survey, Bering Strait/Norton Sound Region.

Additional information on fish, invertebrate, birds, land animals, plants, and macroalgae utilized by Bering Strait communities is listed in the report entitled "A Comprehensive Subsistence Use Study of the Bering Strait Region."

V. Commercial Marine Uses: Fishing, Oil & Gas, Minerals, Tourism, and Shipping

Since quantitative information on commercial marine vessels that steam through the Bering Strait is not available, this section summarizes information about local ports and marine activities near the strait and about vessels that transit the strait without stopping at a port on either side of it. The season for marine shipping is limited to the ice-free months in the Bering Strait.

V.A Commercial Vessels that Use Local Ports

This section summarizes separately the information on ports near the Bering Strait and on marine activities that are conducted near the strait.

V.A.1 Ports near the Bering Strait

In the Bering Strait region there are three primary U.S. ports and two additional lesser traffic areas. The primary ports are Nome, Kotzebue and the DeLong Mountain Transportation System (DMTS) port serving the Red Dog Mine. The other two sites are St. Michael and the entrance to the Yukon River.

Nome

Nome is the U.S. supply, service, and transportation center of the Seward Peninsula. Vessel traffic through the Nome Port covers the largest amount of commercial and tourism traffic for the region. Traffic at Nome and Cape Nome is defined as Nome for this study. Cape Nome is a large rock quarry that in some years, depending on construction around western Alaska, ships large quantities of armor stone and crushed rock throughout the region. Along with mining, government services (direct or tribally contracted) provide the majority of employment opportunities around the Nome region. As in all Alaska rural areas, subsistence is an activity that also contributes to the local economy. Scheduled flights from the Nome airport go to Anchorage, and chartered flights go to Provideniya and Anadyr in Russia.

The draft at the Nome Port is -22.5 MLLW (Mean Lower Low Water) now that the recent construction is complete. The entire seaward side of the Nome Port is protected by a 3,350-foot-long sea wall of granite boulders or armor stone. The Nome Port berthing facilities accommodate vessels up to 20 feet of draft with only a 1.4 foot diurnal tide range. Construction continues in the summer of 2008 to make mooring improvements on the deep-water docks and expand the small boat facilities in the Nome Small Boat Harbor. The regional facility will have improved boat moorage and offloading facilities. The Army Corps of Engineers just completed a $442 million project providing a new harbor channel entrance and protective breakwater east of the existing Causeway. Local development groups (primarily Norton Sound Economic Development Corporation, the City of Nome and the U.S. Economic & Developmental Administration) have provided the funding for the completed portions of the project. Tasks to be completed in 2008 include a second seasonal floating dock, a boat launch, and a low-level sheet pile dock for small vessel maintenance. The new east breakwater and causeway spur allow for more vessel loading and unloading and therefore fewer shipping delays. While these facilities have been improved greatly during recent years, they are probably not suitable for the rapid transfer of cargo from regular cargo vessels to ice-breaking cargo vessels that could transit the Arctic Ocean.

The following are research and cruise vessels that made Nome one of their 2007 destinations, according to the Nome harbormaster records:

June	25	Clipper Odyssey/Cruise Ship
	22-25	Acushnet/Coast Guard
	26	Adrian Flanagan/Sailboat NE Passage
July	15	Spirit of Oceanus/Cruise Ship
Aug	3-5	Oshuru-Maru/Japanese Research
	15-18	Oshuru-Maru/Japanese Research
	26-27	Sever/Russian Research
Sept	5-6	Hanseatic/Cruise Ship
	5	Sever/Russian Research
	6	Cloud Nine/Sailboat from NW Passage
	12	Spar/Coast Guard
	17	Oscar Dyson/NOAA Research
	19	Luck Dragon/Sailboat from NW Passage
Oct	10	Berserk III/Sailboat from NW Passage (wintering here)
	10	Two Vessels/Oil Support from Chukchi

This list does not include commercial fishing vessels, which are vessels approximately 30-32 feet in length that operate out of Nome's Small Boat Harbor. It also does not include all cargo and fuel vessels, which are the main port activity for Nome.

Kotzebue

Another U.S. port near the Bering Strait is Kotzebue, the hub community for the Kotzebue Sound and Northwest Arctic region. Retail services, transportation, mining, medical and other businesses provide year-round income. Vessel activity in Kotzebue consists mainly of cargo/fuel vessels to supply the hub and the regional villages. The only dock belongs to Crowley Marine Services and is very shallow. Most deep water vessels anchor at the sea buoy and have their cargo lightered to the dock. Northland Services, Delta Western, Alaska Logistics, Bowhead Transportation, and several other construction companies move cargo in and out of this region.

DeLong Mountain Transportation System (DMTS)

DMTS supports the Red Dog Mine, which is the largest producer of zinc concentrate in the world. Red Dog mine and port is the largest private employer in the entire region with 480 full time jobs. The DMTS deep water port was constructed specifically for moving cargo and fuel into the site and shipping ore out from the Red Dog mine. Further information on shipping associated with the DMTS is included in Section V.B.

Port Clarence

Located between the Bering Strait and Nome harbor, Port Clarence is the closest deep water port to the Bering Strait that is located on the U.S. mainland. Although only about 2.6-square kilometers (one-square mile), it is relatively deep (over 12 m or 40'). It is the site of a U.S. Coast Guard Loran station that has a private, paved runway. It is not only accessible by ship and plane but also by vehicle - directly from Nome during snow-free months (Nome-Teller Highway). This State of Alaska DOT-maintained gravel road (~70 miles) is used for general traffic and freight/fuel deliveries to the community of Teller - located on the eastern shore. The port was used historically by the commercial whaling ships as a place to wait for sea ice to clear out of the Strait. It was also used historically by the USCGC NORTHWIND and STATEN ISLAND, and may be useful for the staging of emergency operations in the Arctic Ocean. Port Clarence is one of the only U.S. harbors for medium to deep draft vessels near the Bering Strait, as noted in Chapter 6 on the arctic environment.

St. Michael, Yukon River Entrance north mouth

St. Michael was previously a hub for local barge traffic. It sits at the north mouth of the Yukon River, but has a shallower draft (6 feet) and is not extensively used for transshipment for Yukon River traffic.

Yukon River Entrance south mouth

Crowley barges fuel and supplies from Nenana and from Seattle to Yukon River villages through this entrance, which has a deeper draft (10+ feet at high tide). Crowley makes 6 trips a year to the lower Yukon, 14 trips to the middle Yukon, and 3 trips to the upper Yukon with their 175' long barges. Traffic has been steady for the past 10 years and is not expected to increase significantly unless some major economic development activity occurs.

Russian ports

The main ports on the Russian side are just south of the Bering Strait, as they are on the U.S. side. The three largest ports are Provideniya, Anadyr, and Egvekinot. Provideniya is a former Soviet military port with a water depth of less than 10m. The population was about 2,500 in 2002, and the residents are mainly Yupik. Anadyr is a port on the Gulf of Anadyr, and is the eastern most town in Russia. The population was about 11,000 in 2002. The water depth in the port is less than 7m, and it might be closed to foreign vessels. Egvekinot is a town with a population of about 2,500 in 2002. The water depth in the port is less than 10m, and it also might be closed to foreign vessels. There are charter flights from both Provideniya and Anadyr across the strait to Nome, Alaska. Additional information on ports in eastern Russia is located in Section 7.8.1.1.5.
The locations of Provideniya, Anadyr, and Egvekinot are illustrated in Figure 2 and the following web sites:

http://www.fallingrain.com/world/RS/0/Provideniya.html;
http://www.fallingrain.com/world/RS/15/Anadyr.html; and
http://www.fallingrain.com/world/RS/15/Egvekinot.html.

V.A.2 Commercial Marine Activities and Vessels near the Bering Strait

Vessels use the area ports to support a variety of activities, including commercial and subsistence fishing, subsistence hunting of marine mammals, mining, local shipping, tourism, and scientific research.

Commercial Fishing

At present, there are no large commercial fisheries in the case study region and most boat traffic is limited to small skiffs close to the villages. The existing fisheries are important to the local economy and to this report for environmental reasons, but local traffic is not expected to expand significantly in the next 20 years.

In the federal waters of the Chukchi and Beaufort seas north of the Bering Strait, the North Pacific Fishery Management Council does not have a Fishery Management Plan (FMP) that provides comprehensive authority over fishery management issues. Two of the Council's FMPs (the crab FMP and scallop FMP) cover part of the Chukchi Sea north of Bering Strait to Point Hope, but there are limited fisheries in the U.S. federal waters and no routine fish surveys are currently conducted in the region. However, because commercial species appear to be migrating north, the Council is interested in exploring policy and management options to prepare for future changes. Currently, the only known commercial EEZ fishery in the Alaskan Arctic is for red king crab in the southern part of the Chukchi Sea. About 15 crab boats make Nome their home port. Most tend to be 32-footers (former Bristol Bay salmon boats). There are also about six crab boats in Unalakleet, four in Shaktoolik, one in Golovin, and one in Elim.

Some small-scale commercial and subsistence salmon fisheries occur in this region within state waters (up to three miles off shore) and primarily in Norton Sound south of the Bering Strait. For salmon, the permit holders fish open skiffs, usually about 20 feet and larger. The largest is usually about 27 feet. Those skiffs are "homeported" in the village the permit holder is from. Most are in the villages of Elim, Shaktoolik and Unalakleet. The Moses Point Subsistence salmon fishery is next to Elim and the Shaktoolik Subdistrict is next to Shaktoolik. A tender runs the salmon to Unalakleet for processing. Salmon fishing has not occurred in the Golovin Subdistrict since 2001 and in the Nome Subdistrict since 1996.

During 2007 there was a commercial salmon fishing season in the Port Clarence District for the first time in over 40 years. Three vessels from Teller participated. In 2008 there may be some participation from Brevig Mission.

Preliminary information from the ADF&G indicates that the 2007 combined commercial harvest of all salmon species ranked third in the last ten seasons in Norton Sound and first with the pink salmon harvest excluded. The number of commercial permits fished (71) was the second highest in this century (10 more than in 2006), but eighth lowest on record. Sixty of those permits are held by Nome residents. This total included 11 permit holders from the Moses Point Subdistrict. Prior to this year, commercial salmon fishing had not occurred in the Moses Point Subdistrict since 2001. The previous 5-year average was 36 permits fished and the previous 10-year average was 55 permits fished.

The 2007 fishery value for permit holders of $572,195 was well above the 5-year average of $175,196 and the 10-year average of $183,719. The average value per permit holder was $8,059, a record without adjusting for inflation.

Only one salmon buyer operated in Norton Sound during the 2007 season. The Unalakleet fish plant operated by Norton Sound Seafood Products was the base of commercial fisheries operations. Salmon were delivered both to the Unalakleet dock and tendered from the neighboring Shaktoolik and Moses Point Subdistricts. Salmon caught in the Port Clarence District were brought to the Nome plant for processing. Only a few of the fishermen that work the crab & halibut fishery also did salmon, and they typically use their open 18-24 foot skiffs.

In Kotzebue north of the Bering Strait the salmon fishery uses skiffs similar to those in Norton Sound. Since Kotzebue Sound is very shallow, the only barges or tenders that can come into Kotzebue must have a very shallow draft. Occasionally someone will do some crab fishing out of Kotzebue, the last time in 2005. The "crab boat" in Kotzebue would be an open skiff. Harvests from previous years are minimal and most catches are confidential as less than four fishers participated in the fishery.

During most of the 2000s the Kotzebue Sound commercial salmon fishery has been limited by buyer capacity. In 2002 and 2003 no buyer was onsite. In 2004 and 2005 one onsite buyer was present and fish were processed locally. Beginning in 2006, the new buyer shipped the catch by air in the round to Anchorage for processing. In recent years the ADF&G opened the commercial fishery continuously and allowed the buyer to set the fishing time for their fleet. Forty-six permit holders sold fish to the buyer, including one catcher-seller who sold fish to the buyer and also sold some of his catch from his boat to Kotzebue area residents. The number of permit holders that fished has been in the low 40s in the past three years, and is less than half the permit holders that fished in the 1990s, and well below the nearly 200 permit holders that fished in the early 1980s. Boats used in this fishery are primarily skiffs and small boats under 20 feet in length. There are no docks in Kotzebue open to the public, and most boats are either beached or moored close to shore. Vessels are generally shipped in by barge or air.

Mining

Barge traffic currently provides fuel and supplies for local mining activity on the Seward Peninsula, which has several highly mineralized areas that have potential for mining and if developed, could result in increases to local traffic. Most of the mining activity to date has been placer mining for gold, and some small gold mines continue to provide small-scale employment. The largest mine is the Rock Creek gold mine. Among other minerals known to occur in commercial quantities are copper, lead, platinum, silver and zinc.

Mineral exploration and claim staking on state and federal lands have been actively pursued since the 1970s. The Nome area has about 17,000 mining claims. Alaska Native corporation lands are also very active for mineral exploration. Many, if not most, of the Native corporation lands were selected because of their mineral potential and the potential to create jobs and other economic opportunities for their shareholders. Gravel resources are valuable for developing regional infrastructure. Most gravel is shipped by barge to nearby communities that do not have local sources of gravel acceptable for construction projects.

NovaGold Resource Inc. is in the process of developing a new mine at Rock Creek (appropriately 1/3 of the proposed acreage is owned by Sitnasuak and Bering Strait Native Corporations and will be leased to the economic development project). There are two project components: the Rock Creek Mine/Mill Complex located about 6 miles northwest of Nome in the Snake River watershed, and the Big Hurrah Mine located about 42 miles east of Nome in the Solomon River watershed. Both are proposed to be developed as open pit gold mines by the project applicant, Alaska Gold Company (AGC), a wholly owned subsidiary of NovaGold Resources, Inc.

Rock Creek has the potential to be a large ore deposit, with an estimated 720,000 ounces of gold, and production of 100,000 ounces per year. The Rock Creek Mine/Mill Complex as planned includes an open pit mine, two non-acid-generating development rock stockpiles, a gold recovery plant, and a paste tailings storage facility. Standard drilling and blasting techniques would be used to break the ore. Ore milling rates would be about 2.75 million tons/year, while development rock stripping volumes would be in the range of 4.4 to 5.5 million tons/year. Milling would include crushing, screening, gravity separation, flotation, and a cyanide vat leach process. The expected mine life is 4.5 years, with potential for additional discovery and extended mine life. The project will employ 135 employees with an $8.5 million payroll. A local-hire preference is in place. The produced gold would be sent outside by U.S. Mail or courier.

The recent improvements to the Nome Port put it in a good position to export the gravel output from the Rock Creek Mine to locations around the world. The gravel output is a huge, untapped resource that has value not only to regional communities, but to world markets.

The Big Hurrah site will be treated like a rock quarry where a smaller quantity, but higher grade, of ore will be mined. The proposed facility consists of a small open pit gold mine, a non-acid-generating development rock stockpile, a temporary stockpile for acid-generating development rock that would later be backfilled into the pit, and an ore stockpile. Ore would be trucked to the Rock Creek Mine/Mill Complex to be milled and processed. Ore would be mined at a 1,500 tons/day rate on a seasonal basis for a total of approximately 270,000 tons/year for 4 years. The lands surrounding the site belong to the Bering Straits Native Corporation and the Solomon Native Corporation.

After the Rock Creek Mine is established, there are plans to placer-mine the Monroeville area (across the Nome-Beltz Highway from Icy View) as well.

An estimated four trillion tons of high quality bituminous coal—about one-ninth of the world's known coal reserves and one-third of the U.S. reserves—lie in the Northern Alaska Coal Province, a broad belt extending 300 miles eastwards from the Chukchi Sea. There are approximately 2 billion tons of high rank bituminous coal in the Western Arctic. To date, the Arctic Slope Regional Corporation has concentrated its studies on one coal deposit in this region. The initial deposit targeted for development is located only six miles from tidewater on the Chukchi Sea about halfway between Pt. Hope and Pt. Lay. 68 million tons of measured coal reserves have been delineated for underground mining, along with an approximate 23 million tons of coal suitable for surface mining peripheral to the underground mine block. Through continued drilling an additional 50 to 100 million tons could become proven for this one deposit. No actual development is anticipated in the near future. Further information about activity at the Red Dog mine is included in Section IV.B.

Local Shipping

Since western Alaska is not connected to the state or national road system, all goods to regional communities are either flown or barged in. Local Alaska highways lead to Teller, Council and the Kougarok River with a few short connections, including the newly improved Glacier Creek road. Between 2000 and 2006 approximately 50-80,000 tons of gravel and 15-20,000 tons of cargo went through the Port of Nome. Combined revenue from cargo, fuel & gravel is approx $600,000 a year, with the majority of revenue coming from fuel.

Although marine freight to the region is seasonal, it is more economical than airfreight. After ice breaks up in May, barges visit coastal and river villages bringing cargo, fuel, construction materials, food, etc. These goods are delivered in bulk to Nome and Kotzebue, and then redistributed from there by smaller vessels that can access the available beach landings. With the high cost of energy in Alaska's rural communities, it is likely that residents of the smaller communities will migrate to the larger hub communities of Nome and Kotzebue or to the larger cities of Fairbanks and Anchorage, where the cost of living is cheaper. Thus, it is not anticipated that local shipping needs will increase significantly in the near future.

Northland Services conducts about 5 barge sailings (380' barge) to the Norton Sound region. Most goods are then lightered using landing crafts to the smaller communities. Northland does not deliver fuel, but instead, most of its freight supports state and federally funded projects such as school construction, federal housing, tanks for tank farms, etc. They go as far as Kotzebue to deliver, and thus have 1-2 transits per year through the Bering Strait.

Tourism

Tourism is a small, but significant contributor to Nome's economy. Most tourists arrive by plane rather than vessels, with many drawn by the Native culture, the mining history, and the world renowned bird viewing in the region. The City of Nome levies a 4% bed tax that generated $65,255 for the general fund for 2000 according to the Alaska

Department of Community and Economic Development. Known for its gold rush history and service as a transportation hub, Nome lures many visitors to the area and is an established rural destination. Approximately 11,000 people traveled from outside the region to Nome in 2001. Many of these individuals are packaged tourists who travel with major airlines, but the growing trend is towards independent travelers.

New amenities at the Nome Port will have the potential to attract more cruise ship stops to the area. The Nome Chamber of Commerce is currently marketing Nome to other tour operators to develop additional cruise ship package tours that would begin and end in Nome, including several stops in regional villages. The number of cruise ships of the 100 passenger size visiting the Bering Strait region is increasing slowly. Typically the same ships frequent the region, only changing the quantity of stops for Nome. Since the World Discoverer went bankrupt (twice at Nome) the Spirit of Oceanus and Clipper Odyssey alternate having 1 and 2 calls. The Bremen and Hanseatic cruise ships have been landing at the Nome harbor during alternate years; while this pattern of alternation might be convenient for the port, it means that another cruise ship probably is not within rescue distance in the Arctic Ocean, and therefore does not strengthen cruise ship safety in Arctic waters.

An estimated 5,000 out-of-state visitors over-nighted in the Bering Strait region between May and September, 2005. Cruise line agencies report that 786 cruise passengers stopped in Nome in the summer of 2005, some of whom boarded their vessel in Nome and may have spent the night there. Only a very small amount of independent travelers overnight in Nome. The bulk of the passengers fly in on a charter flight, do a quick bus tour through Nome and then board the cruise vessel for departure. Conversely, the inbound ship passengers deboard, do a quick tour through Nome, then board the same charter flight outbound. Locally, CruiseWest's Spirit of Oceanus trip from Nome to Russia was recently rated as one of the top ten cruises by Conde Nast Traveler magazine. Small cruise ships visiting the Bering Strait region include the Clipper Odyssey, Spirit of Oceanus, and Hanseatic cruise ships

The City of Kotzebue has a package deal with Alaska Airlines that includes a structured tour through town.

Summary of Visitor Statistics to the Region

	1999	2000	2001
National Park Service Bering Land Bridge National Preserve Visitations	3,000	3,025	Unavailable
City of Nome Visitor Center Walk-ins	3,729	6,095	4,892
Group Travelers	1,320	1,520	2,285
Alaska Airlines Package Travelers	5,500	3,857	3,272
Total Visitors	10,549	11,472	10,449

Scientific research support

The rapid loss of sea ice, changing marine ecosystems, and possible migration north of a number of commercial fish species has sparked increased interest in research and monitoring in the Bering Sea and Arctic Ocean. This interest has resulted in increased research vessel traffic which will probably continue into the foreseeable future. Table x in Section V.A.1, shows that a Japanese research ship (Oshuru-Maru), Russian research ship (Sever), and U.S./NOAA research ship (Oscar Dyson) transited the strait during 2007. According to the Nome harbormaster records, about 7 large research vessels transit northward through the strait during June and July, and then south through the strait during September (totaling about 15 transits). This list excludes the USCGC HEALY which has conducted research in the Arctic since 2002 (spring-to-fall) as well as the CGCS *Sir Wilfrid Laurier* that transits annually to the Canadian Arctic undertaking international collaborative research along the way. The Chinese icebreaker Xuelong has worked in the region every few years since 2003 and along with the new Korean icebreaker (RV Araon), plans to undertake western Arctic cruises on a regular basis in the future (see Pacific Arctic Group website for further cruise schedule details; http:// http://www.pagscience.org). A new Alaska Research Vessel is in the planning stages to be built by the University of Alaska Fairbanks School of Fisheries and Ocean Sciences with funds from the National Science Foundation; although the vessel did not affect vessel traffic in the Bering Strait region during 2004, it will be large enough to serve the region in the future.

V.B Commercial Vessels that Transit the Strait without Stopping at Local Ports

Industries to the north of the Bering Strait - namely the oil and gas industry and the Red Dog mine - also depend on commercial vessels that transit the strait both northward and southward bound. Overall, approximately 150 large commercial vessels pass through the Bering Strait during the July-October open-water period, with transits of these vessels most frequent at the beginning and end of the period. This estimate excludes fishing vessels, which are generally smaller, as well as the number of fuel barges for coastal mining activities and coastal communities.

Vessel traffic through the Bering Strait is of special concern because of indigenous marine use (subsistence) near the strait, and also because the entire world population of several marine mammals and birds also migrate through the strait during this short open-water period (see Section IV on indigenous marine use and Section III on ecosystems and bio-resource considerations). The probable ecosystem effects of spills were examined in the Arctic Marine Assessment Program's Oil and Gas Assessment's concluding report, entitled Arctic Oil and Gas 2007, and this case study does not re-examine the subject. However, the 12 Key Findings in the concluding report include the following two:

> #5 In the marine environments, oil spills are the largest threat.
>
> #9 Responding to major oil spills remains a challenge in remote, icy environments.

The challenge of oil spills in broken ice near the Bering Strait and in other Arctic waters could be met by further collaboration on research by Arctic states and industry.

Oil and Gas

Vessel traffic through the Bering Strait could be affected by oil and gas operations to the north of the strait and in the waters near the strait. Detailed information about exploratory operations in some of these areas is available through the Minerals Management Service (MMS), which manages operations on the U.S. outer continental shelf (OCS). Oil and gas operations to the north of the strait have occurred on the Alaskan North Slope, in the Canadian and U.S. portions of the Beaufort Sea, and in the U.S. portion of the Chukchi Sea. The specific locations of leases in the U.S. portion of the Chukchi are illustrated in Figure 12. The locations of blocks-receiving-bids indicate the locations of leases, and of some exploration drilling during the early 1990's. Figure 13 of the Beaufort Sea illustrates the location of blocks receiving bids, and of existing leases. Figures 12 and 13 can be downloaded from the following MMS web sites:

http://www.mms.gov/alaska/cproject/Chukchi193/193Saleday/Sale_193_blx.pdf and http://www.mms.gov/alaska/cproject/beaufortsale/Sale202/202saleday/sale_202_final_by_co_april07.pdf.

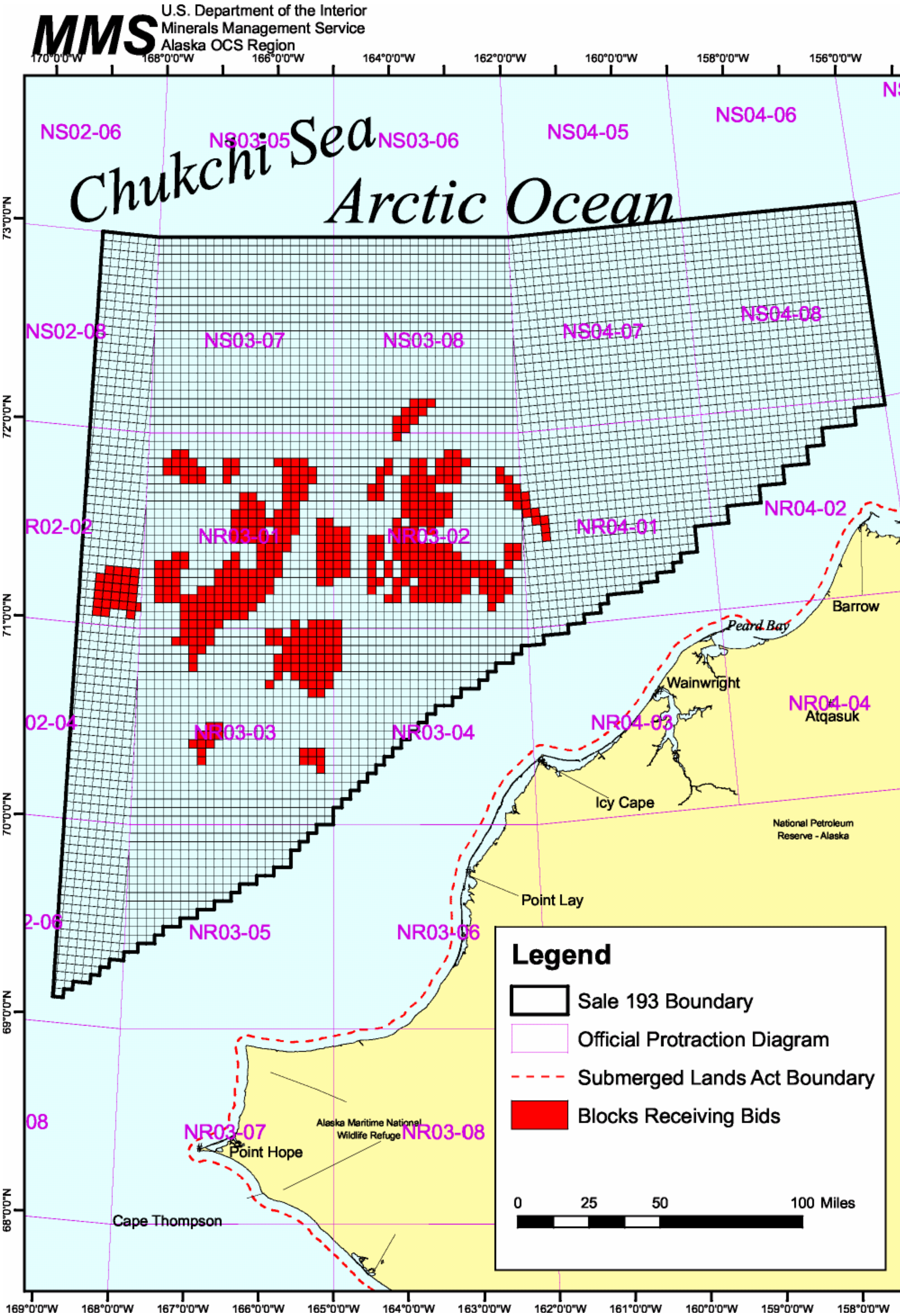


Figure 12 - Specific locations of leases in the U.S. portion of the Chukchi

Figure 13
http://www.mms.gov/alaska/cproject/beaufortsale/Sale202/202saleday/sale_202_final_by_co_april07.pdf.

The vessel traffic to operations in these lease areas and on the Alaskan North Slope is related to sealifts with tugs-and-barges, geophysical (seismic) seismic exploration, drilling with drillships, and support operations, as described in the following subsections.

Sealifts

Operations on the Alaskan North Slope and in the U.S. portions of the Beaufort and Chukchi Seas are supported primarily by an Arctic sealift with tugs-and-barges. An official Crowley history explains that ". . . (i)n more than twenty summer sealifts . . . , Crowley has transported some 315 bargeloads of oil field modules and supplies . . ." (Crowley Maritime Corporation, 1992:p. 142). A subsequent 2003 history by a Crowley employee explains that Crowley began the summer sealifts to Prudhoe Bay in 1968 and that "(s)ince then 334 barges . . . have been successfully delivered to the North Slope . . ." (Tornga, 2002). So, the Arctic sea lift through the Bering Strait has averaged about ten barges per year, or about 20 transits to the north or the south. Crowley has not done a Prudhoe sealift since 2003, but it is anticipated that they will begin again in 2009 and continue for several years.

In contrast, operations in the Canadian Beaufort Sea, which are supported by bases in the Yukon and Northwest Territories (Clark et al., 1997), probably require very little tug-and-barge traffic through the Bering Strait.

Seismic vessels

The MMS explains that seismic surveys are conducted for deep-penetration geophysical exploration, high-resolution site-clearance surveys, and ancillary site surveys. Seismic vessels for each type of survey would be accompanied by one or more service vessels for crew changes, marine-mammal observers, fuel, etc. All of the vessels associated with marine seismic would transit the Bering Strait twice each summer, moving into the Arctic for only summer open-water operations (July-November). The projected number of seismic surveys in both the Beaufort Sea and U.S. portion of the Chukchi Sea are summarized below. The MMS assumes that several surveys would be conducted during each open-water season, and that the surveys in the Beaufort Sea and U.S. portion of the Chukchi Sea would be coordinated to utilize the same vessels. The MMS estimates that two seismic surveys will occur annually in the Beaufort Sea, and that a maximum of three surveys will occur annually in the U.S. portion of the Chukchi Sea (USDOI, MMS, 2006: Appendix II., Sections C.1.a and E.1). The seismic and associated service vessels would transit the Bering Strait twice each summer, moving into the Arctic for only summer "open-water" operations.

Drillships

The previous exploration drilling in the Beaufort Sea is summarized in an MMS study (Wainwright, 2002), and reasonably foreseeable drilling is summarized in an MMS Biological Evaluation (BE) for endangered species consultation (USDOI, MMS, 2006). The current analysis is based also on data in the following MMS web sites for the

Beaufort and Chukchi Seas:
http://www.mms.gov/alaska/fo/wellhistory/BS_WELLS.HTM and
http://www.mms.gov/alaska/fo/wellhistory/CK_WELLS.HTM.

The web sites show that drilling was conducted during the summer "open-water" period with the ice-strengthened drillships *Explorer* and *Kulluk*. Drillship operations typically involved also an icebreaker and several ice-strengthened support vessels for anchor handling, supplies, fuel, etc., as documented by Clark et al. (1997). The MMS web sites document that the drillships were active in the Beaufort during seven of the past 27 years (i.e., during 1985, 1986, 1988, 1989, 1992, 1991, and 1993), and in the Chukchi Sea during three of the past 19 years (i.e., 1989, 1990, and 1991). So, drillship operations in the Beaufort and Chukchi Seas were conducted intermittently during the past several decades; most years had no drilling operations or associated drillship-support traffic. The *Explorer* and *Kulluk* drillships were Canadian (Clark et al., 1997); they were moved to U.S. drill sites from Canada and then returned and overwintered in the Canadian Arctic rather than being moved south through the Bering Strait. However, a recent exploration plan was proposed that included a drillship which might have transited the Bering Strait twice during each drilling season (Shell Offshore Inc., 2007). In summary, drillship operations in the Beaufort and Chukchi Seas were conducted intermittently (e.g., one in five years). Most drillships, icebreakers, and ice-strengthened support vessels have overwintered in the Arctic (Canada), but a few of these vessels moved through the Bering Strait during the early summer and late autumn in each year of operation.

Support operations

The historical information listed on the MMS web sites shows that most Beaufort OCS exploration in shallow water was conducted from artificial gravel islands. Construction of the gravel islands during winter months by over-ice trucking operations often included final work during the summer months with heavy equipment that was delivered by barges which transited the Bering Strait. Also, eight Beaufort exploratory wells were drilled during the past 27 years with bottom-founded drilling structures, such as the Concrete Island Drilling System (CIDS) and Single Steel Drilling Caisson (SSDC). The bottom-founded drilling structures have been moved every few years by ice-strengthened support vessels. A few of these structures and support vessels transited through the Bering Strait. Also, the drilling on the U.S. portion of the Chukchi shelf, which has occurred in offshore areas over 30-meters deep, is too deep for bottom-founded structures like the CIDS and SSDC; so, drillships have been used, as described above. If production operations eventually occur in the Chukchi, large bottom-founded structure might be moved by support vessels through the Bering Strait to field sites.

Crowley and Bowhead operate barge vessels to deliver fuel and supplies to Prudhoe Bay, Barrow and other northern coastal villages once the nearshore sea ice goes out. Crowley maintains a fleet of three triple screw tugs and 200 ft barges in Prudhoe Bay for the open water summer season. They transport cargo that is delivered to Prudhoe Bay to support oil exploration and development activities. The cargo comes from 3 locations: supplies trucked in to Prudhoe over the Alaska pipeline haul road; oversized cargo delivered to the North Slope through the Bering strait in the late July and August time frame; and fuel, small modules and drill rigs from Canada (often built in Edmonton, riled to the Hay River, and barged to Prudhoe).

Bowhead also provides commercial barge service to Barrow and other villages and oil field sites. In 2008 Bowhead operated one 380' barge and plans to operate two beginning in 2009. The barges will be towed in tandem by a single tug from Seattle through the Bering strait to the North Slope (one round trip transit per season). The company operates multiple local trips in the Arctic, primarily between Barrow, Prudhoe Bay and former military Dewline sites that are currently being cleaned up. Bowhead's activities primarily support North Slope and offshore oil and gas activities and military cleanup activities. These activities are expected to increase in future years.

Little is known about the geologic potential on the adjacent Russian portion of the Chukchi Sea, but the U.S. Geological Survey projects that the Hope Basin extends from the southeastern Chukchi Sea near Cape Lisburne into the western, Russian portion (Kenneth et al., 2008). No lease sales or drilling operations have been conducted in the U.S. portion of the Hope Basin. The MMS web site shows also that six wells were drilled during the mid-eighties in Norton Sound, which is located just southeast of the Bering Strait (http://www.mms.gov/alaska/fo/wellhistory/NORWELLS.HTM). However, no wells have been drilled in Norton Sound since that time. Consequently, vessel traffic associated with oil and gas operations near the Bering Strait (specifically between Cape Lisburne and St. Lawrence Island) and in the Russian Chukchi is expected to be low.

In summary, the Arctic sea lift has averaged about ten barges per year through the Bering Strait, or 20 transits to the north or the south. The MMS estimates that two seismic surveys will occur annually in the Beaufort Sea, and that a maximum of three will occur annually in the U.S. portion of the Chukchi Sea. For these operations, the seismic and associated service vessels would transit the Bering Strait twice each summer. Drillship operations in the Beaufort Sea and U.S. portion of the Chukchi Sea were conducted intermittently (e.g., one in five years). Most drillships, icebreakers, and ice-strengthened support vessels have overwintered in the Arctic (Canada), but a few of these vessels moved through the Bering Strait during the early summer and late autumn in each year of operation. Construction of the gravel drilling islands during winter months by over-ice trucking operations often included final work during the summer months with heavy equipment that was delivered by barges which transited the Bering Strait. Bottom-founded drilling structures have been moved every few years by ice-strengthened support vessels. A few of these structures and support vessels transited through the Bering Strait. Vessel traffic associated with oil and gas operations near the Bering Strait (specifically between Cape Lisburne and St. Lawrence Island) is expected to be low. Overall, the Bering Strait is transited to the north or south by about 30 vessels per year that are directly related to oil and gas operations on the Alaskan North Slope, in the Beaufort Sea, and on U.S. portion of the Chukchi Sea. In the future, we expect similar levels of marine vessel transits through the Bering Strait associated with a continuation of exploration seismic and drilling activities on both the U.S. and perhaps the Russian portion of the Chukchi shelf.

Red Dog Mine

The Red Dog Mine is located in northwestern Alaska, approximately 82 miles north of Kotzebue, and 46 miles inland from the coast of the Chukchi Sea. The mine is located on the Middle Fork of Red Dog Creek in the DeLong Mountains of the western Brooks Range, in an area that is otherwise remote and undeveloped. Red Dog is a partnership between NANA and Teck Cominco Alaska. The mine is the primary private business and an important component of the economy of Northwest Alaska, employing approximately 480 people directly and creating an additional 150 jobs indirectly. A majority (56%) of the employees are shareholders of the regional Alaska Native profit corporation. The mine has been operating continuously since its opening in 1989. Red Dog produces more than one million tons of zinc and lead concentrates annually using conventional open-pit mining, milling and flotation technologies. All concentrates are exported to world markets via the DeLong Mountain Transportation System (DMTS), which connects the mine and millsite to port facilities on the Chukchi Sea.

About 25 bulk cargo ships (Pamamax size) owned by foreign companies move ore during the open-water season from the DeLong Mountain Terminal to ports throughout the Pacific, with about 25 transits northbound and 25 southbound through the Bering Strait (totaling about 50 transits). Bulk cargo ships draw so much water that they cannot load at the terminal and are required to anchor three miles offshore. As a result, about 250 local lightering barge trips are used each year to move ore to the bulk cargo ships. The DMTS is owned by the Alaska Industrial Development and Export Authority, but the vessels belong to Teck Cominco. The bulk ore carriers that go to the facility carry some ore to the Tech Cominco metallurgical facilities in Trail, British Columbia and the rest of the ore to ports in Asia and Europe. Alaska Marine Lines, Seacoast Transportation, Delta Western & Crowley move fuel into Red Dog to support the ore carriers. In addition, about five barge loads of fuel and supplies are shipped each season into the terminal for use by the mine and port.

VI. Navigation, communication and ocean observing infrastructure

Infrastructure is defined as the resources available to protect the health, safety and welfare of individuals and their environment. As the human presence in the Bering Strait grows, an adequate infrastructure will need to be created that will have a significant role in the future of the area. This is especially important in the U.S. waters of the region as energy security, U.S. sovereignty, increased Arctic shipping activity and safe guarding resources will become paramount. A U.S. presence will be required.

Navigation

There are currently no formally established vessel routing measures in the Bering Strait. A Traffic Separation Scheme (TSS) may need to be established in the Strait as vessel traffic increases. Before any routing measure is established, U.S. law requires that a Port Access Route Study be completed. In order for the TSS to be recognized by IMO, it would have to be presented as a joint proposal developed by the governments of the neighboring states; U.S. and the Russian Federation. Future safety of shipping through the Bering Strait would be enhanced by the collaborative efforts of U.S. and Russia to develop a unified position with regard to commercial vessels and navigation that could be presented to the IMO.

There is currently no active Vessel Traffic Service (VTS) or other traffic management system in place in the waters of the Bering Strait. In addition, it is not likely that a formal, manned VTS will be created for the Bering Strait by 2020. Shipboard Automated Identification System (AIS) capability is currently limited in the Bering Sea. Presently the Marine Exchange of Alaska has established and is expanding AIS reception capability throughout portions of the Bering Sea.

There are no shore based VHF-FM communication services available in the Bering Strait region. The US Coast Guard does maintain VHF-FM sites in the Bering Sea, and maintains a HF radio guard for emergency and distress calling, but HF coverage of the arctic region is poor.

There are only three USCG maintained navigational aids at the Bering Strait along the North side of the Seward Peninsula into Kotzebue Sound. There are no navigational aids north of Kotzebue Sound. To be prepared for the 2020 timeline and the possibility of increase maritime traffic, the U.S. and Russia need to evaluate the marking system in use in the Bering Strait to ensure that it can support the predicted increase in marine traffic. Prior to making any changes in the aids to navigation or establishing routing measures, the U.S. Government will need to conduct surveys of water routes through the Bering Strait.

There is 100 percent coverage of the Strait from the Global Positioning System – Standard Positioning Service (GPS-SPS). However, the GPS constellation is not configured for optimal positioning in high latitudes; there is degradation of position accuracy. There is currently no Differential GPS (DGPS) coverage of the area.

The topography of the region offers one significant harbor of refuge. Port Clarence provides a good harbor within Bering Strait and provides an anchorage with good holding ground. There are no piers, wharves, or docks located within the harbor. The only modern harbor chart is available at Nome, AK at the scale 1:20,000. All other navigation in the area is based on local knowledge and experience.

Issues must be raised about the construction and structural capacity of the vessels that will transit the Strait. Currently vessels are not required to have ice strengthened hulls for navigating through ice.

Incident Response

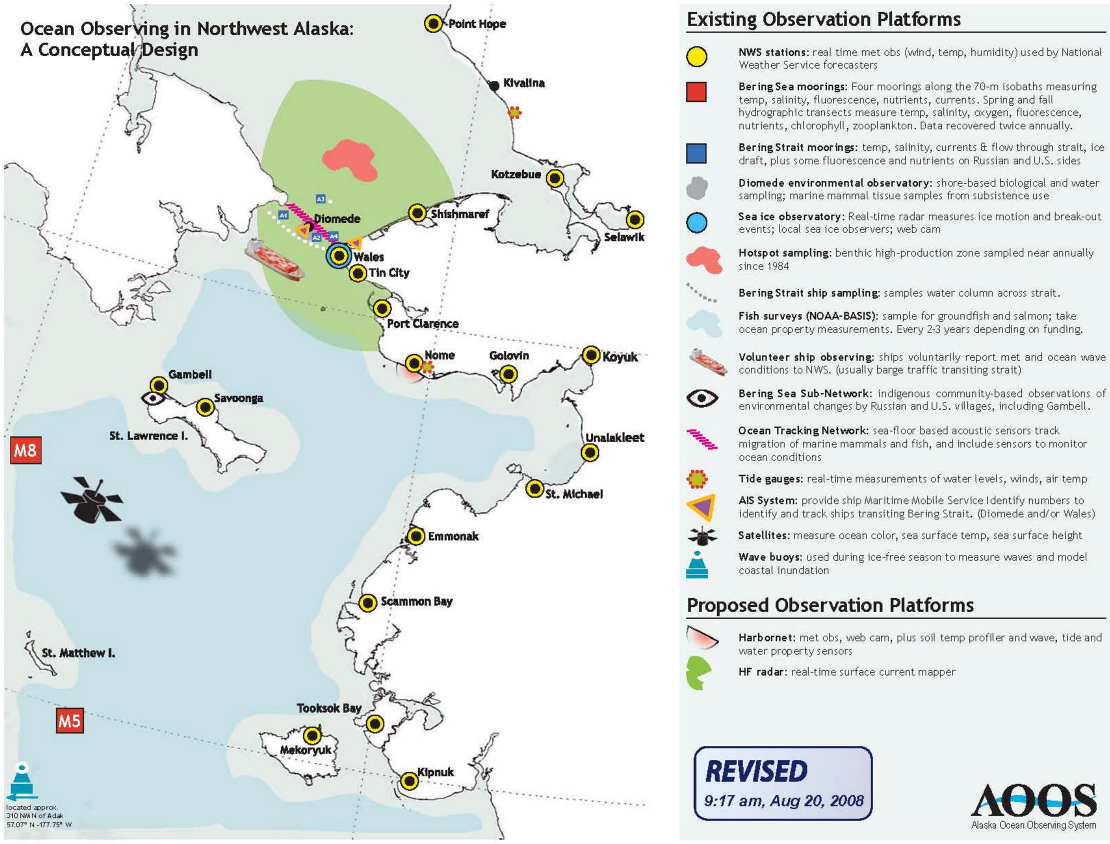
In the Bering Strait region, limited capabilities exist to respond to an incident whether it is for lifesaving or oil recovery. This includes weather and oceanographic observations necessary to support Search and Rescue (SAR) and oil recovery operations. The possibility of having a permanently manned response base in the area of the Strait by 2020 is very limited. There could be spill response equipment staged and in place; however, it will still take time for personnel to arrive to begin initial containment. Caches of oil spill equipment located in containers can be strategically placed to respond to an oil spill in the Strait.

As for SAR assets, it is not likely that SAR platforms of any sort will be permanently in place by 2020. Some may be in place in the near term on a seasonable basis in order to identify issues that need to be overcome such as logistics. Even if a Coast Guard Forward Operating Location (FOL) is seasonally deployed to an Arctic community, weather and distance to the incident site will remain an obstacle. The only possibility to a quicker response to an incident is the presence of a Coast Guard vessel that will conduct routine patrols in the area. Under present circumstances, vessels in distress will have to depend on other vessels or local communities in the area for assistance or will have wait until aid arrives.

Except for polar ice breakers which seasonally work in the Arctic and Antarctic, the USCG rarely operates north of the Bering Sea fisheries area. The U.S. in general is woefully equipped for polar icebreaking missions. The USCG, which has the responsibility of polar icebreaking, has only three vessels capable of conducting these operations and of these vessels, two are aging and will need replacement. The third ice breaker operated by the Coast Guard can only break ice that is less than half the thickness of that by the aging ones. In the future, the need for U.S. maritime presence farther north in Alaska will require significant planning based upon national priorities.

Ocean Observing

There are currently no operational ocean observing platforms in this region. Figure 11 describes an optimal observing system for the region, building upon existing (mostly research) assets.



VIII. Research Agenda

Description of study area

<u>Ocean water characteristics</u> (temperature, salinity, currents)

- Expand ocean observations in region to more accurately reflect real-time state of the ocean conditions: temperature, salinity, acidification, winds, waves, and currents.
- Develop higher resolution ocean circulation, atmospheric and wave models for region.

<u>Bathymetry</u>

- Plan and conduct a bilateral multi-beam survey for establishing preferred navigation routes north and south through the Bering Strait. Corridors should extend south to St. Lawrence Island and north to the northerly extent of Prince of Wales shoal. Additional deep draft corridors should be surveyed east into Kotzebue and Norton Sound (comparable on the Siberian Coast?).
- Recognizing the history and age of the topographic and bathymetric surveys in the Bering Strait case study area, the significance of the navigation needs for transiting through this limited waterway and the environmental challenges and risks, develop a suite of navigation products to support maritime commerce and maritime jurisdiction activities.

Shoreline mapping & water levels

- Establish a multi-year tertiary water level measuring station on Little Diomede Island to collect water level data during the ice free season for modeling water levels between the NWLON stations at Nome (Norton Sound) and Red Dog Dock (Kotzebue Sound) and establishing a vertical datum in the Bering Strait. Gravity measurements should be planned to increase the efficacy in future GPS use.
- Plan and conduct either airborne lidar or satellite based altimetry topographic and wave kinematic bathymetric surveys of the coastline to more accurately delineate the topography and near shore bathymetry as a tool for monitoring coastal change with erosion and accretion. Such surveys will also provide the data in planning precautionary measures for increased future shallow and deep draft shipping through the Bering Strait.

Sea ice

- Develop better capabilities for detecting sea ice and forecasting ice movements, and measuring thickness and different properties of seasonal and multi-year ice.

People

- Track ongoing economic activities in region and assess potential for increased shipping through Bering Strait.

Ecosystem and bio-resource considerations

Ecosystem

- Develop a dynamic Geographic Information System to store and display resource distribution and abundance information. Such a system could be useful for identifying specific areas of resource abundance that may therefore be sensitive to potential impacts.
- Develop contaminant tracking program.

Marine mammals, seabirds, and fish and shellfish

- Monitor over the long-term the seasonal abundance and distribution of ice-dependent species to document anticipated shifts relative to changing ice conditions. Such changes may also affect subsistence harvest patterns.
- Pursue species specific studies to evaluate direct effects of sea ice changes on survival and reproductive parameters.
- Map ambient sound field of Chukchi to be able to identify background noise from noise generated by vessels.
- Monitor and better understand the impact of vessel noise, ship strikes, pollution, and entanglements from marine debris on large marine mammals.

Indigenous Marine Use

- Systematically monitor subsistence and local uses in region on both U.S. and Russian sides and archive data.
- Monitor and better understand the impact of increased vessel traffic and industrial human interactions on the availability and accessibility of subsistence resources.

Commercial Marine Uses

- Monitor and document actual vessel traffic through the Bering Strait in order to more accurately predict future increases in traffic. We do not have quantitative information on commercial marine vessels that steam through the Bering Strait. A detailed study of vessel traffic has been conducted for the Great Circle Route near the Aleutian Islands and through Unimak Pass, and one is needed for the Bering Strait region.
- Identify commercial uses on Russian side.
- Monitor and track commercial activity in region and future activity.
- Identify potential harbors of safe refuge.

Navigation, communications and ocean observing infrastructure

- Identify ways to develop comprehensive ship identification system in Bering Strait region.
- Determine future shipping traffic increase in 5-year increments out to 2020.
- Determine the feasibility and benefits of enhancing observations through the use of unmanned aerial systems.
- Determine the feasibility and benefits of increasing US Coast Guard presence in northern Alaska.
- Develop incident response protocols at the local level.
- Determine the best location to enhance port infrastructure to accommodate an increase in shipping and increase of US Coast Guard presence.
- Develop bi-lateral US/Russia communication networks.
- Identify ocean observing infrastructure needs.

IX. Findings

Description of study area

- The Bering Strait region is the key chokepoint between the Pacific and Arctic oceans.
- Bilateral agreements should be pursued to modernize the basic topographic, bathymetric, gravity and water level surveys. This will provide modern data for navigation tools that will support safe navigation, support Arctic commerce, and minimize environmental risks.
- The general structure of the seabed has been charted historically, but chart coverage is not adequate to normal standards and is poor for harbors other than Nome. The best coverage is spotty, using single beam sonar. Navigation is often based on local knowledge.
- Water level information, essential to determine sea level rise and shoreline and coastal change as well as to support safe navigation is limited for the Bering Strait and north into the Chukchi Sea.
- Gravity measurements should be planned to increase the efficacy of future GPS use.
- Oceanography influences ice cover and the animals that move through the strait.

- The shoulder season/fringe times in the marginal ice zone are hugely affected by oceanography: they provide the biggest challenge to navigation.
- Sea ice coverage is greater than 80% from November to June, but the onset of ice is variable and may occur between September and November.
- The marginal ice zone (ice edge location) is dynamic, and interannual variability is extreme.
- Ice conditions are variable (w/ridges, complex terrain – thicknesses and surface roughness) and the thickness (ranging as high as 2 meters or more) is the parameter least known.

Ecosystem bio-resource considerations

- The Bering Sea, adjacent to the Bering Strait, is considered to be one of the most productive marine ecosystems in the world.
- The Arctic Ocean (Chukchi and Beaufort Seas) is a huge, expansive area that is seasonally home to a number of unique arctic species that also depend on the Bering Sea.
- The Bering Strait region is a critically important migratory pathway for a wide variety of marine mammals and some species of seabirds including waterfowl and sea ducks that seasonally use both the Bering and Chukchi Seas, several of which are ESA listed. For many species, the Bering Strait is the **only** transit between the two regions that are critical to their life history.
- The hazards of ship noise and disturbance on marine mammals near the Bering Strait, and in Arctic waters in general, need to be addressed further through relevant international organizations.
- There are 3 drivers of wildlife concentration in the region. Geography: the geographic constriction in the Straights serves to concentrate wildlife populations during migration. Ice conditions and other events: high concentrations of wildlife are associated with key environmental events, notably ice advance and ice recession. Productivity: **o**verall primary productivity (benthic productivity on shelf and productivity for ice) in the region contributes to high concentrations of wildlife.
- Because of these wildlife concentrations, potential impacts of any oil or other hazardous spill could be significant.
- Certain fish species appear to be extending their range north. As ocean and climate conditions continue to change, the geographic expanse of commercial and subsistence fisheries are likely to change as well.
- Currently there is recreational and subsistence fishing in the Bering Strait. A proposed Arctic Fisheries management plan would prohibit commercial fishing activities in the northern Bering Sea until further research determines appropriate fisheries management. Senate Joint Resolution 17, International Agreement on Management of Arctic Fish Stocks, was signed June 30, 2008 and calls upon the US to enter into international discussions with arctic nations to agree on arctic fishery management.
- Fish surveys had not been routinely conducted in the northern Bering Sea; no data exists on potential economic and environmental impact of arctic fishing grounds.

- The lack of information about some fish and shellfish stocks near the Bering Strait adds to the difficulty of assessing the effects of possible invasive species in ballast water discharges near the strait.

Indigenous marine uses

- Indigenous communities rely significantly on subsistence use of marine mammals, fish and shellfish, and birds in the region.
- Indigenous tribes are now concentrated in permanent communities as opposed to seasonal camps. Traditionally, they have been accustomed to adapting to change, and exploiting available resources. But now changes are happening so fast, they are not able to adapt as easily. People are traversing larger expanses of open, large water with bigger waves. Hunters are forced to deal with conditions that aren't within their historical knowledge.
- Because of changes in sea ice conditions, subsistence users are not able to use the sea ice/land interface for multiple months. This has resulted in reduced time for use of ice as a hunting platform.
- Local knowledge shows that high use resources (marine mammals) are those that are noise-sensitive. And because of funneling, vessel activity and potential contamination in the region, the continued availability of subsistence food concerns local people.
- Given the ecosystem changes and increasing vessel traffic around the Bering Strait, information on traditional marine use could be collected and compiled again, and shared with coastal communities.

Commercial marine uses

- Most significant international shipping to date is due to the Red Dog mine's bulk ore carriers. The Red Dog Mine, 200 miles north of the Arctic Circle and the largest zinc mine in the world, has almost doubled its shipments in the last ten years. Longer ice free seasons have aided this growth. It is estimated with the known resources in the immediate mine area, the mine will continue production for the next 50 yrs and if new deposits are discovered and developed, the mine could be in production for 100 yrs or longer.
- Oil and gas support vessels, a few small-medium cruise ships, 6 or 7 yachts/sailboats, several survey and research vessels, and a few ice breakers make up the bulk of Bering Strait traffic to date. The traffic is not a lot, but it is slowly increasing.
- The most significant increases will likely result from oil and gas development, some tourism, and possible international shipping. The North Sea route and the Northwest Passage will be key factors in facilitating expanded Arctic oil, gas and mineral exploration and extraction.
- There are no really deep water ports in the region. The First deep water port south of the Bering Strait is Dutch Harbor.
- Several small ports support local economic development needs. Small communities are dependent on barge traffic using landing crafts that require minimal maritime infrastructure.

- On the Russian side, of the 3 local ports, 2 are closed to military use only.

Navigation, communication, and ocean observing infrastructure

Coast Guard presence

- Current Coast Guard demand in the Polar Regions, for all missions except icebreaking, is minimal or non-existent. Any increases in demand requiring sustained operations will exceed the Coast Guard's current capability and capacity. As the Polar Regions become more accessible and human activity and associated risks increase, the requirement to conduct all Coast Guard missions will also increase. Geo-political and economic factors such as increased oil and gas exploration, migration of fish stocks, changes in sea routes for commercial traffic, and extended navigation season, and tourism, are expected to increase various risk factors in the region, and therefore increase the demand for risk reduction by all eleven Coast Guard statutory missions. Given the finite current resources and demand in all regions any increase in mission demand in the Polar Regions will require a corresponding increase in capacity.
- .Future safety of shipping through the Bering Strait would be enhanced by the collaborative efforts of U.S. and Russia to develop a unified position with regard to commercial vessels and navigation that could be presented to the IMO
- The Bremen and Hanseatic cruise ships have been landing at the Nome harbor during alternate years; while this pattern of alternation might be convenient for the port, it means that another cruise ship probably is not within rescue distance in the Arctic Ocean, and therefore does not strengthen cruise ship safety in Arctic waters.

Infrastructure

- The US has very limited ability to maintain awareness of shipping traffic. To ensure adequate maritime domain awareness, systems will need to be established to provide shipping traffic information; improving AIS capability or requiring all ships to report location on a routine basis through the use of the Global Maritime Distress Safety System (GMDSS).
- The Bering Strait region has no dependable communications capability. To ensure reliable and timely communications, both HF and VHF-FM systems need to be further established to have 100% coverage.
- Without Differential Global Positioning System (DGPS) available in the Bering Strait Region, there is degradation of position accuracy. Establishing DGPS will support future area surveys to provide accurate information for navigation as well as ATON.
- All ports located along the Bering Strait can only handle small vessels and do not have infrastructure in place to expand port capabilities.
- Issues must be raised about the construction and structural capacity of the vessels that will transit the Strait. At this time there are no regulations that require vessels to have ice-strengthened hulls for navigating through ice.
- The challenge of oil spills in broken ice near the Bering Strait, and in other Arctic waters in general, could be met by further collaboration on research by Arctic states and industry.

Consultations

- Meetings with Bering Strait stakeholders need to be conducted for issues that will affect the social-economic and biological impacts of the area.
- Bilateral agreements with Russia and Canada should be pursued to modernize the basic topographic, bathymetric, gravity and water level surveys. This will provide modern data for navigation tools that will support safe navigation, support Arctic commerce, and minimize environmental risks.

Observing systems

- At the present time, weather forecasts are limited to areas within 100 nautical miles of the Alaska coastline. This occasionally gives rise to situations where a routine weather forecast is not available for a ship in open Arctic waters – a situation that will arise more and more frequently as Arctic shipping increases. NOAA National Weather Service proposes to expand their forecast and warning area to seasonally cover the entire US EEZ in Arctic waters. To obtain this goal and to provide oceanographic observations for wind, waves, currents, and other ocean parameters, additional resources (including observing platforms and models) will be necessary. Weather and oceanographic forecasts are only as good as the observations used to initialize models. Meteorological observations in the Arctic are sparse compared with more populated areas of the globe but are not completely inadequate. Oceanographic observations in the nearshore Arctic are almost non-existent.

X. Bibliography

Clark, K. C. Hetherington, C. O'Neil, and Jana Zavitz. 1997. Breaking Ice with Finesse; Oil & Gas Exploration in the Canadian Arctic. The Arctic Institute of North America, University of Calgary, Calgary, Alberta, Canada. 248p.

Crowley Maritime Corporation. 1992. Two Men at the Helm: The First 100 Years of Crowley Maritime Corporation, 1892-1992. Crowley Maritime Corporation, Oakland, CA. 159p. (http://www.crowley.com/aboutus/Crowley_History_Book_web.pdf)

Gjerdrum, C. et al. 2008. Bering Sea. IPY Report. Canada's Three Oceans (C3O) January 2008

Kawerak, Inc., North Pacific Research Board, and Alaska Department of Fish and Game, 2007. 2005-2006 Comprehensive Subsistence Harvest Survey, Bering Strait/Norton Sound Region.

Kenneth, J.B., R.R. Charpentier, D. L. Gautier, D.W. Houseknecht, T. R Klett, J.K. Pitman, T.E. Moore, C.J. Schenk, M.E. Tennyson, and C. J. Wandrey. 2008. Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle. U.S. Geological Survey, Menlo Park, CA (http://pubs.usgs.gov/fs/2008/3049/)

Shell Offshore Inc. 2007. Beaufort Sea Outer Continental Shelf Lease Exploration Plan 2007-2009. Shell Offshore Inc., Anchorage, Alaska (http://www.mms.gov/alaska/fo/ExplorationPlans/shell_exploration_plan/Exploration%20Plan.pdf)

Tornga, C. 2002. Crowley Alaska marks 50 years of service to the state. Petroleum News, Vol. 7, No. 50. December 15, 2002. (http://www.petroleumnews.com/pnads/98640704.shtml)

U.S. Department of the Interior, Minerals Management Service. 2006. Biological Evaluation of the Potential Effects of Oil and Gas Leasing and Exploration in the Alaska OCS Beaufort Sea and Chukchi Sea Planning Areas on Endangered Bowhead Whales (*Balaena mysticetus*), Fin Whales (*Balaenoptera physalus*), and Humpback Whales (*Megaptera novaeangliae*). Prepared in Accordance with Section 7 of the Endangered Species Act of the United States of 1973, as amended. (http://www.mms.gov/alaska/ref/BioEvalations/final_be_whales.pdf)

Wainwright, P. 2002. GIS Geospatial Database of Oil-Industry and Other Human Activity (1979-1999) in the Alaskan Beaufort Sea. MMS OCS Publication 2002-071. Volume 1. 86pp. (http://www.mms.gov/alaska/reports/2002rpts/2002-071.pdf)

Weingartner, T.J., S. Danielson, Y. Sasaki, V. Pavlov, and M. Kulakov. 1999. The Siberian Coastal Current: A Wind- and Buoyancy-Forced Arctic Coastal Current. Journal of Geophysical Research 104C12:29,697-29,713.