4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Methodology

This chapter describes the predicted direct, indirect, and cumulative effects on the biological and human environment from implementing the alternatives described in Chapter 2. The chapter begins by summarizing the methodology used to predict environmental consequences, including frequently used terms (Section 4.1.1); the steps and criteria used for determining the level of impact (Section 4.1.2); and an overview of the approach to cumulative effects assessment (Section 4.1.3). Section 4.2 explains how incomplete or unavailable information is dealt with in this document, and Section 4.3 identifies resources not carried forward for further analysis. Sections 4.4 and 4.5 analyze direct and indirect impacts to the Western Arctic bowhead whale stock and individual bowhead whales, respectively, from each of the alternatives, while Section 4.6 discusses the cumulative impacts to the Western Arctic bowhead whale stock. Sections 4.7 and 4.8 discuss the analyses of the direct, indirect, and cumulative impacts to other wildlife and the socio-cultural environment, respectively. Section 4.9 summarizes the biological and socio-cultural cumulative effects together.

4.1.1 Definition of Terms

The following terms are used throughout this document to discuss impacts:

Direct Effects – caused by the action and occurring at the same time and place (40 CFR 1508.8). Direct effects pertain to the proposed action and alternatives only.

Indirect Effects – defined as effects caused by an action and later in time or farther removed in distance but still reasonably likely. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems (40 CFR 1508.8).

Indirect effects are caused by the project, but do not occur at the same time or place as the direct effects. Indirect effects pertain to the proposed action and alternatives only.

Cumulative Effects – additive or interactive effects that would result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7). Interactive impacts may be either countervailing (where the net cumulative effect is less than the sum of the individual effects) or synergistic (where the net cumulative effect is greater than the sum of the individual effects). EISs address reasonably foreseeable cumulative effects issues, rather than speculative impact relationships. Section 4.1.3 describes steps involved in the cumulative effects assessment.

Reasonably Foreseeable Future Actions – this term is used in concert with the Council on Environmental Quality (CEQ) definitions of cumulative effects, but the term itself is not further defined. Most regulations that refer to "reasonably foreseeable" do not define the meaning of the words, but do provide guidance on the term. For this analysis, reasonably foreseeable future actions (RFFAs) or impacts are those that are likely (or reasonably certain) to occur within the

timeframe used for analyzing environmental consequences, and are not purely speculative. This determination of "reasonably foreseeable" is based on documents such as existing plans, permit applications, or announcements.

4.1.2 Steps for Determining Level of Impact

NEPA requires federal agencies to prepare an EIS for any action that may significantly affect the quality of the human environment. The CEQ regulations implementing NEPA state that an EIS should discuss the significance, or level of impact, of the direct, indirect, and cumulative effects of the proposed alternatives (40 CFR 1502.16), and that significance is determined by considering both the context in which the action will occur and the intensity of the action (40 CFR 1508.27). Context and intensity are often further broken down into components for impact evaluation. The context is composed of the extent of the effect (geographic extent or extent within a species, ecosystem, or region) and any special conditions, such as endangered species status or other legal status. The intensity of an impact is the result of its magnitude and duration. Actions may have both adverse and beneficial effects on a particular resource. A component of both the context and the intensity of an effect is the likelihood of its occurrence.

The combination of context and intensity is used to determine the level of impact on each type of resource. The first step is to examine the mechanisms by which the proposed action could affect the particular resource. For each type of effect, the analysts develop a set of criteria to distinguish between major, moderate, minor, or negligible impacts. The analysts then use these impact criteria to rank the expected magnitude, extent, duration, and likelihood of each type of effect under each alternative.

Tables 4.1-1 through 4.1-3 provide a guideline for the analysts to place the effects of the alternatives in an appropriate context and to draw conclusions about the level of impact. The criteria used to assess the effects of the alternatives vary for the different types of resources analyzed. The impact criteria tables use terms and thresholds that are quantitative for some components and qualitative for others. The terms used in the qualitative thresholds are somewhat imprecise and relative, necessarily requiring the analyst to make a judgment about where a particular effect falls in the continuum from "negligible" to "major." The following descriptions of the terms used in the criteria tables are intended to help the reader understand the distinctions made in the analyses.

The magnitude or intensity of effects on biological resources is generally assessed in terms relative to the population rather than the individual. The MMPA, as amended, established a management objective to reduce incidental mortality of marine mammals in commercial fisheries. To this end, it defines an upper limit guideline for fishery-related mortality for each species or management stock, its Potential Biological Removal (PBR). PBR is defined in the MMPA as "...the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." While it was originally intended as a measure of impact from fisheries, PBR has also been used as the basis for measuring the magnitude of mortality from other anthropogenic sources, especially in cumulative effects analyses. According to the most recent NMFS stock assessment, the PBR for the Western Arctic stock of bowhead whales is 95 animals (Angliss and Outlaw, 2007).

However, the subsistence harvest is managed under the authority of the Whaling Convention Act. Accordingly, the aboriginal subsistence whaling provisions in the IWC Schedule take precedence over the PBR estimate for the purpose of managing the Alaska Native subsistence harvest from this stock. A conservative approach to setting the harvest limit is to use the values of Q from the 2006 stock assessment (see Section 3.2.1 for the introductory discussion of Q), which range from a low bound of 155 whales per year to a high bound of 412, with a best estimate value of 256 (Brandon and Wade, 2006). The 2006 Q values will also be used as thresholds for determining the level of impact on the bowhead whale population in this EIS. Recognizing that there is some uncertainty (Q is based on probability estimates) in the Q values, this assessment will employ the lower bound of Q at 155 whales, termed Q_{low} and the best estimate of Q at 257 whales, termed $Q_{best,}$ and the high bound of Q at 412 whales, termed Q_{high} , as impact threshold levels.

A take that is below Q_{low} (155 whales per year) is considered a negligible impact. A take that is between and Q_{low} (155 whales) and Q_{best} (256 whales) would be considered a minor impact. A take that is between Q_{best} (257 whales) and Q_{high} (412 whales) would be considered a moderate impact. A take greater than the Q_{high} (412 whales) would be considered a major impact. The impact criteria are summarized in Table 4.1-1.

For wildlife species other than bowhead whales, the magnitude of effects on the population is based on the potential mechanisms for effects on mortality and disturbance and the relationship of bowhead whaling activities with the species considered. The impact criteria for wildlife are summarized in Table 4.1-2.

The analysis of sociocultural impacts examines effects on subsistence use patterns, whaling community health and nutrition, and public safety. For impacts to subsistence uses, the magnitude and intensity of effects are based on the potential for loss or substantial reduction in production of key subsistence resources. For impacts to health and nutrition, and to public safety, the magnitude of effects is based on the proportion of the communities and population affected.

The geographic extent component is intended to estimate the distribution of effects relative to the population or nonbiological resource as a whole. For bowhead whales and other wildlife, local populations are defined as those populations that are generally distributed near a particular whaling community in some portion of their ecological range.

The geographic extent of sociocultural impacts is first defined in relation to the bowhead subsistence whaling communities and their traditional subsistence use areas. In addition, because these communities share bowhead subsistence foods widely, sociocultural effects could indirectly extend to those distant receiving communities, including those in neighboring regions, and also the Inupiat and Siberian Yupik families living in Fairbanks and Anchorage who remain integrated in sharing networks. The impact criteria for sociocultural resources are summarized in Table 4.1-3.

The duration or frequency component provides the context of time. "Short-term" refers to a temporary effect that lasts from a few minutes to a few days, after which the affected animals or resource revert to a "normal" condition. "Long-term" describes more permanent effects that may last for years or from which the affected animals or resource never revert to a "normal" condition. Moderate is somewhere in between. Intermittent or infrequent effects are those that

only occur a couple times a year or fewer. "Frequent" refers to effects that occur on a regular or repeated basis each year. Other elements of the temporal context of effects, such as whether the effects occur primarily during a sensitive or critical part of the year, are described in the analyses for each species or resource.

This assessment also evaluates the likelihood of an effect, in other words whether the potential effects are plausible or just speculative. "Likely" effects are those that could arise from reasonable or demonstrated mechanisms and the probability of those mechanisms arising from the alternatives is greater than 50%. This does not imply that the analysts will perform a formal probability calculation. Instead analysts use professional judgment to make a qualitative determination that the probability of the effect occurring is more likely than not. The likelihood of occurrence is considered in assessing magnitude, extent, and duration, as these factors are defined above. The determination of level of impact for each of these three factors is made on the basis of effects that are more likely to occur than not.

4.1.2.1 Determining the quota

Since the late 1970s the IWC has determined catch limits for bowhead whale harvests, after considering the nutritional and cultural need for bowhead whales by Alaska Eskimos and Russian Natives and the level of harvest that is sustainable. In 1986, the IWC accepted a method to calculate subsistence and cultural need of Alaska Eskimos for bowhead whales. This method incorporates the historic and current size of the Eskimo population residing in Alaskan subsistence hunting villages and the number of bowhead whales historically landed by each community (Appendix 8.1).

The IWC first established the five-year block catch limits for this stock in 1997, allowing a total of 280 bowhead whales to be landed, or an average of 56 whales per year. Suitability of the strike limits is determined using the Bowhead Strike Limit Algorithm (SLA) program (IWC, 2005a). Inputs include bowhead whale catches, abundance estimates from 1978-2001, and the value of need (i.e., 67 whales multiplied by the number of years of the quota). In 2004, the results of the Bowhead SLA calculations showed “that this level of need can be satisfied while fully meeting the Commissioner’s management objectives” (IWC, 2005a:23). For the proposed 2008 through 2012 quota (Alternative 3), annual strike limits would be established at 67 bowhead whales struck, with an allowance for the carry-over of 15 unused strikes from any previous year (including 15 unused strikes from the 2003-2007 block quota). The IWC has sanctioned the aboriginal harvest of whales from this stock by both the U.S. and the Russian Federation. The annual strike limits and quotas for bowhead whales are determined at the beginning of each year after consultation with the AEWC and renewal of the U.S.-Russia bilateral agreement governing the allocation of the bowhead whale subsistence quota between the two countries. Of the quota, the U.S. and Russia have agreed on a suballocation of five whales per year to the Chukotkan aboriginal whalers (Appendix 8.3).

4.1.2.2 Impact Criteria

Table 4.1-1 provides a framework within which effects on bowhead whales can be assured. This table summarizes the criteria for determining the level of impact based on the type (mortality or disturbance), the components (magnitude, extent, and duration) and the thresholds for four levels of effects (negligible, minor, moderate, and major). This framework represents the best judgment

of the analysts in identifying mortality and disturbance as the key types of effects, and in establishing the thresholds for a spectrum of impact levels from negligible to major. As noted in Section 4.1.2, the components of impact (magnitude, extent, and duration) are established in CEQ regulations. Sections 4.4 and 4.5 describe the anticipated direct and indirect effects for each alternative on bowhead whales by evaluating the scope and intensity of each quota carry-over, which differentiates the alternatives.

Table 4.1-1
Criteria for Determining Impact Level for Effects on Bowhead Whales

Type of Effect	Impact Component	Impact Level			
		Negligible	**Minor**	**Moderate**	**Major**
Mortality	Magnitude or Intensity	Total mortality assessment less than or equal to Q_{low} (less than 155 annually, or 775 for five years)	Total mortality assessment between Q_{low} and Q_{best} (155 – 257 annually, or 775 - 1285 for five years)	Total mortality assessment between Q_{best} and Q_{high} (257 - 412 annually, or 1285 - 2060 for five years)	Total mortality assessment equal to or greater than Q_{high} (greater than 412 annually or 2,060 for five years)
	Geographic Extent	No measurable population decline	Population decline measurable at one location	Population decline measurable at several locations	Population decline measurable across range of stock
	Duration or Frequency	No measurable population decline	Short-term or infrequent population decline	Moderate-term or intermittent population decline	Long-term and/or repeated population decline
Disturbance	Magnitude or Intensity	No measurable effects	Disturbance effects but distribution similar to baseline	Noticeable change in localized distribution	Enough to cause shift in regional distribution
	Geographic Extent	No measurable effects	Effects limited to one location	Effects distributed among several locations	Effects distributed across range of stock
	Duration or Frequency	No measurable effects	Periodic, temporary, or short-term	Moderately frequent or intermittent	Chronic and long-term

Table 4.1-2 provides a framework for assessing the effects of bowhead whale harvests and whaling-related activities on other biological resources (other than bowhead whales). These effects are primarily related to disturbance associated with whaling activities, or redirection of subsistence harvests to other species if bowhead whaling were prohibited. Some habitat damage can also occur from other actions and events. This table summarizes the criteria, developed by the project scientists, for determining the level of impact based on the magnitude, extent, and duration. Section 4.7 summarizes the anticipated direct, indirect and cumulative effects under each alternative for other biological resources.

Table 4.1-2
Criteria for Determining Impact Level for Effects on Other Wildlife

Type of Effect	Impact Component	Impact Level			
		Negligible	Minor	Moderate	Major
Mortality	Magnitude or Intensity	Mortality effects but no measurable change in population	Causes minor population change	Causes moderate population change	Causes major population change
	Geographic Extent	No measurable effects	Effects limited to one location	Effects distributed among several locations	Effects distributed across range of population
Mortality	Duration or Frequency	No measurable effects	Short-term or moderate and intermittent or infrequent	Moderate and frequent or long-term and intermittent	Long-term and/or frequent
Disturbance	Magnitude or Intensity	No measurable effects	Disturbance effects but distribution similar to baseline	Noticeable change in localized distribution	Enough to cause shift in regional distribution
	Geographic Extent	No measurable effects	Effects limited to one location	Effects distributed among several locations	Effects distributed across range of stock
	Duration or Frequency	No measurable effects	Periodic, temporary, or short-term	Moderately frequent or intermittent	Chronic and long-term

Table 4.1-3 provides a framework for assessing summarizes the mechanisms for measuring the effects of bowhead whale harvests and whaling-related activities on the social and cultural environment, and the criteria, developed by the project scientists, for determining the level of impact based on the magnitude, extent, and duration. These effects are primarily related to subsistence characteristics and public health and safety. Section 4.8 summarizes the anticipated direct, indirect, and cumulative effects under each alternative for these resources.

Table 4.1-3
Criteria for Determining Impact Level for Effects on Socio-Cultural Resources

Type of Effect	Impact Component	Impact Level			
		Negligible	Minor	Moderate	Major
Effects on subsistence	Magnitude or Intensity	No decline in production of major subsistence resources	Minor decline in production affecting few resources or limited seasons	Moderate decline in production affecting several resources or seasons	Substantial decline in production of major subsistence resources
	Geographic Extent	No measurable effects	Effects realized at few locations	Effects realized in numerous locations	Effects realized throughout the project area
	Duration or Frequency	No measurable effects	Periodic, temporary, or short-term	Moderate and frequent or long-term and intermittent	Chronic and long-term

Table 4.1-3 (continued)
Criteria for Determining Impact Level for Effects on Socio-Cultural Resources

		Impact Level			
Effects on public health and safety	Magnitude or Intensity	No measurable effects	The health and safety of < 5% of the population in the community would be affected	The health and safety of 5%-25% of the population in the community would be affected	The health and safety of >25% of the population in the community would be affected
	Geographic Extent	No measurable effects	Affects individuals in few communities	Affects individuals in half of the communities	Affects individuals throughout project area
Effects on public health and safety	Duration or Frequency	No measurable effects	Periodic, temporary, or short-term	Moderately frequent or intermittent	Long-term and/or frequent

4.1.3 Steps for Identifying Cumulative Effects

To meet the requirements of NEPA, an EIS must include an analysis of the cumulative effects of a proposed action and its alternatives and consider those cumulative effects when determining environmental impacts. The CEQ guidelines for evaluating cumulative effects state that "...the most devastating environmental effects may result not from the direct effects of a particular action but from the combination of individually minor effects of multiple actions over time" (CEQ, 1997). The CEQ regulations for implementing NEPA define cumulative effects as follows:

> The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time (40 CFR 1508.7).

For this EIS, assessment of cumulative effects requires an analysis of the direct and indirect effects of the proposed harvest quota alternatives, in combination with other past, present, or reasonably foreseeable future actions (RFFAs) potentially affecting bowhead whales, and other biological, physical, and socioeconomic resources. The intent of this analysis is to capture the total effects of many actions over time that would be missed by evaluating each action individually, and to assess the relative contribution of the proposed action and its alternatives to cumulative effects. The cumulative effects assessment then describes the additive and synergistic result of the harvest quota alternatives as they are reasonably likely to interact with actions external to the proposed actions. The ultimate goal of identifying cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the harvest quota alternatives.

The methodology used for cumulative effects analysis in this EIS is similar to that followed in the Alaska Groundfish Fisheries Programmatic Supplemental EIS (SEIS) (NMFS, 2004), the Steller Sea Lion Protection Measures SEIS (NMFS, 2001b), the Setting the Annual Subsistence

Harvest of Northern Fur Seal on the Pribilof Islands EIS (NMFS, 2005), and the Draft Steller Sea Lion and Northern Fur Seal Research Programmatic EIS (NMFS, 2007). It consists of the following steps:

- *Identify issues, characteristics, and trends within the affected environment that are relevant to assessing cumulative effects of the research alternatives* – include lingering effects from past activities, and demonstrate how they have contributed to the current baseline for each resource. This information is summarized in Chapter 3.
- *Describe the direct and indirect effects of the harvest quota alternatives*. This information is presented in Chapter 4.
- *Define the spatial (geographic) and temporal (time) frame for the analysis*. This timeframe may vary between resources depending on the historical data available and the relevance of past events to the current baseline. The "reasonably foreseeable future" has been established as the next ten years (through 2017) for the purposes of this EIS.
- *Identify past, present, and reasonably foreseeable external actions such as other types of human activities and natural phenomena that could have additive or synergistic effects* – summarize past and present actions, within the defined temporal and spatial timeframes, and also identify any RFFAs that could have additive or synergistic effects on identified resources. The cumulative effects analysis uses the specific direct and indirect effects of each resource alternative and combines them with these identified past, present, and reasonably foreseeable effects of the identified external actions.
- *Use cumulative effects tables to screen all of the direct and indirect effects, when combined with the effects of external actions, to capture those synergistic and incremental effects that are potentially cumulative in nature* – both adverse and beneficial effects of external factors are assessed and then evaluated in combination with the direct and indirect effects to determine if there are cumulative effects.
- *Evaluate the impact of the reasonably likely cumulative effects using the criteria established for direct and indirect effects and assess the relative contribution of the action alternatives to cumulative effects.*
- *Discuss rationale for determining the impact rating, citing evidence from the peer-reviewed literature, and quantitative information where available* – the term unknown can be used where there is not enough information to determine an impact level.

The advantages of this approach are that it closely follows 1997 CEQ guidance, employs an orderly and explicit procedure, and provides the reader with the information necessary to make an informed and independent judgment concerning the validity of the conclusions.

4.1.3.1 Relevant Past and Present Actions within the Project Area

Relevant past and present actions are those that have influenced the current condition of the resource. For the purposes of this EIS, past and present actions include both human-controlled events (such as subsistence harvest, oil and gas exploration and development activities, and commercial fisheries), and natural events, such as predation and climate change.

The past actions applicable to the cumulative effects analysis have been either presented in Chapter 3 or previously reviewed in the Arctic Ocean OCS Seismic Surveys Programmatic EA

(MMS, 2006c), Chapter 4 of the Alaska Groundfish Draft Programmatic SEIS (NMFS, 2004), Steller Sea Lion Protection Measures SEIS (NMFS, 2001b), Setting the Annual Subsistence Harvest of Northern Fur Seals on the Pribilof Islands EIS (NMFS, 2005), the Draft Steller Sea Lion and Northern Fur Seal Research Programmatic EIS (NMFS, 2007). The cumulative effects analysis relies heavily on the descriptions presented in those documents. Additional past actions were identified using agency documentation, NEPA documentation, reports and resource studies, peer-reviewed literature, and best professional judgment. Table 4.1-4 lists relevant past and present actions, and notes where descriptions of those actions can be located.

4.1.3.2 Reasonably Foreseeable Future Actions (RFFAs)

RFFAs are those that 1) have already been or are in the process of being funded, permitted, described in fishery, oil and gas lease sale documents, or coastal zone management plans; 2) are included as priorities in government planning documents; or 3) are likely to occur or continue based on traditional or past patterns of activity. Judgments concerning the probability of future impacts must be informed rather than based on speculation. RFFAs to be considered must also fall into the temporal and geographic scope described in Section 4.1.3.3.

Reasonably foreseeable future human-controlled and natural actions were screened for their relevance to the alternatives proposed in this EIS. Due to the large geographic scope dealt with in this analysis, the identification of RFFAs was conducted on a broad scale, although some specific RFFAs were considered where applicable. The following list presents the actions to be considered in the cumulative effects analysis, and Table 4.1-4 compares those actions with past and present actions:

- *Subsistence activities*: Subsistence harvests of bowhead whales by Alaska Natives who dwell on the North Pacific Ocean or Arctic Ocean coasts of Alaska are likely to continue at present levels as described in Chapter 3. Subsistence harvests of other animals are likely to continue at present levels also.
- *Oil and gas activities*: Oil and gas leases in the Beaufort and Chukchi Seas will result in continued and future off-shore production facilities and pipelines, drilling activities, seismic programs, transportation and barging, staging, fixed and temporary camp operations, and ice road construction.
- *Industrial pollutants*: Oil pollution in the marine environment can occur from road runoff, bilge cleaning and ship maintenance, natural seeps, pipeline and platform spills, oil tanker spills, and offshore drilling. Other marine pollution and debris can occur due to industrial activities, waste disposal, and atmospheric deposition. Marine species may accumulate contaminants such as PCBs and polyaromatic hydrocarbons (PAHs).
- *Commercial fisheries*: Federal and state fisheries operate according to the designated Fishery Management Plan (FMP). State-regulated and federally regulated fisheries in the project area are administered by the North Pacific Fishery Management Council (NPFMC) and the Alaska Board of Fisheries (ABF). The NPFMC oversees management of groundfish in the U.S. Exclusive Economic Zone (EEZ) off Alaska and ABF manages fisheries in nearshore waters as well as the offshore crab fisheries.
- *Commercial shipping*: It is anticipated that commercial shipping will increase in the future as northern Alaskan ports become ice-free for longer periods throughout the year, as onshore and offshore areas are developed for oil and gas, and as local communities grow.

- *Other economic development*: Coastal development within the project area, including port expansions and the construction of docks and facilities within the project area, is likely to occur as needs for marine support services and shipping capacity increase.
- *Scientific research*: Activities related to the scientific research of the physical environment, bowhead whales specifically, other marine mammals, fish, birds, and marine predator-prey relationships are likely to continue.
- *Climate variability*: Short-term changes in the ocean climate are likely to continue on a scale similar to those presently occurring, as described in Chapter 3. Evidence is emerging that human-induced global climate change is linked to the warming of air and ocean temperatures and shifts in global and regional weather patterns.
- *Mortality*: Disease, parasites and predation will continue to result in mortality of marine mammals, fish, and birds. Factors such as exposure to contaminants, decreased genetic diversity, and increased stress can lead to reduced fitness, which in turn can increase susceptibility to mortality from disease and predation.

Table 4.1-4
Past, Present, and RFFAs Considered in the Impact Analyses

	Past and Present	Reference (within this EIS)	Reasonably Foreseeable
Human-Caused Events			
Subsistence activities	▪ Harvest of marine and terrestrial mammals, fish, and birds	Sections 1.1.4, 1.2, 2.1, 2.2, 2.3, 2.4, 3.2.4, 3.4, 3.5, 4.8	▪ Harvest of marine and terrestrial mammals, fish, and birds
Commercial harvest	▪ Commercial whaling ▪ Commercial sealing	Section 3.2.3	▪ None
Oil and gas activities	▪ Seismic Exploration ▪ Offshore drilling and production ▪ Industrial noise	Sections 3.2.8, 4.6.1	▪ Seismic exploration ▪ Offshore drilling and production ▪ Industrial noise
Industrial pollutants	▪ Marine spills and pollution ▪ Marine debris ▪ Bioaccumulation ▪ Human health	Sections 3.2.8, 4.6, 4.8.1	▪ Marine spills and pollution ▪ Marine debris ▪ Bioaccumulation ▪ Human health
Commercial fisheries	▪ Crab fishery (entanglement in gear) ▪ Ship strikes	Sections 3.2.7, 4.6.3	▪ Crab fishery (entanglement in gear) ▪ Ship strikes
Commercial shipping	▪ Barge/vessel traffic and fuel spills ▪ Ship strikes	Section 4.6.3	▪ Barge/vessel traffic and fuel spills ▪ Ship strikes
Other development	▪ Military activity ▪ Coastal and infrastructure development ▪ Tourism	Section 4.6	▪ Military activity ▪ Coastal and infrastructure development ▪ Tourism
Scientific research	▪ Biological ▪ Oceanographic ▪ Geophysical/chemical (see oil and gas development)	Section 4.6.4	▪ Biological ▪ Oceanographic ▪ Geophysical/chemical (see oil and gas development)
Natural Events			
Climate variability	▪ Global warming	Section 4.3.2, 4.6.2	▪ Global warming
Mortality	▪ Predation ▪ Disease and parasites	Sections 1.1.3, 3.2.5, 3.2.7, 4.4, 4.5, 4.6	▪ Predation ▪ Disease and parasites

Table 4.1-5 provides a list of the RFFAs likely to occur in the project area and identifies which resources a particular RFFA could affect.

Table 4.1-5
RFFAs Considered in the Cumulative Impact Analyses

RFFA	Anticipated Cumulative Impacts to Resource
Subsistence Activities	1, 2, 3, 4, 5, 6
Commercial Harvest	1, 2, 3, 6
Oil and Gas Activities	1, 2, 3, 4, 5, 6
Global and Industrial Pollutants	1, 2, 3, 4, 5, 6, 8
Commercial Fisheries	1, 2, 5, 6
Commercial Shipping	1, 2, 5, 6
Other Development	1, 2, 5, 6
Scientific Research	1, 2
Climate Variability	1, 2, 3, 4, 5, 6,
Mortality	1, 2, 3
KEY	
1. Bowhead Whale (stock) 2. Other Wildlife 3. Eskimo Health	4. Eskimo Safety 5. Other Tribes and Aboriginals 6. General Public

4.1.3.3 Project Area and Scope for Analysis

The spatial scope of the effects analysis is the entire geographic range of the Western Arctic bowhead whale stock in the Bering, Chukchi, and Beaufort Seas, including Russian and Canadian waters in this range. When this spatial scope is not applicable to a given resource, a relevant geographic sub-area is defined in the analysis.

Evaluation of cumulative effects requires an analysis of the potential direct and indirect effects of the proposed alternatives, in combination with other past and present actions and RFFAs. The time frame or temporal scope for the past and present effects analysis was defined as the period since the Western Arctic bowhead whale stock was first commercially hunted in the Bering Sea in 1848. For each resource, the time frame for past and present effects is described in Section 3. RFFAs considered in the cumulative effects analysis consist of projects, actions, or developments that can be projected, with a reasonable degree of confidence, to occur in the foreseeable future and that are likely to affect the resources described. A common practice is to project five to ten years forward, and in this case, the ten-year time frame was chosen because reasonable estimates regarding oil and gas exploration and development along the Chukchi and Beaufort seas are available for this period.

4.2 Incomplete and Unavailable Information

The CEQ guidelines require that:

> When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking (40 CFR 1502.22).

In the event that there is relevant information, but "the overall costs of obtaining it are exorbitant or the means to obtain it are not known" (40 CFR 1502.22), the regulations instruct that the following should be included:

- A statement that such information is unavailable;
- A statement of the relevance of such information to evaluate reasonably foreseeable significant adverse impacts;
- A summary of existing information that is relevant to evaluating the adverse impacts; and
- The agency's evaluation of adverse impacts based on generally accepted scientific methods.

In the analysis, this EIS identifies those areas where information is unavailable to support a thorough evaluation of the environmental consequences of the alternatives. The direct, indirect and cumulative effects analyses are based on readily available information; however, whatever data gaps still exist are identified in accordance with the above CEQ guidelines.

4.3 Resources and Characteristics Not Carried Forward For Analysis

Species that would not be affected directly or indirectly by bowhead whaling activities include gray whales, minke whales, killer whales, harbor porpoise, short-tailed albatross, and many terrestrial mammals. These species were not considered for further analysis because the alternatives would not have any effects on these species.

4.4 Direct and Indirect Effects of the Alternatives on the Western Arctic Bowhead Whale Stock

Alternatives were developed based on the IWC recommended strike limit (including takes in both Alaska and Russia). The action alternatives primarily assess the merits of different options in the carry-over strikes without suggesting a change to the existing catch limits provided through the international forum of the IWC and as established through several decades of scientific research and calculations. In the analysis of impacts under the alternatives, the risk of mortality is estimated based on the strike limits, rather than the quota for landed whales. The fate of struck and lost whales, and the likelihood of their mortality, is not fully known. For the purposes of assessing biological impacts, it is necessary to take the precautionary approach and assume that all struck whales represent mortalities. This is a worst case scenario required for the analysis, and not an assertion that all strikes from subsistence whaling result in mortalities.

4.4.1 Alternative 1

Alternative 1 would eliminate a quota for subsistence taking of bowhead whales and may result in the elimination of subsistence whaling activities and harvest. No bowhead whales would be taken in subsistence harvests. So, the magnitude, extent, and duration of direct mortality under this alternative are considered negligible to the population of bowheads (as per Table 4.1-1). Human activities associated with subsistence whaling would be sharply reduced under this alternative, so that the amount of noise and disturbance from subsistence whaling would also be considered negligible.

4.4.2 Alternative 2

Alternative 2 would authorize a maximum annual mortality of 67 bowheads (strikes) for a five-year period, subject to a total of 255 landed whales over five years. Over the five-year period the total mortality could be 5x67 or 335 whales total. (The total mortality would be lower if all struck whales were landed because of the limit on landed whales.) The total annual mortality assessment under this alternative is 67 whales per year which, given the current abundance and growth trends (Section 3.2.1), is unlikely to cause the population to decline or to slow its rate of recovery. The magnitude, geographic extent, and duration of this level of mortality is therefore considered negligible for the bowhead population (Table 4.1-1). Human activities associated with subsistence whaling under Alternative 2 would vary from year to year and place to place depending on whale movements, weather, ice characteristics, and social factors. Effects of human activities are localized and timed to coincide with the presence of whales during their spring and autumn migrations. Disturbance to the whales from subsistence whaling activities under Alternative 2 would be localized and short-term and would be considered minor at the population level.

4.4.3 Alternative 3

Alternative 3 would authorize a maximum mortality of 82 bowheads (strikes) in a given year, if the authorized carry-over of 15 unused strikes were to occur, subject to a total of 255 landed whales over five years. Over the five-year period the total mortality could be 350 whales (5x67, plus 15 carried over) or an average of 70 bowhead whales per year. This level of mortality is considered negligible in magnitude for the bowhead population (Table 4.1-1), in light of current abundance and growth trends (Section 3.2.1). The extent and duration of the effects under this alternative are the same as those for Alternative 2, so the overall impact is rated negligible. The effects of human activities associated with subsistence whaling under Alternative 3 would be similar to those described for Alternative 2, with disturbance at a minor impact level.

4.4.4 Alternative 4

Alternative 4 would authorize a maximum mortality of 100 bowheads (strikes) in a given year, if the authorized carry-over of 33 unused strikes were to occur, subject to a total of 255 landed whales over five years. Over the five-year period the total mortality could be 368 (5x67, plus 33 carried over strikes), or an average of 74 bowheads per year. This level of mortality is considered negligible in magnitude at the population level for bowheads (Table 4.1-1), in light of current abundance and growth trends (Section 3.2.1). The extent and duration of the effects under this alternative are the same as those for Alternative 2, so the overall impact is rated negligible. The effects of human activities associated with subsistence whaling under Alternative 4 would be similar to those described for Alternative 2, with disturbance at a minor impact level.

4.5 Direct and Indirect Effects of the Alternatives on Individual Whales

In addition to mortality if struck or landed, under the action alternatives, hunting activities have the potential to indirectly affect bowhead whales that are not being pursued. This includes the presence of vessels and underwater noise. The sound of one or more harpoon bomb detonations during a strike is audible for some distance. Acousticians listening to bowhead whale calls as part of the census report that calling rates decrease precipitously after a detonation. The range at

which whales may be affected is unknown and will vary with environmental conditions (e.g., depth of water, ambient noise levels, ice conditions, bottom structure) and the depth at which the bomb detonates.

According to Alaska Native Traditional Ecological Knowledge, after a harpoon bomb detonation, some whales act "skittish" and wary (E. Brower, Barrow Whaling Captain's Association President, personal communication). Whales temporarily halt their migrations, turn 180 degrees away from the disturbance (i.e. move back through the lead systems), or become highly sensitized as they continue migrating (E. Brower, Barrow Whaling Captain's Association President, personal communication). These changes in migratory behavior in response to disturbance are short-term, as several whales are often landed at whaling villages such as Barrow in a single day (George, 1996).

In this respect, the indirect disturbance effects on individual whales will be negligible in magnitude, extent, and duration under Alternative 1, since under this alternative no subsistence whaling would occur. Under Alternatives 2, 3, and 4, subsistence whaling would occur, and as described in the effects analysis in Section 4.4, the magnitude, extent and duration of the associated disturbance effects would be minor for individual bowhead whales.

4.6 Cumulative Effects of the Alternatives on the Western Arctic Bowhead Whale Stock

4.6.1 Offshore Petroleum Extraction Activities Including Seismic Surveys

4.6.1.1 Past and Present Oil and Gas Activities

Fifteen state and federal planning areas make up the Alaska Region for oil and gas exploration. Of these, leasing consideration is being proposed in four of the planning areas: Beaufort Sea, Chukchi Sea, Cook Inlet, and the North Aleutian Basin. The following is a summary of past, present and future oil and gas exploration and development in the Beaufort and Chukchi Seas, which are the only areas that overlap with the distribution of the Western Arctic stock of bowhead whales.

Beaufort Sea

The terrestrial environment adjacent to the Beaufort Sea has experienced most of the oil and gas-related industrial development on the North Slope compared to development in nearshore and offshore waters. Oil and gas exploration and production activities have occurred on the North Slope since the early 1900s, and production has occurred for more than 50 years. Associated industrial development has included the creation of an industry-support community airfield at the town of Deadhorse and an interconnected industrial infrastructure that includes roadways, pipelines, production and processing facilities, gravel mines, and docks. Offshore exploration for oil and gas in the Beaufort Sea has occurred intermittently during the past 30 years. Offshore discoveries have resulted in field development from wells drilled directionally from onshore facilities and from a limited number of structures in nearshore waters (defined as inside the barrier islands) and offshore waters (defined as outside the barrier islands).

Lease Sales. Ten federal lease sales for the OCS have been held in the Beaufort Sea planning area since 1979. Currently there are 181 active leases in this area. Thirty-one exploratory wells

have been drilled and there is production from a joint federal/state unit, with federal production of over 15 million barrels of oil since 2001. While the disposition of the leases purchased in recent lease sales is highly speculative at this time, it is probable that at least some seismic exploration and possibly some exploratory drilling could take place during the ten-year period identified for the cumulative effects analysis in the EIS. The State of Alaska made nearshore state waters (mean high tide line to three miles offshore) available for leasing along much of the coast of the Beaufort Sea. Beaufort Sea Areawide Lease Sales are held annually in October. Four lease sales have been held to date. As of July 2004, 194 active leases in this area encompass 440,000 acres. Future state lease sales will continue on a regular basis.

Seismic Survey Activities. The vast majority of geophysical seismic surveys conducted in the Beaufort and Chukchi Seas to date used the less detailed 2-D methodology; future seismic surveys are likely to use the more informative 3-D methodology to explore for oil and gas deposits (MMS, 2006c). Openwater and over-ice seismic surveys in Beaufort Sea federal waters began in the late 1960s and peaked in the 1980s. More seismic activity permitted by the Minerals Management Service has occurred in the Beaufort Sea OCS than in the Chukchi Sea OCS (MMS, 2006c). The 2-D marine seismic surveys in the Beaufort Sea began with two MMS Geological and Geophysical (G&G) permits issued in 1968 and four in 1969. Both over-ice and marine 2-D seismic surveys were conducted in the 1970s. With one exception, the 80 marine and 43 over-ice surveys permitted in the Beaufort Sea OCS by MMS in the 1980s were 2-D. In the 1990s, both 2-D and 3-D seismic surveys were conducted. The first 3-D over-ice survey occurred in the Beaufort Sea OCS in 1983 and the first marine 3-D seismic survey occurred in 1996. More than 100,000 line-miles of 2-D and 3-D seismic surveys have been collected to date in the Beaufort Sea Planning Area (MMS, 2006c).

In 2006, Shell Offshore Inc., conducted open-water seismic programs, which consisted of an estimated 3,000 miles of 3-D seismic line acquisition and site-clearance surveys in the eastern Beaufort and Chukchi Seas (MMS, 2006c). The open-water seismic program consisted of two vessels, one active in seismic acquisition and the second providing logistical support. Shell Offshore Inc., expects to eventually spend two to three seasons acquiring 3-D seismic data from all of its Beaufort Sea leases, although exactly which areas it surveys in any particular season will depend on ice conditions. The open-water program will involve a geotechnical investigation supported by a soil-boring vessel.

A 2-D seismic survey was conducted in late summer to early fall 2006 in the Mackenzie Delta region of the Canadian Beaufort Sea, by Input/Output, a subsidiary of GX Technology. This work provided high-resolution data for the Mackenzie Delta and adjoining Canada Basin (First Break, 2007).

Seismic surveys for exploration purposes in state waters are authorized under Miscellaneous Land Use Permits; however, seismic surveys conducted for other purposes, such as shallow hazard assessments, do not require permits unless they are not conducted from the ice and/or involve contact with the seafloor (MMS, 2006c). Since 1969, the State of Alaska has issued 42 permits for seismic survey activities in the Beaufort Sea. There are no current seismic activities in state waters in the Chukchi or Beaufort Sea Planning area.

Site Clearance Survey Activities. To date, high-resolution site-clearance surveys in the Beaufort Sea OCS were conducted for 30 exploration wells. Additional site-clearance surveys may have

been conducted in the proposed action area where no exploration wells were drilled. In the Beaufort Sea OCS, site-clearance surveys in 2006 occurred on three oil and gas prospects.

Oil and Gas Development. Since the discovery and development of the Prudhoe Bay and Kuparuk oil field, more recent fields generally have been developed not in the nearshore environment, but on land in areas adjacent to existing producing areas. Notable exceptions to this are the Northstar, Endicott, and Lisburne fields. Endicott Field was developed using causeways whereas the Lisburne Field was developed using directional drilling from shore. The Oooguruk Field is currently under development by Pioneer Natural Resources Alaska in nearshore waters off of Oliktok Point (Figure 4.6.1.1-1). The Northstar development is an offshore gravel structure outside of the barrier islands with flow lines to onshore facilities. The Northstar facility has been issued a Letter of Authorization under the MMPA from NMFS to cover Level A and Level B taking of bowhead, gray, and beluga whales, and ringed, spotted, and bearded seals, incidental to operation of the facility. This includes potential effects from presence of personnel, structures, and equipment; oil spills; on-ice construction or transportation; vessel and helicopter activity; and acoustic impacts from power generation and oil production. The Letter of Authorization excludes seismic surveys because they are not a component of operation of the facility.

Chukchi Sea

Lease Sales. There have been two sales in this area with the most recent in 1991. There have been five exploratory wells drilled with no commercial discoveries. There are no existing leases at this time. This area is included in the current program as a special interest sale. No interest was expressed in the first two calls for information in 2003 and 2004. There was industry interest expressed in a large portion of the area, in response to the call in early 2005, but there was not adequate time remaining in the current program to complete the necessary pre-lease steps and environmental documentation. The sale was deferred for consideration in the 2007-2012 program. Chukchi sale 193 is currently scheduled for 2007.

Seismic Survey Activities – Openwater and over-ice seismic survey activity in the federal waters of the Chukchi Sea has been significantly less than that in the Beaufort Sea (MMS, 2006c). The MMS-permitted seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960s/early 1970s. Between 1970 and 1975, 12 MMS G&G permits were issued for Chukchi Sea 2-D marine seismic surveys, but none between 1976 and 1982. Seismic survey activity increased between 1982 and 1991, when MMS issued 30 G&G permits. The most G&G permits issued in any one year in the Chukchi Sea was seven (6 marine and one over-ice) in 1986. ConocoPhillips Alaska, Inc., and GX Technology conducted open-water seismic programs in the Chukchi Sea in 2006.

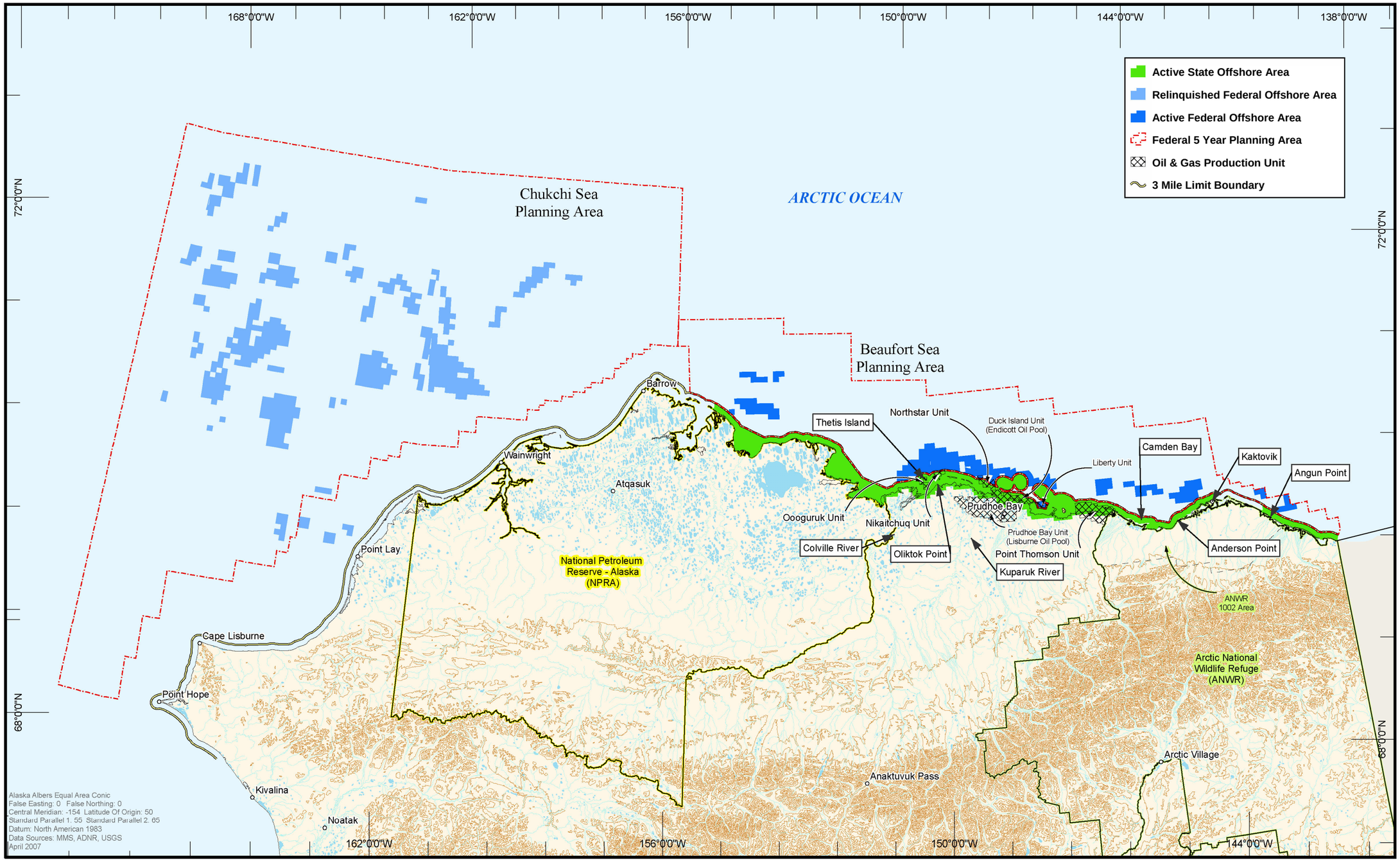

Figure 4.6.1.1-1 Offshore North Slope Oil and Gas Lease Areas

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In addition to the industry seismic surveys, a team from the University of Texas and the U.S. Geological Survey with research funding from the National Science Foundation acquired seismic data in the northern Chukchi Sea and Arctic Ocean, using the U.S. Coast Guard icebreaker Healy during the 2006 summer season. This seismic program forms part of a scientific study of the composition of submarine plateaus and the structure of the Earth's crust in the Arctic Ocean (MMS, 2006c).

Site Clearance Survey Activities – In the 1980s, five high-resolution site-clearance surveys were conducted in the Chukchi Sea OCS prior to five exploration wells being drilled. No high-resolution site-clearance surveys occurred in the Chukchi Sea in 2006 (MMS, 2006c,d).

Oil and Gas Development – There are currently no remaining leases from earlier sales and no operating oil or gas facilities in the Chukchi Sea Planning Area.

4.6.1.2 Reasonably Foreseeable Future Oil and Gas Activities

Beaufort Sea

Lease Sales. As required by the OCS Lands Act, MMS has prepared a draft proposed five-year program (2007 through 2012) to replace the current leasing program, and it is currently under public review. Options for the 2007 through 2012 evaluated in the Federal OCS Lease Sales in the Beaufort Sea include:

- Option 1 Five sales (annual) in the program area
- Option 2 Two sales in 2009 and 2011 in the same area as Option 1,
- Option 3 One sale in 2009 in the same area as Option 1,
- Option 4 No sale

Seismic Surveys. Projected seismic 2-D/3-D surveys in the Beaufort Sea planning area are estimated at three per year for 2007 and 2008 and two per year for 2009 and 2010 (MMS, 2006c). In State waters, seismic surveys are projected at one per year for 2008 and 2010 (MMS, 2006c).

Site Clearance Survey Activities. In those leased blocks where there is sufficient potential for further exploration drilling or development and production, geological site surveys and shallow hazard surveys would be required. MMS projects two site clearances per year between 2007 and 2010 (MMS, 2006c). ConocoPhillips Alaska, Inc., is planning to conduct an over-ice geophysical survey and portions of a site-clearance survey in the Beaufort Sea just north of Cross Island in spring 2007 (EPA, 2007).

Oil and Gas Exploration and Development. Shell Offshore Inc., proposes to drill exploration targets during open water season on various MMS OCS lease blocks in the Beaufort Sea. Proposed activities include exploration and appraisal drilling. The Shell Kulluk Submersible Drilling Platform and the Frontier Discoverer Drilling Vessel would be utilized in open-water exploration drilling operations (Arctic Slope Regional Corporation [ASRC] Energy, 2007). The proposed 2007 drilling activities would occur offshore approximately 16 miles north of Pt. Thomson in Camden Bay.

The Oooguruk Unit is located adjacent to and immediately northwest of the Kuparuk River Unit in shallow waters of the Beaufort Sea, near Thetis Island. The unit operator, Pioneer Natural Resources, is currently conducting a feasibility study for the potential development of reservoirs encountered in previous exploration drilling. Facilities would include an offshore production island between Thetis Island and the Colville River Delta, a 5.7-mile underground pipeline, where landfall will occur near the mouth of Kalubik Creek.

The planned development in the Nakaitchuq Unit will incorporate the construction of a gravel pad with drilling, gathering and production facilities on Oliktok Point, construction of a gravel drilling island near Spy Island, a 3.8-mile sub-sea flow line and utility bundle to Oliktok Point for fluid processing, and a 14-mile pipeline from Oliktok Point to a tie in to the Kuparuk common carrier pipeline. A small gravel island is to be constructed within the barrier islands for future drilling.

BP Alaska is in the process of pursuing the Liberty Project in Beaufort Sea waters east of Prudhoe Bay. Current plans call for accessing the project through directional drilling from onshore.

The State plans to drill a stratigraphic test well at one of two potential locations in state waters offshore of the 1002 area of the Arctic National Wildlife Refuge. One location is approximately 20 miles southwest of Kaktovik near Anderson Point; the second is approximately 30 miles southeast of Kaktovik near Angun Point. The locations are in water depths of 25-30 feet (ft), and drilling operations will be conducted in winter using a mobile offshore drilling unit, the steel drilling caisson.

An onshore/on-ice geotechnical program will acquire soil borings in state waters from approximately 200 ft onshore seaward to 10 km offshore between the state's offshore Hammerhead leases and the shoreline within the Point Thompson Unit. The work will be conducted on offshore ice over waters approximately 10 to 15 meters in depth. Shell Offshore Inc., will drill approximately 60 borings ranging from 35 to 75 ft in depth.

Following 2-D seismic survey work conducted in 2006, exploration and development activity on new and existing leases in the Canadian Beaufort are expected to continue in the near future.

Chukchi Sea

Lease Sales. In October 2006, MMS published a draft EIS for proposed lease sale 193 in the Chukchi Sea. The lease sale is scheduled to occur in late 2007 or later, pending decisions in the 2007-2012 five-year OCS Leasing Program. The options for this five-year plan that were evaluated in the 2006 MMS EIS include the following:

- Option 1 Three sales in 2007, 2010, and 2012 in the program area
- Option 2 Two sales in 2007 and 2010 in the same area as Option 1
- Option 3 No sale
- Option 4 Other

In the western Chukchi in Russian waters, there has been little exploration activity. The simultaneous U.S./Russia OCS lease sale that was proposed in the five-year program for 1992-

1997 was canceled, with this area being deferred for consideration in later programs (MMS, 2006c). No additional oil and gas development activities have been identified in the Russian Chukchi Sea.

Seismic Survey Activity. Additional seismic surveys are planned for the Chukchi Planning area for the remainder of the five-year leasing program (MMS, 2006c). MMS projects that three surveys per year would occur during 2007 and 2008, but that this would decrease to two per year in 2009 and 2010.

Site Clearance Survey Activities. High resolution site-clearance surveys on leases in the Chukchi Sea are not anticipated until at least 2009 and 2010 and would consist of only one site-clearance per year (MMS, 2006c).

4.6.1.3 Effects of Noise on Bowhead Whales

Past and Present Effects

The spring season appears to be a particularly critical period in the bowheads' annual cycle. This is the time most, if not all, of the population migrates, through areas covered by dense ice, where migration routes are constrained and most likely to be blocked by elevated sound sources (Richardson et al., 1995a,b). Exposure to man-made sound and contaminants may produce short- and long-term effects (Richardson and Malme, 1993; Bratton et al., 1993). However, Richardson and Malme (1993) state that data are not available to assess long-term impacts. Further, research in 1996 through 1998 showed that some seismic noise can deflect autumn migration of bowheads to farther offshore (Miller et al., 1999; Richardson, 1999; Richardson et al. 1999). Residents of the Arctic have expressed concern regarding the cumulative and long-term effects of anthropogenic noises on Western Arctic bowhead whales (Ahmaogak, 1985, 1989). Anthropogenic impact is a function of the extent that industrial activities coincide with the bowhead whales' seasonal occupation of certain regions and the whales' tolerance level of the impacts (Richardson and Malme, 1993; Bratton et al., 1993).

As noted in Section 3.2.8 of this EIS, the effects of oil and gas activities on bowhead whales are discussed at length in several documents: NMFS (2006), MMS (2002), and MMS (2006b) with additional information presented on the MMS Alaska OCS Region website: www.mms.gov/alaska. NMFS (2006) concluded that the effects from an encounter with aircraft generally are brief and whales should resume their normal activities within minutes (Patenaude et al., 2002). Bowheads may exhibit temporary avoidance behavior to vessels at distances of 1 to 4 km. Many earlier studies indicate that most bowheads exhibit avoidance behavior when exposed to sounds from seismic activity. Bowheads also exhibited tendencies for reduced surfacing and dive duration, fewer blows per surfacing, and longer intervals between successive blows. Eskimo whalers have stated that noise from seismic surveys and some other activities at least temporarily displaces whales farther offshore, especially if the operations are conducted in the main migration corridor (MMS, 2006c). Studies in the 1980s indicated that bowheads appeared to recover from these behavioral changes within 30-60 minutes following the end of seismic activity (Richardson et al., 1986b; Ljungblad et al., 1988). Monitoring studies of 3-D seismic exploration in the nearshore Beaufort Sea during 1996-1998 have demonstrated that nearly all bowhead whales will avoid an area within 20 km of an active seismic source (Richardson et al., 1999). Sound levels received by bowhead whales at 20 km ranged from

117-135 dB re 1μPa rms[9] and 107-126 dB re 1μPa rms at 30 km, but did not persist beyond 12 hours after seismic operations (Richardson et al., 1999). Data from monitoring seismic operations from 1996-98 suggested that the offshore displacement may have begun roughly 35 km (19 n. mi. or 22 st. mi.) east of the activity and may have persisted more than 30 km to the west (Richardson et al., 1999). Bowheads reoccupied the area within 12-24 hours after seismic surveys ended (Richardson et al., 1999).

Bowheads have been sighted within 0.2-5 km from drill ships, although bowheads change their migration speed and swimming direction to avoid close approach to noise-producing activities. During autumn migration, however, bowheads may avoid drill ships and their support vessels at 20-30 km. There are no observations of bowhead reactions to icebreakers breaking ice, but it has been predicted that roughly half of the bowheads would respond at a distance of 4.6-20 km when the signal-to-noise ratio is 30 dB (Richardson et al. 1995a). Overall, bowhead whales exposed to noise-producing activities are most likely to experience temporary, nonlethal behavioral effects.

Available information does not indicate that oil and gas-related activity (or any recent activity) has had detectable long-term adverse population-level effects on the overall health, current status, or recovery of the bowhead population (MMS, 2006c). Data indicate that the bowhead whale population has continued to increase over the timeframe that oil and gas activities have occurred and that there is no evidence of long-term displacement from habitat (MMS, 2006c).

Reasonably Foreseeable Future Effects

Overall, bowhead whales exposed to noise-producing activities are most likely to continue to experience temporary, nonlethal behavioral effects in the future. As sea ice retreats due to climate change, seismic exploration vessels may have access to areas where they were previously excluded at certain times of the year, which may contribute to an increased exposure to bowheads to future seismic activities. However, it is not clear whether such potential changes in the distribution of seismic efforts or development activities would coincide with potential changes in the distribution or migratory movements of bowheads as a result of climate change.

4.6.1.4 Oil Spills

The Biological Opinion prepared for oil and gas leasing and exploration activities by the MMS in the Beaufort Sea considered the effects on bowhead whales if there was to be oil and gas leasing and exploration on the OCS portion of the U.S. Beaufort Sea (MMS 2006e). Oil spills can occur during seismic exploration, exploratory drilling, construction and operation of offshore platforms and from subsea pipelines. Spills can occur as large spills, greater than 1000 barrels, small spills, between 50 and 1000 barrels, and very small spills, under 50 barrels (MMS 2006e). The probability of a large oil spill is considered to be remote during exploration, but was

[9] Sound is typically measured in decibels, which measure the reduction of a sound's intensity over distance. C Because sound travels differently through different media, the measurement of sound must also take into account a medium's impedance (or resistance) of sound pressure to be meaningful.C A standard reference point for sound pressure in water (through which sound waves propagate more efficiently than through air) is one microPascal (1μPa), a measure of pressure. In underwater acoustics, the *source level* of a sound represents the intensity of a sound at a certain distance, usually one meter, from the source, referenced to one microPascal; this is the meaning of the scientific phrase dB re 1μPa at 1 m.CC The *received level* is the intensity of the sound at the listener's actual distance from the source; this is the value represented by the scientific phrase dB re 1μPa rms (rms = root mean square, a statistical measure of the amplitude of the variable intensity of a sound wave).

assessed due to the pronounced effects it might have on bowheads and the potentially higher probabilities associated with subsequent development and production phases (NMFS 2006).

Bowhead whales can be affected by oil spills through displacement, direct contact with oil, and disturbance from response vessels. Displacement of individual bowhead whales may occur in the event of a large oil spill, and avoidance of the contaminated area may last for several years (MMS, 2001). This suggests that bowhead whales may have some ability to detect an oil spill and would avoid surfacing in the oil by detouring away from the spill area (NMFS 2001c). Displacement from feeding areas or contaminated food may also occur as a result of an oil spill, but it is unlikely that the availability of food sources for bowheads would be affected given the abundance of plankton resources in the Beaufort Sea (Bratton et al., 1993).

Modeling efforts have indicated that only up to 2 percent of the Beaufort Sea bowhead whale population would be affected by a large oil spill (NMFS 2001c). However, the impacts of oil exposure to the bowhead whale population would depend upon how many animals contacted oil. In the worst case, if oil found its way into leads or ice-free areas frequented by migrating bowheads, a substantial portion of the population could be affected (Englehart 1987).

Prolonged exposure to freshly spilled oil could kill some whales, but the numbers are estimated to be small due to a low chance of such contact (MMS 2006e). This would be most likely to occur if oil spilled into a lead that bowhead whales could not escape (MMS 2006e). Most whales exposed to spilled oil could be expected to experience temporary, nonlethal effects from skin contact with oil, inhalation of hydrocarbon vapors, and ingestion of oil-contaminated prey (NMFS 2006). Spilled oil may also foul the baleen fibers of mysticete whales during feeding at the surface, including the bowhead whale, temporarily impairing food-gathering efficiency or resulting in the ingestion of oil or oil-contaminated prey (Geraci and St. Aubin 1987).

Bowhead whales may be displaced temporarily from an oil-spill area due to the large numbers of personnel, equipment, vessels, and aircraft that could be involved in oil-spill cleanup activities. However, because of such displacement, fewer bowhead whales would be expected to be exposed to oil as a result of cleanup operations (MMS 2001, MMS 2006e). The Industry Site-Specific Bowhead Whale-Monitoring Program should be effective in detecting a delay or blockage of the migration (MMS 2004).

In investigating the probability of spilled oil contacting bowhead whales, MMS identified specific offshore areas (Ice/Sea Segments [ISS]) and modeled for probability of contact with a spill. Certain of these ISS's overlay the migratory corridor of the bowhead (MMS 2003). Using data from the MMS oil spill analysis for Sale 170, and assuming an oil spill of 1,000 barrels or more occurred at any of several offshore release areas during the summer season, the chance of that oil contacting these ISS's within 30 days during the summer season ranged from 5-82%. Overall, the combined probability of a spill occurring and also contacting bowhead habitat during periods when whales are present is considered to be low, and the percentage of the bowhead whale stock so affected is expected to be very small.

4.6.2 Climate Change - Cumulative Effects of Environmental Variability

4.6.2.1 Past and Present Effects of Climate Change

Evidence of climate change in the past few decades, commonly referred to as global warming, has accumulated from a variety of geophysical, biological, oceanographic, and atmospheric sources. The scientific evidence indicates that average air, land, and sea temperatures are increasing at an accelerating rate. Although climate changes have been documented over large areas of the world, the changes are not uniform and affect different areas in different ways and intensities. Arctic regions have experienced some of the largest changes, with major implications for the marine environment as well as for coastal communities. Recent assessments of climate change, conducted by international teams of scientists (Gitay et al., 2002 for the Intergovernmental Panel on Climate Change [IPCC]; Arctic Climate Impact Assessment [ACIA], 2004; IPCC, 2007), have reached several conclusions of consequence for this EIS:

- Average arctic temperatures increased at almost twice the global average rate in the past 100 years.
- Satellite data since 1978 show that perennial arctic sea ice extent has shrunk by 2.7% per decade, with larger decreases in sea ice extent in summer of 7.4% per decade.
- Arctic sea ice thickness has declined by about 40% during the late summer and early autumn in the last 3 decades of the 20th century.
- The ice pack is retreating from the land sooner in the spring and reforming later in the fall. This affects the timing of phytoplankton blooms and zooplankton concentrations.
- The ice pack is retreating further seaward than in the past, which creates larger areas of open water near coastal areas and leads to larger waves, higher storm surges, and accelerated rates of coastal erosion. This dynamic is exacerbated by rising sea levels due to thermal expansion of seawater and other sources.
- The arctic tundra is warming rapidly, causing permafrost to thaw deeper in the summer and over much larger areas than previously observed, accompanied by substantial changes in vegetation and hydrology.
- The melting ice pack, melting glaciers, and increased precipitation are adding large amounts of freshwater to the sea, causing decreases in salinity that may combine with longer ice-free seasons to affect the timing and intensity of phytoplankton blooms.

Bowhead whales are associated with and well adapted to ice-covered seas with leads, polynyas, openwater areas, or thin ice that the whales can break through to breathe. Arctic coastal peoples have hunted bowheads for thousands of years, but the distribution of bowheads in relationship to climate changes and sea ice cover in the distant past is not known. It has been suggested that a cold period 500 years ago resulted in less ice-free water near Greenland, forcing bowheads to abandon the range, and that this led to the disappearance of the Thule culture (McGhee, 1984; Aagaard and Carmack, 1994, as cited in Tynan and DeMaster, 1997). However, it is not clear if larger expanses and longer periods of ice-free water will be beneficial to bowheads. The effect of warmer ocean temperatures on bowheads may depend more on how such climate changes affect the abundance and distribution of their planktonic prey rather than the bowheads' need for ice habitat itself (Tynan and DeMaster, 1997).

4.6.2.2 Reasonably Foreseeable Future Climate Change Effects

The most recent analysis of climate change (IPCC, 2007) concluded that there is very strong evidence for global warming and associated weather changes and that humans have "very likely" contributed to the problems through burning fossil fuels and adding other "greenhouse gasses" to the atmosphere. This study involved numerous models to predict changes in temperature, sea level, ice pack dynamics, and other parameters under a variety of future conditions, including different scenarios for how human populations respond to the implications of the study. It is not clear how governments and individuals will respond or how much these future efforts will reduce greenhouse gas emissions. Although the intensity of climate changes will depend on how quickly and deeply humanity responds, the models predict that the climate changes observed in the past 30 years will continue at the same or increasing rates for at least 20 years.

The implications of these trends for bowheads are uncertain but they may be beneficial, in contrast to affects on ice-obligate species such as polar bears and walrus (ACIA, 2004). There will be more open water and longer ice-free seasons in the arctic seas which may allow them to expand their range as the population continues to recover from commercial whaling. However, this potential for beneficial effects on bowheads will depend on their ability to locate sufficient concentrations of planktonic crustaceans to allow efficient foraging. Since phytoplankton blooms may occur earlier or at different times of the season, or in different locations, the timing of zooplankton availability may also change from past patterns (Arrigo and van Dijken, 2004). Hence, the ability of bowheads to use these food sources may depend on their flexibility to adjust the timing of their own movements and to find food sources in different places (ACIA, 2004).

Moore and Laidre (2006) have examined sea ice changes in areas important to the Western Arctic bowhead stock and developed a conceptual model of how sea ice changes could affect the whales' access to prey. There was little change in the average amount of open water along the primary springtime migration corridors but extreme variability in the amount of open water from year to year (Moore and Laidre, 2006). Years with early and extensive retreat of the ice pack may allow migrating bowheads to access areas they could not occupy when sea ice is more extensive. This affects the migration routes of the whales and may therefore affect the ability of whaling communities to hunt successfully. However, for the past ten years bowheads have been feeding more frequently in ice-free waters northeast of Barrow than in past years, leading to increased hunting success for Barrow crews in the fall (Treacy, 2002; Bodenhorn, 2003; as cited in Moore and Laidre, 2006). This observed pattern of new feeding opportunities for bowheads agrees with modeling predictions that the retreat of the ice edge relative to the underwater shelf break facilitates wind-driven upwelling of zooplankton-rich waters, as well as allowing greater primary production in ice-free waters, which leads to a beneficial increase in prey availability for bowheads (Moore and Laidre, 2006).

4.6.3 Commercial Shipping and Fishing

4.6.3.1 Past and Present Effects

Commercial shipping and fishing activities would potentially affect mortality of bowhead whales through ship strikes or interactions with fishing gear or result in disturbance from vessel noise. Between 1976 and 1992, only three ship strike injuries were documented out of a total of 236 bowhead whales examined from the Alaskan subsistence harvest (George et al., 1994). Since that

publication, six additional whales have been noted with ship strike injuries (1995-2002) out of approximately 180 examined whales (J.C. George, Department of Wildlife Management, North Slope Borough, personal communication), indicating that the rate of ship strikes may have increased slightly in recent years. The most recent stock assessment provides no estimate for past mortality from ship strikes (Angliss and Outlaw, 2007). The low number of observed ship strike injuries suggests that bowheads either do not often encounter vessels or that avoid interactions with vessels. It is possible that an unknown number of unobserved and unreported mortalities may occur after ship strikes. However, given the steadily increasing population trend, the magnitude of this potential effect is likely to be small. It is not known when or where ship strikes are most likely to occur.

Most commercial fishing activity in the Bering Sea occurs well south of the range of bowhead whales. There are very limited commercial fisheries in the Chukchi Sea and none in the Beaufort Sea due to small commercial fish stocks, operating difficulties near sea ice, and great distance to markets (ACIA, 2004). The North Pacific Groundfish Observer Program places observers on many of the large commercial fishing vessels that operate in the northern Bering Sea but there are no observer records of fishery interactions with bowheads either through entanglements in fishing gear or ship strikes (Angliss and Outlaw, 2005). There are also no self-reported interactions from vessels without observers. However, since 1978 there have been approximately 20 records of scarring by fishing lines and entanglement in crab fishing gear from bowheads that have been harvested or found stranded on beaches (Angliss and Outlaw, 2005). Data from the North Slope Borough Department of Wildlife (1990-2001) suggest that perhaps 10% of the population exhibits clearly identifiable fishing line injuries of varying degrees of severity (George, 2001). It is not known whether these injuries are from active fishing gear or from gear that had been lost and drifting. The number of serious injuries resulting from fishing gear entanglement appears to be very small. The most recent stock assessment report attributes 0.2 mortalities per year resulting from interactions with fishing gear (Angliss and Outlaw, 2007).

The effects of anthropogenic noise, such as vessel noise, on bowhead whales are primarily related to disturbance of migration. The effects of noise are discussed in detail in Section 4.6.1.

4.6.3.2 Reasonably Foreseeable Future Effects

Observed and predicted decreases in the summer extent of the ice pack could lead to a substantial increase in commercial shipping in the Arctic, especially if the Northwest Passage becomes reliably navigable (ACIA, 2004). Increased vessel traffic in the Beaufort and Chukchi Seas would be likely to result in greater disturbance effects on foraging bowheads and could result in a higher incidence of ship strikes with the potential for serious injury and mortality. However, if bowheads are able to move away from future shipping lanes and still find suitable foraging areas, the increased risk of ship strikes could be minimal.

Commercial and subsistence fishing activities are certain to continue in the future but potential changes in fishing effort relative to the range of the bowhead are not clear. Some commercially exploited fish stocks may expand in both abundance and northward range as a result of climate warming while other stocks are predicted to decline (ACIA, 2004). It is not clear whether such changes would lead to increased or decreased fishing effort in arctic waters. The potential risk of injury to bowheads from entanglement in fishing gear is therefore uncertain but likely to remain

small in the foreseeable future given the relatively high cost of transporting arctic fish resources to distant markets.

The effects of anthropogenic noise, such as vessel noise, on bowhead whales are primarily related to disturbance of migration. The effects of noise are discussed in detail in Section 4.6.1.

4.6.4 Research Activities

4.6.4.1 Past and Present Effects

Research activities occurring in the project area have the potential to affect bowhead whales, primarily by introducing noise into the environment, incidentally through operation of the vessel or intentionally through seismic surveys or sonar.

The greatest potential impact from arctic-based research comes from underwater noise generated by icebreakers. The Western Arctic Shelf Basin Interactions project was a multi-year, interdisciplinary program investigating the impacts of climate change on biological, physical, and geological processes in the Western Arctic Ocean. The project was conducted from the US Coast Guard HEALY and POLAR STAR icebreakers. Although radiated noise levels for these ships have not been measured, estimated source levels for icebreakers of similar size range from 177-191 dB re 1μPa at 1 m (Richardson et al., 1995a: Table 6.5). Increases in noise level (510 dB) during ice breaking are caused by propeller cavitation, are broadband (10-10,000 Hz), and are extremely variable over the period of pushing ice. Noise from research activities aboard the icebreakers, or from ice camps may also be audible underwater, but their source level would be expected to be much lower than that of a ship breaking ice. It should be noted that ambient sea-ice noise is also extremely variable, with source levels of 124-137 dB re 1μPa at 1 m for 4 and 8 Hz tones measured for ice deformation noises at pressure ridges (Richardson et al., 1995a).

Based on previous studies of bowhead response to noise, ice-breaking noise could result in temporary displacement of whales from the area where the icebreakers were operating and could potentially cause temporary deflection of the migration corridor (see Section 4.6.1 for further discussion of noise disturbance).

Research specifically on bowhead whales has been conducted since the early 1980s. The early focus of research was to understand the species' biology and ecology, particularly abundance, distribution, and habitat use. Current research focuses on population growth, genetics, and response to anthropogenic sources, particularly because bowheads utilize habitat near oil and gas developments. The following briefly describes the type of research being conducted on bowhead whales.

Land, vessel, and aerial surveys are conducted to collect data on population abundance, distribution, and behavior throughout the bowhead whales' range. Individual and group behaviors are observed during these surveys to provide information on feeding ecology, distribution, habitat use, and behavior. Shore-based counts along the migration route, particularly at Point Barrow, are supplemented with acoustic survey data (George et al., 2004a). Acoustic survey data are collected with the use of autonomous acoustic recorders. Calls of individual whales are localized in realtime or once the recorders have been collected. Radio and satellite tracking provides information on the migration pattern and timing, distribution, and habitat use (Mate et

al., 2000). Tags are placed on whales through the use of a pole extended from a vessel in close proximity to the whale or via a crossbow. Skin biopsy samples are also taken to study genetic variability among and within stocks, as well as sex of the whales. The characteristics and segregation of size and age class, in addition to calf growth patterns, are determined through the use of photo identification and photogrammetry taken during aerial surveys (Rugh, 1990; Koski et al., 1993). Many studies have also been conducted to determine the effect of anthropogenic noise (i.e., drilling, dredging, seismic surveys) on the behavior of bowhead whales (e.g., Richardson et al., 1995a,b). Generally, these ship-based and aerial surveys could cause temporary disturbance of individual whales in the area and result in avoidance of the vessel. Aerial surveys are generally flown at heights that do not harass the whales.

Various tissue samples are taken from harvested or stranded whales for physiological studies. Stomach content analysis and isotopic composition of materials (baleen, muscle, and blubber) provide information on the feeding ecology (e.g., Lowry, 1993). These studies can be supplemented with collection of zooplankton in feeding areas to determine the prey composition. Reproductive tissues are taken to determine age of whales, pregnancy rates, and toxicology studies (effects of contaminants on tissues) (e.g., Willetto et al., 2002). Mortality of bowheads is studied by looking at the bacterial, mycotic, and viral infection rates of harvested whales (Philo et al., 1993). Because tissue samples are taken from whales already dead, there would be no effects on bowheads associated with this type of research. Furthermore, the knowledge gained from this research would be beneficial in understanding whale biology and ecology.

4.6.4.2 Reasonably Foreseeable Future Effects

Research is expected to continue in the area. Noise from ice-breaking, vessels, and other sources (e.g., seismic, sonar) would continue to add to the cumulative levels of noise in the whale's environment. Increased noise may result in disturbance and temporary displacement of the whales or temporary deflection of the migration. At present, data do not indicate that current noise levels result in behavioral or physiological adverse effects on the bowheads in this stock.

4.6.5 Other Development

4.6.5.1 Past and Present Effects

Other activities that may possibly contribute to the cumulative effects on bowhead whales include military activities, other industrial development, and tourism. The surface and airspace of the Chukchi and Beaufort seas are not extensively used for testing or training of aircraft, vessels, weapon systems, and personnel. There are no military vessels or aircraft stationed in the Beaufort or Chukchi Seas. None of the airspace over the Beaufort and Chukchi Seas is classified as "special use airspace" for the military by the Federal Aviation Administration. Military vessels may occasionally transit through the area. Submarines are often used for oceanic research or military activities in the area, particularly for use of passive and active acoustic technologies. Information about the response of bowhead whales to submarines is not available. Passive acoustics would not introduce noise to the environment and would likely result in no impact to bowhead whales.

Past military activities in the area were associated with the Defensive Early Warning System (DEW-Line), an integrated chain of radar and communications sites across Alaska, northern

Canada, and Greenland. This system was discontinued in 1963 and replaced with short- and long-range radar. The U.S. Department of Defense is in the process of dismantling the abandoned sites.

On the Chukchi Sea, the major industrial developments are associated with the Red Dog Mine and Delong Mountain Terminal. Red Dog Mine is the largest producer of zinc concentrate in the world. Mining operations have reserves for over 40 years. The Delong Mountain Terminal receives ore concentrate from the Red Dog Mine and stores it until the area is free of ice. Approximately 250 barge trips per year transfer 1.5 millions tons of concentrate to about 27 bulk cargo ships, which are anchored 6 miles offshore (MMS 2006c).

Tourism activities are concentrated on land but may include the occasional use of marine vessels and aircraft. The effects of vessels are related to ship strikes and anthropogenic noise. The effects of ship strikes are discussed in Section 4.6.3 and the effects of anthropogenic noise on bowheads are discussed in Section 4.6.1.

4.6.5.2 Reasonably Foreseeable Future Effects

The level of future military activities in the area is expected to remain low, but transit of vessels or aircraft through the area is expected to continue. In routine operations, submarines use passive sonar, which is not likely to disturb bowhead whales. The use of submarines as research platforms is likely to continue, resulting in potential disturbance to bowheads.

The U.S. Army Corps of Engineers is currently in the process of evaluating the feasibility of expanding the Delong Mountain Terminal port so that cargo ships can access the terminal directly, instead of being loaded offshore. This would result in fewer barges being needed for transport of concentrate from the terminal to cargo ships, but would not change the number of cargo ships in the area. Noise associated with dredging during construction would result in temporary noise disturbance to bowhead whales. Future development associated with the Red Dog Mine facility includes onshore developments, such as roads and/or infrastructure, which would have no impact on bowhead whales.

Tourism activities are likely to increase in the area, resulting in potential ship strikes and increased noise. The effects of ship strikes are discussed in Section 4.6.3 and the anthropogenic noise on bowheads are discussed in Section 4.6.1.

4.6.6 Cumulative Effects of the Alternatives on Bowhead Whales

The major elements of cumulative effects on bowheads have been described above, primarily in terms of mortality and disturbance. The intent of this section is first to summarize the combined effects from factors other than subsistence whaling and then to assess the contribution of the alternatives to the overall cumulative effects on bowheads. (For the direct and indirect effects of subsistence harvests on bowhead whale populations, see Section 4.4.)

4.6.6.1 Anthropogenic Mortality from Sources other than Subsistence Whaling

Offshore oil and gas development would not likely contribute to mortality unless there was an oil spill. The potential magnitude of mortality on bowheads would depend on a large number of variables that cannot be predicted ahead of time: size, location, and timing of a spill; ice/open

water characteristics at the time; weather; cleanup efforts; and presence of whales. Although there are a number of oil development projects that could contribute to this risk of mortality, the high degree of uncertainty regarding the magnitude and duration of a future oil spill event precludes the identification of a particular mortality level as a "reasonably foreseeable" effect. Ship strikes and entanglement in fishing gear also likely contribute to mortality and could affect whales throughout their range. Evidence from harvested whales indicates that entanglement is fairly common (perhaps 10%) but probably temporary for most whales because serious injuries are thought to be relatively rare and observed mortality from these sources is 0.2 whales per year (Angliss and Outlaw, 2007). The incidence of ship strikes and entanglement could increase in the future depending on the impacts of climate change on the expansion of fisheries and marine traffic in the Arctic. The very low level of bowhead mortality from sources other than subsistence whaling efforts (less than one whale per year) is unlikely to cause the population to decline or slow its rate of recovery. The magnitude, geographic extent, and duration of this level of mortality is therefore considered negligible for the bowhead population (Table 4.1-1).

4.6.6.2 Disturbance from Sources other than Subsistence Whaling

Offshore petroleum development, shipping, fishing, and research all contribute marine noise and activities that may disturb bowheads to the point of altering their movement patterns and behavior. These activities take place across the range of the bowheads and are likely to continue or expand in the future. Although climate change does not disturb whales directly, it may affect bowhead movement patterns and behavior through its effects on sea ice distribution and zooplankton populations. Long-term and localized sources of noise such as offshore petroleum facilities can be regulated to mitigate the effects on bowheads during the times when they are present, but none the less may lead to bowheads avoiding those areas, essentially creating habitat loss. Mobile sources of noise such as marine vessels tend to be short-term and inconsistent in time and place. Whales may avoid these sources when they encounter them but are not likely to abandon a particular area of their range unless the disturbance is more consistent. While human sources of disturbance could serve to inhibit the use of some areas by bowheads, the retreat of sea ice due to climate change may allow bowheads to expand their range. The cumulative effect of disturbance on bowheads is minor in magnitude, since the distribution of the bowhead population is unlikely to be changed. Concerning the factor of geographic extent, the disturbance effects discussed in this section are primarily localized, but in a number of locations, for a rating of moderate. The duration of these effects is short-term, for a rating of minor. In all, the effects of disturbance are unlikely to limit bowhead population growth and so they are considered to be minor (Table 4.1-1).

4.6.6.3 Contribution of the Alternatives to Cumulative Effects

Alternative 1 would eliminate the federal quota for subsistence taking of bowhead whales and result in the elimination of subsistence whaling activities and harvest. The magnitude of direct mortality under this alternative is considered negligible to the population of bowheads. Human activities associated with subsistence whaling would be sharply reduced under this alternative so that the amount of noise and disturbance from subsistence whaling would be considered negligible. The cumulative effects of human activities other than subsistence whaling were described and rated negligible to minor in the preceding sections. Alternative 1 would contribute a negligible amount of mortality and disturbance to the cumulative effects on bowheads as previously described.

Alternative 2 would authorize a maximum annual mortality of 67 bowheads (strikes) for a five-year period (up to 335 whales total, subject to a cap of 255 landed whales) (see Section 4.4 for more detailed discussion). This level of mortality is considered negligible at the population level for bowheads (Table 4.1-1). Mortality from sources other than subsistence whaling is also considered negligible (as described above), so the cumulative effect of these two sources of mortality would be considered negligible at the population level. Human activities associated with subsistence whaling under Alternative 2 would vary from year to year and place to place depending on whale movements, weather, ice characteristics, and social factors. Disturbance to the whales from subsistence whaling activities under Alternative 2 would not affect the distribution of bowheads, and would be localized and short-term, so this is considered a minor impact to the population. Subsistence whaling activities would contribute on a regular, seasonal basis to the cumulative effects of disturbance from non-whaling activities. Overall, disturbance sources tend to be minor in magnitude, to impact a relatively small portion of the range for the population, or to be very short in duration. The cumulative effects of disturbance from all sources, including the contribution from Alternative 2, would be considered minor to the population.

Alternative 3 would authorize a maximum mortality of 82 bowheads (strikes) in a given year, if the authorized carry-over of 15 unused strikes were to occur, with a total mortality of up to 350 whales over the five-year period, subject to a cap of 255 landed whales (see Section 4.4 for more detailed discussion). This level of mortality is considered negligible at the population level for bowheads (Table 4.1-1). The cumulative effects analysis for Alternative 3 is similar to that described for Alternative 2 above, with negligible cumulative effects through mortality and minor cumulative effects through disturbance, including the contribution from Alternative 3.

Alternative 4 would authorize a maximum mortality of 100 bowheads (strikes) in a given year, if the authorized carry-over of 33 unused strikes were to occur, with a total mortality of up to 368 whales over the five-year period, subject to a cap of 255 landed whales (see Section 4.4 for more detailed discussion). This level of mortality is considered negligible at the population level for bowheads (Table 4.1-1). The cumulative effects analysis for Alternative 4 is similar to that described for Alternative 2 above, with negligible cumulative effects through mortality and minor cumulative effects through disturbance, including the contribution from Alternative 4.

4.7 Direct, Indirect and Cumulative Effects on Other Wildlife

4.7.1 Direct and Indirect Effects of the Alternatives

Alternative 1 would eliminate the federal quota for bowhead whales and result in the elimination of authorized subsistence whaling activities and harvest. It is likely that hunting pressure on other species (especially seals, walrus, and caribou) would increase substantially to compensate in part for the loss of whale harvest. Although this increased effort on other species is unlikely to replace the whale harvest, it could lead to moderate reductions in the populations of popular game species around the whaling communities. Hunting pressure on smaller game species might increase a small amount with minor effects on populations. Increased hunting activity would also increase noise and disturbance to game species and other wildlife. Since the loss of whaling would affect a number of communities, increased hunting disturbance would affect game populations in numerous locations, but not range-wide for any species. For species that often congregate in numbers, like walrus and caribou, disturbance could affect numerous animals for

each hunting event and the effects would be considered moderate. For species that are primarily dispersed, like seals and polar bears, few animals would be disturbed and the effects would be considered minor. The duration of effects would depend on the duration of a whaling moratorium but the frequency of disturbance on other wildlife would likely vary from minor to moderate.

Alternatives 2, 3, and 4 are not expected to have more than negligible or minor effects on other wildlife species. The USFWS was consulted and concurred with NMFS's conclusion that the proposed action is not likely to adversely impact ESA listed species under USFWS jurisdiction (USFWS, 2002b). Just as individual whales may be indirectly affected by hunting activities, (e.g., vessel noise) (Section 4.5), other wildlife such as seals or polar bears may also be disturbed by these activities. Moreover, the Native villages and communities which currently harvest bowhead whales would be likely to alter their harvest patterns of other subsistence foods depending on the number of bowhead whales harvested. This currently occurs, as other species may be sought out when bowheads cannot be hunted due to weather/ice or whenever a village's hunting is only partially successful. At these times it is possible that subsistence hunters may increase their harvest of other animals, such as seals, ducks, fish, caribou, bear, walrus, beluga whales, or Dall sheep. It is not possible to quantify this effect, as each subsistence food may have its own individual value and place within the Native diet. A pound of bowhead whale *maktak* is not necessarily replaceable by a pound of caribou or whitefish, even if that were possible. In magnitude, extent, and duration, these effects are considered negligible to minor.

4.7.2 Cumulative Effects of the Alternatives

4.7.2.1 Past and Present Effects

Chapter 3 describes a number of marine and terrestrial wildlife species that are present in the Alaskan coastal areas considered in this EIS. Some of these bird and mammal species are affected directly or indirectly by bowhead whaling activities:

- Disturbance (marine species)
- Mortality associated with supplying whaling crews with food (seals, caribou)
- Mortality associated with whaling equipment (bearded seal, walrus, furbearers)
- Personal defense mortality of polar bears attracted to hunting camps and butchering sites
- Mortality associated with community celebrations (waterfowl, caribou, seals)
- Mortality associated with alternative food sources when whaling is not successful (marine and terrestrial species)

Other species (gray whales, minke whales, killer whales, harbor porpoise, short-tailed albatross, and many terrestrial mammals) would not be affected directly or indirectly by bowhead whaling activities. These species will not be considered further because the alternatives would not contribute to any cumulative effects for the species.

Chapter 3 summarizes the major natural and human-influenced factors that affect different wildlife species in the Arctic. For most of these species, reasonable population estimates and trends are not available so it is difficult to establish the relative importance of natural and human influenced factors to population level effects. Some of the major human influenced factors that contribute to cumulative effects on these species include:

- Subsistence and sport hunting
- Noise and disturbance from motorized vehicles and vessels
- Environmental contamination (air, water, and land) from distant industrial and agricultural sources
- Oil spills and other discharges from marine traffic
- Noise and pollution from oil and gas development
- Environmental changes due to global warming
- Commercial fishery interactions

4.7.2.2 Reasonably Foreseeable Future Effects

All of the human activities and factors that have contributed to wildlife effects in the past are likely to continue in the future. The relative importance of various factors and intensity of effects on different species is likely to change over time, especially as environmental (climate) changes become more pronounced. Although extensive modeling efforts are underway to help predict changes in the physical environment (ACIA, 2004; IPCC, 2007), the synergistic responses of animals and humans to future environmental conditions are very difficult to predict. Major conservation concerns in the Arctic include substantial reductions in ice pack habitat with major adverse impacts on ice-dependent species such as seals, walrus, and polar bears (ACIA, 2004). In addition, the retreat of sea ice has forced many polar bears to spend more time on land where they are more susceptible to starvation and more frequent interactions with people, leading to an increasing frequency of bear and human mortalities that will likely continue in the future (Wohlforth, 2004; Schliebe et al., 2006).

4.7.2.3 Cumulative Effects

Under Alternative 1, it is likely that hunting pressure and associated disturbance on other wildlife species (especially seals, walrus, and caribou) would increase substantially to compensate in part for the loss of whale harvest, which might result in minor to moderate reductions in game populations around the whaling communities. These populations are managed for sustainable harvests by the Alaska Department of Fish and Game the state under its regulations and under co-management agreements with Alaska Native Organizations. For ice-dependent species, cumulative effects are likely to be dominated by the effects of climate change but the contribution of Alternative 1 would be minor to moderate based on increased harvest and associated disturbance of ice-dependent marine mammals (i.e. seal and walrus populations), at least near whaling communities. Increased harvest of terrestrial game species might add to the difficulty of managing game populations, especially with the uncertainty of how climate change will affect different terrestrial species. For other species, including threatened and endangered species, cumulative effects are likely to be dominated by conservation issues independent of whaling activities, as outlined above. The contribution of Alternative 1 to the cumulative effects on these species would be moderate for important game species (e.g. caribou) and minor for other species based on increased hunting pressure.

Alternatives 2, 3, and 4 would result in a similar amount of whaling activity and harvest over a five-year period, although total take levels could vary annually among these alternatives, due to differing provisions concerning carry-over of unused strikes. Based on low magnitude, limited geographic extent, and short-term duration, the direct and indirect effects of these alternatives are considered to be negligible to minor for other wildlife, depending on the species. For ice-

dependent species, cumulative effects are likely to be dominated by the effects of climate change and the contribution of the alternatives is considered negligible to minor. For other species, including threatened and endangered species, cumulative effects are likely to be dominated by conservation issues independent of whaling activities, as outlined above. The contribution of the alternatives to the cumulative effects on these species is considered negligible.

4.8 Direct, Indirect and Cumulative Sociocultural Effects

4.8.1 Effect on Subsistence Patterns

The past, present, and future importance of the bowhead whale in these Eskimo villages cannot be overemphasized. The AEWC has stated "whaling, more than any other activity, fundamentally underlies the total lifeway of these communities" (AEWC, undated). Eskimos have hunted the bowhead whale for over 2000 years, and the hunt remains the dominant aspect of their culture. Subsistence whaling is a year-round activity in these villages, beginning each winter with preparation of skin boats and caribou hunting for meat supplies for the crews and sinew for sewing bearded seals skins used for *umiaks*, preparation of ice cellars, outfitting the camps with supplies. Spring whale hunting involves shared labor in harvesting followed by widespread distribution of bowhead whale food and, cultural events celebrating the harvest. By summer time, whalers are hunting for bearded seals for use in building *umiaks* for the following year's spring bowhead hunt, followed by autumn whaling (in Barrow, Nuiqsut, and Kaktovik).

Bowhead whale meat and oil have long provided and continue to provide important contributions to the Eskimo diet and are thought to be especially valuable in supplying high-calorie protein in a cold and harsh climate. Subsistence foods are highly nutritious and contain heart-healthy fats (Nobmann, 1997 in MMS, 2006a:167). A recent study found that Alaska Natives with higher levels of polyunsaturated fats, found in fish oils and marine mammals, had lower heart disease mortality (McLaughlin et al., 2005). A permanent loss of whale meat could precipitate the physical, psychological, and cultural trauma that often accompanies drastic and forced dietary changes (Michie, 1979). The sale of bowhead whale meat is prohibited; however, edible portions are shared throughout the communities of Alaska's North Slope. Bowhead whales also provide raw materials for the creation of Native handicrafts, which may be legally sold.

In 1997, the AEWC documented a level of 280 landed whales over a five-year period as necessary to provide for the nutritional and cultural needs of these communities. The 2007 need statement of the AEWC (Appendix 8.1) documents a continuing need at the same level. Any alternative that would provide fewer whales would be expected to have some level of adverse impact to socioeconomic and cultural needs of these villages. It is not likely the nutritional or cultural void created would or could be filled with substitute foods. Imported foods cannot readily take the place of whale and other marine mammals which are central to the cultural identity and diets of Eskimos (Michie, 1979).

Under Alternative 1, there would be no federal authorization of subsistence bowhead whaling for the five years 2008 through 2012. With no subsistence whaling, the direct effects of this alternative would include the loss of tens of thousands of pounds of highly valued food, attenuation of the social cohesion occasioned by the shared work among whaling crews and other cooperators in the year round work of preparation for whaling, disruption in the bonds established through food sharing, and diminished the opportunity for young people to continue to

learn the knowledge, practice, and beliefs associated with this central cultural institution (Worl, 1979). Indirectly, Alternative 1 would likely result in redirection of subsistence harvest effort to other subsistence resources, but it is unlikely that the volume of food produced in whaling could be recreated. It is likely that local residents would increase their use of imported foods, but given the high costs of imported foods, especially for frozen and fresh foods, it is likely that the increase would be in imported foods of lower nutritional value.

Eskimo leaders and institutions would likely contest the elimination of subsistence bowhead whaling, as they did in 1977 at the time of the IWC moratorium (Langdon, 1984). This might involve litigation, and highly charged efforts to petition federal agencies and the Congressional delegation seeking relief. Alternative 1 would likely be viewed by the AEWC as a failure by the U.S. Government to uphold Native rights of Alaska Eskimos. Since the MMPA and ESA expressly provide for the right for Alaska Native subsistence hunting, and since there is no conservation-based rationale for denying the quota, elimination of a quota would not comport with NMFS's objective to accommodate Federal trust responsibilities to the fullest extent possible consistent with applicable law. Alternative 1 could also result in confrontation between the AEWC and NMFS. Cooperative research and management efforts between the AEWC and NMFS that benefit marine mammals could be jeopardized. The loss of such an important subsistence food resource would be an impact of major magnitude. Since all AEWC communities would be similarly affected, this impact would be major in extent. The duration of such an effect is uncertain, since NMFS might revisit such a decision in a subsequent year, or it could last for the five-year period of the current authorizations for aboriginal subsistence whaling. In all, the direct, indirect and cumulative effects of Alternative 1 on subsistence patterns would be adverse and major (Table 4.1-3). Alternative 1 would result in major impacts to socio-cultural systems, and this contributes more to total cumulative effects than do the other activities, such as oil and gas exploration or ship strikes and fisheries entanglements.

Alternative 2 would provide for subsistence bowhead whaling at a level that would address the identified Alaska Eskimo cultural and nutritional subsistence needs. However, Alternative 2 provides for no carry-over of unused strikes. The direct effects would include continuation of the subsistence food contribution of bowhead whales, the cooperative work and food sharing practices, and crucial cultural learning opportunities for young people. Indirect effects would include continuation of the current levels of diversity in subsistence resource uses, and continuing levels of reliance on subsistence foods, supplemented by purchased foods. Alternative 2 would avoid the adverse reaction to no quota predicted under Alternative 1. With no carry-over of unused strikes, Alternative 2 would not provide the flexibility that whaling captains have been afforded for many years. When weather conditions are adverse late in a year, whaling captains have previously had confidence that unused strikes would be available in a subsequent year, although these have actually been used infrequently (i.e. once in the period 1998-2006, as shown in Figure3.5.2-4). These direct and indirect socio-cultural effects are considered beneficial, and of major magnitude, extent and duration.

The direct and indirect effects of Alternative 2 contribute to cumulative effects with the noise and disturbance impacts from oil and gas exploration and development as outlined in Section 4.6.1. In particular, whales tend to avoid areas of high noise, and these deflections of the migration might make subsistence whaling more time-consuming and, in periods of rough seas, more dangerous. These impacts may differ by season, and as a result of mitigation measures imposed by the MMS on industry and the cooperative Conflict Avoidance Agreements

negotiated between industry and the AEWC (MMS, 2006a:170). The Conflict Avoidance Agreements include provisions for observers to sight whales and exclusion distances, so that seismic activities are stopped when whales are in the vicinity, in order to minimize disturbance. Generally, spring whaling occurs before seismic activities are underway, and mitigation measures and the Conflict Avoidance Agreement create exclusion zones to avoid seismic activities when whales are nearby. Cumulative effects on spring whaling would be rated as minor. For fall whaling, the likelihood of impacts is less certain, because it turns on the effectiveness of mitigative measures. Given the generally limited, but not completely known, potential for disturbance to the whales and to subsistence whalers, these cumulative socio-cultural effects are considered moderate in magnitude and extent, and minor in duration. In total, the cumulative effects of Alternative 2 on subsistence patterns would be positive and minor to moderate in magnitude, extent, and duration. The beneficial contribution of Alternative 2, in authorizing the subsistence whale hunt, is a greater proportion of total cumulative socio-cultural effects than the adverse effects resulting from other activities, including noise from oil and gas exploration and development.

Alternative 3 would provide for the same continuity in subsistence harvests and related social and cultural benefits as Alternative 2. However, Alternative 3 would provide for the longstanding flexibility to carry-over up to 15 unused strikes into a subsequent year. In contrast to Alternative 2, the carry-over feature of Alternative 3 would provide whaling captains with the continuing confidence that if adverse weather prevents a safe hunt late in the season, they will recoup the opportunity in the following year through the carry-over of up to 15 unused strikes. Direct, indirect, and cumulative effects would be the same described for Alternative 2. In total, the cumulative effects of Alternative 3 on subsistence patterns would be positive, and minor to moderate in magnitude, extent and duration. When considered in conjunction with other cumulative effects, the beneficial contribution of Alternative 3, in authorizing the subsistence whale hunt, is a greater proportion of total cumulative socio-cultural effects than the adverse effects resulting from other activities, including noise from oil and gas exploration and development.

Alternative 4 provides for the ongoing subsistence allocation and the carry-over of unused strikes, up to half of the strike quota of 67, into a subsequent year. This might be viewed as more favorable to the AEWC because it would allow Alaska Eskimos the maximum flexibility in conducting their subsistence hunts from year to year. The direct and indirect impacts of Alternative 4 would be the same as for Alternative 2 concerning the continuing food production, social, and cultural benefits of the current levels of subsistence bowhead whaling. Direct, indirect, and cumulative effects would be the same described for Alternative 2. In total, the cumulative effects of Alternative 4 on subsistence patterns would be positive, and minor to moderate in magnitude, extent and duration. When considered in conjunction with other cumulative effects, the beneficial contribution of Alternative 4, in authorizing the subsistence whale hunt, is a greater proportion of total cumulative socio-cultural effects than the adverse effects resulting from other activities, including noise from oil and gas exploration and development.

4.8.2 Effects on Eskimo Health and Public Safety

4.8.2.1 Nutritional Benefits and Risks

In addition to the food volume produced through subsistence bowhead whaling, nutritional benefits and risks can be assessed, at least in qualitative terms. As a result of industrial pollution, long distance vectors for transport and deposition in Arctic environments, and high rates of persistence, many contaminants are found in Arctic subsistence resources. As described in Section 3.2.6, bowhead whale subsistence foods have been analyzed for their levels of contaminants, including PCBs, DDTs, OCs, and chlordanes and heavy metals. These contaminant levels varied with gender, length/age, and season, but were generally relatively low compared to other marine mammals. Reports by the Arctic Monitoring and Assessment Programme (AMAP) identified levels of contamination meriting closer public health attention in some parts of the Arctic, through generally not in Alaska (AMAP, 2002; 2003).

At the same time, public health officials recognize that the loss of subsistence foods would have far-reaching consequences throughout the sociocultural system of small, predominantly indigenous communities. A report from the Alaska Division of Public Health, Section of Epidemiology in 1998 observed that:

> Changes in diet, lifestyle, and the social and cultural disruption that follows the cessation of subsistence may contribute to a wide array of changes in communities from increases in obesity and diabetes, to increases in violence, alcoholism and drug abuse (Egeland et al., 1998: 9).

Moreover, highly nutritious subsistence foods are generally replaced by nutritionally inferior purchased foods. The report further stated:

> The market foods that often replace locally harvested wildlife are high in saturated fat and vegetable oils and carbohydrates and often lower in nutrient value. In addition, dietary changes are complex in nature, often coinciding with a number of other lifestyle changes which also contribute to increases in chronic diseases such as heart disease, diabetes, and cancer (Egeland et al., 1998: 9).

In a 2004 update on risk and benefits of traditional foods, the Alaska Section of Epidemiology studied mercury contaminant levels in fish and marine mammals, including data on human uptake (i.e. biomonitoring through hair samples). This study reiterated the findings of the 1998 report and continued to recommend "unrestricted consumption of fish and marine mammals from Alaska waters as part of a balanced diet" (Arnold and Middaugh, 2004:2). The authors also acknowledged the AMAP work, and noted:

> Public health officials from AMAP and other arctic scientists concluded that the nutritional and physiological health benefits of traditional Arctic subsistence foods outweigh potential risks in most areas of the Arctic, and advise local public health policy makers to encourage continued traditional food use when indicated by risk benefit analyses (AMAP, 2002; 2003; cited in Arnold and Middaugh, 2004:11).

In short, documented contaminant levels in bowhead whales in Alaska do not represent a threat to the health of subsistence users at current levels. Given the low levels of risk, public health officials conclude that the nutritional decline from loss of subsistence foods, like bowhead whale meat and blubber, would be far more adverse.

Under Alternative 1, there would be no federal authorization of subsistence bowhead whaling for the five years 2008 through 2012. The direct effects of this alternative, assuming no unauthorized whaling, would be to eliminate the nutritional benefits of bowhead whale consumption, and to eliminate exposure to the low contaminant levels in bowhead whale meat and blubber. Indirect effects would include consumption of a different mix of subsistence foods, as hunters redirect their harvest efforts to species not prohibited to them. However, it is unlikely that redirected subsistence hunting effort could replace the exceptional volume of bowhead whale food for most of the affected communities. Instead, it is likely that purchased food of inferior nutritional value would become a larger portion of total food consumption, with deleterious health effects. As noted above, the loss of a central subsistence harvest activity may also contribute to behavioral health problems. The AEWC considers it very important to recognize the adverse nutritional and behavioral health effects that would likely follow if bowhead subsistence whaling were prohibited (AEWC, personal communication). In their view, this category of impacts has not been previously been given sufficient attention.

Since it would affect a large portion of the all AEWC communities, the effects of Alternative 1 would be major in magnitude and extent. The duration of these effects is not known, since the NMFS could revisit its decision in a subsequent year, or the decision to deny a quota could continue for the five-year period similar to current authorizations. In all, the effects of Alternative 1 on the nutrition and health would be adverse and major (Table 4.1-3).

Alternative 2 would reauthorize subsistence bowhead whaling at a level sufficient to address the identified Alaska Eskimo cultural and nutritional subsistence needs, with no provision for carry-over of unused strikes into a subsequent year. The direct effect of this alternative would be to continue the significant positive contributions of bowhead whale foods to the nutritional level of subsistence users. Concurrently, subsistence users would continue their low levels of exposure to contaminants in bowhead meat and blubber. Few indirect or cumulative effects would be expected, as this alternative provides for continuity in bowhead harvest levels, rather than redirection to other subsistence resources or purchased foods. The lack of provisions for carry-over of unused strikes may make a very small difference in harvest levels. While carry-over provisions do provide flexibility to whaling captains late in the season, they have rarely been used. Since this alternative does reauthorize the subsistence hunt, the effects of Alternative 2 on nutrition and health would be positive and major in magnitude, extent, and duration, securing a substantial subsistence harvest opportunity for all AEWC communities for the next five years.

Alternative 3 would provide for the same continuity in subsistence harvests and related social and cultural benefits as Alternative 2. The only difference is that Alternative 3 would continue the longstanding flexibility to carry-over up to 15 unused strikes into a subsequent year. The direct, indirect, and cumulative effects of Alternative 3 on health and nutrition are the same as those in Alternative 2. The additional flexibility provided by the opportunity to carry-over unused strikes into a subsequent year is expected to have a small, but positive, effect on harvest levels. Although this flexibility has rarely been used, carry-over of unused strikes could increase the take in a year following one in which adverse weather prevented optimal hunting success.

Since this alternative reauthorizes the subsistence hunt, the effects of Alternative 3 on nutrition and health would be positive and major in magnitude, extent, and duration, securing a major subsistence harvest opportunity for all AEWC communities for the next five years.

Alternative 4 provides for the ongoing subsistence allocation and the carry-over of unused strikes, up to half of the strike quota of 67, into a subsequent year. The direct, indirect, and cumulative effects of Alternative 4 on health and nutrition are the same as those in Alternative 2. The additional flexibility provided by the opportunity to carry-over unused strikes into a subsequent year is expected to have a small, but positive, effect on harvest levels. Again, carry-over provisions have rarely been used, but the flexibility could increase the harvest in a year following one in which adverse weather prevented optimal hunting success. The effects of Alternative 4 on nutrition and health would be positive and major in magnitude, extent, and duration, securing a major subsistence harvest opportunity for all AEWC communities for the next five years.

4.8.2.2 Public Safety

Subsistence whaling carries a range of inherent risks, including the dangers of small open boats in Arctic waters, shore ice breaking off and isolating whaling camps, and accidents on the ice as snow machines travel from the village to ice edge whaling camps. Inupiat and Siberian Yupik whalers have long expressed a profound concern for safety. A rich body of oral history includes episodes of hunters thrust into life threatening situations, as lessons for survival. Cumulative traditional knowledge and ongoing close-grained observations of weather and ice conditions are topics of constant discussion, as whaling captains and crews assess safety and risks arising from these conditions (George et al., 2004b).

Another class of safety risks arises from the incorporation of new technologies into whaling, ranging from the historic adoption of the harpoon bombs in the Yankee whaling era, to more recent use of heavy equipment and steel cables to haul massive bowhead whales up onto the ice. The AEWC has implemented a village training program to promote hunter safety and effectiveness, including the use of newer penthrite projectiles.

Several recent episodes are representative of the risks involved in whaling. In a tragic accident in 2005, a skin-covered whaling boat from Gambell capsized while helping to tow a bowhead back to the community in the eight-foot swells and overnight darkness. The mayor, his two children and another adult were drowned, while two crew members survived (Spero News, 2005; Siku Circumpolar News Service, 2005). In the mid-1990s, a Nuiqsut whaling boat capsized while on a resupply run in rough seas during the fall hunt. One hunter died. In a recent report to the IWC, the AEWC referred to an accident during a recent hunt in Barrow, in which "one of the most experienced harpooners in the Arctic was killed when his board capsized while towing a whale; he was trapped under it" (AEWC, 2006). In the early 1980s, six whale hunters from Savoonga survived a capsizing accident just after harpooning a large bowhead whale (Alaska Magazine, 1982).

Two major episodes of sudden break-off of the ice are recounted in George et al., (2004b). In a famous episode of onshore ice thrust, known in Inupiat as *ivu*, in 1957, the break up of shorefast ice was so sudden and abrupt that whaling camps and equipment were abandoned and dog teams cut loose, as whalers scrambled for shore. No lives were lost, but the event became famous as a

warning about setting camp on flat pans of multi-year ice, referred to as *piqaluyak*. It took many years for whaling crews to recover and obtain new equipment. In 1997, twelve whaling camps and 142 people were carried off as the shorefast ice broke off, an event referred to as *uisauniq*. Although captains recognized some signs of unstable ice, this particular episode arose suddenly, without time to retreat to shore. Fortunately, many whalers had GPS equipment and radios, and the Barrow Search and Rescue helicopters were able to retrieve all hunters with no loss of life (George et al., 2004b). In another example of risks attributable to changes in ice quality, North Slope Borough officials cite recent instances of hunters falling through ice while traveling on snow machines from the community to the camps (R. Suydam, North Slope Borough, personal communication).

Injuries involving accidental discharge of harpoon bombs are reported in earlier decades. In 1940, an anthropologist working in Point Hope reported four accidental explosions of the shoulder guns, resulting in one death and one injury (Rainey, 1940). Three members of a Barrow whaling crew sustained injuries, serious in one case, when a bomb exploded in the whale gun in May 1968 (Naval Arctic Research Laboratory, 1968). Another accident involving equipment failure was reported in Barrow in 1992, when the block and tackle gear used to haul the whale up on the ice broke, and flying cables killed two women (R. Suydam, North Slope Borough, personal communication).

In the perspective of cumulative effects, the trends of several of these dangers interact with the effects of climate change, as the shorefast ice environment becomes more unstable and less predictable. In addition, changes in open water lead patterns oblige whaling crews to pursue bowhead whales through greater distances. Weather conditions may be less predictable and therefore more dangerous to whaling crews. Declines in the thickness of shorefast ice due to global warming increase the dangers of breakoffs, in which camps are separated from land, with significant dangers to the whaling crews (George et al., 2004b).

Under Alternative 1, there would be no federal authorization of subsistence bowhead whaling for the five years, 2008 through 2012. The direct effect of this moratorium would be to avoid exposure to the risks associated with whaling. However, as an indirect effect, subsistence efforts would be redirected to other resources and these involve risks as well. Harvest of other marine mammal species, such as seals and walrus, may involve similar risks. In the cumulative case, the effects of climate change are increasing the risks associated with less predictable weather, dangerous open water conditions, and unstable ice. In all, the effects of Alternative 1 on public safety would be positive and minor to moderate in magnitude, because subsistence harvest effort redirected to other resources would involve similar risks on the ice and open water, though not through the use of harpoon guns and large block and tackle equipment. Since the effects of this alternative would reach all AEWC communities they would be rated major in extent, and since this would last for five years, this would be moderate in duration. In all, the effects of Alternative 1 on public safety would be beneficial and minor.

Alternative 2 would provide for subsistence bowhead whaling at a level that would address the identified Alaska Eskimo cultural and nutritional subsistence needs. However, Alternative 2 provides for no carry-over of unused strikes. Direct and indirect effects of this alternative would be continuing exposure to the current levels of risk inherent in bowhead whaling, and other subsistence pursuits. The provisions regarding carry-over of unused strikes would not appreciable change the effects of this alternative. The cumulative effects would be driven by the

effects of climate change, as noted in the account for Alternative 1. The magnitude of effects of Alternative 2 on public safety would be minor, since the effects reach a minor proportion of the communities, and major in extent, in that all AEWC communities are affected. The safety incidents are very infrequent, and so are rated minor in duration and frequency. In all, the effects of Alternative 1 on public safety would be adverse at a minor level.

Alternative 3 would provide for the same continuity in subsistence harvests and related social and cultural benefits as Alternative 2. The only difference is that Alternative 3 would provide for the longstanding flexibility to carry-over up to 15 unused strikes into a subsequent year. The direct, indirect, and cumulative effects would be the same as those noted for Alternative 2. In all, the effects of Alternative 3 on public safety would be adverse at a minor level.

Alternative 4 provides for the ongoing subsistence allocation and the carry-over of unused strikes, up to half of the strike quota of 67, into a subsequent year. The direct, indirect, and cumulative effects would be the same as those noted for Alternative 2. The effects of Alternative 4 on public safety would be adverse at a minor level.

4.8.3 Effects on Other Tribes and Aboriginals

The IWC provided for aboriginal groups to hunt whales in the original Schedule of Regulations adopted in 1946. The Commission began regulating aboriginal subsistence hunts when it first set catch limits for bowhead whales in 1977. Revision of bowhead catch limits in furtherance of subsistence hunts by Alaska Eskimos and Chukotkan aboriginal people sets no new precedent that could increase commercial or subsistence hunts. The media has reported that Canadian Aboriginal First Nations have also conducted subsistence hunts. Canada is not a member of the IWC, and the U.S. government opposes any hunts by Canadian Aboriginal people unless Canada seeks and receives authorization from the IWC. Nonetheless, Canada has, since 1991, allowed its Aboriginal people to take bowhead whales regularly from the Davis Strait and Hudson Bay stocks of bowhead whales. Infrequently, Canadian Inuvialuit have taken bowhead whales in the eastern Beaufort Sea at the Mackenzie Delta. As noted above in Section 3.2.4, successful harvests of a single whale were reported for 1991 and 1996.

Under Alternative 1, there would be no NMFS authorization of subsistence bowhead whaling for the five years, 2008 through 2012. If the Russian Federation did the same, the Chukotkan aboriginal people would also be denied a subsistence hunt. This would represent the loss of the food value of up to five bowhead whales authorized per year, although average harvests as described in Section 3.2.4 are closer to one bowhead whale per year. Since the Canadian government has withdrawn from the IWC, the very limited harvest of Western Arctic stock bowheads would continue in the Mackenzie Delta area. As an indirect effect of Alternative 1, working relationships with other tribes might be adversely affected since the tribes might view NMFS's action under this alternative as a breach of faith by the U.S. Government in upholding Native subsistence rights. Most Native tribes throughout the U.S. would likely view Alternative 1 as a failure on the part of NMFS to exercise its trust responsibility with respect to Alaska Eskimos, and possibly to Native Americans in general. In light of the potential for political action by Alaska Natives to defend the bowhead subsistence hunt, described in Section 4.8 above, the potential impact on other tribes may be moderate to major, depending on the extent to which this emerges as a national issue among Native American tribes.

Alternative 2 would provide for a continuing level of subsistence bowhead whaling and would promote cultural diversity and recognize the importance of maintaining traditions for the coherence of Alaska Eskimo groups. This alternative would also make it possible for the AEWC to carry on subsistence hunts that are sanctioned by the IWC. Official recognition that traditional subsistence activities, such as whale hunts, are culturally valuable will be reassuring to Native Americans in general. Thus, Alternative 2 would avoid the adverse, indirect effects of deterioration in working relations between NMFS and other tribes. Alternative 2 does not provide flexibility to the bowhead subsistence whalers in the form of carry-over of unused strikes into a subsequent year, but this is not likely to affect the working relations of NMFS with other tribes. The effects of Alternative 2 on other tribes would be negligible.

Alternative 3 provides for continuation of the current level of flexibility with carry-over of unused strikes, in that up to 15 can be carried into a subsequent year. The direct and indirect effects of this alternative on relations with other tribes are the same as those of Alternative 2. The effects of Alternative 3 on other tribes would be negligible.

Alternative 4 provides for a greater level of flexibility in that up to half of all unused strikes could be carried over into a subsequent year. The direct and indirect effects of this alternative on relations with other tribes are the same as those of Alternative 2. The effects of Alternative 4 on other tribes would be negligible.

4.8.4 Effects on the General Public

There is a segment of the U.S. population that is opposed to whaling, particularly commercial whaling (according to letters and environmental group communications to the U.S. Government). However, many citizens and non-governmental groups understand and appreciate the cultural and nutritional needs of Alaskan Natives to harvest bowhead whales in a subsistence hunt. Some citizens and groups oppose all whaling, no matter the situation.

Under Alternative 1, there would be no federal authorization of subsistence bowhead whaling for the five years, 2008 through 2012. This alternative may be supported by citizens opposed to all whaling. However, as noted above Alternative 1 is likely to result in political action by Alaska Native whalers, appealing for support to the general public. Citizens who support a limited opportunity for aboriginal whaling may be sympathetic to the claims of the Alaska Native whalers that their needs have been sacrificed for ideological reasons. Alternative 1 may be most acceptable to citizens who oppose all whaling. The effects of Alternative 1 on the general public may be seen as mixed, with countervailing tendencies, depending on the position of support or opposition to subsistence whaling held by a particular portion of the general public. The overall result is a moderate impact, beneficial in the eyes of the anti-whaling public, and adverse for those who support indigenous whaling rights.

Alternative 2 provides for an ongoing subsistence hunt for bowheads at a level which meets the nutritional and cultural needs. However, this alternative would not provide any flexibility for carry-over of unused strikes. Citizens who support aboriginal whaling would support this allocation, and would be relieved that confrontations between the subsistence whaling communities and the government agencies have been avoided. Citizens who oppose aboriginal whaling would not support this alternative. The specifics of the provisions on carry-over of unused strikes are not likely to be consequential to the general public. The effects of Alternative

2 on the general public may be seen as mixed, with countervailing tendencies, depending on the position of support or opposition to subsistence whaling held by a particular portion of the general public. The overall result is a minor impact.

Alternative 3 provides for the ongoing subsistence whaling allocation at a level which meets the identified need, and provides flexibility to whaling captains in that up to 15 unused strikes can be carried over to a subsequent year. The support and opposition to this alterative among the general public would be the same at that described for Alternative 2. The effects of Alternative 3 on the general public may be seen as mixed, with countervailing tendencies, depending on the position of support or opposition to subsistence whaling held by a particular portion of the general public. The overall result is a minor impact.

Alternative 4 provides for the ongoing subsistence whaling allocation at a level which meets the identified need, and provides flexibility to whaling captains in that unused strikes up to half of the authorized strike limit can be carried over to a subsequent year. The support and opposition to this alterative among the general public would be the same at that described for Alternative 2. The effects of Alternative 4 on the general public may be seen as mixed, with countervailing tendencies, depending on the position of support or opposition to subsistence whaling held by a particular portion of the general public. The overall result is a minor impact.

4.8.5 Environmental Justice

In February 1994, the President issued Executive Order 12898 on Environmental Justice (1994). Executive Order 12898 requires the Federal government to promote fair treatment of people of all races, so no person or group of people bear a disproportionate share of the negative environmental effects from the country's domestic and foreign programs. Fair treatment means that no population, due to lack of political or economic power, is forced to shoulder the negative human health and environmental impacts of pollution or other environmental hazards. Environmental justice means avoiding, to the extent possible, disproportionate adverse environmental impacts on low-income populations and minority communities.

A minority is any individual classified as American Indian, Alaska Native, Asian or Pacific Islander, African American, or Hispanic. A low-income person is a person with a household income at or below the U.S. Department of Health and Human Services poverty guidelines. A minority population and low-income population are defined as any readily identifiable group of minority or low-income persons who live in geographic proximity, and if circumstances warrant, geographically dispersed/transient persons (such as migrant workers or Native Americans) who would be similarly affected by a proposed program, policy, or activity.

Potentially affected populations are presented below. The analysis of benefits and adverse effects on minority and low-income populations is presented in Section 4.8.5.2.

4.8.5.1 Affected Populations

The communities affected by the proposed action are the 10 member communities of the AEWC. As discussed in Section 3.4 Socio-economic Environment, these are small, predominantly Alaska Native villages, with the exception that Barrow, as a regional service center, is larger and accounts for just over half of the regional population. In 2005 the AEWC member communities

counted a total of 8,131 residents, of whom 6,333 or 77.9% are Alaska Native or part Alaska Native.

According to the 2000 Census, the ten AEWC member communities had generally high rates of residents living below the federally-defined poverty level. Five communities (Diomede, Gambell, Kaktovik, Kivalina, Savoonga) had comparatively high poverty rates, ranging from 26% through 35% of residents living below the poverty level. Three communities (Wainwright, Point Hope, Wales) had intermediate rates, with 12% - 19% of residents below the poverty level. Two communities, Barrow and Nuiqsut, have low levels, with less than 9% of residents below the poverty level. All but two of these communities exceed the average rate of Alaska residents living below the poverty level, which is 9.4%, and in most cases these rates are two and three times the Alaska average.

For the purposes of the Environmental Justice analysis, all of the AEWC communities qualify as predominantly minority, based on the high percentages of Alaska Native residents. The majority of these communities would qualify has having significant proportions of residents living below the poverty level, particularly when compared to the Alaska average.

4.8.5.2 Environmental Justice Effects Analysis

The analysis of Environmental Justice concerns examines whether disproportionate, adverse human health or environmental impacts would affect minority and low income communities. As shown in Section 4.8.5.1, all of the AEWC communities affected by the proposed action would qualify as minority and in most cases low income communities. For the purposes of this EIS, major impacts on bowhead whale populations or major impacts on subsistence whaling patterns would raise Environmental Justice concerns, as these would have a disproportionate adverse impact.

Under Alternative 1, no quota for subsistence bowhead whaling would be provided. As noted in Section 4.8.1, this would have major adverse direct, indirect and cumulative effects upon the communities. Disruption of the bowhead harvest would eliminate a substantial food resource, disrupt cooperative labor and sharing practices, disrupt the learning process for young hunters, and disrupt highly valued cultural ceremonial events, particularly Nalukatuk, the spring whaling festival. As a result of these disproportionate adverse effects, Alternative 1 would raise Environmental Justice concerns.

Alternatives 2, 3, and 4 would provide for an ongoing subsistence bowhead whaling quota, with variations in the provisions for carry-over of unused strikes into a subsequent year. Since these alternatives provide for continuity of subsistence whaling, the communities would not be affected by adverse direct or indirect effects. Concerning cumulative effects, Section 4.6 concluded that none of the alternatives, when ongoing mitigation measures are taken into consideration, would result in major adverse impacts on the bowhead whale population. Therefore, Alternatives 2, 3, and 4 would provide beneficial effects for the AEWC communities and do not raise Environmental Justice concerns that a minority population may be disproportionately impacted.

4.9 Summary of Effects

As presented in Chapter 2 of this document, four alternatives are analyzed in this EIS. Under Alternative 1, NMFS would not issue the AEWC a subsistence whaling quota for cultural and nutritional purposes. This could occur if, among other things, NMFS chose not to issue a quota based on environmental concerns.

Under Alternative 2, NMFS would (through annual quotas) grant the AEWC a quota of 255 landed whales over five-years (2008 through 2012), with an annual strike quota of 67 bowhead whales per year. Under this alternative, no unused strikes from a previous year would be added to the quota for a subsequent year, notwithstanding the IWC's approval, in May 2007, of a carry-over of unused strikes in the bowhead subsistence quota.

Under Alternative 3 (the proposed action), NMFS would (through annual quotas) grant the AEWC a quota of 255 landed whales over five years (2008 through 2012), with an annual strike quota of 67 bowhead whales per year. Under this alternative, 15 unused strikes from a previous year (including from the 2003 through 2007 quota block) could be added to the quota for a subsequent year, consistent with the IWC catch limits adopted in May 2007. A carry-over of 15 unused strikes was approved by the IWC in May 2007. A carry-over allows for variability in hunting conditions from one year to the next within limits that conserve the Western Arctic bowhead stock.

Under Alternative 4, NMFS would (through annual quotas) grant the AEWC a quota of 255 landed whales over five years (2008 through 2012), with an annual strike quota of 67 bowhead whales per year. Under this alternative, up to 50% of the unused annual strike limit from a previous year (including from the 2003 through 2007 quota block) could be added to the quota for a subsequent year. The 50% carry-over would not be consistent with the actions of the IWC in May 2007.

The following tables (Tables 4.9-1 through 4.9-3) summarize the direct, indirect, and cumulative effects under each alternative for all resources where environmental consequences were evaluated and found to be possible. More detailed discussions of direct, indirect, and cumulative effects can be found in Sections 4.4 through 4.8.

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Table 4.9-1
Summary of Direct, Indirect, and Cumulative Effects on Bowhead Whales

Effect		Alternative 1 No Action: Do Not Grant AEWC a Quota	Alternative 2 Grant AEWC Annual Quotas (67 Strikes) with No Unused Strikes Carried Over	Alternative 3 (Preliminary Preferred Alternative) Grant AEWC Annual Quotas (67 Strikes) with No More Than 15 Unused Strikes Carried Over Any One Year	Alternative 4 Grant AEWC Annual Quotas (67 Strikes) with Up to 50% of Unused Strikes Carried Over Any One Year
Direct and Indirect Effects	Mortality	Because this alternative would result in no authorized subsistence whaling, no direct or indirect mortality is likely. The magnitude, extent and duration of effects are considered negligible to the population of bowheads.	This alternative would authorize a continuing level of direct subsistence harvests comparable to the previous five years. Given the current level of bowhead abundance, the magnitude, extent, and duration of direct mortality under this alternative is considered negligible to the population of bowheads.	Bowhead whales - (Same as Alternative 2)	Bowhead whales - (Same as Alternative 2)
	Disturbance	The noise and disturbance to bowheads under this alternative, with no subsistence whaling, would be considered negligible in magnitude, extent, and duration.	For the bowhead population, the direct and indirect effects of noise and disturbance under this alternative would be minor in magnitude, extent, and duration.	Bowhead whales - (Same as Alternative 2)	Bowhead whales - (Same as Alternative 2)
Cumulative Effects		For bowhead whales, this alternative would contribute a negligible amount of mortality and disturbance to the cumulative effects on bowheads. Overall cumulative effects, taking into account other human activities and natural factors in the project area, are considered negligible in magnitude, extent and duration in regard to mortality. In regard to disturbance, the cumulative effects are considered minor in magnitude, extent, and duration, at the population level.	For bowhead whales, Alternative 2 would contribute a negligible amount of mortality and a minor amount of disturbance to the cumulative effects. Overall cumulative effects are the same as for Alternative 1: negligible in regard to mortality and minor in regard to disturbance.	Bowhead whales - (Same as Alternative 2)	Bowhead whales - (Same as Alternative 2)

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Table 4.9-2
Summary of Direct, Indirect, and Cumulative Effects – Other Wildlife

Effect		Alternative 1 No Action: Do Not Grant AEWC a Quota	Alternative 2 Grant AEWC Annual Quotas (67 Strikes) with No Unused Strikes Carried Over	Alternative 3 (Preliminary Preferred Alternative) Grant AEWC Annual Quotas (67 Strikes) with No More Than 15 Unused Strikes Carried Over Any One Year	Alternative 4 Grant AEWC Annual Quotas (67 Strikes) with Up to 50% of Unused Strikes Carried Over Any One Year
Direct and Indirect Effects	Mortality	For other species (especially seals, walrus, and caribou), hunting pressure would increase to compensate in part for the loss of whale harvest and could lead to reductions in game populations around the whaling villages. In magnitude, extent, and duration, these effects are considered minor to moderate, depending on the importance of the species as a subsistence resource.	For ice-dependant species, this alternative would have negligible to minor direct and indirect effects, depending on the species. For other wildlife species, this alternative would have negligible to minor direct and indirect effects, depending on the species.	Ice-dependent species – (Same as Alternative 2) Other wildlife species (including threatened and endangered species) - (Same as Alternative 2)	Ice-dependent species – (Same as Alternative 2) Other wildlife species (including threatened and endangered species) - (Same as Alternative 2)
	Disturbance	Increased hunting efforts on subsistence species other than bowheads would cause noise and disturbance to other wildlife in many areas around the whaling communities and would be considered minor to moderate, depending on the social structure of the species (aggregated or dispersed).	For ice-dependant species, this alternative would have negligible to minor direct/indirect effects, depending on the species. For other wildlife (including threatened or endangered species), this alternative would have negligible to minor direct/indirect effects, depending on the species.	Ice-dependent species – (Same as Alternative 2) Other wildlife species (including threatened and endangered species) - (Same as Alternative 2)	Ice-dependent species – (Same as Alternative 2) Other wildlife species (including threatened and endangered species) - (Same as Alternative 2)
Cumulative Effects		For ice dependant species and other wildlife, increased harvest would contribute to the adverse effects of climate change on ice-dependent species and add to the difficulty of managing game populations, especially with the uncertainty of how climate change will affect different species.	To partially compensate for the loss of bowhead hunting under Alternative 1, increased harvest of other species would contribute to the adverse effects of climate change on ice-dependent species and add to the difficulty of managing other game populations, especially with the uncertainty of how climate change will affect different species.	Ice-dependent species – (Same as Alternative 2) Other wildlife species (including threatened and endangered species) - (Same as Alternative 2)	Ice-dependent species – (Same as Alternative 2) Other wildlife species (including threatened and endangered species) - (Same as Alternative 2)

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Table 4.9-3
Summary of Direct, Indirect, and Cumulative Effects – Socio-cultural

Effect		Alternative 1 No Action: Do Not Grant AEWC a Quota	Alternative 2 Grant AEWC Annual Quotas (67 Strikes) with No Unused Strikes Carried Over	Alternative 3 (Preliminary Preferred Alternative) Grant AEWC Annual Quotas (67 Strikes) with No More Than 15 Unused Strikes Carried Over Any One Year	Alternative 4 Grant AEWC Annual Quotas (67 Strikes) with Up to 50% of Unused Strikes Carried Over Any One Year
Direct and Indirect Effects	Effects on Subsistence	Direct effects include: ▪ loss of an annual average of one million pounds of bowhead *maktak* and meat, a highly valued food, ▪ diminished social cohesion occasioned by the shared work among whaling crews and others cooperating in the year round work of preparation for whaling, ▪ disruption in the bonds established through food sharing, and ▪ diminished opportunity for young people to continue to learn the knowledge, practice, and beliefs associated with this central cultural institution. Indirect effects include: ▪ redirection of subsistence harvest effort to other subsistence resources, and ▪ greater recourse to purchased food, with adverse nutritional and economic implications, would result. These direct and indirect effects are adverse and of major magnitude and extent, but of unknown duration.	Direct effects include continuation of existing subsistence practices such as: ▪ the subsistence food contribution of bowhead whales, ▪ the cooperative work and food sharing practices, and ▪ the crucial cultural learning opportunities for young people. Indirect effects include: ▪ continuation of the current levels of diversity in subsistence resource uses, and continuing levels of reliance on subsistence foods, supplemented by purchased foods. These direct and indirect effects are positive and major in magnitude, extent, and duration.	(Same as Alternative 2)	(Same as Alternative 2)
	Effects on public health and safety	Direct and indirect effects include: ▪ elimination of exposure to very low levels of contaminants in bowhead whale foods, ▪ adverse effects on diet and health as nutritious bowhead foods are replaced to some extent by less nutritious purchased foods, and ▪ elimination of exposure to the safety risks associated with whaling, but increased exposure to risks in hunting of other subsistence resources, such as seals and walrus. These direct and indirect effects of this alternative on health are adverse and major in magnitude and extent, but of unknown duration. The effects on safety would be minor.	Direct and indirect effects include: ▪ continued high levels of reliance on nutritious bowhead whale foods, and ▪ continued exposure to the current levels of risk inherent in bowhead whaling and other subsistence pursuits. Taken together, the highly beneficial nutritional effects outweigh the infrequent and therefore minor safety risks. This alternative has positive effects of major magnitude, extent, and duration.	(Same as Alternative 2)	(Same as Alternative 2)
Cumulative Effects		Given the important nutritional and cultural role of bowhead whale foods, under this alternative, in magnitude, extent, and duration, the cumulative effects on subsistence practices and nutrition and health would be adverse and major. This alternative would make a major contribution to overall cumulative effects on subsistence practices, when considered alongside other activities in the project area. Cumulative effects of climate change are increasing the risks associated with weather, open water and unstable, unpredictable ice. Subsistence harvest effort redirected to other resources would involve similar risks on the ice and open water, though not through the use of harpoon guns and large block and tackle equipment. This alternative makes a minor contribution to the cumulative effects on public safety which overall would be minor to moderate.	Given the important nutritional and cultural role of bowhead whale foods, under this alternative, in magnitude, extent, and duration, the cumulative effects on subsistence practices and nutrition and health would be adverse and major. This alternative would make a major contribution to overall cumulative adverse effects on subsistence practices, when considered alongside other activities in the project area. Cumulative effects of climate change are increasing the risks associated with weather, open water, and unstable, unpredictable ice. Subsistence harvest effort redirected to other resources would involve similar risks on the ice and open water, though not through the use of harpoon guns and large block and tackle equipment. This alternative makes a minor contribution to the cumulative adverse effects on public safety which overall would be minor to moderate.	For spring whaling, the cumulative effects of other activities, notably those associated with oil and gas exploration and development would be rated as adverse and minor. For fall whaling, the likely magnitude of impacts from these activities is less certain, because it turns on the timing, location and extent of oil and gas related activities and on the effectiveness of mitigative measures. Taking into account magnitude and likelihood, these impacts would be adverse and could be moderate, based on the effectiveness of current mitigation measures. The beneficial contribution of the proposed activities to cumulative effects, in authorizing the subsistence whale hunt, would be a greater proportion of overall cumulative effects than the contribution of noise from oil and gas exploration and development. Overall, cumulative effects on subsistence patterns would be positive and minor to moderate.	(Same as Alternative 2)

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