Rapid- Response Resource Assessments and select References for the 1002 Area of the Arctic National Wildlife Refuge in anticipation of an Oil and Gas Exploration, Leasing and Development Program per the Tax Act of 2017 Title II Sec 20001

Prepared by the Alaska Regions of the
US Fish and Wildlife Service and Bureau of Land Management

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Following the passage of the Tax Act of 2017, the US Fish and Wildlife Service (FWS), the Bureau of Land Management (BLM) and other federal and state agencies organized to evaluate the possible types of decisions that might need to be made to successfully implement an oil and gas program in the 1002 Area of the Arctic National Wildlife Refuge (Coastal Plain). A lead expert from FWS or BLM lead the development of a document (Rapid Response Resource Assessment) that identified i) regulatory or management related decisions that may have to be made, ii) what information is available to support that decision making, iii) possible knowledge gaps and iv) recommended studies or actions to fill any knowledge gaps or improve the best available science. The FWS used the results of the recommended studies or actions sections to help guide funding for FY 2018 towards projects that would be useful for improving future regulatory decision making, mitigating the impacts of seismic exploration and establishing contemporary pre-development baseline data.

The Rapid-Response Resource Assessments capture the results of this effort. The Resource Assessments are not to be considered comprehensive, complete or final, and recommended studies or actions may be added or removed over time as FWS has an increased understanding of how an oil and gas program will be implemented on the 1002 Area of the Coastal Plain and with increased awareness of existing information.

A bibliography of select manuscripts, reports and other publications authored by past and present FWS employees is included. It is not intended to be comprehensive of all research in the 1002 Area of the Coastal Plain.

Discipline/Subject Area: Acoustic Environment

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What do we need to know and why regarding subjects? Decisions to issue oil and gas leases and to permit development-related activities will indirectly or directly result in the generation of noise (i.e., unwanted sound) that has the potential to impact the acoustic environment and noise-sensitive resources within and adjoining the 1002 Area. Gravel mining (blasting), drilling, and aircraft operations generally produce the highest levels of noise and have the potential to be audible above natural ambient sound levels and disruptive to noise-sensitive resources up to many miles from the noise source, depending on several factors that affect noise propagation and attenuation.

Noise-sensitive resources within and adjoining the 1002 Area include:

- **Wildlife** such as caribou, polar bears, musk ox, and numerous bird species, many of which are important subsistence resources for rural residents;

- **Residents** of Kaktovik, including those engaged in subsistence activities on the coastal plain beyond the village itself;

- **Visitors** to the coastal plain; and

- **Visitors and wilderness values** in congressionally designated Wilderness that borders the coastal plain to the south and east, including opportunities to experience solitude (i.e., the absence of distractions from mechanization, noise, and unnatural light).

Several types of information are needed to understand, assess, and disclose potential impacts on the acoustic environment and noise-sensitive resources, and to provide a basis for decisions about lease stipulations and permit conditions necessary for avoiding, minimizing, or mitigating impacts to the extent possible. (For specific details regarding information needs for noise-sensitive resources themselves, see other sections that address polar bears, caribou, birds, subsistence activities and values, visitors and recreation, and wilderness values.) These information needs include:

- **Baseline (pre-development) acoustic conditions**, including natural ambient sound levels and characteristics of baseline noise conditions such as magnitude, timing, duration, and frequency of occurrence of noise events. The metrics used for characterizing baseline conditions should be those that are most relevant to impact assessment and mitigation, and may vary among different types of noise-sensitive resources. For example, metrics that characterize the frequency and duration of abrupt noise events loud enough to trigger disturbance responses in wildlife and metrics that characterize average hourly noise levels both may be important for describing baseline conditions. Baseline data are required for those specific time periods and specific geographic locations when and where noise from proposed development activities is expected to coincide with periods and locations of high resource sensitivity, considering factors that affect noise propagation and attenuation. Periods and locations of particularly high resource sensitivity may include those associated with:

    - Polar bear denning activities;
    - Caribou calving and post-calving activities;
    - Migratory bird breeding and brood-rearing activities;
    - Kaktovik (all periods of occupancy);
    - Subsistence activities beyond Kaktovik;
    - Visitor use on the coastal plain; and
    - Visitor use in designated Wilderness adjoining the 1002 Area.

- **Acoustic characteristics of specific development-related noise sources**, including typical and maximum magnitude, timing, duration, and number of occurrences during time periods relevant to impact analysis and mitigation (analogous to an air emissions inventory necessary for predictive modeling of development-related impacts on air quality and air quality related values). One-third octave band frequency resolution is preferred.

- **Modeled spatial predictions of acoustic impacts** attributable to development-related noise sources (i.e., noise propagation modeling.) Spatial noise propagation modeling is required for the purpose of estimating how development-related noise would be expected to propagate and potentially impact noise-sensitive resources depending on factors such as noise magnitude, distance

from the noise source, ambient sound levels, atmospheric conditions, and landscape characteristics.

- **Disturbance-response information** that quantitatively or qualitatively characterizes relationships between noise metrics and response metrics for noise-sensitive resources including wildlife, residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness. This information is necessary for assessing, disclosing, avoiding, minimizing, and mitigating potential noise impacts to the extent possible.

  The degree to which noise disturbs and impacts wildlife and people is dependent on many factors. Wildlife responses to noise are known to vary by species, and depend on acoustic factors including the frequency, intensity / magnitude (loudness), and duration of noise; as well as on non-acoustic factors including life-history stage, environmental or behavioral context, and degree of past exposure (Francis and Barber 2013). Noise that is chronic may impact sensory capabilities via masking of biologically important natural sounds such as those used for communication or detection of predators or prey. Noise that is intense and abrupt (therefore unpredictable) may be perceived as a predation threat by prey species such as caribou, potentially triggering a startle response or antipredator behavior such as fleeing. In these cases, the type of disturbance response also may be contingent on whether the noise stimulus is accompanied by an abrupt and threatening visual stimulus, as can be the case with noise events associated with low-flying aircraft.

  As with wildlife, human responses to noise also are contingent both on acoustic and non-acoustic factors. Among the non-acoustic factors are social context and perceived ability to exert control over the noise source (Stallen 1999).

  The special case of aircraft disturbance. Disturbance of subsistence resources (particularly caribou) and subsistence activities by low-flying aircraft associated with oil and gas development has long been an issue of concern to North Slope residents (e.g., see Brown 1979, pp. 38-39). The level of concern has increased over time as use of aircraft to support research and monitoring, recreation, oil and gas development, and other activities on the North Slope has increased during the past few decades.

  Aircraft disturbance of subsistence resources and activities is an issue that involves noise, but is one that is not solely attributable to acoustic factors. Relevant non-acoustic factors include all of those listed above for wildlife and for people. Because of the importance of non-acoustic factors, potential impacts of development-related noise on subsistence resources and activities cannot be assessed only on the basis of acoustic metrics and must be considered in relation to non-acoustic factors as well. For example, BLM staff have noted that subsistence hunters' concern with aircraft disturbance in and near NPR-A is affected by the high degree of uncertainty and unpredictability about where aircraft will be, and therefore by hunters' inability to foresee and avoid aircraft disturbance when engaged in subsistence pursuits (BLM 2017). The spatial unpredictability of aircraft disturbance contrasts with other development-related

disturbances that are predictably associated with gravel roads, pads, and other forms of fixed infrastructure.

The information needed to address this issue is a rigorous, interdisciplinary understanding of the effects of aircraft disturbance (including acoustic factors and contextual non-acoustic factors) on subsistence resources, users, and activities.

- **Long-term acoustic monitoring** to determine actual development-related impacts on the acoustic environment, determine the need for noise-mitigation measures, evaluate the effectiveness of such measures following implementation, and support adaptive management.

What information is currently available to address the information needs for subjects?

- **Baseline acoustic conditions**. During 2010, short-term baseline acoustic data were collected at two sites (Canning River West Bank and Brownlow Spit) in the extreme northwest corner of 1002 Area in support of the Environmental Impact Statement (EIS) for the Point Thomson project (see USACE 2012, Appendix O, Noise Technical Report). Relevant baseline data also were collected at a third site (Coastal Plain) located approximately 2 mi (3.2 km) west of the 1002 Area. In a study conducted in the NPR-A rather than the 1002 Area, Stinchcomb (2017) demonstrated methods for collecting baseline acoustic data, focusing on baseline characterization of aircraft noise events and noise-free-intervals in relation to subsistence resources and activities.

- **Acoustic characteristics of specific development-related noise sources**. Typical noise levels generated by individual pieces of construction equipment and specific construction operations are available online from the U.S. Department of Transportation Federal Highway Administration (USDOT 2006). Recent noise levels for common gas field activities (including active drilling operations) are reported by Ambrose and Florian (2014) based on field data collected in 2013 at locations near the Pinedale Anticline Project Area in Wyoming.

  Noise levels generated by different types of aircraft during different phases of flight operations are available from the Federal Aviation Administration's (FAA's) Aviation Environmental Design Tool (AEDT, https://aedt.faa.gov/), a software system that models aircraft performance for the purpose of estimating emissions, noise, and fuel consumption. Aircraft noise data extracted from the FAA model, previous versions of the model, or similar sources also can be found in a number of publications. Examples include data for a Bell 206 helicopter, a Cessna 207, and a de Havilland DHC-6 Twin Otter (Miller et al. 2003); and a C-130 cargo aircraft (USACE 2004, Appendix H).

- **Modeled spatial predictions of acoustic impacts**. Currently there is no spatial noise propagation information that is specific to anticipated activities, landscape characteristics, and noise-sensitive resources in and adjoining the 1002 Area, although methods used for the Point Thomson EIS are relevant (see USACE

2012, Appendix O; note that aircraft noise propagation was modeled using an FAA model that has since been replaced by the AEDT). Lacking time and technical capacity for spatial noise propagation modeling, BLM (2018) estimated propagation distances for development-related noise by assuming that noise levels would attenuate by 6 dBA for each doubling of distance from the source (Attenborough 2014). This estimation method does not account for potential effects of meteorological conditions, sound barriers, and landscape characteristics on noise propagation and attenuation.

- **Disturbance-response information**. For noise-sensitive resources in and adjoining the 1002 Area, information that relates specific disturbance responses to specific noise metrics are lacking, but several general sources of pertinent information are available. General reviews on the topic of noise disturbance on wildlife include Pepper et al. (2003), Pater et al. (2009), and Shannon et al. (2015). Frid and Dill (2002) and Francis and Barber (2013) provide theoretical frameworks for understanding noise impacts on wildlife, and risk-assessment frameworks for evaluating low-altitude aircraft impacts are provided by Efroymson and Suter (2001) and Efroymson et al. (2001). Stallen (1999) provides a theoretical framework for considering human annoyance with noise.

  Information sources with greater direct relevance to 1002 Area resources include the literature review prepared by Anderson (2007) and several specific papers on caribou responses to low-flying aircraft including Calef et al. (1976), Valkenburg and Davis (1983), and Harrington and Veitch (1991). Murphy et al. (1993; Maier et al. 1998 is the same study) investigated effects of low-altitude military jet aircraft on the Delta Caribou Herd and is the only work that includes actual noise-level data. Lawler et al. (2005) examined effects of low-altitude military jet overflights on the Fortymile Caribou Herd, focusing on the calving season.

  Blix and Lentfer (1992) measured noise and vibration levels resulting from seismic testing, drilling, and transport (including helicopters) in artificial polar bear dens in Prudhoe Bay and concluded that "…the dry and wind-beaten arctic snow muffles both sound and vibrations extremely well and it seems unlikely that polar bears in their dens will be disturbed by the type of petroleum-related activities measured here, providing those activities do not take place within 100 m of the den." But there remains a lack of information about noise levels that are most likely to cause bears to abandon dens, and variation among individual bears also is a factor. There have been instances in which bears have denned immediately adjacent to industrial infrastructure and stayed in the den for the full term. There also have been instances in which dens were abandoned early due to nearby disturbances such as ice-road construction (T. Atwood, pers. comm., 2/13/2018).

  On the topic of aircraft disturbance of subsistence activities, Stinchcomb (2017) concluded on the basis of a meta-analysis of published literature that "…no peer-reviewed literature has addressed the conflict between low-flying aircraft and traditional harvesters in Arctic Alaska" despite extensive evidence that such conflicts are widespread. She speculated that "…the scale over which aircraft, rural communities, and wildlife interact limits scientists' ability to determine causal

relationships and therefore detracts from their interest in researching the human dimension of this social-ecological system."

Christensen and Christensen (2009) reported results of surveys conducted to determine experiences and preferences of visitors to the Arctic Refuge. Although no survey questions addressed the issue of noise *per se*, several questions addressed visitor experiences of and preferences for aircraft use for particular types of activities.

In addition to the Point Thomson EIS and the forthcoming BLM Supplemental EIS for the GMT-2 project, other relevant information sources include impact analyses, stipulations, and best management practices included in the Integrated Activity Plan (IAP) for NPR-A (BLM 2013). Although the IAP did not address noise as a specific issue topic, noise was a factor considered in analyses conducted for several topics related to wildlife and subsistence. The Record of Decision (ROD) for the IAP includes several specific requirements for permitted aviation activities (see Best Management Practice F1, ROD pp. 65-67; also see BLM 2017) that are intended to avoid, minimize, or mitigate aircraft disturbances on wildlife and subsistence activities. These include spatial and seasonal buffers, in addition to minimum flight altitudes (contingent on flight safety considerations).

- **Long-term acoustic monitoring**. No long-term monitoring has been established in the 1002 Area for the purpose of detecting future changes in acoustic conditions and attributing such changes to particular activities including those associated with oil and gas exploration and development.

What are key information gaps?

- **Baseline acoustic conditions**. Baseline acoustic data for the 1002 Area are completely lacking, with the exception of short-term data collected in the extreme northwest corner of 1002 Area in support of the Point Thomson EIS (USACE 2012). Baseline data provide a foundation for long-term monitoring that will be required to support impact mitigation and adaptive management.

- **Acoustic characteristics of specific development-related noise sources**. Although some general acoustic information is available, impact assessment and mitigation actions would benefit from specific acoustic information associated with specific development activities that are anticipated or proposed for the 1002 Area. Such information is analogous to emissions inventory data that are used to support impact analyses and mitigation requirements for air quality and air quality related values.

- **Modeled spatial predictions of acoustic impacts**. Spatial noise propagation modeling that specifically applies to anticipated / proposed development activities and specific landscape characteristics and seasonal atmospheric conditions of the 1002 Area is lacking.

- **Disturbance-response information**. Although much general information is available, specific disturbance-response information is needed to quantitatively or

qualitatively characterize relationships between noise metrics and response metrics for noise-sensitive resources including wildlife (especially caribou and polar bears), residents and subsistence users, and Refuge visitors on the coastal plain and in adjoining Wilderness.

- **Long-term acoustic monitoring**. To support impact mitigation and adaptive management, long-term acoustic monitoring should be established early during the phased progression of development activities. Baseline data and long-term monitoring are required for those specific geographic locations and specific time periods where and when anticipated / proposed development activities are expected to coincide with high resource sensitivity. Note that long-term monitoring also is lacking in the BLM-administered NPR-A and the nearby village of Nuiqsut despite public concerns over impacts of aircraft disturbance and development-related noise on village residents, subsistence resources, and subsistence activities. This lack of monitoring information has relevance to the 1002 Area, if BLM Best Management Practice F-1 (BLM 2013) is to be considered for application to future development activities in the 1002 Area.

In addition to key information gaps, both BLM and USFWS have significant gaps in the subject matter expertise necessary for credibly and effectively assessing and mitigating impacts of development-related noise on noise-sensitive resources of the 1002 Area.

What studies/surveys need to be conducted to fill those information gaps?

- **Baseline acoustic conditions** should be quantified for those specific geographic locations and time periods where and when anticipated / proposed development activities are expected to coincide with high resource sensitivity (see list above under **What we Need to Know and Why**). Costs will be contingent on the scope of the data collection effort necessary for accurately characterizing baseline acoustic conditions for key locations and time periods. Design parameters such as the number and locations of monitoring sites, and the timing and duration of data collection should be determined jointly by subject matter specialists with expertise in anticipated development activities, specific noise-sensitive resources, and acoustic monitoring and analysis. Based on past work experience, contractors with appropriate acoustic expertise may include HDR Alaska Inc. (contractor for the Point Thomson EIS, including acoustic work), and HMMH, Inc. (a firm with specialized experience in acoustics and Federal projects).

- **Acoustic characteristics of specific development-related noise sources** should be determined through direct measurements of analog noise sources or should be provided by project proponents in the form of a noise emissions inventory for each phase of development.

- **Modeled spatial predictions of acoustic impacts** should be conducted for purposes of impact assessment, disclosure, and mitigation associated with proposed development activities.

- **Disturbance-response research** should be conducted to satisfy specific information needs for understanding, assessing, disclosing, and mitigating impacts of development-related noise on noise-sensitive resources. Priorities for this type of research should be identified in collaboration with subject matter experts for specific noise-sensitive resources.

- **Long-term acoustic monitoring** should be designed and implemented by BLM or USFWS staff (or appropriate cooperators / contractors) with expertise on the topics of acoustic engineering and environmental monitoring. This should be done in close collaboration with subject matter experts for specific noise-sensitive resources. As noted above, long-term acoustic monitoring (or the lack thereof) in NPR-A has potential implications for development planning and impact mitigation in the 1002 Area. Although recent work by Stinchcomb (2017) provides important baseline acoustic data for NPR-A, further acoustic research and monitoring is warranted to determine the effectiveness of Best Management Practice F1 (BLM 2013, pp. 65-67) and aid in evaluating whether alternative or additional practices may be required to minimize effects of low-flying aircraft on subsistence resources, activities, and residents of Kaktovik as phases of oil and gas development progress in the 1002 Area.

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REPORTING TEMPLATE: Air Quality Monitoring and Analysis

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What do we need to know and why regarding Air Quality Monitoring and Analysis?

- Air Quality (AQ) and Air Quality Related Values (AQRV) analyses will be required for oil and gas exploration and development in the 1002 Area of the Arctic National Wildlife Refuge (NWR).

- The **legal basis** for performing AQ and AQRV analyses for industrial activities that may affect federal lands and for operating in the Arctic NWR come from:
    - Clean Air Act (CAA),
    - National Environmental Protection Act (NEPA),
    - Federal Land Policy Management Act (FLPMA),
    - Refuge Improvement Act and the Wilderness Act,
    - Alaska National Interest Lands Conservation Act (ANILCA), and
    - Arctic NWR Comprehensive Conservation Plan (CCP).

- **Guidance and Policy** regarding AQ and AQRV analysis can be found in the:
    - Federal Land Managers' Air Quality Related Values Work Group (FLAG) Phase I Report—Revised (2010), and
    - Memorandum of Understanding among the U.S. Department of Agriculture, U.S. Department of the Interior, and U.S. Environmental Protection Agency, Regarding Air Quality Analyses and Mitigation for Federal Oil and Gas Decisions through the National Environmental Policy Act Process (June 23, 2011).

- **Sensitive resources:** The Arctic Refuge 1002 area is at the eastern end of the Arctic Coastal Plain, and therefore has similar resources to the NPR-A e.g., lichens and moss, which are important caribou forage during winter and migration. Lichens and moss are particularly sensitive to air pollution. Additionally, the Arctic Refuge coastal plain has:

- Adjacent designated Wilderness which could be degraded by exploration and development activities;
- Prevailing NE winds that place it upwind of other Dept. of Interior land management areas, particularly Gates of the Arctic National Park and Preserve;
- Fish and wildlife resources used for subsistence, including berries, fish, and migratory birds, that may be affected by airborne pollutants;
- Denning and feeding ESA- and MMPA-protected polar bears, which have demonstrated contaminant loads and may be susceptible to impacts from additional airborne contaminants.

- Interested stakeholders for oil and gas development in the Arctic Refuge include subsistence users, hunters and fishers, river and trekking guides, and the nation's public, who may conclude that oil and gas development in the Arctic 1002 area would permanently and irreversibly disrupt the ecological integrity. This interest may initiate litigation.

- Based on legislation, the maximum extent of surface development footprint is known. Construction and operation activity related to that footprint can reasonably and should be identified.

- AQ and AQRV analyses quantify:
  - Criteria Pollutants (for National and Alaska Ambient Air Quality Standards; NAAQS and AAAQS) Carbon Monoxide (CO), Ozone (O_3), Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2), Particulate Matter (PM_{10}, and $PM_{2.5}$), Lead;
  - Air Quality Related Values (AQRVs) – impact to visibility and Nitrogen & Sulfur deposition;
  - Air Toxics (Benzene, Formaldehyde, etc.);
  - Greenhouse Gases (GHGs; Carbon Dioxide [CO_2], Methane [CH_4], etc.); and
  - Ultra-fine particulates and Black Carbon (Soot), which are related to changing albedo ("graying" of the Arctic).

- AQ and AQRV analyses are cumulative over the life of a project, so below we discuss Information Needs for three phases:
  - Phase 1: Information needed to develop an Integrated Activity Plan and a lease sale within one year;
  - Phase 2: Information needed for subsequent NEPA processes leading to drilling and production; and,
  - Phase 3: Information needed to protect resources as further exploration, drilling, and production programs proceed.

  For all phases, **information needed** to conduct AQ and AQRV analyses include:
  - Detailed **project descriptions**.
  - **Analysis of current data** sufficiency and evaluation of the need for **additional data collection**, as adequate ambient background concentration data do not exist.
  - Air quality modeling (AQ and AQRV) **modeling and result interpretation**.
  - **Incorporation** of AQ and AQRV results **into the NEPA process**.

Information Needs (by Phase)

Phase 1. Information needed to develop an Integrated Activity Plan (IAP) and a lease sale within one year:

- Key project description elements for seismic exploration or exploratory drilling:
  - Aircraft Information (number, type of planes; number of Landing/Takeoffs(LTOs))
  - Camp Facilities (Camp water maker, heaters, etc.)
  - Fuel Supply and storage
  - Size of operation (e.g., cat train versus drilling rig)

- Adequate data substitutes for background National Ambient Air Quality Standards (NAAQS) and Hazardous Air Pollutant Standards (HAPS) concentrations (no local ambient air quality data exists and could not be collected within one year).

  Especially true for background NO_2 for subsistence hunting, trapping and fishing access.

  - Past modeling efforts in Alaska have found that 1-hour NO_2 emissions can be significant around large drill rigs (e.g. 5 km radius buffer). The 1-hour NO_2 standard was established by the Environmental Protection Agency (EPA) to protect human health. An example of the process (not the data) is previous work on the Kenai NWR.

  - There is also a drill rig workgroup for NO_2 impacts to the Arctic with respect to permitting (http://dec.alaska.gov/air/ap/docs/North-Slope-POGO-Simulation-Modeling-Report-FINAL-2017-10-17.pdf)

- Modeling, interpretation, and review could take 1 week to 1 month depending upon the geographic area, nearby sensitive resources, and and impact of operations (e.g., seismic surveys would be much less than a large exploratory drilling rig).
  Estimated resources needed to complete this work is one to four technical specialist FTE's from BLM or FWS, all of whom have national-level workloads, and assuming data are sufficient and project is clearly defined.

Phase 2. Information needed for NEPA processes leading to drilling and production:

- Project description sufficient for NEPA purposes.

- Ambient air quality data for modeling to determine background AND assessment and tracking of cumulative impacts.
  - Long-term ambient air quality monitoring station data (NAAQS) from Nuiqsut (adjacent to NPR-A) was used for NPR-A draft EIS, but there are no local ambient air quality data available for the Arctic 1002 area.

- Collecting sufficient data to inform the NPR-A draft EIS took two years and utilized considerable BLM/FWS staff, significant contractor assistance, and additional agency (EPA) coordination.

- There is an existing BLM contractor working on the Reasonable Foreseeable Development (RFD) for the Alaska North Slope Air Quality study (NSRAQ study). This work is targeted to be complete by Spring 2019.
    - An estimated $150-200K would be required to to add to the current contract to include the Arctic 1002 project, assuming that it could be modified and a clear funding source is identified.

- AQ and AQRV modeling of air quality impacts using:
    - Near Field Modeling (AERMOD)
    - Far-Field Modeling (North Slope Regional Air Quality Modeling – NS RAQM)

  The worst-case prediction of air quality impacts needed for management decisions can reasonably be modeled.

- Northern Alaska federal lands such as Arctic NWR and Gates of the Arctic (National Park Service) requires quantitative, not qualitative, AQ and AQRV analyses prior to development under NEPA.

- Incorporation of air quality data and modeling results in IAP
    - Typically requires significant contracted assistance (or would require significant additional federal FTEs).
    - BLM and FWS must have control of the contract and would provide the contract requirements, technical input and perform the final review.
    - Contract option time frame of 24 to 30 months: initiating and awarding contract (3-4 months); complete contract work (12-15 months); review (3-6 months); incorporating work into NEPA document (3 months).

Phase 3. Information needed to protect resources during drilling and production.

- Sensitive resources specific to lease area
- Specific project development descriptions
- Likely, additional site-specific AQ and AQRV analyses
- Further developments of near-field Modeling (AERMOD) and far-Field Modeling (North Slope Regional Air Quality Modeling – NS RAQM)
    - Recent analyses examples include NPR-A Greater Moose's Tooth (GMT)-1 and GMT-2, and the proposed Willlow project. (1002 area project size is similar to Alpine, but that analysis is out-of-date and timeline or costs would not be accurate for the 1002 development.)

What information is currently available to address the information needs for subjects?

- Short-term: The process (not data) used for air impact evaluation for oil and gas development on the Kenai NWR could be used to initially analyze NO_2 impacts for seismic and exploratory drilling.
- Longer-term: Current projects in NPR-A, including GMT-1 and GMT-2 have existing near- and far-field AQ and AQRV analyses, but these would need to be expanded in scope and include location-specific ambient air quality data.

What are key information gaps?

- A clear project description that details the Reasonable Foreseeable Development (RFD). With the RFD estimate, additional high, medium or low projection are created to characterize the future potential development.

  For each stage (exploration, construction/drilling, production), project descriptions need to include:
  - number, size, and highest probability location of wells
  - number of pads
  - estimates of air emissions
  - number and location of roads
  - specific and auxiliary equipment used
  - supplemental power used (fuel, storage)
  - control technologies used
  - construction activity and equipment used
  - geographic proximity of sensitive resources
  - topography
  - emission magnitude

- Additions to current near-field and far-field modeling to include the Arctic 1002 area.

- Ambient air quality monitoring in the Arctic 1002 area and downwind (minimum of NAAQS, $PM_{2.5}$, and Prevention of Significant Deterioration (PSD)) to address cumulative impacts and support accurate modeling.

  Kaktovik residents who use the 1002 area for subsistence and other stakeholders will benefit from a long-term NAAQS air quality monitoring station (and potentially HAPS, based on Nuiqsut requests for NPR-A development) within or downwind of the Arctic 1002 area to alleviate concerns regarding air quality impacts to the community from development.

What studies/surveys need to be conducted to fill those information gaps?

- Far-field (North Slope Regional Air Quality Modeling – NS RAQM) and Near-field modeling (AERMOD) will need to be modified to incorporate the Arctic 1002 area, through extension of a current BLM contract, a new agency contract, or with additional agency personnel.
  - While not an information need *per se*, the time necessary to oversee, conduct, and incorporate needed additional air quality modeling will be significant. This includes adherence to Request for Proposal and contract processing times.

- Establish long-term NAAQS ambient monitoring stations in or near Arctic 1002 area and downwind in sensitive areas, including monitoring and study sites. Per site, equipment and startup costs = $500K and annual costs = $250-300K, depending on location, logistics, and availability of operators.

- Evaluate adequacy of current data sources to meet some needs, especially for Phase 1:
    - satellite data (e.g., validation of NO_x plumes from Prudhoe Bay, average patterns of potential pollution dispersion)
    - Limited NOAA/NWS/FAA data
    - BLM ozone study in NPR-A
    - Toolik Lake Field Station research
    - Industry-sponsored PM speciation studies at Wainright and Deadhorse.

- Establish “Interagency Monitoring of Protected Visual Environments” (IMPROVE) data collection at Toolik Research Station and a coastal site. Equipment cost =$20 - 30K and annual cost per site = $37K (2018 dollars).

- Establish ethane/methane monitoring station at Tooklik, which will help in source attribution of methane from industrial activities.

COASTAL PLAIN 1002 AREA: BIRDS

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What do we need to know and why regarding subjects?

The Coastal Plain of the Arctic National Wildlife Refuge (hereafter Refuge) and adjacent marine waters (including the 1002 area) are recognized as Important Bird Areas (IBA) by the American Bird Conservancy, Audubon, and Birdlife International. Prior studies have demonstrated the value of the coastal plain 1002 area to both breeding and non-breeding birds. During the short Arctic summer, millions of shorebirds, waterfowl, loons, gulls, and landbirds use the 1002 Area. At least 158 species of birds have been recorded on the coastal plain of Arctic Refuge, and birds that use the Refuge have ranges that include all 50 U.S. states and 6 continents. Of the 57 species known to regularly occur in the 1002 Area, 24 are USFWS Birds of Management Concern, 14 are USFWS Alaska Region Priority Species, and 10 are listed as Near Threatened or Vulnerable by the International Union for Conservation of Nature or are on the Audubon Red List. Two species listed under the provisions of the Endangered Species Act have been reported in the 1002 Area, although only spectacled eiders are known to currently reside and breed there.

Purposes of the Refuge, as established by the Alaska National Interest Lands Conservation Act (ANILCA), include:

- "to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to…snow geese, peregrine falcons and other migratory birds";
- "to fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats";
- "to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents";

Applicable international treaties include the Migratory Bird Treaty. Other authorities under which we manage and conserve birds on the Refuge include the Endangered Species Act, the Bald and Golden Eagle Protection Act, and the Refuge Administration Act of 1966 as amended by the Refuge Improvement Act of 1997.

Conservation of birds in association with exploration, development, and production of oil and gas resources in the 1002 Area of the Coastal Plain of the Refuge will require information regarding:

- Contemporary abundance and distribution of breeding and non-breeding birds in the 1002 Area, with particular attention to identification of important nesting, feeding, and molting areas;
- Phenology and patterns of seasonal movement by breeding and non-breeding birds in the 1002 Area; and
- Impacts of development and disturbance to birds using the 1002 Area (including pre-development baseline data) during sensitive time periods, with special consideration given to how the dissimilarities in water availability between the 1002 Area and areas like Prudhoe Bay and National Petroleum Reserve – Alaska (NPR-A) may lead to differential impacts.

What information is available to address information needs and what are the remaining gaps?

1. Resource Inventories

Bird abundance and distribution information for the 1002 Area will help define the areas that are most important for species, or groups of species, and can therefore help define conservation and management priorities.

1.1 Historical surveys for breeding and non-breeding birds

Surveys in the late 1970s through mid-1980s in the 1002 Area included site-specific ground-based tundra breeding bird surveys on the coast and inland, breeding and post-breeding bird surveys on barrier islands and in lagoons, aerial breeding swan surveys, aerial- and ground-based breeding raptor surveys, and post-breeding snow goose surveys. Although these data provide important historical information about the bird resources of the 1002 Area, abundance and distribution for many species has likely changed as it has on the broader Alaska Coastal Plain over the intervening 40 years.

1.2 Recent surveys of breeding birds

- Ground-based surveys of breeding shorebirds were conducted throughout the 1002 Area during summer 2002 and 2004. That work found higher shorebird density in wetlands and near the Canning River Delta. Although surveys were informative, some species were encountered in low numbers, making distribution and abundance estimates unreliable.
- Aerial surveys of waterbirds, including waterfowl, loons, and gulls, have been conducted annually across much of the Alaska Coastal Plain since the mid-1980s. However, only about 1/4th of the 1002 Area is included, and what is surveyed is done so at the lowest intensity, making estimates of waterbird abundance and distribution for the 1002 Area unreliable.
- Aerial breeding bird surveys (primarily for common eiders) were conducted on barrier islands in summer 1999-2009. Ground-based surveys were conducted in summer 2003/04 and 2014-17. Aerial survey estimates were variable between years. Ground surveys revealed breeding common eider abundance on the barrier islands may have increased significantly between 1976 and 2017.
- Breeding cliff-nesting raptors were periodically surveyed in the Brooks Range, foothills, and 1002 area in the 1990s and early 2000s. Overall abundance of nesting raptors was generally low in the 1002 Area.

1.2.1 Site-specific surveys of breeding birds

The Canning River Delta on the western edge of the Refuge Coastal Plain is the only site within the 1002 Area for which contemporary, fine spatial scale breeding bird data are available. Intensive surveys focused on shorebird breeding abundance were conducted in

1979-80, 2002-07, and 2010-11. Some waterbird and passerine abundance data were also collected. This site has provided significant information on habitat use patterns and variation in phenology of tundra nesting shorebirds, passerines, waterfowl, and loons. The long-term data collected at the site also provide information on trends in abundance for birds breeding in the 1002 Area, including an apparent 15-fold increase in cackling geese since 1980.

1.3 Recent Surveys of non-breeding birds

- Boat- and ground-based coastal shorebird surveys were conducted during fall staging and migration at the major river deltas, 2006-2011. These investigations found the vast majority of shorebirds using the surveyed deltas were juveniles.
- Aerial fall-staging snow geese surveys occurred in the 1990s and early 2000s. Up to 325,000 snow geese were estimated to use the Refuge Coastal Plain in some years.
- Lagoon and near-shore surveys of post-breeding and molting waterbirds were conducted during fall 2002-2003. Up to 20, 28, 29, 33, and 41% of the yellow-billed loons, red-throated loons, long-tailed ducks, scaup, and pacific loons, respectively, counted during the entire Alaska North Slope survey occurred along the Refuge coast.
- Adults of three species of shorebirds were tagged at four sites on the ACP (including two species at one site in the 1002 Area) with GPS loggers to document use of stopover sites along the Beaufort Sea coast in summer 2017, but tagging of more individuals and species is needed before assessments can be completed.

1.4 Resource inventory gaps for breeding and non-breeding birds

Most of the current information on bird abundance and distribution in the 1002 Area was collected for only one or two years, covers only a small portion of the 1002 Area, and/or was collected at low survey intensity. In addition, the 1002 Area contains far fewer waterbodies compared to sites further west (e.g., within NPR-A), therefore birds are likely more patchily distributed. Contemporary information on bird abundance and distribution patterns in the 1002 Area are needed, especially considering that many shorebirds (either at the species or sub-species level) are declining, some goose species are increasing broadly across the North American Arctic, and habitats are changing across the Arctic Coastal Plain due to warmer, longer summers.

2. Phenology

The timing of key life events (phenology) is a critical part of nearly every important ecological relationship. For birds, the phenology of arrival, nesting, brood-rearing, and staging prior to migration likely coincides with availability of critical food and other resources. Understanding bird phenology in the 1002 Area may facilitate mitigation by conducting exploration and development activities during periods when birds are less reliant on specific areas and habitats.

2.1 Status of phenology information for 1002 Area birds

- A large amount of information on the timing of breeding is available for tundra-nesting birds from across the Alaska Coastal Plain (including the Canning River Delta), and may be reasonably extrapolated for general approximations to the 1002 Area.
- Phenological data are available for juvenile shorebirds using the 1002 Area river deltas in the late summer and fall, although substantial differences in timing among sites was detected.
- Some phenology information is available for molting sea ducks and waterbirds using coastal lagoons from studies in the 1980s, but surveys were generally conducted only a few times across several months, therefore the range in timing of peak use is not known.

- Reasonably good information is available on the general phenology of snow geese using tundra areas during fall staging from studies conducted through the early 2000s.
- Raptor phenology is fragmented and limited to observations of birds on nests during surveys along major rivers during the 1990s and 2000s.
- Adults of a few shorebird species were tagged in summer 2017 with GPS loggers at the Canning River Delta. These devices may provide phenology data for the post-breeding season if recovered.

2.2 Information gaps for bird phenology

- Although surveys have demonstrated the importance of the Refuge lagoons for waterbirds, there is poor understanding of the phenology of their use of this habitat. In addition, climate-mediated changes to the Beaufort Sea nearshore areas may be affecting benthic prey communities and ice conditions, and therefore the timing of when birds use the lagoons could be affected.
- Post-breeding phenology of adult shorebirds using the 1002 Area is poorly understood, and so far, the only data available from recently deployed tracking devices are for buff-breasted sandpipers from breeding locations to the west of the Refuge.
- The amount of time birds remain at key stopover sites is virtually unknown for most birds using the 1002 Area. These data are important for calculating disturbance or displacement risk and determining seasonal abundance estimates.

3. Potential impacts of development and disturbance

Oil and gas development may impact breeding and post-breeding birds through building and line strikes, loss or alteration of habitat, increased predator abundance, disturbance, and contamination.

3.1 Knowledge on impacts to birds from oil and gas development and disturbance

Numerous studies have been conducted on the impacts of development and disturbance to nesting and non-breeding birds at Prudhoe Bay and in NPR-A since the 1970s. Additionally, several studies on the potential impacts of industrialization and disturbance to birds were conducted in the 1002 Area. Results of some projects focused on impacts to birds can be found in summary documents, including the Refuge Coastal Plain Resource Assessments and Updates (e.g., Garner and Reynolds 1986, Garner and Reynolds 1987), Refuge Coastal Plain Terrestrial Wildlife Research Summaries (Douglas et al. 2002, Pearce et al. 2018), and the National Research Council report on the cumulative environmental effects of oil and gas activities on Alaska's North Slope (National Research Council 2003).

3.2 Information gaps for potential impacts to birds from oil and gas development and disturbance

- Before an assessment of potential impacts of development can be conducted, better information on abundance, distribution, habitat use, and phenology of breeding and non-breeding birds in the 1002 Area is required. Therefore, the topics below only address the most apparent immediate needs.
- The extent to which wetlands will be lost due to water use for oil and gas development needs to be better understood to evaluate impacts on birds. Exploration and development activities generally require substantial volumes of freshwater, but the 1002 Area contains less than $1/10^{th}$ the density of lakes compared to areas to the west where oil and gas activities are ongoing. In addition, 1002 Area lakes tend to be shallower and freeze to the bottom during winter. Therefore, wetlands and waterbodies, especially where clustered, have high value for birds inhabiting the 1002 Area. Because of this, activities that affect the

availability, seasonality, or flow of water could have different effects on birds, their habitats, and their foods in the 1002 Area compared to areas further west, but how and to what extent is unknown.

- Changes in the avian predator community makeup, predator abundance, and impacts to avian productivity are some of the most commonly described consequences of industrial activity for birds breeding on the Alaska Coastal Plain. Shelter associated with winter exploration activities may attract predators such as arctic fox and raven. Little is known about the contemporary predator community makeup or abundance in the 1002 Area.
- Limited contemporary exposure data for birds are available for contaminants related to oil and gas development in the 1002 Area.

What studies/surveys need to be conducted to fill information gaps?

- Conduct aerial- or ground-based inventories of breeding birds. Species groups should include waterfowl, loons, gulls, shorebirds, and landbirds and should also include both area-wide and site-specific surveys. These data will provide contemporary information on distribution and abundance and help identify important areas for birds. Prioritization of surveys should be based on conservation needs. Because this information may be important to leasing, and because year-to-year variability will require baseline data to be collected over several years, surveys should begin as soon as possible.
- Conduct aerial- or ground-based inventories of Brooks Range, foothills, and Coastal Plain rivers for breeding cliff-nesting raptors. Because raptors may begin using the Coastal Plain while winter exploration activities occur, these surveys/studies should begin in the near future.
- Conduct surveys to estimate abundance and distribution of predators of birds and eggs. Additional studies should also be conducted to determine current makeup of nest predators for common or sensitive bird species, and gather baseline information on movement patterns of foxes in the 1002 Area. Because high annual variability will require baseline data to be collected over many years, surveys and studies should begin as soon as practical.
- Conduct studies on the foraging ecology of nest predators and how individuals choose food items and adjust diet patterns based on alternative prey. Objectives should target ways to inform potential management actions if local predator abundance is found to increase in response to oil and gas related activities.
- Determine post-breeding abundance, distribution, habitat use, and phenology of waterfowl and loons in lagoons, and of shorebirds in deltas and coastal areas. Prioritization should be based on species' conservation need and sensitivity to disturbance and development.
- Investigate how water availability and the patchiness of waterbodies in the 1002 Area affects how disturbance and development may impact birds.
- Update baseline contaminant exposure information for birds breeding in the 1002 Area and using deltas and lagoons for fall staging, with particular emphasis on hydrocarbon exposure and how contaminant burdens may affect reproduction, survival, and subsistence value and human health.
- The above studies should incorporate how predators and birds adjacent to the 1002 Area may change their behavior in response to activities directly associated with 1002 Area oil and gas development.
- Much of the data from surveys and studies conducted in the 1002 Area are not widely available. The Refuge is working with FWS Science Applications to build a publically accessible database for the long-term dataset for the Canning River Delta tundra nesting bird project. Comparable efforts should follow for other projects to ensure appropriate storage and management of important data and allow for public data access to both contemporary and historical data.

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REPORTING TEMPLATE

- **Discipline/Subject Area: Caribou**

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- **What do we need to know and why regarding subjects?**

  The purposes of the Arctic National Wildlife Refuge, as established by the Alaska National Interest Lands Conservation Act include:

  - "to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Porcupine caribou herd (including participation in coordinated ecological studies and management of this herd …);
  - "to fulfill the international fish and wildlife treaty obligations of the United States";
  - "to provide the opportunity for continued subsistence uses by local residents";

  In addition, the International Agreement for the Conservation of the Porcupine Caribou Herd (1987) obligates the governments of the United States and Canada to:

  - "conserve the Porcupine Caribou Herd and its habitat through international co-operation and coordination so that the risk of irreversible damage or long-term adverse effects as a result of use of caribou or their habitat is minimized";
  - "ensure opportunities for customary and traditional uses of the Porcupine Caribou Herd" by rural Alaska residents and members of Canadian First Nations;

Conservation of the Porcupine caribou herd in association with the exploration, development, and production of oil and gas resources on the coastal plain of the Arctic Refuge will require information regarding:

- Importance of the 1002 Area relative to caribou birth rates, calf survival, and overall herd health;
- Likelihood and consequences of disturbance or displacement of caribou from the 1002 Area (or portions thereof) during calving and post-calving seasons;
- Potential impacts of development on access to caribou by hunters and on viewing opportunities of other Refuge visitors;

- **What information is currently available to address the information needs for subjects?**

- The Porcupine caribou herd occupies a range of approximately 130,000 square mi (337,000 square km) spanning the border between Alaska and Canada. The herd is an important cultural and economic resource utilized by local and indigenous people in Alaska and the Yukon and Northwest Territories of Canada. Approximately 2,000 – 3,000 caribou are harvested annually, mostly by subsistence users. In addition, viewing the large aggregations of caribou that occur during summer is a unique experience valued by visitors from across the U.S. and around the world.
- Telemetry data from collared adult female caribou from the Porcupine herd have been collected since 1982. These data indicate that this herd migrates to the Arctic coastal plain of northeastern Alaska and northwestern Canada for calving during early June. The area used for calving for all years combined extends approximately from the Canning River in Alaska to the Babbage River in Yukon Territory, Canada and includes the 1002 Area of the Arctic Refuge. Additional aerial surveys conducted over the coastal plain beginning in the 1960s, and surveys of relative abundance of bone and antler specimens on the tundra dating back to the early 20th century confirm that this area has been used for calving for many decades, and likely for millennia. Annual distributions of caribou during the calving season have varied among years; however, the highest densities of calving caribou were within the central coastal plain of the Arctic Refuge, including the 1002 Area, during many years.
- Predator densities are lower within areas of the coastal plain used for calving compared to neighboring areas in the foothills of the Brooks Range.
- Availability of high-quality food plants consumed by caribou during the calving season is greater within the calving range than in neighboring areas to the south and east.
- Modeling the potential effects of displacement of the caribou calving range from the coastal plain suggested that this would expose caribou calves to higher rates of predation and lower quality forage.

- During 1982-1998, caribou from the Porcupine herd used the 1002 Area and neighboring coastal areas of the Arctic Refuge for insect relief habitat during late June and early July of most years. From 1999-2017 caribou moved through this area after calving but the duration of use was variable and generally shorter than during the previous period, and most caribou moved south into the Brooks Range or east into Canada during early July.
- All arctic caribou herds fluctuate in size over periods of several decades. However, the rate of change (both increase and decline) of the Porcupine herd has been slower than other herds in arctic Alaska. The herd increased slowly during the 1980s, reached a peak of 178,000 in 1989, declined to approximately 123,000 in 2001, then increased to its current population of 218,000 in 2017.
- Studies of the Central Arctic caribou herd in developed areas west of the Arctic Refuge suggested that pregnant female caribou avoided roads and other oil field infrastructure during the calving period. Avoidance of infrastructure was less evident or absent among non-pregnant females and males. Caribou were more tolerant of human disturbance during mid to late summer, when caribou movements are largely driven by insect harassment. When human activity is low, caribou may even seek out raised gravel pads, roads, or structures to escape insect harassment.
- Prior to development, the area surrounding Prudhoe Bay was used by Central Arctic caribou for both calving and as insect relief habitat. The intensive development that occurred in this area apparently caused caribou to shift their calving distribution southward, and to cease using the developed area for forming the large aggregations that occur in response to insect harassment. Caribou seem to be more tolerant of the lower density of infrastructure associated with more recent installations west of Prudhoe Bay and have continued to use developed areas near the Kuparuk and Milne Point oil fields for insect relief.
- Displacement of Central Arctic caribou from preferred calving areas near Prudhoe Bay was associated with reduced calf size at birth, but the difference was not sufficient to cause a statistically detectable reduction in calf survival.
- Elevating pipelines to a minimum of seven feet above ground and separating roads and pipelines by at least 300 feet reduced the impact of linear features that might obstruct caribou movements.
- Despite any negative impacts that might have occurred during the period of development, the Central Arctic caribou herd grew from approximately 10,000 caribou in the late 1970s to a peak population of 70,000 in 2010. The herd subsequently declined to 22,000 in 2016.

➢ **What are key information gaps?**

Much of the available information regarding effects of oil field development on caribou came from studies of the Central Arctic herd during the 1980s and 1990s. These studies did not utilize the sophisticated analytical methods that have been developed since then, and most were limited to documenting large-scale distribution

patterns, comparing density of caribou at varying distances from infrastructure, and observing changes in caribou numbers over time. In addition, many studies were of limited duration and had low statistical power to detect differences in demographic rates (survival, reproduction, and population change). Because of the variety of natural factors that drive caribou demographics (e.g., variation in climate, weather, forage quality, predator abundance) and the general tendency of caribou herds to fluctuate in abundance, these studies provide only limited information to evaluate the potential impacts of development on the Porcupine caribou herd. Furthermore, there are significant geographic differences between the ranges of the Central Arctic and the Porcupine herds. For example, the coastal plain used for calving by the Central Arctic herd extends up to 100 mi (160 km) inland from the Arctic coast to the foothills of the Brooks Range; whereas, the coastal plain used by the Porcupine herd is only 10-40 mi (16-64 km) wide and contains a much smaller proportion of moist and wet sedge tundra habitat used by caribou for feeding during early summer. These differences suggest that impacts on the Porcupine herd could be greater due to the relative scarcity of alternative calving and post-calving habitat within the range of that herd. Key information gaps include:

- Estimated rates of survival and recruitment are not sufficiently precise to detect biologically significant differences among years;
- Lack of understanding of what drives the variation in calving site selection by caribou;
- Little empirical data are available concerning the potential physiological and demographic effects of displacement of caribou from preferred calving and insect relief habitats (e.g., evaluate the value of the 1002 Area in providing higher nutrition, reduced predation, and access to insect relief habitat in comparison to other areas).
- Data are needed to assess effectiveness of existing measures used to mitigate effects of disturbance on caribou and to develop more cost-effective measures;
- Research is needed to differentiate the effects of disturbance from natural variation in caribou distribution, abundance, and demographic parameters;.
- Limited understanding of how interchange of caribou between neighboring herds might affect population dynamics of those herds.

What studies/surveys need to be conducted to fill those information gaps?

Exploration phase:

- Increase demographic/behavior monitoring: To improve precision of estimates of survival, birth rates, and recruitment so that changes in important demographic parameters can be detected, monitoring intensity should be increased (number of radiocollared caribou and monitoring effort). This monitoring should use GPS collar technology so that fine-scale behavior data can simultaneously be collected, increasing the ability to understand the influence of habitat conditions on demography. Such data would also reveal emigration rates to neighboring

herds. Increased field monitoring would also facilitate the following proposed studies (potential cost: $75,000-$100,000 annually);

- Assess factors associated with calving site selection: Identify and evaluate the relative importance of climate, predator abundance, forage quality, insect harassment, population density, and anthropogenic disturbance on calving site selection using a combination of long-term and newly collected data; Estimated cost: $75,000 annually for 5 years. Should be done during exploration period so that impacts of future development can be differentiated from natural drivers.
- Investigate characteristics associated with post-calving distribution: Use long-term and newly collected data to understand the influence of weather, forage conditions, insect harassment and population density on caribou movement and resource-selection patterns during the post-calving period. Estimated cost: $150,000 annually for 5 years. This information will be needed during the development phase to guide design and placement of infrastructure.
- Analyze existing telemetry data to quantify seasonal ranges and migration routes: A large database of telemetry data exists that could provide valuable baseline information on caribou movements. These data need to be formally analyzed to update the report “Sensitive Habitats of the Porcupine Caribou Herd” (International Porcupine Caribou Board, 1993). Estimated cost: $25,000 (seasonal salary; no costs other than staff time); this information is needed to identify sensitive areas that may require special management during development and production.
- Monitor body condition and survival: Existing long-term monitoring programs should be continued to predict population trends and evaluate the roles of natural vs. anthropogenic factors. These data will be needed to evaluate causes of future changes in population size that are likely to occur during the development and production periods.

Development and production phase:

- Continue monitoring caribou movements: Monitoring data are needed to identify calving areas and seasonal ranges and to quantify caribou recruitment and survival; Estimated cost: $250,000 annually, collaboration with state, federal, and Canadian agencies, cost sharing to be determined.
- Identify drivers of caribou fitness traits (body condition, survival and recruitment): Use long-term and newly collected data on collared individuals to quantify the effects of annual variation in summer and winter forage conditions (vegetation type, nutritional condition), weather (phenology, snow depth and density, icing events), predator abundance, population density, insect harassment and human activity on caribou body condition, survival and recruitment; Estimated cost: $200,000 annually for 5 years. This information will be needed to differentiate potential effects of displacement from variation due to natural causes, to evaluate mitigation measures that are applied, and to develop improved mitigation strategies.
- Monitor body condition and survival: Long-term monitoring of basic physiological and demographic traits is necessary to predict population trends and evaluate

the roles of natural vs. anthropogenic factors. These data will be needed to evaluate causes of future changes in population size that are likely to occur during the development and production periods.

- Project future changes in distribution and demography: With an improved understanding of the factors that influence the behavior and demography of Porcupine caribou (see previous needed studies), the influence of development within the 1002 Area on the herd can be projected, along with expected future changes in other key factors (i.e., climate, insect harassment, forage conditions). Estimated Cost: Analysis time after the other studies have been completed.

REPORTING TEMPLATE

Discipline/Subject Area: Coastal resources

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What do we need to know and why regarding subjects? We discussed that decisions affecting/involving coastal resources would include the following resource development issues: sea ice roads, sea ice airstrips, barge access, coastal infrastructure (e.g. pads, pipelines, docks), water treatment (desalinization input/output; other discharges), offshore gravel resources.

To address these issues, we need to understand:

1. Sea ice dynamics
2. Coastal erosion
3. Coastal & Barrier Island geomorphology
4. Coastal bathymetry
5. Coastal habitats
6. Coastal water quality and chemistry

What information is currently available to address the information needs for subjects?

1. Sea Ice Dynamics: Understanding the timing and duration of sea ice may affect seasonal access.
    a. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.

i. Open-access Synthetic Aperture Radar from the Sentinel-1a satellite will be used to monitor ice formation and breakup conditions throughout the Alaska Beaufort Coast.

ii. Time lapse cameras and meteorological stations on 3-meter towers adjacent to each lagoon system to capture freeze-up, break-up and ice-out (220° field of view with red, green, blue, infrared and thermal imagery) and measure air temperature, atmospheric moisture, wind speed and direction, soil temperature and moisture, photosynthetically active radiation, and atmospheric pressure

b. Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort Sea to understand the spatial and temporal distribution of sea ice and leads in support of coastal access and wildlife habitat.

i. Mahoney, A., H. Eicken, L. Shapiro, R. Gens, T. Heinrichs, F. Meyer, and A. Graves-Gaylord. 2012. **Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort and Chukchi Seas. Final Report.** OCS Study BOEM 2012-067, University of Alaska Fairbanks and USDOI, BOEM Alaska OCS Region, 154 p. https://marinecadastre.gov/espis/#/search/study/7020

2. Coastal erosion: Coastal erosion will affect lands available for leasing, infrastructure siting, and potentially access from land to sea and vice versa. Rates of erosion available every 50m for Arctic Refuge from USGS Change for entire coastline of Arctic Refuge published in 2015

a. Gibbs, A.E., and Richmond, B.M., 2015, National assessment of shoreline change—Historical shoreline change along the north coast of Alaska, U.S.–Canadian border to Icy Cape: U.S. Geological Survey Open-File Report 2015–1048, 96 p.

b. Lidar along entire coast was acquired between 2009-2012, and are incorporated into an updated report

i. https://pubs.er.usgs.gov/publication/ofr20171107

ii. GIS data: https://www.sciencebase.gov/catalog/item/57e96bd2e4b09082500c91b0

3. Coastal & Barrier Island geomorphology: Understanding the coastline will be important if access to the refuge from offshore ice or waters is desired and to inform erosion modeling. Barrier islands take the brunt of storm impacts and erosion, especially at inlets. Critical to protecting erodible coastline. The

USGS led a study to evaluate barrier island stability and projected change. Overall, elevational data for the coastline is sufficient; however morphology data could be better and is the focus of several ongoing and newly initiated projects.

a. General descriptions of coastline in Gibbs, A.E., and Richmond, B.M., 2015, National assessment of shoreline change—Historical shoreline change along the north coast of Alaska, U.S.–Canadian border to Icy Cape: U.S. Geological Survey Open-File Report 2015–1048, 96 p., http://dx.doi.org/10.3133/ofr20151048.
    i. Updated report: https://pubs.er.usgs.gov/publication/ofr20171107
    ii. GIS data: https://www.sciencebase.gov/catalog/item/57e96bd2e4b09082500c91b0
b. Historical shoreline change rates dating back to 1947 and computed from T-sheets, satellite imagery, and airborne lidar were used to assess the stability of the mainland shores and Arey Island. In order to evaluate future stability and the ability of Arey Island to mitigate wave energy delivery to the lagoon, hindcast (probable past conditions: 1981-2010) and future coastal storm conditions (2011-2100) were simulated with a suite of numerical models. Model simulations were further used to quantify anticipated changes in flood frequency, duration, and extent of Arey Island and coastal wet sedge areas along the mainland shores of Arey Lagoon.
    i. Erikson, L.H., Gibbs, A.E., Richmond, B.M., Storlazzi, C.D., Jones, B.M., Ohman, K.A., 2018, Changing Storm Conditions in Response to Projected 21st Century Climate Change Scenarios and thePotential Impact on an Arctic Barrier Island –Lagoon System: A Pilot Study for Arey Island and Lagoon, Eastern Arctic Alaska, U.S. Geological Survey Open File report, *in press.*
c. NOAA Shorezone, includes imagery for coast and barrier islands, classifications https://alaskafisheries.noaa.gov/
    i. Length of homogenous shoreline unit
    ii. Habitat classification
    iii. Biological Wave Exposure
    iv. Oil Residency Index
    v. Coastal Classification
    vi. Environmental Sensitivity Index (substrates)
d. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.

i. Annually for each lagoon and once every 5 years for the entire Beaufort Sea Coast, coastline and barrier island position and morphology will be digitized from high spatial resolution pan-sharpened orthorectified WorldView2 satellite imagery acquired at no cost from the Polar Geospatial Center.

4. Coastal bathymetry: This information is needed to understand seafloor morphology/depth, gravel deposits and identify habitat for coastal species out to approximately 20m water depth. Bathymetry was last completed in 1940's. Industry has done work in their areas of interest, but not offshore of 1002 area.
5. Coastal habitats: Impacts of coastal activities, desalinization/discharge could affect coastal ecosystems, including habitats that Threatened and Endangered Species depend on as well as fish and migratory birds.
    a. NOAA Shorezone, including habitat classification for coast and barrier islands, classifications https://alaskafisheries.noaa.gov/
    b. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.
        i. Benthic and water column biota assessments; microbes; fish surveys; community subsistence catch sampling.
6. Coastal water quality and chemistry:
    a. Studies conducted, underway and proposed by Beaufort Lagoon Ecosystem LTER, which includes the Kaktovik and Jago Lagoons.
        i. Samples will be collected during ~2 week field campaigns during (a) the ice-covered period in April, (b) during and immediately following ice break-up in June, and (c) during the open-water period in July/August. The season-specific data from these field campaigns will be complemented by continuous data streams for select parameters measured with sensors.
        ii. Sampling: Water biogeochemistry: Seasonal Alkalinity, NO3, NH4, DOC, DON, CDOM, POC, PON, stable isotopes, fatty acids, Chl. (HPLC)
        iii. In-situ sensors (moorings), Continuous monitoring of pH, temperature, salinity, water level (wave height and sea level), velocity.
        iv. In-situ sensors (discreet) Seasonal pCO2, temperature, salinity, O2, pH, PAR, Chlorophyll (chl), NEP/GPP/R, velocity

What are key information gaps?

1. Sea ice dynamics

2. Coastal erosion: We need updated shoreline erosion/change rates. Sandia National Laboratories and partners have proposed developing a predictive model of thermos-abrasive erosion for the permafrost Arctic coastline, which will complement efforts by the Beaufort Lagoon Ecosystems LTER (See sec 4. Coastal Habitats) and BOEM's Wave and Hydrodynamic Modeling in the Beaufort Sea (Stefansson Sound). USGS will conduct research on shoreline change in 2018 to understand coastal bluff and beach change.
    a. Overview presentation available at: https://www.iarpccollaborations.org/members/documents/10925?utm_medium=email&utm_source=transactional&utm_campaign=Weekly
    b. BOEM's Wave and Hydrodynamic Modeling in the Beaufort Sea is calibrated for Stefansson Sound, but will be informative along the broader coastline https://www.boem.gov/po-ak-17-01/

3. Coastal & Barrier Island geomorphology:
    a. Need more information on substrates, including ice content/permafrost, sediment composition, grainsize, etc.
    b. Recent observations of brown tundra along coast suggest salt-kill of tundra due to inundation; sometimes recovers when apparently associated with storm surges, but some areas have not recovered since 19070's suggesting subsidence. GPS instrumented monuments across area coast would provide information on changes in elevation, and this could be a component of the BLE LTER monuments if not already.
    c. Given the importance of barrier islands in protecting the erodible coast, a better understanding of barrier islands is needed to understand how they will change in a warmer, ice-free environment. Some have a thick tundra core, others may be entirely sediments; process is that they roll inland and are dynamic at a decadal scale now, but how will that change with altered runoff and increased storms?
4. Coastal bathymetry This information is needed to understand seafloor, gravel deposits and identify habitat for coastal species out to about 20m water depth.
5. Coastal habitats: Although it will take several years to assemble the baseline, the BLE LTER will make significant contributions to this topic. Study of Fish of nearshore Beaufort Sea planned by USGS in 2018.
6. Coastal water quality and chemistry: Need water quality and sedimentation baselines to understand changes associated with development; much of this baseline information will be collected as part of the new Beaufort Sea LTER

What studies/surveys need to be conducted to fill those information gaps? If possible, please include duration (start and end), staffing and cost estimates.

A significant number of studies are underway by USGS, BOEM and the National Science Foundation (NSF) funded Beaufort Sea Lagoons Long Term Ecological Research project. Continued funding support of the personnel and research for these projects is important.

1. Sea Ice Dynamics
2. Coastal erosion
3. Coastal & Barrier Island Geomorphology
4. Coastal bathymetry
5. Coastal habitats
6. Coastal water quality and chemistry

REPORTING TEMPLATE: Contaminants in Resources Other Than Air

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What do we need to know and why regarding subjects?

- *Legal, policy and management basis*:
    - ANILCA: Continued use of subsistence resources, and quality and quantity of water resources
    - Arctic National Wildlife Refuge Comprehensive Conservation Plan (CCP)
    - National Environmental Policy Act (NEPA)
    - Clean Water Act (CWA)
    - Endangered Species Act (ESA)
    - Marine Mammal Protection Act (MMPA)

- *Contaminants of concern* associated with oil and gas exploration and development (air emissions addressed elsewhere) include:

    - Heavy metals (cadmium, chromium, lead, mercury, nickel)
    - Salts
    - Naturally occurring radioactive materials (NORMS)
    - Components of dissolved and dispersed oil: Benzene-Toluene-Ethylbenzene-Xylene (BTEX), phenols, aliphatic and aromatic hydrocarbons (e.g., polycyclic aromatic hydrocarbons or PAHs), carboxylic acid, other volatile and semi-volatile organics
    - Many other industrially produced chemicals associated with equipment and camp maintenance, and oil and gas operations (e.g., batteries, compressors, heaters/separators)
    - Chemicals that are of concern to human health and safety, including:
        - arsenic, heavy metals, hydrochloric and sulfuric acids, hydrogen sulfide gas, BTEX, 1,1,1-trichloroethane, 1,2 - dichloroethane, chloroform,
        - cyclohexanone, methyl ethyl ketone, methyl isobutyl ketone

    - Sources of these include large and small spills, injection wells (saltwater disposal, other waste disposal, hydraulic fracturing), drilling muds (may include diesel, oils, detergents), drill cuttings, oily waste pits, other waste fluids such as produced water, hydraulic fracturing fluids, solid waste such as clays, precipitates, minerals, and suspended solids, landfill leachate, sewage lagoons, POL (Petroleum, Oil and Lubricants), dust, small spills from equipment failures (well casings, truck transport, pipe and tank corrosion, fittings failure), and abandoned equipment such as batteries, storage tanks, and electrical equipment.

- *Sensitive resources*:
    - Aquatic habitats: rivers, lakes, groundwater, springs
    - Terrestrial habitats: soil, vegetation
    - Species groups:
        - Birds (from generally lowest to highest trophic level; higher trophic levels tend to accumulate higher contaminant concentrations):
            - Waterfowl (ducks, geese, seaducks) - important subsistence resource, including spectacled eiders which are listed under the ESA
            - Shorebirds - 1002 area is breeding area of international importance
            - raptors - some raptors on the North Slope already have elevated mercury concentrations
        - Fish - freshwater, anadromous fish are used for subsistence
        - Caribou - used for subsistence:
        - Polar bears - listed under the ESA and the MMPA
    - Fish, wildlife, and vegetation used for subsistence

What information is currently available to address the information needs for subjects?

- In the late 1980's, "baseline" data were captured in a scientifically and statistically sound manner (Contaminant Baseline Studies of the Arctic Coastal Plain 1002 Area and Adjacent Lagoons, Arctic National Wildlife Refuge, Alaska, 1988 - 1989). However, these data are too old to be used as pre-operational, or current baseline, data.
- There are contemporary data directly from the 1002 area on mercury in shorebirds (Perkins et al. 2016); trace elements in common eiders (Miller et al. in prep); and certain contaminants in polar bears (USGS unpubl. data). There are other data from across Arctic Alaska that may provide transferable information. All data would have to be evaluated for use as baseline data for oil and gas exploration and drilling.

What are key information gaps?

- Lack of contemporary contaminant concentrations in almost all sensitive resources that would serve as baseline data for NEPA, oil spill planning, and NRDAR.
- Complete project description, including timetable.
- Description of potential hazards to humans (including subsistence users) and the environment. These should be addressed in the NEPA process for all phases, but will need to be reviewed by the U.S. Fish and Wildlife Service.
- Disposal methods for all waste, including sewage, produced water and drilling muds. These should be addressed in the NEPA process for all phases, but will need to be reviewed by the U.S. Fish and Wildlife Service.

- Monitoring plans, including pre-operation baseline, for contaminants of concern and sensitive resources. These should be addressed in the NEPA process for all phases, but will need to be reviewed by the U.S. Fish and Wildlife Service.

- Full disclosure, characterization, and tracking of hazardous materials, including potential proprietary mixtures, which may be disposed of in the 1002 area, including by injection, to protect groundwater and springs. This may not be entirely addressed during the NEPA process, especially if proprietary information is involved.

What studies/surveys need to be conducted to fill those information gaps?

- The U.S. Fish and Wildlife Service does not currently have sufficient FTEs with environmental contaminants knowledge and skills to conduct or review studies, or evaluate NEPA documents, for oil and gas exploration or drilling in the 1002 area.

- Develop statistically sound contaminant monitoring program with enough power to detect biologically significant changes in contaminants concentrations, and changes in contaminants concentrations that may exceed regulatory thresholds. Include:

    - Evaluate sampling locations and matrices from previous contaminants baseline study for sufficiency as monitoring sites and matrices, and evaluate current data for suitability as baseline data.

    - Add site-specific monitoring sites and matrices depending upon project description to provide baseline (pre-project) data.

    - For groundwater monitoring, include location, depth, and monitoring interval of groundwater wells that would identify changes from baseline specifically for springs.
- Hydrological evaluation of underground aquifers and surface waters, including springs, in the 1002 area to avoid and minimize contaminant migration potential.

- Updated baseline sampling in fish, especially those used for subsistence, of contaminants associated with oil and gas development including heavy metals, persistent organics, NORMs, and hydrocarbons.

- Updated baseline contaminant exposure information for birds breeding in the 1002 area, and those using deltas and lagoons for fall staging, with particular emphasis on hydrocarbon and heavy metal exposure, and how contaminant burdens may affect subsistence value.

- Continued collection of polar bear contaminants exposure data, with an emphasis on hydrocarbon and heavy metal exposure.

REPORTING TEMPLATE

Discipline/Subject Area: Cultural Resources

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What do we need to know and why regarding subjects?

Section 106 of the National Historic Preservation Act requires federal agencies to take into account the effects of its actions (in this case permitting oil and gas exploration and extraction) on historic properties (defined as prehistoric and historic objects, features, structures, sites, and districts).

In order to consider effects, we will need to know the nature, extent and locations of historic properties (hereinafter, cultural resources) and evaluate these alongside specific oil and gas exploration and operations proposals.

Recorded cultural resource sites consist of consist of prehistoric and historic features (eg., drying racks and graves), structures, tent rings and artifact scatters.

Threats to cultural resources include disturbances caused directly by seismic testing, installation of ice roads, support facilities and drill pads.

Mitigation measures are consideration of avoidance, minimization, and data recording (via archaeological excavation).

What information is currently available to address the information needs for subjects?

Previous cultural resource investigations in the Arctic Plain 1002 area are limited to the coast, some waterways and the northern foothills of the Brooks Range. Key sources include:

Grover, Margan A. and Erin Laughlin
2012 Archaeological Survey of the Mid-Beaufort Sea Coast: An Examination of the Impacts of Coastal Changes on Cultural Resources.

Hall, Edwin. S., Jr. and David Libbey
1982 Preliminary Archaeological and Historic Resource Reconnaissance of the Coastal Plain Area of the Arctic National Wildlife Refuge, Alaska.

Generally, these concentrated on limited aerial and pedestrian reconnaissance surveys of areas modeled to likely have high potential to contain archaeological resources. Collectively, the surveys identified several prehistoric to early historic period seasonal occupation sites consisting of:

a. Structures and features such as log cabins, sod houses, graves, ice cellars, and drying racks. Most occur adjacent to Beaufort Sea coast, although a few have been found on river courses several miles inland.

b. Tent ring complexes generally located on well-drained river banks, terraces, ridge lines and hill/bluff tops that provide extensive views across the surrounding landscape.

c. Lithic artifact scatters, not associated with features or structures, located adjacent to watercourses.

What are key information gaps?

Previous cultural resource inventories and investigations in the Arctic Plain 1002 area have been limited to theoretically predicted high potential areas along the coast and some watercourse segments. We do not know the extent of cultural resource sites across the landscape.

What studies/surveys need to be conducted to fill those information gaps?

Cultural resource investigations will be necessary to sufficiently identify cultural resource sites, determine the significance of such sites, to evaluate effects to sites determined eligible under National Register of Historic Places criteria, and to determine avoidance, minimization and mitigation standards for eligible sites that would be adversely affected by oil and gas activities.

USFWS should commit one full-time GS-0193-11 archeologist to oversee agency cultural resource investigation permitting and Section 106 responsibilities during the duration of oil and gas exploration and extraction operations development.

Subject Area: Fishes

Lead facilitator: Randy Brown, U.S. Fish and Wildlife Service, <randy_j_brown@fws.gov>, (907 456-0295

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What do we need to know about fishes and why:

Water is essential fish habitat. Water is also a critical component in virtually all stages of the industrial process of hydrocarbon development. Potential sources of water for industrial use along Alaska's North Slope include rivers, lakes, snow, and ice; perhaps even desalinated marine sources. Fish depend on the aquatic environments of nearly all rivers, many lakes, and the near-shore marine areas in or adjacent to the 1002 Area. Surplus water, water that is present in rivers and lakes and in the form of snow and ice, that is not required to sustain fish populations, would conceivably be available for industrial use. If our goal is minimizing the impact of industrial development on fishes that live in or migrate through the 1002 Area we must identify water that is required to sustain them and preserve that water for fish use.

In addition to direct industrial use of water, seismic activity during the exploratory phase of hydrocarbon development has the potential to impact fishes as well. In recent years winter seismic surveys most commonly use a truck-based technology called Vibroseis to generate the acoustical energy pulses necessary to locate subsurface geological formations that might contain oil or gas. Vibroseis is much less harmful to fishes than explosive charges that were commonly used in the past. These downward directed pulses of acoustic energy create pressure waves into the ground or through ice into lakes and rivers below. They are known to influence the behavior of fish in the vicinity of the energy source, although experimental data suggest it does not cause the physical damage typical of explosives.

What information is currently available to address the information needs for fishes:

The eastern North Slope in Alaska is endowed with limited freshwater options for fish. As a result, there are only a few species that occupy the freshwater habitats that are available. Lake density is very low east of the Canning River drainage but increases progressively to the west. Several mountain streams cross the coastal plain between the Canning River and the Canadian border. These streams flow during summer with snowmelt, rainfall, perennial springs, and for some streams, melting glaciers, however, only the perennial springs provide flow during winter reducing habitable environments for fishes to about 5% of what is available during summer.

The nearshore environment in the southern Beaufort Sea, adjacent to the coastal plain of the eastern North Slope in Alaska, is a mix of open coast and lagoons bounded by barrier islands. In summer, water along the coast becomes brackish and relatively warm because of flow from the Mackenzie River and other rivers along the eastern Arctic coastline. The lagoons are relatively shallow, the amplitude of the tides is very small (≤30 cm), barrier islands restrict flow to some extent, and the environment becomes much less salty and much warmer than sea water outside the barrier islands. The lagoons are very productive foraging environments for marine and anadromous species during summer. In winter, in part because of reduced flow between lagoons and the sea, and in part because of ion exclusion during ice formation, lagoons become hypersaline environments that get even colder than normal sea water under ice. As winter approaches and the lagoons begin freezing up, anadromous fishes return to freshwater environments and marine fishes retreat to adjacent marine habitats.

Freshwater species present in the eastern North Slope of Alaska include lake trout *Salvelinus namaycush*, Arctic char *S. alpinus*, Dolly Varden *S. malma*, Arctic grayling *Thymallus arcticus*, round whitefish *Prosopium cylindraceum*, burbot *Lota lota*, ninespine stickleback *Pungitius pungitius*, and slimy sculpin *Cottus cognatus*. Slimy sculpin are known to occur only in drainages west of the Canning River. Round whitefish and burbot are present in the Canning River and large drainages farther west but not east of the Canning River. Lake trout and Arctic char are found only in certain lakes. Dolly Varden is present in three life history forms: anadromous populations in which most members rear in freshwater rivers for 2–4 years then begin migrating to sea to feed each summer; residual dwarf males of the anadromous populations that choose to stay in freshwater rivers rather than migrate to sea; and dwarf resident populations that exist in perennial springs and isolated lakes. Arctic grayling occur in some lakes and also in rivers with perennial springs that are used for overwintering habitat. Ninespine stickleback occur as both freshwater residents and as anadromous forms. They are common in lakes within the coastal plain and the lower reaches of many rivers throughout the eastern North Slope.

Anadromous species known to occur in or adjacent to the eastern North Slope of Alaska include Dolly Varden, ninespine stickleback, Arctic cisco *Coregonus autumnalis*, broad whitefish *C. nasus*, humpback whitefish *C. clupeaformis*, least cisco *C. sardinella*, chum salmon *Oncorhynchus keta*, pink salmon *O. gorbuscha*, Chinook salmon *O. tshawytscha*, and rainbow smelt *Osmerus mordax*. Dolly Varden and ninespine stickleback are the only anadromous species in this group that maintain populations within the rivers of the eastern North Slope. Dolly Varden are known to migrate long distances along the coast during their summer feeding forays, east to the Mackenzie River and west to the Colville River or beyond, and some individuals migrate into offshore waters as well. Ninespine

stickleback appear to be much more localized in nearshore environments. Arctic cisco have natal origins in the Mackenzie River to the east but disperse as juveniles to coastal habitats farther west including the Colville River delta, where many overwinter in brackish environments. Rearing Arctic cisco make annual feeding migrations along shore during summer and eventually return to the Mackenzie River to spawn. Broad whitefish, humpback whitefish, and least cisco that are encountered in nearshore environments in the eastern Arctic have natal origins in either the Mackenzie River to the east or the Sagavanirktok or Colville rivers to the west. Salmon species that occur in the eastern Arctic are thought to be strays from southern Chukchi or northern Bering Sea populations, although some believe that self-sustaining chum salmon populations may exist in the Mackenzie River drainage somewhere. Rainbow smelt are known to spawn in the Mackenzie and Colville rivers as well as in the Kuk River drainage farther west. Dolly Varden and Arctic cisco are the primary food fishes for people in north east Alaska.

There are about 12 species of marine fishes that are commonly encountered in nearshore brackish environments, only four of which are relatively abundant during the summer season. These are fourhorn sculpin *Myoxocephalus quadricornis,* Arctic flounder *Pleuronectes glacialis,* saffron cod *Eleginus gracilis,* and Arctic cod *Boreogadus saida*. While anadromous species tend to migrate along shore in the southern Beaufort Sea, marine species are thought to follow a very different pattern; moving towards shore and into shallow water during summer and away from shore and into deeper water during winter. It is not uncommon to find these four common marine species in brackish environments during summer, or even in the very lower reaches of the rivers in the area.

What are the key information gaps:

We currently have a good understanding of fish species present in or near the 1002 Area, as well as the types of aquatic habitats they use. We have some information on species presence in specific lakes, streams, and near-shore habitats. We don't have this information for all aquatic habitats that might be considered for exploratory seismic surveys or industrial water use. This information will be important prior to permitting for these activities.

We do not have a good understanding of the consequences of harvesting aufeis from perennial springs on flow levels downstream the next summer. Will it be adequate to support fish migration or not? This information will be important prior to permitting the use of aufeis.

What studies or surveys need to be conducted to fill those information gaps:

REPORTING TEMPLATE: Oil Spills

Lead facilitator:
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What do we need to know and why regarding subjects?

- *Legal, policy and management basis* for oil (and other hazardous materials) spill planning, response, and restoration include:
    - Oil Pollution Act (OPA), including Natural Resource Damage Assessment and Restoration (NRDAR)
    - Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
    - National Contingency Plan (NCP)
    - Endangered Species Act (ESA)
    - Marine Mammal Protection Act (MMPA)
    - National Environmental Policy Act (NEPA)
    - U.S. Department of the Interior and U.S. Fish and Wildlife Service (Service) policies

- *Concerns* associated with oil (and other hazardous materials) spills in the event of oil and gas exploration and development include:
    - Exposure of sensitive resources to dissolved and dispersed oil, including Benzene-Toluene-Ethylbenzene-Xylene (BTEX), phenols, aliphatic and aromatic hydrocarbons (e.g., polycyclic aromatic hydrocarbons or PAHs), carboxylic acid, other volatile and semi-volatile organics and potentially, heavy metals, and their effects on biota managed by the Service. Also, adverse perturbations in the ecosystem upon which Service trust resources rely due to exposure of any ecosystem component to these substances.
    - Exposure and recovery of sensitive resources to response activities (e.g., use of heavy equipment, trenching and digging, use of dispersants or *in-situ* burns, etc.).
    - The effect of any interaction between climate change and adverse exposure to oil or other hazardous substances on the fitness of Service trust resources on the individual and population levels.
    - Lack of logistic capacity to respond to spills in the 1002 area, and limited capacity elsewhere on the North Slope.

- *Sensitive resources*:

- Aquatic habitats: shorelines, near-shore marine waters and lagoons, rivers, lakes, groundwater, springs

- Terrestrial habitats: soil, vegetation

- Species groups:
  - Birds (seabirds, waterfowl, shorebirds, raptors), including eiders listed under the ESA
  - Fish (freshwater and anadromous)
  - Polar bears - listed under the ESA and the MMPA
  - Terrestrial mammals, including caribou, muskox, grizzly bears, and small mammals that have important roles in the Arctic ecosystem food web

- Fish, wildlife, and vegetation used for subsistence

What information is currently available to address the information needs for subjects?

- In the late 1980s, "baseline" data on environmental contaminants were captured in a scientifically and statistically sound manner (Contaminant Baseline Studies of the Arctic Coastal Plain 1002 Area and Adjacent Lagoons, Arctic National Wildlife Refuge, Alaska, 1988 - 1989). However, these data are too old to be used as pre-assessment data for spill response (resources at risk) and NRDAR purposes.

- National and statewide oil spill planning tools exist and can be updated (e.g., shoreline Environmental Sensitivity Index (ESI) maps; NOAA's Arctic Environmental Response Management Application (ERMA): https://response.restoration.noaa.gov/maps-and-spatial-data/environmental-response-management-application-erma/arctic-erma.html). These tools inform oil spill planning and response; however, they are generally focused on coastal and marine habitats. Tools for the 1002 area, especially inland, may need updating.

What are key information gaps?

- NRDA pre-assessment data identified as "information gaps" under other Reporting Templates. These include biological and other trust resource survey data. For example, date-specific locations, species, numbers, and habitat-based activities (e.g., breeding, staging) of waterfowl and shorebirds. If breeding in the Arctic, quantitative information on reproductive success. These data would also help inform contingency planning and spill response activities, including identification of resources at risk.

- Oil spill response plans and contingency plans, based on seismic project applications and NEPA project descriptions.

- Full disclosure, characterization, and tracking of hazardous materials, including potential proprietary mixtures, for spill planning purposes. Including ecological toxicity data for both components and mixtures of hazardous substances.

What studies/surveys need to be conducted to fill those information gaps?

- Identify shoreline segments for Shoreline Classification and Assessment Techniques (a spill response technique used when assessing the degree of oiling).

- Evaluate data layers in Arctic ERMA and other oil spill planning tools to determine suitability for adequate spill response relative to proposed activities. Inland areas are especially data poor.
- Evaluate project-specific oil spill response plans, focusing on how fish and wildlife resources are addressed.
- NRDA pre-assessment data needs to be enumerated in other Reporting Templates.
- Area-specific surveys of wildlife presence, numbers, and reproductive success, addressing all times of the year.
- Toxicity testing on wildlife.

REPORTING TEMPLATE

- **Discipline/Subject Area: Terrestrial mammals other than caribou**

- **Lead facilitator:** Stephen M. Arthur, U.S. Fish and Wildlife Service, stephen_arthur@fws.gov, 907-455-1830.
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- **What do we need to know and why regarding subjects?**

  The purposes of the Arctic National Wildlife Refuge, as established by the Alaska National Interest Lands Conservation Act include:

  - to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, …, grizzly bears, muskox, Dall sheep, wolves, [and] wolverines, …;
  - to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents,

  Conservation of the mammals in the Arctic National Wildlife Refuge in association with the exploration, development, and production of oil and gas resources on the coastal plain will require information regarding:

  - Importance of the 1002 Area relative to distribution, abundance, reproduction, and habitat requirements of mammal species;
  - Likelihood and consequences of disturbance or displacement of mammals from the 1002 Area (or portions thereof) due to exploration and development of petroleum resources;
  - Potential impacts of development on access to the area by subsistence hunters and trappers, and on viewing opportunities of other Refuge visitors;

  Major mammal species or species groups of concern include:

  Carnivores

  - Documenting the location of grizzly bear dens near areas of on-going human activities is needed on an annual basis to avoid disturbing bears and to reduce potential human-bear conflicts. Seasonal diets of bears should be evaluated,

and effects of supplemental food (primarily garbage) on bear distribution, behavior, and rates of reproduction and growth, and the frequency of human-bear conflicts need to be monitored. Periodic density estimates for grizzly bears in the 1002 area and the neighboring foothills will be needed to assess long-term population-level effects on bears and resulting effects on prey species.

- Studies of effects of human activities, including provision of supplemental food and construction of roads and pipelines, on populations and distributions of red and arctic foxes are needed to assess potential effects on both foxes and their prey (ground-nesting birds and rodents). Competitive relationships between fox species also need to be monitored.

- Little is known about wolf and wolverine densities and relationships with infrastructure on the North Slope. Surveys are needed to document wolf and wolverine abundance and distribution and to identify den sites.

Herbivores

- Changes in moose distribution and abundance are likely to occur as a result of shrub expansion on the coastal plain, and potential effects of winter snow conditions should be monitored to understand changes in moose populations and availability of moose for subsistence hunters.

- Information is needed to assess the major factors limiting distribution and abundance of moose and muskox (e.g., forage quality and abundance, weather, predation, disease).

- Abundance and density of muskoxen within the Arctic Refuge should be monitored to determine if muskoxen return to the Refuge from adjacent areas and if this is influenced by oil field infrastructure or changes in abundance and distribution of predators and other prey species.

- Distribution, abundance, and habitat associations of arctic ground squirrels should be documented. Ground squirrels are a key species in the Arctic, in that they are an important prey for many predators and can influence vegetation communities by consuming vegetation and by fertilizing the tundra around their colonies. Thus, changes in ground squirrel populations can have profound effects on local communities.

- Population levels of microtines and other small rodents should be monitored to determine the timing and magnitude of population highs and lows and how these relate to other components in the ecosystem, especially population dynamics of mesocarnivores and their alternate prey (ground-nesting birds). Effects of climate

change on the distribution and dynamics of small mammals should also be investigated.

- Small mammal species (rodents and shrews) on the coastal plain should be inventoried; particularly species for which little is known, such as the holarctic least shrew. Very little data are currently available concerning which small mammal species occur on the coastal plain, or their population status.

- The distribution and abundance of hares on the coastal plain should be documented, and species identity should be determined (snowshoe vs. Arctic hare). Hares are a key species of the boreal forest, and are likely to increase their range northward as the climate warms. This will have far-reaching effects on both vegetation and other mammals and birds.

➢ **What information is currently available to address the information needs for subjects?**

Surveys of the abundance and distribution of several mammal species were conducted during the Arctic National Wildlife Refuge Coastal Plain Resource Assessment studies of the 1980s. These included studies of muskoxen, moose, Dall's sheep, wolves, arctic foxes, wolverines, grizzly bears, arctic ground squirrels, and other rodents. Much of this information was limited to documenting the occurrence and, in some cases, estimates of abundance of these species. Since 1987, some additional surveys have been conducted to monitor abundance and distribution of muskoxen, moose, and Dall's sheep and to collect demographic data on some of these. Small mammal species occurrence along the Canning River and a few other locations has been documented.

- Grizzly bear use of the 1002 Area varies seasonally. Bear abundance is greatest during early summer; bear density in the area at this time was estimated at 1 bear per 30 square mi (78 square km). Most bears that use the coastal plain move into the foothills for denning, but approximately 5% of grizzly bears den on the coastal plain. Bears commonly prey on caribou, moose, muskoxen, ground squirrels, and small rodents, as well as berries and other vegetation. Across northern North America there is evidence of increasing abundance of grizzly bears along the arctic coast; however, no data are available to determine if this has occurred in the Arctic Refuge. Denning bears are susceptible to disturbance from human activities during winter (particularly seismic exploration). Disturbance may cause bears to abandon their dens and suffer increased rates of mortality. This risk is especially high for newborn bear cubs.
- Arctic foxes are widespread and relatively common near the arctic coast during summer. Red foxes are fairly common inland, and may be increasing in abundance along the coast. Where both species occur, red foxes have been

observed killing arctic foxes. Sudies in Scandinavia suggest that red foxes may outcompete arctic foxes and may be the cause of declining arctic fox populations in some areas. The principal prey of both species during summer includes a variety of small mammals and ground nesting birds, but particularly brown and collared lemmings. Lemming populations in the Arctic cycle in abundance, with large peaks in abundance occurring approximately every 4 years, and arctic fox abundance generally cycles in response to changes in lemming abundance. There is evidence from Scandinavia that the magnitudes of these cycles have been reduced in recent years in association with a warming climate. Reduction or elimination of fox population cycles is predicted to have negative effects on alternate prey species, such as ground-nesting birds. In addition, provision of supplemental food, such as garbage, is likely to increase fox abundance near industrial infrastructure, and this may reduce survival of some ground nesting bird species. On the Alaskan North Slope, arctic foxes have a high incidence of rabies, but little is known about the relationship between disease and fox population dynamics or the potential for rabies to spread to other species.

- Wolves and wolverines are present but not abundant on the Arctic coastal plain. During the 1002 resource assessment studies of the 1980s, the locations of several wolf dens were documented. However, little is known about current wolf or wolverine abundance and distribution in the Arctic Refuge.
- Moose densities are generally low on the Refuge's coastal plain in winter, but some moose that spend the winter along drainages in the mountains use the 1002 area in summer. Survey data suggest that moose numbers along these drainages declined during the late 1980s and remained low through approximately 2010. More recent surveys suggest a moderate increase in moose abundance has occurred in areas to the east and west of the 1002 area, but little change is evident within this area.
- Muskox abundance in the Arctic Refuge peaked at approximately 300 during the mid 1990s, then declined to near zero by 2006. Since then, small groups of muskoxen have been found occasionally within the Refuge during summer; these most likely are animals that live primarily east of the Refuge in Canada or on Alaska state land west of the Canning River. The population decline was likely due to a combination of predation and other factors, including winter weather, disease, and changes in distribution of other ungulates.
- Dall's sheep do not occur in the 1002 Area but are found in the Brooks Range Mountains to the south, where the species reaches its northernmost geographic extent. The eastern Sadlerochit Mountains, near the southern border of the 1002 Area, contains habitat suitable for sheep, and the species has occasionally been seen there. Sheep are sensitive to disturbance from noise and aircraft traffic, particularly during the lambing season (mid to late May). Dall's sheep populations throughout the Brooks Range peaked during the 1980s, declined steeply during the early 1990s (most likely due to adverse weather), increased slowly through approximately 2011, then declined again during 2012-2014 in association with a

series of severe winters. Surveys during 2015-2017 suggested that lamb production and survival were relatively high, and the population may once again be increasing.

- Ground squirrels have a patchy distribution in the 1002 Area because denning habitat is limited by a lack of well drained soils. In areas where ground squirrels occur, they are an important source of food for foxes, bears, wolves, wolverines and weasels.
- Microtine rodents, particularly brown lemmings, are year-round residents of the 1002 Area and are an important source of food for many species including bears, wolves, foxes, and wolverines in years when they are abundant. Extreme fluctuations in population abundance affect the abundance and distribution of lemming predators as well as predation on other species such as ground nesting birds.
- Hares have been documented in the mountains of the Brooks Range and on the arctic coastal plain further west. Presumably these are snowshoe hares from more southern distributions, but they also may be arctic hares coming from Canada. Hares are a valuable resource for predators in areas where they are abundant. Hare populations can increase quickly and can affect local vegetation communities, with cascading effects on other herbivores. The presence of hares could increase the presence of lynx, a species that has been observed in the 1002 area in past years.

➢ **What are key information gaps?**

- We need a greater understanding of predator/prey and competitive relationships among red and arctic foxes, lemmings, and ground-nesting birds; how these are affected by lemming cycles; and how these complex relationships may be altered by a warming climate and anthropogenic disturbance.
- We lack current data regarding the abundance and distribution of grizzly bears; the relative importance of the 1002 area as denning habitat is unknown; improved methods are needed to reduce availability of anthropogenic foods and the resulting negative interactions with human activities.
- Current data are needed regarding the distribution and abundance of wolves and wolverines; to document den site locations and habitat attributes; evaluate potential for disturbance or mortality related to interaction with human activities; and evaluate effects of increased access by subsistence hunters and trappers.
- More information is needed regarding how predation, weather, disease, and nutrition influence population dynamics of moose and muskoxen; the potential for reestablishment of muskoxen in the Refuge by expansion of neighboring populations; and the potential effects of human activities (positive: protection from predators; or negative: disturbance or displacement) on both species.

- Are lemming cycles changing? How does this affect survival and population dynamics of ground-nesting birds? Does this moderate or increase effects of human activities?
- We have only limited knowledge of which mammal species are present on the coastal plain; information is particularly needed for little-known species and those whose ranges are restricted to arctic tundra.

➢ **What studies/surveys need to be conducted to fill those information gaps?**

Exploration phase:

- Develop methods to estimate abundance of fox and lemming populations; monitor changes over time; and assess impacts on nesting birds. Estimated cost: $70,000 annually for 3 years to develop and verify techniques. This information will be needed to distinguish between natural influences and potential effects of future development, and to assist with the design and siting of future infrastructure.
- Estimate abundance of grizzly bears in the 1002 Area during June. Estimated cost: $100,000 during one year, or $50,000 per year for 2 years. This baseline information will be needed to assess potential effects of future development.
- Continue annual surveys for moose and muskoxen that systematically cover the 1002 area. Parameters should include abundance, distribution, sex and age structure, reproduction and survival. Estimated cost: $10,000-$20,000 per year. These ongoing surveys are needed to assess responses of these species to human activities and habitat changes.
- Investigate factors limiting distribution and abundance of muskoxen on the eastern North Slope. Collaboration with Alaska Dept. of Fish and Game and Yukon Dept. of Environment. Potential cost: $100,000 annually for 5 years; cost sharing to be determined. Expansion of muskoxen back into the Arctic Refuge would greatly enhance the chances of survival for this small and fragmented population. These data are needed to evaluate potential effects (both positive and negative) of development and operation of oil field infrastructure.
- Investigate the relationship between climate change, vegetation, and moose population dynamics. Could be built into ongoing monitoring work; primary cost would be additional staff time for data analysis plus ~$10,000 per year for browse surveys. These data are needed to differentiate between natural and anthropogenic effects on moose populations. Study should begin prior to development to provide baseline information on this population.
- Revisit wolf dens documented during the 1980s to see if any are still being used and identify any new den sites. Wolf observations during seasonal surveys for ungulates would provide some indication of wolf packs that occupy the 1002 area. Estimated cost: $10,000. Wolf dens are thought to be rare within the 1002

Area; however, any that are found should be flagged for special management consideration.

- Record observations of wolverines and their tracks during late winter surveys for ungulates to obtain information on relative abundance and distribution. Potential denning habitats of wolverines with kits should be mapped using satellite imagery or other methods. (No cost other than staff time, assuming ungulate surveys are funded). Surveys should begin prior to development to provide baseline information.
- Conduct an inventory of small mammal occurrence on the coastal plain. Estimated cost: $30,000 annually for one to 4 years. There is a critical need for baseline information prior to development of the coastal plain. This information will be needed to guide the design and siting of future infrastructure.
- Map the distribution of potential ground-squirrel habitat. This may be possible from satellite imagery based on local vegetation or in combination with broad-scale vegetation or soils mapping efforts. (No cost other than staff time). This information will be needed to guide the design and siting of future infrastructure.

Development and production phase:

- Conduct long-term monitoring of relative abundance of foxes and lemmings, and their effects on nesting birds; Estimated cost: $20,000 annually, in collaboration with shorebird and waterfowl monitoring. These data are needed to distinguish between natural and anthropogenic effects.
- Monitor occurrence and behavior of grizzly bears in relation to human activities; identify locations of dens; estimate population size at 5-year intervals. Estimated cost: $30,000 per year plus $100,000 every 5 years. This information is needed to monitor effectiveness of established mitigation measures and to ensure human safety.
- Continue annual surveys for moose and muskoxen that systematically cover the 1002 area in late winter. Estimated cost: $10,000 per year. These ongoing surveys are needed to assess responses of these species to human activities and habitat changes.
- Continue investigation of the relationship between climate change, vegetation, and moose population dynamics. Could be built into ongoing monitoring work; primary cost would be additional staff time for data analysis plus ~$10,000 per year for browse surveys. These data are needed to differentiate between natural and anthropogenic effects on moose populations.
- Develop protocols for long-term monitoring of habitat characteristics important to large herbivores, including vegetation type, nutrient quality, snow characteristics (depth, density, extent, phenology, icing events). Initial costs would be limited to additional staff time; future costs to be determined. This information will be needed to assess long-term impacts of development and to distinguish those from effects of natural processes.

- Record observations of wolves and wolverines and their tracks during seasonal surveys for ungulates to obtain information on relative abundance and distribution. An inventory of known dens should be established. (No cost other than staff time, assuming ungulate surveys are funded). This information will be used to guide design and siting of future infrastructure.
- Monitor observations of hares and their tracks to detect potential range expansion; determine species identity of hares that are observed. (No cost except staff time to compile and verify observations).

REPORTING TEMPLATE

Discipline/Subject Area: Paleontological Resources

Lead facilitator: Edward J. DeCleva, Regional Historic Preservation Officer, U.S. Fish and Wildlife Service, 1011 East Tudor Road, MS-235, Anchorage, AK 99503. Telephone: (907) 786-3399. Email: edward_decleva@fws.gov.

Individuals contacted:

Patrick S. Druckenmiller, Ph.D., Associate Professor of Geology, University of Alaska Fairbanks, (907) 474-6954.

Brent Breithaupt, Geologist (Paleontology), Bureau of Land Management, (307) 775-6052.

Robert King, State Archaeologist, Bureau of Land Management, Alaska State Office. (907) 271-5510.

What do we need to know and why regarding subjects?

The Paleontological Resources Preservation Act (PRPA) of 2009 requires the Secretary of the Interior to manage and protect paleontological resources on Federal lands using scientific principles and expertise.

The vast majority of the Arctic Plain 1002 has very little exposed geology, most of which is likely comprised of Quaternary Period deposits (personal communication with Patrick Druckenmiller). Therefore, any scientifically significant paleontological resources that may be present are most likely to be associated with Pleistocene Epoch remains, particularly mammoth, steppe bison, horse and other Ice Age mammal fossils.

The probability of scientifically significant paleontological resources older than the Quaternary Period being encountered and impacted by oil and gas exploration is low.

What information is currently available to address the information needs for subjects?

The University of Alaska Fairbanks, Department of Geology, is currently working with the Bureau of Land Management Alaska State Office to prepare a Potential Fossil Yield Classification document to identify the geologic time scale within the Arctic Plain 1002 area and to evaluate the potential for paleontological resources (p.c. with Patrick Druckenmiller).

What are key information gaps?

There have been no paleontological resource investigations conducted within the Arctic Plain 1002 area.

What studies/surveys need to be conducted to fill those information gaps?

Because USFWS has no expertise in the field of paleontology, it is recommended that the BLM paleontologist would need to advise on the subject and review any technical aspects of environmental review generated for oil and gas exploration and extraction.

Paleontological resource investigations, if any, can likely be conducted concurrent with cultural resource investigations to sufficiently identify Pleistocene Epoch paleontological resources that may be located at the surface to determine avoidance, minimization and mitigation standards.

USFWS may need to authorize and oversee paleontological research on the Arctic Plain 1002 in advance of or during oil and gas related project proposals. Responsibility for paleontological permitting lies partially with the USFWS Regional Historic Preservation Officer and can be accommodated with current regional cultural resources staffing.

Subject Area: Polar Bears

Lead (name and contact information): Dr. Patrick Lemons, Chief Marine Mammals Management, U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska 99516. Phone: 907-786-3668. Email: patrick_lemons@fws.gov

Individuals Contacted: Todd Atwood (USGS), George Durner (USGS), James Wilder (FWS), Christopher Putnam (FWS), Ryan Wilson (FWS), Michelle St. Martin (FWS), and Mary Colligan (FWS).

What do we need to know and why (i.e. what decisions or determinations are required)(please address what we know about resources in the area (distribution, abundance, seasonal movements), how they may be impacted by oil and gas development, mitigation measures available and their effectiveness, subsistence activities)?

> **MMPA:** We can specify the incidental, but not intentional, taking of **small numbers** of polar bears by harassment if we can find that such harassment will have a **negligible impact** on the stock of polar bears and will not have an unmitigable adverse impact on the **availability of polar bears for subsistence uses** (emphasis added).
>
> **ESA:** Under Section 7 of the ESA we will have to conduct consultations on federal action(s) and will have to make a determination as to whether such actions would **jeopardize** the continued existence of polar bears or **adversely modify or destroy** designated critical habitat (emphasis added).

What information is currently available to address the information needs identified above (include citations)?

Information needed to make the above determinations includes population dynamics of the Southern Beaufort Sea (SBS) subpopulation of polar bears, habitat and denning ecology of polar bears in the 1002 area, the subsistence and cultural use of the 1002 Area, and information on human-bear interactions that will accompany oil and gas development. We briefly describe the current state of that information relative to our determinations below.

- Population Dynamics
    - Information on the population size and trend of SBS polar bears suggests that the population experienced a 40% decline between 2001 and 2010. However, this information also suggested that the population may have stabilized by the end of that time period. Given the current information is now 8 years old, and the uncertainty surrounding the trend of the population at the end of the time period, reliance on this information for management decisions is problematic.

- Habitat Ecology
    - Our current understanding of polar bear habitat use and denning in the 1002 area is primarily based on satellite radio collared bears from the larger SBS subpopulation. However, because we are reliant on satellite radio collars applied primarily to the western portion of the SBS, and the number of collared bears that then use is only a subset of this larger sampling effort, we generally lack an understanding of the

importance of the 1002 Area to the overall population of SBS bears. Therefore, reliance on the current information is problematic.

- Subsistence and Cultural Use
    - The only study conducted that included information concerning subsistence use and the cultural importance of polar bears in the 1002 Area was published in 1997. The information provided in that study pertaining to the 1002 Area is limited. Updated and more detailed information will be necessary as part of our determinations outlined above.

- Human-Bear Interactions
    - Because the 1002 Area was managed as a wildlife refuge in the past, no significant industrial activity and related human-bear interactions have occurred there in the last 35 years. Importantly, given the uniqueness of the habitat in this area and the importance of the 1002 Area to polar bears, reliance on mitigation measures used in the NPR-A and Prudhoe Bay may not comprehensively address potential human-bear interactions in the 1002 Area.

What are key information gaps?

- Population Dynamics
    - An accurate and current understanding of the population dynamics of the Southern Beaufort Sea subpopulation of polar bears is needed in order to estimate the impact of anticipated take (i.e. to determine small numbers and make negligible impact determinations under MMPA and jeopardy determinations under ESA).

- Habitat Ecology
    - Understanding the relationship between polar bears and environmental parameters helps us explain current habitat use patterns and make future predictions on how distribution and movement is likely to respond to predicted sea ice loss and other habitat changes. This understanding is needed in order to predict how many and how animals are likely to be impacted by proposed activities (small numbers and negligible impact determination under MMPA) and whether proposed actions are likely to adversely modify or destroy designated critical habitat (ESA determination).

- Subsistence and Cultural Use of Polar Bears
    - An activity or suite of actions can affect the availability of polar bears for subsistence use by decreasing the overall number of animals or by changing their movements.
    - Understanding polar bear movements and current hunting practices helps us understand the current availability of polar bears for subsistence hunting and predict the potential impact of proposed actions on the availability of polar bears for subsistence use (MMPA determination).
    - Maintaining clear and consistence communications and relationships with communities concerning ongoing research and development activities.

- Human-Polar Bear Interactions

- Understanding the potential spatial and temporal overlap between polar bears and oil and gas development and the factors influencing the likelihood and consequences of interactions between polar bears and those development activities is essential to our ability to determine the number of polar bears likely to be taken (small numbers determination under MMPA) and the consequences of that take to the individual animal and ultimately the stock (negligible impact determination under MMPA) and to the species (jeopardy determination under ESA).
- Identification of possible methods to avoid overlap and interactions between polar bears and Industry activities, and to reduce the potential for interactions, are essential tools to facilitating our ability to achieve a small numbers determination and reach a negligible impact determination (MMPA) as well as avoid jeopardy and adverse modification or destruction of critical habitat (ESA).

What studies/surveys need to be conducted to fill those information gaps? Please include duration (start and end), lead, and cost estimates.

- Population Dynamics
  - Estimation of abundance and population dynamics (i.e. demographic rates such as survival and reproduction). Surveys using mark-recapture methods are a more viable option than other non-invasive techniques (e.g., aerial survey).
  - Continue to evaluate emerging technologies (e.g., high-resolution satellite imagery, GPS collar reliability, collar drop off mechanism performance) for integration into existing monitoring plans.

- Habitat Ecology
  - Improve our understanding of the environmental and biological characteristics of important polar bear habitats, with a particular focus on denning habitat.
    i. Continue, expand, and improve den detection, mapping, and monitoring activities. We see higher use of habitat within the 1002 area and greater reproductive success for land-based dens.
    ii. Identify movement and land use patterns of polar bears in the 1002 area, and projected changes due to sea ice loss, especially given the increased proportion of the population coming on shore in that region. Identify potential for habitat use and behavioral patterns to be modified due to increased human activities.

- Assess Impacts to Subsistence and Cultural Use of Polar Bears
  - Periodically assess key community perspectives, values and needs regarding human-polar bear interactions and sustainable use of polar bears for subsistence purposes.

- Human-Polar Bear Interactions – Identify Current Methods and Develop New Methods to Avoid, Reduce and Mitigate impacts to Polar Bears from Oil and Gas Development Specific to the 1002 Area
  - Understand how polar bears respond to disturbance
    i. Use existing movement data to look at relationships with existing infrastructure (does it appear bears are avoiding those areas and if so what is the impact zone)
    ii. Monitor for potential disturbances at den sites

- Evaluate efficacy of mitigation measures currently used outside of the 1002 area to determine effectiveness and transferability to the 1002 area
    i. Comprehensive Review of Management Measures (e.g., season/area restrictions, den buffer zones, facility location/design)
    ii. Avoidance: Examine available data to identify areas of particularly high use or biological importance for seasonal or year round avoidance areas
- Develop new mitigation measures specific to the unique characteristics of the 1002 area to reduce the number of bears taken and the overall impact of Industry.

REPORTING TEMPLATE

- **Discipline/Subject Area**: Public Health

- **Lead facilitator** Sara Longan slongan@blm.gov 907-271-3431:

- **Individuals contacted** Once external partners are contacted, the State Department of Health and Social Science (DHSS) are public health experts and have led the multi-agency (federal, state, local) development of past Health Impact Assessments in Alaska. DHSS maintains working relationships and partnerships with public health experts statewide, including contributing authors and experts from the North Slope Borough Public Health Department, among others.

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- **What do we need to know and why regarding subjects?** The Health Impact Assessment (HIA) approach is a nationally and internationally used preventive health tool that anticipates the human health impacts of new or existing development projects, programs, or policies. The overall goal of HIA is to minimize negative health effects while maximizing the health benefits of a particular action. Health Impact Assessments are not legally required in the U.S., but have been used statewide in Alaska to address specific interests and concerns raised by affected communities and have typically been used to enhance the "Public Health" analysis requirements driven by the National Environmental Policy Act (NEPA) and associated guidelines.

  The status of human health is generally well understood for North Slope communities, including Kaktovik. Public health and demographic profiles are fully described in the Health Impact Assessments completed for recent North Slope oil & gas leasing and development proposals and actions. These same documents suggest mitigation measures to lessen the effects of potential public health impacts associated with oil & gas development.

- **What information is currently available to address the information needs for subjects?** The Liberty Draft EIS released July 2017 includes a Health Baseline Assessment covering all North Slope villages and Kaktovik. A comprehensive Health Impact Assessment was released in 2013 as part of the Point Thomson Final EIS

and includes the following categories for all North Slope communities, including Kaktovik:

Social Determinants of Health
Accidents and Injuries
Exposure to Potentially Hazardous Materials
Food, Nutrition, and Subsistence Activity
Infectious Disease
Water and Sanitation
Non-communicable and Chronic Diseases
Health Services Infrastructure and Capacity

References:

BOEM, 2017. Liberty Draft Environmental Impact Statement. Bureau of Ocean Energy Management. Prepared by the Alaska Department of Health and Social Services. Available at: https://www.boem.gov/2016-010-Volume-2-Liberty-EIS/

US ACOE, 2013 (2011). Point Thomson Project Health Impact Assessment: Appendix D. Final Environmental Impact Assessment. U.S. Army Corps of Engineers. Prepared by the Alaska Department of Health and Social Services. Available at: http://www.arlis.org/docs/vol1/AlaskaGas/Report3/Report_PtThom_FEIS/appR.pdf

The Bibliographies for the Liberty and Point Thomson Health Impact Assessments are thorough and could provide supplemental reference materials and source information for additional research on specific public health categories.

NOTE: more current North Slope public health data and information will be available from on-going Health Impact Assessment work supporting the Greater Mooses Tooth 2 and Nanushuk oil & gas projects. Both project locations are distances further from the ANWR 1002 Coastal Plain when compared to the Liberty and Point Thomson projects, but may be evaluated for use in order to supplement and further inform interests as it relates to Public Health considerations made for ANWR 1002 assessments.

- **What are key information gaps?** A health baseline assessment focusing on potential health benefits and impacts from oil & gas exploration and development in the ANWR 1002 Coastal Plain does not exist. Multiple health baseline assessments are complete or in-process for oil & gas projects across the North Slope, which includes a demographic profile, baseline health assessment, subsistence activity profile, summary of harvest data, and potential mitigating factors, etc. as it relates to North Slope communities generally, and specific to Kaktovik. The outcomes and main findings from these recent Health Impact Assessments could help inform environmental assessments and information needs to address management

questions as they relate to Public Health considerations for future oil & gas exploration and development in the ANWR 1002 Coastal Plain.

- **What studies/surveys need to be conducted to fill those information gaps?** Additional health assessments, from what already exists, may not be necessary to evaluate potential health impacts from exploration activities (e.g., seismic). Some level of future Health Impact Assessment may be considered to help inform lease plan reviews and/or specific project proposals for future oil & gas development in the 1002 region.

  Project duration, timelines and costs cannot be determined without understanding the scope and phase (e.g., exploration, leasing, development, transportation, etc.) of the potential Health Baseline Assessment project.

REPORTING TEMPLATE

Discipline/Subject Area: Snow & Climate

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What do we need to know and why regarding subjects?

Development decisions that will be affected by snow/climate information include; seismic exploration*, water availability, and ice road construction*. To better inform decisions on these issues we will need to understand:

1. Snow Depth/Density/Distribution/Snow Water Equivalent to minimize the impacts on vegetation from tundra travel. **(short-term)**
2. Active Layer cycles/depths and their dependence on soil types to better plan routes of tundra travel. **(short-term)**
3. Late Season/ Fall Hydrologic Regimes and end of season snowpack to inform water availability for ice roads. **(intermediate/long-term)**

What information is currently available to address the information needs for subjects?

1. Snow Depth/Density/Distribution: Sporadic but little systematic survey effort. Early surveys were done related to seismic activity, snow cover and tundra damage.
    a. Felix & Raynolds 1989a
    b. Felix & Raynolds 1989b

   Snowfall measurements date back to 1949 on Barter Island but were taken out of service in 1989. New stations were started miles from that site in 1998 and several are currently active (GTN-P network) with data available in the 1002 area from 2001-2015.

   Over the last 5 years the Kuparuk Basin has been surveyed using structure from motion and some LiDAR which can provide ~0.1 m depth accuracy at 2 m spatial resolution. These data products can be produced very quickly after capture but are currently limited in spatial extent.

    c. Nolan et al. 2015

   Since 2002, high-resolution commercial imagery (e.g., WorldView 1-4; IKONOS) have been collected over the 1002. A recent search of the National Geospatial-Intelligence Agency (NGA) database revealed ~30k high-resolution images (1-3 m) available (no assessment of quality control or spectral bands). These images are available at no cost other than processing.

    d. Shean et al. 2016

2. Limited information (both spatially and temporally) is available to capture the variability inside the 1002.

a. There are 27 plots with thaw depth information spanning several periods between 1984-2009 collected by the refuge staff.
b. GTN-P stations (mentioned above) monitor freeze/thaw cycles.
c. There is a network of 20 sites (measurements at depths of 10cm, 20cm, 30cm) from the coast heading south (~110 miles) operated by DNR (Northern Oil & Gas Team) along the Dalton highway corridor. Length of season data have been collected since 1969 but modern data using these stations are available from 2003 (for tundra travel).
d. Soil survey data at 1:1 million scale is best available from STATSGO.

3. Depths, volume, and sensitive fish species of the 119 largest lakes in the area have been documented (Lyons and Trawicki 1994) but little is known about the watershed area of isolated lakes in this region and the potential for lakes to be recharged during snowmelt following water withdrawal. Although hydrologic studies have been conducted on three large rivers (Pearce et al. 2018) and seven smaller rivers and streams (Lyons & Trawicki 1992), late-season hydrologic regimes are rapidly changing. More information is needed to understand these changes will impact water availability and winter travel. Much of the information about larger climatological trends in and around the refuge is available in the CCP produced in 2015.

What are key information gaps?

1. Snow Cover and Composition across both local and regional gradients of coastal plain
    a. Basic Climatology (i.e., precipitation, wind, temperature)
    b. Remote-sensing information to capture snow depth (e.g., Structure from motion, LiDAR, high-resolution satellite imagery)
    c. Snow density (e.g., what condition does the snow need to be in to minimize impacts of tundra travel)
    d. Snow water equivalent
    e. How snow cover, depth, and wind operate in concert to produce conditions amenable to tundra travel.
2. Active Layer Information
    a. How long does the subsurface need to be frozen and at what temperature/depth? Currently DNR uses a rough standard where ground temps need to be approximately -5° at 30 cm depth. Typically BLM follows this standard.
    b. How do active layer dynamics change based on soil type?
3. End of season snowpack and changing hydrologic regimes in late season (Fall).
    a. How do current climate trends impact alluvial water availability for winter activity in 1002?
    b. How does end of season snowpack contribute to lake recharge potential and water deficit?
    c. How does groundwater connectivity contribute to lake recharge potential?

What studies/surveys need to be conducted to fill those information gaps?

1. A 2016 review of methods to quantify common snow parameters can be found here. A combination of in-situ measurements (e.g., SNOTEL site, weather stations spanning N-S gradient), ground surveys, and remote sensing information will need to be collected. Currently LiDAR and structure from motion (SFM) are promising technologies that could be expanded this winter (FY 18) with limited operations currently scheduled for April. In addition, SFM sensors could be mounted to FLIR aircraft for ~ $10,000 plus processing. Operating a SNOTEL site costs approximately $3,000/yr and approximately $24,000 – $30,000 for installation. Some of the

installation may be offset by NRCS. Long-term access costs will need to be addressed in advance of siting.

2. Active layer can be monitored via weather stations but will also need to be measured with ground surveys. Soil surveys will need to be produced at a finer spatial resolution than is currently available in order to capture some of the variability in the 1002.
3. Compared to Prudhoe Bay, Kuparuk, and the NPR-A, the 1002 area lacks surface water storage in lakes which provide the main water source for ice roads. Much of the water to support winter activity in the 1002 may need to come from isolated lakes, alluvial aquifers, and/or floodplain gravel pits. End of season snowpack surveys and watershed delineation will be important to understand lake recharge potential and water deficiency. Hydrologic monitoring will need to be implemented in selected river basins (e.g., Canning). In the longer term, there is potential to develop late season monitoring technology and methods in more accessible watersheds where stations are already in place and where there is a long-term record (e.g., Kaparuk) and this could be emphasized in 2018 field efforts.

* Relevant state land use regulation: Alaska Statutes (AS) 38.05.035(a)(2) & (7) - Tundra travel permits are authorized by AS 38.05.850.

REPORTING TEMPLATE

> **Discipline/Subject Area:** Subsistence Use

> **Lead facilitator:** Hollis Twitchell, Arctic Refuge Assistance Manager, hollis_twitchell@fws.gov, 907-456-0512

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> **What do we need to know and why regarding subjects?**

Subsistence Legal Mandates and International Agreements

- ANILCA Section 303(2)(B) sets forth the enabling purposes for Arctic National Wildlife Refuge, one of which is to: "(*iii)...*provide the opportunity for continued subsistence uses by local residents".

- Section 810(a) of ANILCA further states: "In determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands…the head of the Federal agency…over such lands…shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes. No such withdrawal, reservation, lease, permit, or other use, occupancy or disposition of such lands that would significantly restrict subsistence uses shall be affected until the head of such Federal agency…"

- The International Agreement for Conservation of the Porcupine Caribou Herd obligates the U.S. and Canadian governments to: "conserve the Porcupine Caribou Herd and its habitat through international co-operation and coordination so that the risk of irreversible damage or long-term adverse effects as a result of use of caribou or their habitat is minimized"; and "ensure opportunities for customary and traditional uses of the Porcupine Caribou Herd" by rural Alaska residents and members of Canadian First Nations.

Iñupiat subsistence users – Kaktovik Demographics

- Kaktovik located on Barter Island, is the only village within Arctic Refuge's the coastal plain and nearest to the 1002 area. It would be the community most significantly affected by oil and gas development. Kaktovik is an Iñupiat coastal community with a high dependence upon marine and inland resources for subsistence harvests. In order to consider effects, we need to know the nature, extent and locations of subsistence resources and the cultural and subsistence practices of local residents and evaluate these along with specific oil and gas exploration and operations proposals.

- In 2010, Kaktovik's population was 239 persons with early 90 % of the population being of Native Iñupiat decent (Alaska Census Data, 2010). Participation in subsistence activities by Kaktovik households is high with 95.7 % of households using subsistence resources (ADF&G 2010). The subsistence way of life encompasses much more than just a way of obtaining food or natural materials. It involves traditions, which are important mechanisms for maintaining cultural values, family traditions, kinships, and passing on those values to younger generations. It

involves the sharing of resources with others in need, showing respect for elders, maintaining a respectful relationship to the land, and conserving resources by harvesting only what is needed. Subsistence is regarded as a way of life, a way of being, rather than just an activity (Alaska Federation of Natives 2005).

Kaktovik's Resource Seasonality and Access

- The community's harvest of subsistence resources can fluctuate widely from year to year because of variable seasonal migration patterns of marine and land based mammals, fish and waterfowl. Subsistence harvesting techniques are extremely dependent on changing weather and surface conditions at sea and on land dramatically affecting ability to access resources. Determining when and where a subsistence resource will be harvested is a complex activity due to variations in seasonal distribution of animals, migration patterns, surface access conditions, severe weather events and often complex and changing hunting regulations. Human factors such as timing constraints (due to employment or other responsibilities), equipment (or lack thereof) to participate, and hunter preference (for one resource over another or for one sort of activity over another) are important components in determining the overall community pattern of subsistence resource harvest.

Kaktovik's Mixed Subsistence and Market Economies

- Modern mixed subsistence-market economies require cash income sufficient to allow for the purchase of this mechanical equipment (boats and motors and snow machines) as well as the operational supplies such as fuel, oil, maintenance parts and equipment, firearms, ammunition, nets and traps, etc. Subsistence is focused toward meeting the self-sustaining needs of families and small communities (ADF&G 2000). Participants in this mixed economy supplement their subsistence harvests by cash employment from construction jobs, oil and gas industry jobs, commercial fishing, Alaska Permanent Fund or Native Corporation dividends and/or wages from the public or government services sectors. In Kaktovik, major employers are the North Slope Borough, City of Kaktovik and the Kaktovik Iñupiat Corporation. There are also a few private sector jobs and business such as grocery stores, motels, air carrier services and recreational wildlife viewing and boat transportation providers. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987).

Kaktovik's Subsistence Uses and Conflicts with other Non-local Users

- Various members of the Kaktovik community and the Native Village of Kaktovik Tribal Council (NVK) have raised the issue of low flying planes and helicopters disturbing caribou on the coastal plain and disrupting local subsistence caribou and waterfowl hunters for many years. NVK states that low flying aircraft is causing the caribou to be displaced away from the coastal areas which they access to hunt in the summer and fall seasons. They attribute much of the low flying aircraft use to non-local caribou hunters and recreational scenic and wildlife viewing visitors. They have requested Arctic Refuge for a greater law enforcement presence to prevent this type of activity from harassing wildlife and causing the displacement of local subsistence resources away from the coastal plain areas they depend upon (Native Village of Kaktovik Tribal Council Meetings).

Kaktovik's Subsistence Uses and Oil and Gas Development Conflicts

- During the January 12, 2010, Public Scoping meeting in Kaktovik for the Point Thomson Project EIS, subsistence users of the community expressed significant concerns regarding impacts from development of facilities, pipelines, roads, aircraft and operations, which could displace caribou

and other important species away from coastal areas where subsistence harvesters could access them. In citing past history regarding the original Point Thomson drilling project they said there were many restrictions to subsistence hunting around the project area and they questioned how close subsistence hunters will be allowed to hunt near the drill pads, pipeline, and other facilities, and what new restrictions will be placed upon subsistence users with this new expanding Point Thomson development project (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Barging and fuel spills in marine waters continue to be a major concern as well as the proposed grounding of barges extending a significant distance from shore for lengthy periods of time. This they believe will affect movement of seals and various species of fish which migrate through the area. There are further concerns about the exploration, production and scale of development, and the cumulative impacts of future development over time from other off-shore and inland fields, resulting in an even larger scale of impacts upon their subsistence resources and subsistence use opportunities (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Subsistence users stated there needs for base line studies to determine what fish, waterfowl and marine mammals are in the area, their critical habitat and population levels. This is necessary in case of a major spill or disruptions of migration patterns and timing. They say baseline information is needed in case of a major oil spill and subsequent law suits, citing the case example of the Exxon Valdez oil spill (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- The issue of noise impacts to subsistence users was raised since Kaktovik people travel, camp and harvest in the 1002 area. Commenters stated that helicopter and aircraft traffic and roads and facilities on the ground would result in combined impacts likely to drive caribou and other wildlife further away from the coastal plain areas they hunt. Questions were raised on how much aircraft traffic and vehicle traffic on winter ice and gravel roads will occur and what times of the year (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Concerns were raised about air quality and environmental pollution caused by the burning (pilot purging and flaring) from oil and gas wells. Examples were given citing the black clouds and air pollution seen around the Prudhoe Bay oil fields. They say development of the Point Thomson oil and gas field will bring air pollution that much closure to the community of Kaktovik (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

- Concerns were expressed that the Point Thomson EIS project is looking only on the small scale, not the long term impacts of future field development and expansion. The project's cumulative impacts do not take into account future development of this field over time, or that of other off-shore and inland fields. The resulting larger scale impacts to resources and our subsistence opportunities are not being fully considered. For example they cite, Prudhoe Bay and all the other surrounding oil and gas field developments and their combined cumulative impacts upon subsistence opportunities (Point Thomson EIS Kaktovik Scoping Meeting, 2010).

Kaktovik's Subsistence Species Harvest Patterns

- Marine Mammals - In years when Kaktovik residents harvest and land a whale, marine resources have composed 59 to 68 % of their total subsistence harvest. Bowhead whaling occurs between late August and early October, with the exact timing depending on ice and weather conditions (Minerals Management Service 2003). There are at least 10 whaling crews in Kaktovik, and the community has a quota of three strikes (whether the animals are landed or not). Kaktovik has what is essentially an intercommunity agreement with Anaktuvuk Pass under which muktuk, whale meat and other marine mammal products (especially seal oil) are sent to Anaktuvuk Pass and Anaktuvuk Pass sends caribou and other land mammal products to Kaktovik (Bacon et al. 2009). Other marine mammal hunting (mainly seals) can take place year-round. Kaktovik

residents also harvest a significant number of bearded and smaller seals, and the occasional beluga whale or polar bear.

- Terrestrial Mammals - Land mammals are the next largest category of harvest, ranging from 17–30 percent in those same years. The primary land mammal resource is caribou, but Kaktovik residents also harvest a significant number of Dall's sheep. Of lesser abundance and availability are muskox, moose and grizzly bears. While Kaktovik hunters have taken moose and muskox, harvest opportunities are significantly restricted due to their low population numbers. Kaktovik's annual caribou harvest fluctuates widely because of the unpredictable movements of the herds, weather-dependent hunting technology, and ice conditions. Caribou hunting occurs throughout most of the year, with a peak in the summer when open water allows hunters to use boats to access coastal and lower coastal plain areas for caribou. In the winter with snow cover snowmachines are used to hunt inland coastal plain, foothills and the north slope drainages of the Brooks Range. Both the Porcupine and Central Arctic caribou herds are hunted when seasonally available. Dahl Sheep are hunted in winter when access by snowmachine is available.

- Fishery Resources - Fish comprise 8–13 % of the total subsistence harvests. Fish may be somewhat less subject to variable surface access conditions but still exhibit large year-to-year variations. In some winter months, fish may provide the only source of fresh subsistence foods. Kaktovik's harvest effort seems to be split between Dolly Varden and Arctic Cisco, with the summer fishery at sites near Kaktovik being more productive than winter fishing on the mid and lower reaches of the Hulahula River.

- Bird Resources - Birds and eggs harvest makes up 2–3 % of the total harvest. Since the mid-1960s, subsistence use of waterfowl and coastal birds has been growing at least in seasonal importance. Most birds are taken during the spring and fall migrations. Important subsistence species are black brant, long-tailed duck, eider, snow goose, Canada goose, and pintail duck. Waterfowl hunting occurs mostly in the spring from May to early July (Minerals Management Service 2003). Ptarmigan are also a seasonally important bird.

- Furbearer Resources - Trapping of furbearers in the Kaktovik area has decreased with time. Furbearers are taken in the winter when surface travel by snowmachine is possible. Hunters pursue wolf and wolverine by searching and harvesting them with rifles primarily between March and April or in conjunction with winter sheep hunting. Some hunters may go out in the fall or early winter, but usually weather and snow conditions are poor at that time and people are more concerned with meat than with fur.

Kaktovik's Subsistence Harvests Data

- Community subsistence harvest data for Kaktovik is dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADF&G). In 1995, the North Slope Borough (NSB) began to systematically collect subsistence harvest data for the eight villages in the Borough. However, the NSB was only able to collect subsistence harvest data for the village of Kaktovik in 1994-1995 and in 2002-2003.

- Subsistence harvest studies for Kaktovik in 1995 indicated that 61% of the subsistence harvest (in edible pounds of food) were from marine mammals, consisting of bowhead whales, bearded seals, ringed seals, spotted seals, polar bears, and beluga whales. Terrestrial mammals comprised another 26% of the estimated edible pounds harvested, consisting of caribou, Dall's sheep, muskox, moose, and brown bear. Fishery resources accounted for 11% of the estimated total edible pounds of harvest. Seven species of fish accounted for the 4426 fish harvested of which Arctic Cisco and Dolly Varden represented 4233 of the fish caught. The harvest of birds

accounted for the remaining 2% of edible pounds of subsistence harvest with 530 birds reported harvested (Brower et al 2000).

- In addition to the Beaufort Sea, Kaktovik residents have access to a number of rivers and lakes, which support significant subsistence fish resources. Pedersen and Linn (2005) conducted surveys of the Kaktovik subsistence fishery in 2000-2001 and 2001-2002, with estimated community harvests of fish at 5,970 pounds and 9,748 pounds, respectively. Dolly Varden, lake trout, and Arctic Cisco were the only fishery resources reported harvested by Kaktovik households in this study. Dolly Varden was the most commonly harvested fish in terms of numbers harvested and estimated harvest weight, with Arctic Cisco and lake trout ranking second and third (Pedersen and Linn, 2005).

Gwich'in Subsistence Users of interior Alaska and Canada

- Gwich'in people of northeastern Alaska and northwestern Canada have opposed drilling and development on the Refuge's coastal plain (1002 area) because its importance as a primary calving and post-calving habitat for the Porcupine Caribou Herd. These communities are heavily dependent upon subsistence uses of caribou from this herd even though they live a considerable distance from the Alaska's coast plain. Oil and gas development is seen as a threat to the safety or success of calving season and therefore, a potential impact to the health and population of the Porcupine Caribou herd to which they are dependent upon.

- Porcupine caribou are the primary subsistence resource of the Gwich'in people. In Alaska, Arctic Village and Venetie are located strategically along the herd's migration paths and they depend on the herd for their physical, cultural, social, economic and spiritual needs. In Arctic Village, caribou and moose constitute more than 90% of their subsistence harvest in weight in most years. And in Venetie, caribou constitute up to 71% of their subsistence harvest in some years (ADF&G Community Subsistence Information System).

- To the Gwich'in people the Refuge's coastal plain including the 1002 area where the Porcupine herd calves is considered a "sacred place where all life begins". Opening the 1002 area to oil and gas exploration and development threatens both the porcupine caribou and the Gwich'in way of life (Gwich'in Steering Committee, 2012).

- Any significant reduction or loss of the Porcupine Caribou Herd would have a substantial impact upon the Gwich'in communities. There is a need for an analysis of the economic value of caribou to subsistence users, and the potential economic impacts that might result if the herd is negatively affected by oil and gas exploration and development on the 1002 area.

> **What information is currently available to address the information needs for subjects?**

- Kaktovik's subsistence Use: The most recent and thorough publication regarding Kaktovik's subsistence and traditional land/marine water use patterns were prepared for the US Army Corps of Engineers Point Thomson Project EIS and published in July 2012. Appendix Q of the final EIS and Environmental Impact Statement contains the information on the "Subsistence and Traditional Land Use Patterns for Kaktovik and Nuiqsut" which was prepared by Stephen Braund and Associates at the request of HDR Alaska for the US Army Engineer District Alaska Regulatory Division.

- The Point Thomson Project is located adjacent to Arctic National Wildlife Refuge on coastal plain approximately 60 miles west of Kaktovik. In describing the affected environment for subsistence, the study team reviewed the Point Thomson Environmental Report (ER) (ExxonMobil 2009), as well as other sources of subsistence data including harvest amount data obtained from the

Alaska Department of Fish and Game (ADF&G) Division of Subsistence and North Slope Borough (NSB) Department of Wildlife Management subsistence publications. The ER included harvest data for the majority of available study years. Appendix Q includes additional harvest amount and harvest location data, including unpublished subsistence harvest data from the ADF&G Division of Subsistence and the NSB Department of Wildlife Management acquired in 2002 and unpublished subsistence harvest data acquired from the NSB in 2010. It incorporates additional data from previous Environmental Impact Statement (EIS) efforts, including issues raised during a Point Thomson EIS meeting on caribou in 2002 and subsistence use area data collected in Kaktovik in 2003. Finally, this affected environment incorporates 1995-2006 subsistence use areas collected during a Minerals Management Service (MMS) funded subsistence mapping project in Kaktovik and Nuiqsut (SRB&A 2010a).

- There is a significant lack of current and contemporary subsistence and harvest information for the villages of Arctic Village and Venetie. Ethnographic and socio-economic information is not available to assess subsistence uses and impacts to these communities if substantial declines to the Porcupine Caribou Herd occur as a result of oil and gas development and production.

Literature Review and Citations for the FWS Resource Assessment

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Bacon, J.J., T. R. Hepa, H. K. Brower, Jr., M. Pederson, T. P. Olemaun, J. C. George, and B. G. Corrigan. 2009. Estimates Of Subsistence Harvest For Villages On The North Slope Of Alaska, 1994-2003. North Slope Borough, Department of Wildlife Management. Barrow, Alaska.

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> **What are key information gaps?**

- Currently there is no complete synthesis of cultural work (subsistence, historical, and archaeological) that has been conducted in the Arctic Refuge as a whole or in particular for the northern half of the Refuge. A limited number of archeological and historical resource surveys have taken place on the Refuge due to funding, logistical difficulties of working in remote locations and lack of infrastructure to support investigations in the Refuge. A more through and complete synthesis of what work has been completed and in what areas would help identify informational gaps and help set priorities for future work.

- Community subsistence harvest data for Kaktovik is dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADF&G). In 1995, the North Slope Borough (NSB) began to systematically collect subsistence harvest data for the eight villages in the Borough. However, the NSB was only able to collect subsistence harvest data for the village of Kaktovik in 1994-1995 and in 2002-2003. There needs to be a more through and consistent collection of community subsistence harvest information.

- In 2010, Morgan Grover of the US Army Corps of Engineers conducted a survey of 70 known cultural sites along the coastal areas from Flaxman Island to the Canadian border (including the 1002 area) to examine the effects of environmental changes and erosion has had on these sites over the past 30 years. The study concluded that of the 69 previously reported cultural sites, 21 were found to be impacted to some extent by erosion or thermokarsting, and 20 had been completely eroded away. She concludes that many of the remaining cultural sites are in imminent threat of eroding in the next decade. Follow-up studies and research is needed to recover cultural information before it is lost to erosion. The report strongly recommended that selected threatened sites be documented and potentially excavated after consultation and agreement with Tribal leaders.

- In 1982, Ed Hall conducted an inventory and survey of archaeological and historical resources in the 1002 area examining areas of high archaeological and historical potential. The areas surveyed were focused on areas proposed for exploratory drilling for oil and gas and areas more likely to have cultural sites such as coastal areas and barrier islands, and along rivers and streams that crossed the 1002 area, and high points of land that have overlooks above the surrounding tundra. There is a need to reassess these areas since visitors and users have reported several graves, human remains and artifacts in these areas that have not been documented and record by professional cultural resource staff.
- The Porcupine Caribou Herd is of great importance as a major subsistence resource for both the Iñupiat and Gwich'in users in Alaska. Impacts to this herd could have significant ramifications on their traditional way of life and economics. There is a need for an analysis of the economic value of caribou to subsistence users, and the potential economic impacts that might result if the herd is negatively affected by oil and gas exploration and development on the 1002 area.

> **What studies/surveys need to be conducted to fill those information gaps?**

- Hire one Archeologist/Anthropologist GS-11/12: USFWS should hire an archeologist or anthropologist to oversee the agency's cultural resource management/compliance programs during the seismic, exploration and production phases of the oil and gas development associated with the 1002 area of the coastal plain.

- Manage Subsistence Use Data: Compile a complete synthesis of archaeological, ethnographic and subsistence work that has been completed for Arctic Refuge's north slope and 1002 areas and create a functional repository of existing contemporary and historical data. Multiple sources of published and unpublished subsistence use and harvest data reside with various agencies, organizations, tribal governments, and universities.

- Identify gaps in data: A comprehensive review of existing information is needed to identify gaps in the data and to identify priorities for future subsistence research and monitoring. This information is needed to ensure traditional subsistence use and knowledge is thoroughly and accurately considered in Federal and State proposals for subsistence regulations, as well as Refuge management actions including oil and gas development in the 1002 area.

- Establish a Subsistence Harvest Monitoring Program: A NSB/Kaktovik community supported harvest monitoring program with implementation protocols based on timely and accurate harvest information is needed to ensure long-term conservation of subsistence species of fish and wildlife and subsistence uses for qualified subsistence users. The majority of the ethnographic and subsistence data for Kaktovik and the 1002 area was collected in the 1980s and may not accurately portray current patterns in subsistence use, demographics, harvest amounts, hunting seasons, locations, or community needs.

- Conduct Oral Histories and Traditional Knowledge Study: Much valuable cultural, historic, and traditional ecological knowledge about the Refuge and the coastal plain (1002 area) is possessed by local elders. Oral histories and place names contain an enormous amount of information on traditional uses, culturally important places, historic camps and settlements, and other natural and cultural information. This information is an untapped archive that could potentially benefit historical site protection and guide management decisions setting priorities for surveys and research in the 1002 area.

- Need for an analysis of the economic value of caribou to subsistence users, and the potential economic impacts that might result if the herd is negatively affected by oil and gas exploration and development on the 1002 area.

1002 Vegetation, soils, permafrost, and wetland Resource Assessment, February 16, 2018

- Discipline/Subject Area. Vegetation, soils, permafrost, and wetlands

- Lead facilitator.

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- **What do we need to know and why regarding subjects?**

  1) We need distribution maps of vegetation and wetland types, plant growth forms, soil types, near-surface ground ice, snow regime and soil depth above permafrost across the 1002 area. We also need descriptions of these types and information on relationships between them, snow patterns and human or natural disturbance. The region is particularly sensitive to surface disturbance due to the relationships between vegetation, soil water content, soil type, and permafrost. To minimize the impact of development activities and to facilitate restoration land managers will require an accurate map of sensitive habitats. In the near term this is needed to design stipulations for a seismic program that minimizes persistent damage by routing vehicles over less sensitive areas and requiring adequate snow cover and soil conditions.
  2) Impacts to be expected from three phases of oil exploration and development, and mitigation measures for each. A) Impacts if seismic exploration is done in 1002 area using current technology (eg overland vehicle travel). B) Impacts from exploratory well phase (eg temporary well pads, ice roads, overland vehicle travel). C) Impacts from production phase (eg gravel roads and pads, infrastructure). For each, we need information on short and long term impacts likely to plants, soils, permafrost and wetlands, including information for different vegetation communities, species, soil types and soil moisture conditions and for overland travel by different types of vehicles under different snow conditions. This information is needed to manage new seismic

exploration in the 1002 area and subsequent development and to design appropriate stipulations and mitigation measures.

- **What information is currently available to address the information needs for subjects?**

For 1 (above):

Classification and description of natural vegetation, soils, permafrost and wetlands of 1002 area and of the North Slope in general: Vegetation types are determined by many factors including soil texture, moisture, age and chemistry, soil depth above permafrost, slope, snow depth in winter and climate effects of distance from the coast. Vegetation is dominated by shrubs and sedges, mainly less than 2 feet tall, with a moss ground cover. Vegetation cover is nearly 100% except on floodplains. Most of the area is classified as wetlands because permafrost is near the surface and hinders soil drainage. Thaw of soil in summer is hindered by an insulating blanket of thick layers of organic soils and moss. Less than 3 feet thaws down from the surface in summer and often only ~1 foot. Large amounts of soil ice accumulate in the near-surface permafrost (often 20 – 60% of soil volume) and ice is subject to thaw if the organic layer is damaged leading to surface subsidence. About half of the 1002 area has a honeycomb-pattern surface microtopography ("polygon tundra") caused by uneven distribution of ice in the near-surface permafrost, which shows it is prone to subsidence if disturbed. The Arctic NWR 2015 Comprehensive Conservation Plan synthesizes much of the available information on these topics.

U.S. Fish and Wildlife Service. (2015). Arctic National Wildlife Refuge comprehensive conservation plan. U.S. Fish and Wildlife Service, Region 7. https://www.fws.gov/home/arcticccp/.

Maps of natural vegetation, soils, permafrost and wetlands of 1002 area:

While there is much information available for the North Slope on these topics, the tight relationships between them and their susceptibility to disturbance, there are no accurate maps of them for the 1002 area.

Vegetation Maps:

Two state-wide vegetation maps exist (NLCD and Landfire) but the scale of mapping and accuracy are inadequate for planning purposes. Ducks Unlimited produced a map of the North Slope on contract for the North Slope Science Initiative in ~2015, but used existing maps where available; maps from 1994 and 1984 were used for the Arctic Refuge portion. No new imagery classification was done for the 1002 area.

The most detailed vegetation map of the 1002 area is from 1994.

Jorgenson, J.C., Joria, P.E., McCabe, T.R., Reitz, B.E., Raynolds, M.K., Emers, M., & Wilms, M.A.(1994). User's guide forthe land-cover map of the coastal plain of the Arctic National Wildlife Refuge. In (p. 46). Anchorage, AK: U. S. Fish and Wildlife Service.

Wetlands Maps:

The National Wetland Inventory (NWI) is the only avaiable wetland map. The scale and accuracy are inadequate for planning purposes.

U. S. Fish and Wildlife Service. May 2014. National Wetlands Inventory website. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. http://www.fws.gov/wetlands/

Soils Maps:

Two general soils maps exist for the 1002 area, STATSGO2 and the Ecological Landscape Map of Northern Alaska. Both are at 1: 1M scale and are inadequate for finer scale planning purposes.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. U.S. General Soil Map (STATSGO2). Available online.

Permafrost Maps:

Jorgenson, M. T., M. Kanevskiy, Y. Shur, J. Grunblatt, C. L. Ping, and others. 2015. Permafrost database development, characterization, and mapping for northern Alaska. Report for Arctic Landscape Conservation Cooperative by Alaska Ecoscience and University of Alaska Fairbanks. 46 p.

Topographic Maps:

A new digital elevation model is available, from which topography information can be derived. Terrain of the 1002 area is hillier than the parts of the North Slope that have had oil development thus far and has higher elevations and more sloped terrain.

For seismic exploration, 2-A (above):

Information on vegetation, soils, permafrost or wetlands impacts and recovery from vehicle traffic during seismic programs between 1984 and 2001:

Three studies of vegetation and soils impacts from seismic exploration conducted before 2002 generally had similar results showing that overall, vegetation impacts did occur on over half of the trail length but were generally low and mostly recovered in the first decade. Trail visibility was rated separately and usually recovered over the first few years. The studies showed that

some vegetation types were more impacted than others and recovered more slowly, including drier soil conditions more than wetter and shrubby types more than sedge types. All three documented more damage and less recovery on camp move trails than on seismic lines. Two studies tracked recovery for at least 15 years, showing that 10 – 20% of the camp move trails were still disturbed 15 years after exploration. This was sometimes due to ground subsidence that caused the trail to become a wetter trough. Higher damage on camp trails was attributed to the use of higher ground pressure vehicles and the sheering action of camp trailers on skis pulled across the tundra by tractors. Management implications and mitigation measures were discussed.

The study of 1980s seismic trails in the Arctic Refuge also highlights the need to monitor disturbed areas for at least five years afterward exploration. Depth to permafrost, trail subsidence and plant community dissimilarity measures increased gradually on trails over the first four years after exploration.

Jorgenson, J.C., Hoef, J.M.V., & Jorgenson, M.T. (2010). Long-term recovery patterns of arctic tundra after winter seismic exploration. *Ecological Applications, 20*, 205-221

Jorgenson, M. T., J. E. Roth, T. C. Cater, S. Schlentner, M. E. Emers, and others. (2003). Ecological impacts associated with seismic exploration on the central arctic coastal plain. Final Report for ConocoPhillips Alaska, Inc., Anchorage, AK, by ABR, Inc., Fairbanks, AK, 76 p.

Yokel, D., and J. M. Ver Hoef. (2014). Impacts to, and recovery of, tundra vegetation from winter seismic exploration and ice road construction. (2014). BLM Arctic District, Fairbanks, AK, 61 p.

Information on vegetation, soils and permafrost impacts from Alaska DNR tundra travel modeling study 2003 - 2004:

This study developed a model to predict impacts of winter vehicle travel under different snow/freeze conditions and in different types of vegetation, in order to develop objective and easily measurable criteria for opening the tundra travel season. They tested different vehicle types on tundra in winter and the following summer recorded variation in soil temperature, soil depth to permafrost and photosynthetically active radiation absorption on the resulting tracks and control plots. Changes to these variables were minor, but did vary by vegetation types and did decrease as winter progressed. In the subsequent validation study they tested a disturbance ranking system more similar to those used in the three studies cited above. This showed that vegetation damage and surface depression did occur during the early winter dates tested and decreased greatly at later dates, related to greater snow density and deeper soil freeze. It also showed more impacts from vehicles with greater pounds per square inch.

Bader, H. R., and Guimond, J. (2004). Tundra Travel Modeling Project. Alaska Dept. of Natural Resources, Division of Mining, Land and Water. 65 p.

Bader, H. R. (2005). Tundra Travel Modeling Project: validation study and research recommendations. Alaska Dept. of Natural Resources, Division of Mining, Land and Water. 20 p.

Information on vegetation, soils, permafrost or wetlands impacts and recovery from seismic programs conducted in Alaska in the past 15 years (2002 to present):

No published papers and no in-house reports found yet, either from state or federal lands.

For 2-B and 2-C (above):

Known issues with infrastructure in the production phase include habitat loss from gravel pads and roads, habitat fragmentation due to long linear structures (roads), alteration of surface hydrology, thawing of permafrost and ground ice, introduction of non-native species and road dust effects on plants. Summaries are given in these documents.

National Research Council. (2003). *Cumulative environmental effects of oil and gas activities on Alaska's North Slope*. National Academies Press.

Raynolds, M. K., Walker, D. A., Ambrosius, K. J., Brown, J., Everett, K. R., Kanevskiy, M., ... & Webber, P. J. (2014). Cumulative geoecological effects of 62 years of infrastructure and climate change in ice-rich permafrost landscapes, Prudhoe Bay Oilfield, Alaska. *Global change biology*, *20*(4), 1211-1224.

- **What are key information gaps?**

For 1)

Vegetation maps: There is a great deal of descriptive information on vegetation and its relation to physical factors but no detailed high-accuracy map exists. The 1994 map of 1002 area had a measured accuracy of 52% for 18 vegetation classes. The age and low accuracy make this map inadequate for planning of industrial operations or stipulations on vehicle routing.

Soils, permafrost and wetlands maps: To date data have been collected to increase our knowledge of general landscape processes at a broad scale. These data do not meet the accuracy or resolution required to develop infrastructure or manage this remote landscape in conjunction with industrial use. No detailed high-accuracy maps exist for soils, permafrost or wetlands. Maps have been developed from limited or old data with little field validation and at scales lacking enough detail to effectively facilitate exploration, development, and restoration.

More information is needed on the seasonal soil freeze/thaw and snow pack/melt cycles in the 1002 area to determine stipulations for opening and closing the tundra travel season.

For 2-A) To predict and manage impacts from new seismic exploration in the 1002 area and design appropriate stipulations and mitigation measures, we need to know how impacts would be different from the substantial impacts documented in papers and reports about seismic

programs conducted on the North Slope between 1984 and 2001. Current NEPA documents for seismic programs state that impacts will be negligible due to improvements in technology, much less than those documented earlier, but we have found no follow-up studies or data to be able to evaluate this. We particularly need information from current or recent exploration in hillier terrain since those areas are more similar to terrain in the 1002 area.

For 2-B & C) Development beyond the seismic exploration stage in 1002 area would probably follow the trajectory of the Alpine Field or another newer field, rather than the older Prudhoe Bay field. We need information on the history and current status of these fields.

- **What studies/surveys need to be conducted to fill those information gaps?**

For 1) A database of geographic information for the 1002 area is needed. Layers would include:

New vegetation map.

Updated wetlands map

Soils map with field validation at a 1:63,000 scale

Map of permafrost characteristics and depth of soil active layer

Topography from most recent DEM

Terrain sensitivity map, modeled using the above layers

Cost estimate $1,500,000 – $3,000,000. Field validation for vegetation, soils, permafrost and wetlands could occur at the same time.

For 2-A) Studies of impacts and recovery from seismic exploration currently occurring on North Slope are needed. Do a literature search for draft or in-house documents regarding any follow-up done after seismic exploration conducted on the North Slope in the past 15 years. Information about exploration in hillier terrain would be most useful. Cost estimate: staff time only, but requires work by staff from multiple agencies.

For 2-B & C) Summary of history and current status of Alpine oil field or other newer oil fields on North Slope. Cost estimate: staff time only, but requires work by staff from multiple agencies.

Arctic Refuge 1002 Visitor Use Technical Report

Discipline/Subject Area: Visitor Use

Lead facilitators: Jennifer Reed, Arctic Refuge (907) 455-1835; and Tracy Fischbach, FWS RO Refuges (907) 786-3369

Individuals contacted: Roger Kaye, Wilderness Discipline/Subject Area Lead; Hollis Twitchell, Subsistence Use Discipline/Subject Area Lead; Steve Berendzen, Arctic Refuge Manager; Tom Bickauskus, BLM State Lead for Recreation, NLCS, NHST and W&SR

What do we need to know and why regarding subjects?

Definition of "Visitor": The term "visitor" includes any non-local person who takes part in recreation activities on the Refuge.

What and Why: Understanding current characteristics of visitor use (amount, type, timing, and distribution of visitor activities and behaviors), and visitor experiences (perceptions, feelings, and reactions that a visitor has before, during, and after a visit to an area) is essential to evaluating, and possibly minimizing, the effects of oil and gas development and infrastructure upon visitors, and commercial operators that support those visitors. However, because management of the Arctic Refuge has not required visitor registration or field contacts, information about what, where, and how visitor activities occur is limited.

Effects of highest concern on visitor opportunities and experiences include:

- Changes in opportunities for immersion in the area's wild character; its freedom from the human intent to control, alter, or manipulate its components and ecological and evolutionary processes.
- Changes to desirability of the destination (visitor displacement resulting from new user types; and/or increased visitation by new user types).
- Changes to the timing or availability of access for recreation (both consumptive and non-consumptive uses).
- Changes to the distribution of visitors, possibly leading to crowding.
- The emergence of new behaviors, modes of travel, or activity types, possibly leading to social conflicts.
- Reduced scenic opportunities due to changes to apparent naturalness by the addition of man-made structures.
- Reduced auditory quality due to addition of man-made noise to the natural soundscape.
- Reduced quality of night sky visibility due to atmospheric light pollution.
- Reduced opportunity for solitude. Solitude coincides with the Refuge CCP where it is defined as being free of the reminders of society, its inventions, and conventions. Solitude is greater than just being isolated from other people.

- Reduced opportunities for immersion in undeveloped area void of permanent structures or modern human occupation. Changes to levels of visitor satisfaction resulting from changes in overall quality of recreational opportunities.
- Changes to the quality of visitor experience could affect demand for commercial services among the majority of guide and air transporting businesses.
- Changes to the frequency of commercially-supported services may further limit managers' capacity to deliver quality visitor opportunities, since managers rely heavily upon the interests of commercial service providers to act as our eyes, ears, and workforce to deliver services.

What information is currently available to address the information needs for subjects?

Known Access Points/Routes used for Primitive/Unconfined Recreation: There are multiple areas and/or routes of known historic interest and sensitivity to visitors of the Coastal Plain:

- The historic caribou calving ground areas in May and June;
- Known caribou migration viewing areas allowing reasonable access in June and July including the following unimproved landing areas: Jago Bitty, Lower Marsh Creek, Lower Canning River; Kataktuiruk River, Aichilik River;
- Known abundant and diverse bird sighting areas include the Kaktaktuiruk River and Canning River delta June-July;
- Routes from the Neruokpuk Lakes Complex through the Arctic Coastal Plain from March until September (includes spring ski touring);
- The route stemming from the Sadlerochit Mountains along the Kataktuiruk River to Brown Low Point
- Canning River due to its non-technical rating and floatability all summer June until September (flow); whereas the Hulahula and Kongakut are experiencing lower water levels than historically seen (Hulahula receives high winds all winter and is a "scour point" so lower water and less floatable than past);
- Coastal lagoons between Hulahula River and Kongakut River, providing paddling access to Kaktovik during open water, from June through October; and,
- Coastal Lagoons which are Marine Protected Areas in the fall from July until freeze-up (recently mid-late October) for polar bear viewing.
- Packrafting routes including Upper Marsh Fork to Kaktovik; Arctic Village to Kaktovik; Neruokpuk Lakes Complex to Kaktovik; and Turner River to Kaktovik, with resupplies at major river crossings.

Two known reports on Visitor Use:

Arctic Refuge. 2011. Arctic National Wildlife Refuge Public Use Summary

This report, based on available indirect visitor data obtained through commercial client use reporting, and analyzed through 2009, provides a summary of historic visitor use information compiled for the area now designated within the Arctic National Wildlife Refuge boundary (up to 1997); depicts a general index of recent visitor use patterns (1998-2009) based upon available data; summarizes available harvest data for general hunting and trapping through 2009; and discusses current trends in public use with implications for future management practices.

Christensen N. and L. Christensen. 2009. Arctic National Wildlife Refuge Visitor Study: the characteristics, experiences and preferences of Refuge visitors
This report summarizes data directly collected from visitors and shows that:

- The greatest positive influence on visits came from experiencing the components of "Wilderness" (92%), "A Sense of Vastness" (92%), "Remoteness and Isolation" (89%), "A Sense of Adventure" (84%), and 'Natural Conditions" (84%).
- Refuge purposes most frequently rated as "Very Important" were "Wildlife"(97%), "Wilderness"(96%), "A bequest to future generations"(89%), "Remoteness and isolation"(89%), and 'A place where natural processes continue"(86%).
- Respondents encountered an average of two other groups on their trip, saw or heard four airplanes, and saw an average of one site with evidence of previous visitor use.

What are key information gaps?

- Baseline information on most of the concerns listed above as "Effects of highest concern on use opportunities and experiences."
- River floating, one of the main river activities, requires adequate flow. There is limited information about the Refuge's most-visited rivers.
- Fishing is a secondary activity enjoyed by many visitors who float the Refuge's rivers; the extent, to which fishing on the Canning and Hulahula Rivers occurs, among other Coastal Plain destinations, is unknown.
- There is no information about the number of people who visit the Refuge without using commercial services or about what activities they participate in.
- Client Use Reporting (CUR) by commercial air transporters does not provide consistent data about transported visitors' specific access areas and no data is requested for egress areas; therefore, there is no trip length data available from reports. CUR also does not include visitor's primary activity.

What studies/surveys need to be conducted to fill those information gaps? Please include duration (start and end), staffing and cost estimates.
<u>Ongoing efforts that could be focused or modified to meet needs:</u>

- Evaluate existing OMB-approved FWS visitor surveys for generalized information about Alaska Region's visitation patterns and preferences (duration: XX; lead: Natalie Sexton/Debbie Steen?; cost: XX).
- Re-evaluate 2009 visitor survey data held by Neal Christensen, to identify any possible additional information about experience condition expectations of visitors, specific to the Coastal Plain (duration: 3 months after contracted; lead: Jen Reed?; cost estimate: $10K?)
- Repeat/focus Arctic Refuge Visitor Survey to obtain current data about expectations of visitors, specific to the Coastal Plain (warning: dependent upon OMB approval) (duration: lead: XX, cost estimate: XX).
- Evaluate Refuge's raw 2010-2011 Client Use Report (CUR) data, consistent with previous data, to identify additional information specific to the Coastal Plain; and of Refuge's limited 2012-2017 CUR data (reporting requirements inconsistent with previous

data). (duration of effort: 6 months; lead: Reed; cost estimate: $3K for contracted database support).

<u>New efforts that are short-term priorities, since baseline data currently does not exist:</u>

- River flow data (duration: XX, lead: XX, cost estimate: XX).
- Viewscape baseline study (including visible pollution plume resulting from air quality affecting viewscape) to document visual resource conditions and potential future changes to existing undeveloped viewshed (duration of sampling: March-Oct, lead: XX, cost estimate: XX).
- Soundscape baseline study to document auditory resource conditions and potential future changes to existing natural sound environment (duration of sampling: March-Oct, lead: XX, cost estimate: XX).
- Night sky baseline study to document auroral, stargazing, and other astronomical resource conditions and potential future changes to existing night sky opportunities (duration of sampling: March-Oct, lead: XX, cost estimate: XX).

What management actions could be conducted to fill some information gaps?

- Require air transporters to obtain primary visitor activity by unguided but transported (plane or motorboat) visitors.
- Require primary access locations to be reported as lat/long.
- Develop a voluntary registration system for non-guided, non-commercially transported visitors.

Water Resources

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Alan Peck; Soil, Water, & Air Program Lead; Bureau of Land Management, State Office, KPeck@BLM.gov, 907-271-4411 **What do we need to know and why?**

The Alaska National Interest Lands Conservation Act (ANILCA) explicitly directs the U.S. Fish and Wildlife Service to ensure water quality and quantity for the conservation of the natural diversity of fish, wildlife and their habitats:

(i) to conserve fish and wildlife populations and habitats in their natural diversity……

(iv) to ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in paragraph (i), water quality and necessary water quantity within the refuge.

Winter seismic and other oil exploration activity will involve temporary infrastructure and withdrawals of large volumes of water that could have substantial short-term or long-term impacts to hydrology, water quality, fish and wildlife populations, and habitats. Development and production will involve even larger water withdrawals, gravel extraction from floodplains for permanent infrastructure, and generation and storage of hazardous wastes. These practices will result in increased potential for contamination, alteration of surface and groundwater hydrology, and additional impacts to fish and wildlife habitat.

To ensure legal mandates are met during exploration and development and allow for science-informed impact assessments, NEPA processes, best management practices (BMPs), and permit stipulations the following information is necessary:

- Identification of high-value and vulnerable aquatic habitats and critical hydrologic processes by season to ensure sufficient water is available to meet refuge mandates.
- Evaluation of the efficacy, applicability and transferability of BMPs, permit stipulations and mitigation measures used in the NPR-A for use on the coastal plain, 1002 area (per National Research Council (NRC) 2003) for all phases of industrial activity (seismic, exploration, development, restoration). This evaluation must recognize and understand the implications of the stark hydrologic and topographic differences between the coastal plain, 1002 area and areas with ongoing development:
    - Water covers 20.2% of the developed area in NPR-A, but only 1.6% of the coastal plain, 1002 area where large expanses of land are nearly devoid of lakes (figure 1).
    - Most lakes in the coastal plain, 1002 area are isolated from major drainages with limited recharge and may be more vulnerable to water withdrawals.

- Most flowing waters in the coastal plain, 1002 area are alluvial mountain streams.
- Groundwater-fed springs are unique to the coastal plain, 1002 area and provide critical habitat for extraordinarily high concentrations of invertebrates and overwintering fish.
- The relatively steep terrain and lack of water in the coastal plain, 1002 area will make it necessary to employ alternative untested practices.

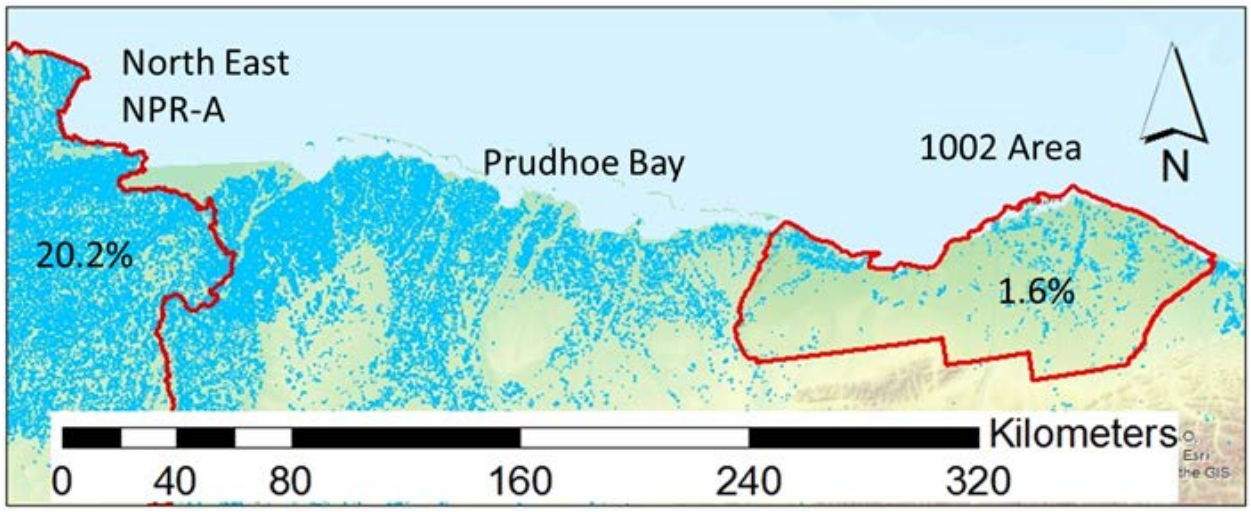

Figure 1. Surface water extent in the coastal plain, 1002 area and north eastern NPR-A planning area.

What information is currently available to address the information needs?
Most water resource studies were conducted nearly thirty years ago and include the following:

Rivers:

- Continuous hydrologic monitoring: five-plus years for three large rivers (USGS 2018) and four-plus years for seven smaller rivers during the open water season (Lyons and Trawicki 1994). The longest and only ongoing monitoring is on the glacier-fed Hulahula River (2011-2018).
- Quantity of liquid under ice hummocks in large rivers during winter (Lyons and Trawicki 1994)
- Limited water quality and channel geometry: Single sampling event for a limited suite of parameters on 11 streams and rivers (Childers et al. 1977)
- Documentation of fish: Sensitive species have been documented in all major rivers
- Groundwater springs: Reconnaissance inventory of spring locations with limited data on hydrology, macroinvertebrates, chemistry and aufeis extent (Childers et al. 1977)

Lakes:

- Water quantity (one-time sampling events):
  - Bathymetry and winter water availability of 115 of the largest lakes (Trawicki et al. 1991)
  - Elevation of lakes and marginal wetlands of 150 of the largest lakes (Bayhas 1996)
- Water quality: Summer sampling of 36 small lakes (Synder-Conn and Lubinski 1995), late fall sampling of 7 large lakes, and late winter sampling of one large lake (Childers et al. 1977).
- Fish:
  - Reconnaissance surveys targeting nine spine stickleback identified stickleback in 34 of 52 lakes surveyed (Trawicki et al 1991). More intensive surveys of 22 lakes documented nine spine stickleback in 10 lakes and more sensitive species in 6 lakes (Wiswar and others).

A Remote sensing inventory identified lakes of sufficient depth to support overwintering fish (Grunblatt and Atwood 2014).

What are key information gaps?

Seismic and exploration will involve water withdrawals and temporary infrastructure. Prior to activities, the following questions need to be answered to allow for science-informed decisions:

- How effective are existing BMPs and mitigation measures used in the NPR-A at ensuring protection of habitat? Will they ensure protection of habitat in the coastal plain, 1002 area? According to the NRC (2003), these questions have not been answered.
- What habitats or areas need additional protection due to their vulnerability and/or high-value to fish, waterbirds, other wildlife, recreation, and subsistence?
- What is the status and natural variability in water quality and quantity of rivers and lakes? This information is necessary to allow for impact assessments and adaptive management practices.

During development, production and restoration phases, water use, alteration of surface and ground water hydrology and potential for contamination will increase. Prior to water withdrawals, drilling, leasing, gravel extraction, permanent infrastructure, injection of hazardous waste, and restoration the following questions need to be answered to allow for science-informed decisions:

- What BMPs, mitigation measures, and restoration standards will ensure protection of habitat from impacts of development in the coastal plain, 1002 area where there are considerable differences in hydrology, terrain, and management purposes compared to the NPR-A?
- How important are springs and associated aufeis and ice-dam flooding events in supporting fish and wildlife habitat and river recharge?

What studies/surveys need to be conducted to fill those information gaps?

Rivers and groundwater springs (figure 2):

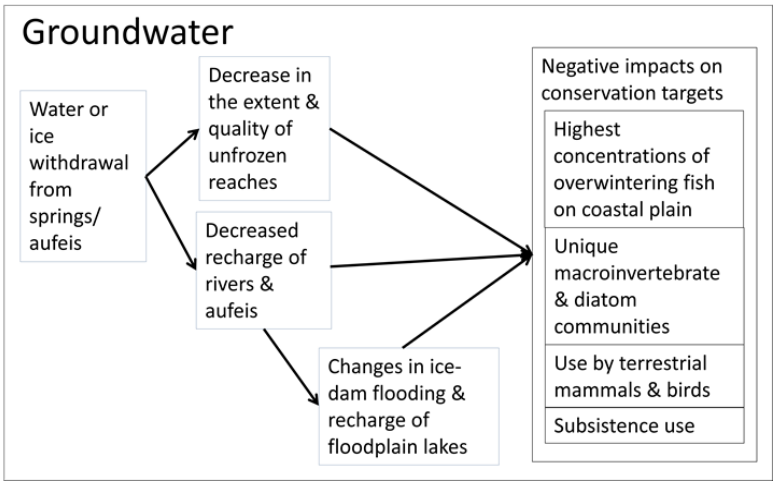

Figure 2. Adverse impacts of groundwater/ice withdrawals on fish, wildlife and subsistence.

Near-term and medium-term (starting FY18):

- Characterize seasonality in water quantity and quality to allow for science-informed NEPA processes and development of BMPs and permitting stipulations that ensure protection of fish and wildlife habitat and account for cumulative impacts of climate change. Conduct continuous water quality and quantity monitoring on the Hulahula, Tamayariak, and Canning rivers to evaluate the current status and natural variability in late fall and spring surface water quality

and quantity in relation to the timing of fish use and industrial activity (August 2018-2030: $175,000 per year, potential leads USGS, USFWS, BLM).

- Identify the extent and value of groundwater to delineate special areas and support science-informed NEPA processes, BMPs, and decisions regarding hazardous waste disposal that ensure protection of fish and wildlife and habitat:
    - Evaluate groundwater flow paths and recharge -- Develop a conceptual groundwater model informed by isotopic studies to delineate and age flow paths. Quantify river recharge rates to inform water withdrawal permits in areas that are primarily recharged from groundwater. (FY18-20 total cost: $$, potential leads: USGS and USFWS).
    - Identify open-water areas and aufeis-associated fish habitat and evaluate terrestrial mammal use of aufeis, aufeis contributions to late summer flows, and the importance of aufeis and ice-dam flooding in recharging fish and wildlife habitat in the Canning, Hulahula, Itkilyariak, Katakturak, and Sadlerochit river drainages (FY18/19 costs: $, USFWS and USGS).

Medium-term (starting FY19): seismic, development, production and restoration phases

- Evaluate efficacy of current practices and applicability to the coastal plain, 1002 area to support science-informed NEPA processes, BMPs, and restoration plans that ensure protection of fish and wildlife. Considerations must include effects on sheet flow, ice-dam flooding, and recharge of floodplains and differences between the coastal plain, 1002 area and the NPR-A.
    - Identify and conduct studies to minimize impacts of gravel extraction and infrastructure
    - Identify and conduct studies to ensure adequate restoration

Lakes (figure 3):

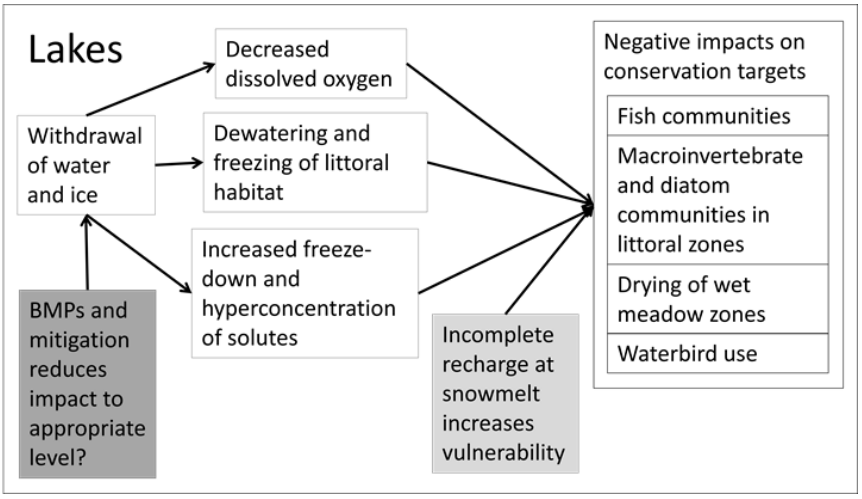

Figure 3. Adverse impacts of lake water and ice withdrawals on fish, wildlife and habitats.

Near to medium-term:

- Identify high-value and/or vulnerable lakes and characterize seasonality in water quantity and quality to allow for science-informed NEPA processes and development of BMPs and effectiveness monitoring protocols that ensure protection of fish and wildlife habitat with a known level of confidence (FY18-22 cost: $$, leads: USFWS, USGS, BLM).
    - Fish surveys have only been conducted in 2.3% of lakes in the 1002 area and most surveys were brief reconnaissance surveys only targeting nine spine stickleback. Fish distribution models and sample collection protocols have been developed for other

areas on the North Slope, but their applicability to the 1002 area is unknown. Macroinvertebrate diversity is an indicator of ecosystem health and has never been assessed in 1002 area. Baseline contaminants surveys of fish have only been conducted at a small handful of sites. To identify high-value aquatic habitats, inform planning, and provide baseline samples there is a need to document fish presence; test the applicability of existing fish survey protocols and distribution models, and collect baseline macroinvertebrate, fish e-DNA, and fish tissue samples to archive for future analysis (for more information, see resource assessment for contaminants). Results would include the following: traditional fish surveys in up to 60 lakes, validation of protocols and fish distribution models for applicability in the 1002 area, baseline macroinvertebrate and fish contaminant samples collected in up to 60 high-priority lakes, and e-DNA samples available to test for fish presence in up to 200 lakes. Refuge staff and two arctic fisheries biologists can conduct this field work in FY18. (FY 18 cost: $76,150, FY19 cost: $82,000, Lead: Greta Burkart, John Trawicki, Phaedra Budy, Angela Matz, Sandy Talbot, Damian Menning, and Robert Gerlach) Develop geospatial inventory of hydrologic connectivity, watershed areas and relative snowpack to assess lake vulnerability/recharge potential (FY18-20, leads: USGS, USFWS). Integrate this effort with surveys of snow pack (see resource assessment for snow and climate) and updates of the national wetland inventory updates (see resource assessment for wetlands) and national hydrography dataset.

    - Continuous water level and winter water quality monitoring on representative lakes to evaluate current status and natural variability relative to timing of potential impacts of industrial activities and use by fish and wildlife (FY18-22, leads: USFWS, USGS, BLM).
- Evaluate efficacy of current practices and applicability to coastal plain, 1002 area to support science-informed NEPA processes and BMPs that ensure protection of fish and wildlife.
    - Assessments of the adverse impacts of water withdrawal on lake biota in the NPR-A are necessary to assess the efficacy of existing BMPs (per National Research Council 2003). Comparing aquatic macroinvertebrate diversity in the NPR-A on 6 untapped lakes and 6 lakes where the entire permitted volume has been withdrawn and the vulnerability is similar to a range of lake types in the coastal plain 1002 area (FY18-19 costs: $80,000, potential leads: BLM, USFWS, USGS) will help assess the efficacy of existing BMPs. This effort would require 5 field days and could be conducted by the Arctic Refuge aquatic ecologist with assistance from BLM in identifying potential study lakes that are vulnerable to water withdrawals and have had permitted volumes withdrawn. Estimated costs for FY18 or 19: $63,480 (sample analysis by contract lab: 41,000, five days of field food: $230, helicopter and fuel: $21,850). Note the cost would be $10,000 cheaper and the project would have a lower carbon footprint if a helicopter already based on the North Slope is used. The power to detect change in macroinvertebrate community composition is unknown, but could at least be estimated if this study were conducted. If additional funds were available surveys of the following could be conducted as well: wet meadow zones, recharge rates, and winter water quality.

Geospatial:

Near-term:

- Cross reference existing technical reports to map any known areas of special values including Wild and Scenic Rivers, springs, subsistence use areas, and recreational areas (e.g. Canning River takeout). Identify data gaps in our knowledge in addition to those mentioned previously.

Medium-term:

- Develop NHDPlus High Resolution hydrography framework, which extends the hydrologic network seamlessly across the terrain by including not only streams and lakes, but also associated catchment areas that drain to each lake or stream segment. This association allows information about the landscape to be related to the drainage network. Observational data on the drainage network, such as water quality samples, stream gauge measurements, or fish distribution, can be linked to the framework, integrating data and facilitating analyses required during all phases of exploration and development. This effort should be combined with wetland and vegetation surveys (see resource assessment for wetlands and vegetation).

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