American Society of Mammalogists

DOUGLAS A. KELT, President
Department of Wildlife, Fish,
and Conservation Biology
University of California
Davis, CA 95616-5270
(530) 754-9481
Email: dakelt@ucdavis.edu

ENRIQUE P. LESSA, President-Elect
Universidad de la República
(+598) 2525-8618
Iguá 4255 piso 6
Montevideo 11400, Uruguay
Email: enrique.lessa@gmail.com

FELISA A. SMITH, Vice-President
Department of Biology
University of New Mexico
Albuquerque, NM 87131-001
(505) 277-6725
Email: fasmith@unm.edu

HAYLEY C. LANIER, Recording Secretary
Dept. of Biology and Sam Noble Museum
University of Oklahoma
Norman, OK 73072
(405) 310-7281
Email: hclanier@ou.edu

PAUL STAPP, Publications Director
Department of Biological Science
California State University, Fullerton
Fullerton, CA 92831
(657) 278-2849
Email: pstapp@fullerton.edu

CODY W. THOMPSON, Program Director
Department of Ecology and Evolutionary Biology
and Museum of Zoology
University of Michigan
Ann Arbor, MI 48109
(734) 615-2810
Email: cwthomp@umich.edu

28 September 2020

President Donald J. Trump
The White House
1600 Pennsylvania Avenue NW
Washington, DC 20500

Dear President Trump:

I am writing you on behalf of the American Society of Mammalogists (ASM), a non-profit, professional, scientific, and educational Society consisting of nearly 2,400 members from all 50 United States and 60 other countries worldwide. The ASM was founded in 1919 and is the world's oldest and largest organization devoted to the study of mammals. We strongly support the conservation and responsible use of wild mammals based on current, sound, and accurate scientific knowledge. The Society has a long history of reviewing issues related to mammalian conservation, and where appropriate, providing summaries of issues as they pertain to the conservation and responsible management of mammals and their habitats.

I write today in response to your recent decision to open drilling contracts for the Arctic National Wildlife Refuge (ANWR). Established in 1960 [1], this refuge was doubled in area in 1980 with passage of the Alaska National Interest Lands Conservation Act (ANILCA). In ANILCA, most of the refuge was set aside as wilderness; a large part of the Coastal Plain was set aside as the 1002 Area, named after Section 1002 of ANILCA, which described the data that Congress would need before designating this as wilderness or permitting oil development. Executive Order 13783, which you signed in March 2017, called for an update of regulations limiting oil exploration and development in ANWR. Subsequently, the 2017 Tax Cuts and Jobs Act changed the stated purposes of ANWR to include oil and gas development, and on 17 August 2020, Interior Secretary Bernhardt signed a Record of Decision (ROD) approving the Coastal Plain Oil and Gas Leasing Program in ANWR [2].

Clearly, ANWR also overlies oil and gas reserves The most recent assessment of petroleum reserves in ANWR [3] suggested that 7,668 million barrels of "technically recoverable" oil were expected from the 1002 Area. This full amount comprises less than one-half of one percent of global reserves, and is sufficient to supply the United States for just over one year at current rates of oil consumption [4]. A recent economic analysis [5] concluded that drilling in ANWR would have inconsequential impacts on the price of oil and on our reliance on foreign imports, and the Congressional Research Service reported that market prices for both oil and natural gas are unlikely to support development at ANWR [6]. Nonetheless, we leave discussions on the viability of oil and gas exploration to others with relevant expertise [3, 6].

The Arctic National Wildlife Refuge is one of the last remaining expanses of wild lands in the United States, and has been formally established as part of the National Wildlife Refuge system "to preserve 'unique wildlife, wilderness and recreational values'" [7, p. 3]. ANWR is home to 42 fish species, almost 40 species of land mammals, an additional seven or more species of marine mammals, and over 200 resident and migratory bird species [8]. One of the most diverse regions in the Arctic, ANWR includes several species of biological or political concern, such as polar and grizzly bears, muskox, and caribou. The presence of the Porcupine caribou herd adds a layer of cultural diversity to this region, as this herd is central to the identity of the Gwich'in people [9]. Additionally, surveys of the American public indicate that ANWR "is most valued . . . for its wildness and naturalness—a place of undisturbed wildlife and wild landscapes" [7, p. 3], and that two thirds of respondents oppose drilling, including over 80% of Democrats, two thirds of Independents (64%), and half of Republicans [10]. As with the economic feasibility, we will leave discussions of the social, ethnic, and cultural impacts of oil and gas exploration to others [e.g., 11, 12], and focus our attention on wild non-human mammals, which is our area of expertise.

Oil and gas exploration in the Arctic is complicated by a rigorous environment. This environmental impact is to some extent reduced by pursuing most drilling and infrastructure development in winter, when much wildlife is inactive or has migrated elsewhere. Reflecting technological advancements, the scale of physical infrastructure involved in Arctic oil and gas exploration has been substantially reduced since the Prudhoe Bay facilities were installed [13]. Drill pads and roads made of ice have replaced gravel roads to some extent, although these rely upon extensive amounts of fresh water [e.g., 1-1.5 million gallons of fresh water per mile of road, and 1.7 million gallons for a single-well pad; ref. 14, p. 243]. Seismic surveys, using so-called "thumper trucks" on balloon tires, reduce impacts on subnivean vegetation, but still leave measurable impacts on vegetation that persist over multiple decades [15, 16, see also 17]. Specifically, plant communities on seismic trails were impacted, reducing cover by shrubs and mosses, and their replacement by grasses [see also 18, 19]. Moreover, where impacts are more substantial, thawed ground ice leads to trail subsidence, thereby influencing water flow and potentially compounding impacts on tundra vegetation. This has the potential to leave "significant, extensive, and long-lasting direct, indirect, and cumulative impacts of 3D-seismic to the microtopography, hydrology, permafrost and vegetation of the 1002 Area" [19], with consequent impacts on wildlife. Moreover, thawing of ground is likely to increase the impact and cost of operations, and "[c]leaning up oil spills in ice-covered waters will be more difficult than in other areas, primarily because effective strategies for cleaning up oil spills in ice-covered waters have yet to be developed" [20, p. ii]. Complicating this still further, the Arctic is warming at twice the rate of the rest of the world [21], with its attendant impacts on ecological function [22-24] and also on oil and gas exploration and remediation [20].

Finally, strong winds and topographic heterogeneity of the 1002 Area create a heterogeneous environment in terms of snow depth, complicating efforts to find routes for seismic surveys that meet minimum snow-cover standards. Application of 3-D seismic surveys requires greater density of survey trails, larger crews, more camps, and more vehicles than do 2-D surveys [cited in abstract of 25], suggesting even greater impacts on wildlife and sensitive tundra soils and vegetation [19]. Proposed surveys will create approximately 61,000 km of seismic trails in a grid with lines as close as 1,100 feet [26].

In spite of these efforts, Arctic ecosystems are notoriously fragile, and available data suggest that oil and gas exploration will substantially impact some species and thereby exert long-term impacts on Indigenous people, wildlife communities, vegetation, hydrology, and ecological functions [18, 27, 28]. Environmental damage is unavoidable when exploring and extracting oil and gas. The BLM's Final EIS [29] devotes 348 pages to discuss how these leases and subsequent oil and gas exploration may affect the environment at ANWR. The question is not "whether" there will be environmental impacts, but rather how extensive, severe, and lasting will they be? Sovacool [30, p. 189] notes that "the most conservative development proposals submitted to the U.S. Department of Interior call for three major oil fields, removal of 40–50 million yards of gravel, construction of a 100 mile-long main pipeline, at least 280 miles of gravel road, two large marine salt-water treatment plants, seven large central-production facilities, four airfields, and 50–60 permanent drilling pads." Broadly similar results were reported by the independent National Research Council [18].

With respect to mammals, concerns over the impact of exploration in the 1002 Area of ANWR have focused on three terrestrial species and one marine mammal. I turn my attention now to summarize what we know about these potential impacts.

The **Porcupine caribou herd (PCH)** is one of four North Slope herds in Alaska. The PCH has the lowest capacity for growth of any of these, with apparent maximum growth rates never exceeding about half that observed in other Arctic herds [27]. This herd is formally protected under the 1987 *Agreement on the Conservation of the Porcupine Caribou Herd* [31], which explicitly recognizes the importance of habitat conservation for the PCH, "including such areas as calving, post-calving, migration, wintering and insect relief habitat" (Preamble, paragraph 3). In this document, both countries agree to "take appropriate action to conserve the [PCH] and its habitat", to "avoid or minimize activities that would significantly disrupt migration or other important behavior patterns" (Sec. 3.2, 3.6).

All caribou populations fluctuate over time. Numbers in the PCH increased by about 4.9% annually between 1979 (ca. 110 thousand animals) and 1989 (ca. 178 thousand), then declined through 1998 at about 3.6% annually and more slowly through 2001 (123 thousand) [27]. Numbers have subsequently increased by about 4% annually through 2013 (197 thousand) and then slowed to about 2% annually through 2018 (218 thousand). Whether they will now decline or continue to increase awaits further survey. Some authors have argued that the Central Arctic Herd actually increased during the time that the Prudhoe Bay oil complex was being installed, so direct impacts of such development to the herd are difficult to quantify. However, the only other caribou herd with similar characteristics, the Teshekpuk Lake Herd, which was not exposed to similar development, grew even more rapidly than did the Central Arctic Herd during the same time period, which suggests that growth of the latter was in fact impeded by oil and gas exploration [27, p. 14, Fig. 3.9].

The PCH also migrates over 400 miles between winter foraging and summer calving grounds [32]. Extensive telemetry work [see video of movements at 33] highlights how caribou scatter throughout their approximately 250,000 km^2 range for much of the year, but compress to the coastal plain, especially in the 1002 Area, during calving, which occurs from May through June. The 1002 Area is a "concentrated calving area" of unparalleled importance to the PCH, providing high quality food to nourish lactating mothers, as well as open the terrain necessary to see and avoid predators [34]. The quality of available forage in the 1002 Area is superior to that in adjacent parts of Canada, which permits faster growth and superior survival in the 102 Area as compared to the neighboring Canadian sites [35]. Key predators of caribou at the 1002 Area – grizzly bears, wolves, and for young fawns, golden eagles – are more abundant in the foothills and mountains of the adjacent Brooks Range [34, 36]. Additionally, the impact of insect harassment may be substantial on warm, calm days, leading to blood loss and energy use as animals move to escape harassment, which reduces foraging time and potentially calf growth [37]. When parturient females or mothers with young are displaced from the 1002 Area, they are forced south to foothill regions where food quality is lower and predation risk is higher. The extent to which parturient caribou in the 1002 Area may be displaced by exploration activities has not been quantified. However, those in the Central Arctic Herd move their calving areas 7-8 km from drilling infrastructure [38, cited in 27], and female caribou there evidently have not habituated to such disturbances over the past four decades [39].

Reflecting lower food quality and elevated predation and insect harassment, calf survival declines linearly with displacement, and Griffith et al. [27, p. 32] concluded that a 4.6% reduction in June calf survival, equivalent in their models to a 27 km displacement, would be sufficient to completely halt population growth. The approved Alternative B in the BLM's Final EIS [29] allows for full development of 98% of the 1002 Area; under such conditions, Griffith et al.'s models predict mean displacement of over 50 km, and at least 8% reduction in calf survival [27], which they note are consistent with earlier reports by Clough et al. [34]. Somewhat surprisingly, the Final EIS [29] assumes that calving females are influenced by drilling operations and infrastructure to a distance of only 2.49 miles (about 8 km), evidently following

Wolfe [40], but ignoring or downplaying subsequent work that suggests potentially much greater displacement.

Griffith et al. [27, p. 34] conclude their report with "[four] research-based ecological arguments" suggesting that the PCH "may be particularly sensitive to development within the 1002 portion of the calving ground." These factors include the herd's low capacity for growth; documented shifts in calving areas by Central Arctic caribou away from drilling infrastructure, with the logical expectation that PCH will behave similarly; the lack of alternate high-quality calving areas, which would result in reduced growth and elevated predation if animals are displaced; and the strong link between calf survival and a mother's ability to move freely to select high-quality sites with superior food and protection from predators. A recent review [41] suggests that a number these concerns was not adequately addressed in BLM's [42] draft leasing assessment for the 1002 Area, and Pearce et al. [28, p. 1] note "persistent and emerging uncertainties about the long-term effects of energy development for caribou."

The other key herbivore in the 1002 Area is the **muskox**. The ANWR muskox population was established through reintroductions in 1969 and 1970 [43, 44]. Unlike caribou, muskox do not migrate; they remain residents of the coastal plain, and in particular of the 1002 Area, year-round [43]. Population size has declined markedly since the mid-1990s [28], likely due to a combination of factors, including disease, poor nutrition, low calf survival, low adult survival, but mostly as a result of elevated predation by grizzly bears during years when moose populations had declined, and the PCH shifted their calving areas [45]; that is, when the bear's preferred prey were unavailable. These observations suggest that activities in this region that adversely impact caribou will also adversely impact muskox through elevated predation. Not surprisingly, winter conditions are key to the dynamics of muskox at ANWR. Winters at ANWR may extend nine months, and during this time animals minimize movement to reduce energy use [46, cited in 25]. Calves are born in April and May, several weeks before green forage becomes available; hence, reserving limited energy stores through winter is critical to reproduction and population stability. Consequently, concerns have been raised that any exploration or other activities that disturb muskox during winter may depress reproduction. Muskox also are very selective of the habitat they occupy, preferring sites with lower snow cover and with greater access to forage [47]. They frequently use habitats adjacent to rivers, which puts them at risk if oil and gas exploration requires gravel or water, as expected for winter road construction [43]. The response of muskox to seismic exploration is not clear; Clough et al. [34] reported that muskox may flee over half a mile in response to vehicles that were nearly two miles distant, but Winters and Shideler [in 18, p. 117] noted that responses "differ from herd to herd, perhaps because of each herd's previous experience." Hence, the extent to which proposed winter construction activities may impact muskox populations is not clear but will require active monitoring.

A third terrestrial mammal of particular concern in the 1002 Area is the **polar bear.** Listed as threatened under the endangered species act on the basis that climate change is reducing the pack ice they use for hunting seals and because of threats from oil and gas development [48-50], polar bears also are the subject of the multilateral *Agreement on the Conservation of Polar Bears*, a formal treaty which the USA signed with Canada, Denmark, Norway, and the former Soviet Union (27 UST 3918; TIAS 8409). Both of these documents require protection of the bear's habitat within the reserve.

Traditionally denizens of offshore ice, females may come to shore to den and bear young; many polar bears den in coastal regions, and in the Southern Beaufort Sea (arctic waters offshore from ANWR), over 40% were on land [51]. Moreover, fully one third of land-based dens in the Southern Beaufort Sea occurred in the 1002 Area [52], even though this represents only 10% of the mainland coastline. The 1002 Area contains over three thousand km of potential denning sites [53]. Reflecting the importance of the 1002 Area for polar bear maternity denning, 77% of this area has been designated as critical denning habitat [54]. As climate change is reducing the distribution and availability of pack ice, the viable range of polar bears is reducing, almost certainly with parallel declines in polar bear numbers [55]. The loss of sea ice is leading to greater proportions of polar bears seeking denning sites on land [56], and many are thought likely to focus on the 1002 Area. Moreover, facing reduced summer foraging opportunities on pack ice [57-59], many polar bears move to land where they encounter the smaller but more efficient grizzly bears; under these competitive conditions, polar bears suffer reduced body condition and survival [60].

Recent work suggests that maintenance of a minimum one mile buffer around known polar bear dens is needed to prevent den (and cub) abandonment [52, 56]. Although careful planning and incorporation of aerial den detection prior to seismic surveys can reduce predicted impacts substantially [61], the ca. 1,100 foot grid that is likely for 3-D seismic surveys [26] will make this challenging. Additionally, Larson et al. [56] reported that aircraft had the greatest potential for eliciting den abandonment by bears. Delaying seismic surveys until later in the season, when bears have emerged from their dens, could help to ameliorate this threat.

Finally, production at the 1002 Area will further amplify industrial activities that already have displaced endangered **bowhead whales** from their traditional fall migration routes [18]. The NRC [18, pp. 99-103] emphasize how noise from exploratory drilling may displace whales, and possible oil spills "would pose a great potential threat" to these species, as well as to polar bears and ringed seals (p. 106). Moreover, predicted impacts of climate change on these and other species are expected to be exacerbated by any negative effects of oil and gas development [22, 23, 62].

This review suggests that at least four mammals appear particularly susceptible to impacts of oil and gas exploration in the 1002 Area of ANWR. Three of these are subject to protection under the Endangered Species Act, the Marine Mammal Protection Act, or formal treaties or agreements with other countries. The ultimate decision on exploration in ANWR is a political decision, and must weigh the social and economic gains associated with such exploration against the social and environmental costs that appear likely to accrue. We provide this letter to ensure that you are aware of the likely impacts on mammals, which is our area of expertise. We do so in an effort to remain apolitical and to provide our scientific assessment but not to promote any agenda. Should you wish to discuss these issues further, or should your staff wish to solicit additional input, the ASM stands ready to provide further input in this effort.

Sincerely,

Douglas A. Kelt, President

Cc:

<u>**Senate Leadership**</u>

Senator Mitch McConnell
317 Russell Senate Office Building
Washington DC 20510

Senator Charles E. Schumer
322 Hart Senate Office Building
Washington DC 20510

<u>**House Leadership**</u>

Representative Kevin McCarthy
2468 Rayburn House Office Building
Washington, DC 20515

Representative Nancy Pelosi
1236 Longworth House Office Building
Washington, DC 20515

Alaska Congressional Delegation

Senator Lisa Murkowski
22 Hart Senate Office Building
Washington DC 20510

Representative Don Young
2314 Rayburn House Office Building
Washington, DC 20515

Senator Dan Sullivan
302 Hart Senate Office Building
Washington DC 20510

Alaska Governor

Governor Mike Dunleavy
P.O. Box 110001
Juneau, AK 99811-0001

Senate Committee on Commerce, Science, and Transportation

Senator Roger F. Wicker, Chair
555 Dirksen Senate Office Building
Washington DC 20510

Senator Amy Klobuchar
425 Dirksen Senate Office Building
Washington DC 20510

Senator Maria Cantwell
511 Hart Senate Office Building
Washington DC 20510

Senate Committee on Energy and Natural Resources

Senator Lisa Murkowski, Chair
22 Hart Senate Office Building
Washington DC 20510

Senator Joe Manchin
306 Hart Senate Office Building
Washington DC 20510

Senate Committee on Environment and Public Works

Senator John Barrasso, Chair
307 Dirksen Senate Office Building
Washington DC 20510

Senator Bernard Sanders
332 Dirksen Senate Office Building
Washington DC 20510

Senator Thomas R. Carper
513 Hart Senate Office Building
Washington DC 20510

Senate Committee on Indian Affairs

Senator John Hoeven, Chair
338 Russell Senate Office Building
Washington DC 20510

Senator Tom Udall, Vice Chair
531 Hart Senate Office Building
Washington DC 20510

U. S. Department of the Interior

Secretary of the Interior David Bernhardt
Department of the Interior
1849 C Street, N.W.
Washington DC 20240

U. S. Fish and Wildlife Service

Director Aurelia Skipworth
Department of the Interior
U.S. Fish & Wildlife Service
1849 C Street, N.W.
Washington DC 20240

Gwich'in Steering Committee
Ms. Bernadette Demientieff, Executive Director
201 1st Ave. Suite 124
Fairbanks, Alaska 99701

State Attorneys General

California Attorney General Xavier Becerra
Attorney General's Office
California Department of Justice
Attn: Public Inquiry Unit
P.O. Box 944255
Sacramento, CA 94244-2550

Connecticut Attorney General William Tong
Office of the Attorney General
165 Capitol Avenue
Hartford, CT 06106

Delaware Attorney General Kathy Jennings
Delaware Department of Justice
Carvel State Building
820 N. French St.
Wilmington, DE 1980

Illinois Attorney General Kwame Raoul
Carbondale Main Office
601 South University Ave.
Carbondale, IL 62901

Maine Attorney General Aaron Frey
6 State House Station
Augusta, ME 04333

Maryland Attorney General Brian Frosh
200 St. Paul Place
Baltimore, MD 21202

Massachusetts Attorney General Maura Healey
1 Ashburton Place
20th Floor
Boston, MA 02108

Michigan Attorney General Dana Nessel
G. Mennen Williams Building
525 W. Ottawa Street
P.O. Box 30212
Lansing, MI 48909

Minnesota Attorney General Keith Ellison
445 Minnesota Street
Suite 1400
St. Paul, MN 55101-2131

New Jersey Attorney General Gurbir Grewal
Office of The Attorney General
RJ Hughes Justice Complex
25 Market Street, Box 080
Trenton, NJ 08625-0080

New York Attorney General Leticia James
Office of the Attorney General
The Capitol
Albany, NY 12224-0341

Oregon Attorney General Ellen Rosenblum
Office of the Attorney General
Oregon Department of Justice
1162 Court St. NE
Salem, OR 97301-4096

Rhode Island Attorney General Peter Neronha
Office of the Attorney General
150 South Main Street
Providence, Rhode Island 02903

Vermont Attorney General T. J. Donovan
Vermont Attorney General's Office
109 State Street
Montpelier, VT 05609

Washington Attorney General Bob Ferguson
Office of the Attorney General
1125 Washington Street SE
PO Box 40100
Olympia, WA 98504-0100

<u>Alaska Audubon</u>
Dr. Natalie Dawson, Executive Director
431West Seventh Ave., Suite 101
Anchorage, AK 99501, USA

<u>Alaska Conservation Foundation</u>
Mr. Michael Barber, Executive Director
1227 W. 9th Ave., Suite 300
Anchorage, Alaska 99501

Mike Coumbe, Deputy Director
1227 W. 9th Ave., Suite 300
Anchorage, Alaska 99501

<u>Alaska Wilderness League</u>
122 C St NW, Suite 240
Washington, DC 20001

<u>Alaska Wildlife Alliance</u>
P.O. Box 202022
Anchorage, AK 99520

<u>National Wildlife Federation</u>
Mr. Collin O'Mara
President and Chief Executive Officer
P.O. Box 1583
Merrifield, VA 221116

<u>Northern Alaska Environmental Center</u>
30 College Road
Fairbanks, AK 99701

<u>The Wilderness Society</u>
1615 M Street NW
Washington, DC 20036

References

1. USFWS, *[U.S. Fish & Wildlife Service] Arctic National Wildlife Refuge. Time line: establishment and management of Arctic Refuge. Available at https://www.fws.gov/refuge/arctic/timeline.html. Accessed 6 September 2020.* 2012.
2. USDI, *[U.S. Dept. of the Interior] Secretary Bernhardt signs decision to implement the Coastal Plain Oil and Gas Leasing Program in Alaska. Available at https://www.doi.gov/pressreleases/secretary-bernhardt-signs-decision-implement-coastal-plain-oil-and-gas-leasing-program. Accessed 30 August 2020.* 2020.
3. USGS, *[U.S. Geological Survey] Arctic National Wildlife Refuge, 1002 Area, petroleum assessment, 1998, including economic analysis. Available at https://pubs.usgs.gov/fs/fs-0028-01/. Accessed 5 September 2020.* . 2001.
4. USEIA, *[U.S. Energy Information Administration] Frequently asked questions (FAQS). How much oil is consumed in the United States? Available at https://www.eia.gov/tools/faqs/faq.php?id=33&t=6. Accessed 7 September 2020.* 2020.
5. Kotchen, M.J. and N.E. Burger, *Should we drill in the Arctic National Wildlife Refuge? An economic perspective.* Energy Policy, 2007. **35**(9): p. 4720-4729.
6. CRS, *[Congressional Research Service]. Arctic petroleum technology developments. i-iv + 25 pages. Available at https://www.everycrsreport.com/. Accessed 6 September 2020.* 2006.
7. USFWS, *[U.S. Fish & Wildlife Service] A sense of the refuge: Arctic National Wildlife Refuge. Available at https://www.fws.gov/uploadedFiles/Region_7/NWRS/Zone_1/Arctic/PDF/Sense%20of%20the%20Refuge%20booklet%20web.pdf. Accessed 2 September 2020.* 2011.
8. USFWS, *[U.S. Fish & Wildlife Service] Arctic National Wildlife Refuge: Wildlife & Habitat. Available at https://www.fws.gov/refuge/arctic/wildlife_habitat.html. Accessed 3 September 2020.* 2016.
9. Gwich'in Steering Committee, *Caribou people. Available at http://ourarcticrefuge.org/about-the-gwichin/caribou-people/. Accessed 2 September 2020.* 2020.
10. Ballew, M., et al., *Americans oppose drilling in Arctic National Wildlife Refuge.* . 2019, Yale University and George Mason University. New Haven, CT: Yale Program on Climate Change Communication. Available at https://climatecommunication.yale.edu/publications/americans-oppose-drilling-arctic-national-wildlife-refuge-2019/. Accessed 5 September 2020.
11. Zentner, E., et al., *Ignoring Indigenous peoples-climate change, oil development, and Indigenous rights clash in the Arctic National Wildlife Refuge.* Climatic Change, 2019. **155**(4): p. 533-544.
12. Lathrop, A., *People of the caribou in the land of the oil: climate ghange, the Venetic Decision, and oil development in the Arctic National Wildlife Refuge.* Wisconsin Environmental Law Journal, 2002. **8**(8): p. 169-196.
13. Arctic Power, *Today's drilling leave a small footprint. Available at http://anwr.org/2014/11/todays-drilling-leaves-a-small-footprint/. Accessed 8 September 2020.* 2014.
14. Pelley, J., *Will drilling for oil disrupt the Arctic National Wildlife Refuge?* Environmental Science and Technology, 2001. **35**(11): p. 241A-247A.

15. Jorgenson, J.C., *Long-term monitoring of recovery of trails from winter seismic exploration. .* Arctic Research of the US 2000. **14**: p. 32-33.
16. Jorgenson, J.C., J.M.V. Hoef, and M.T. Jorgenson, *Long-term recovery patterns of arctic tundra after winter seismic exploration.* Ecological Applications, 2010. **20**(1): p. 205-221.
17. USFWS, *[U.S. Fish & Wildlife Service] Arctic National Wildlife Refuge: Seismic trails. Available at https://www.fws.gov/refuge/arctic/seismic.html. Accessed 3 September 2020.* 2014.
18. NRC, *[National Research Council] Cumulative environmental effects of oil and gas activities on Alaska's North Slope*. 2003, Washington, D.C.: The National Academies Press. 304.
19. Walker, D.A., et al., *Likely impacts of proposed 3D-seismic surveys to the terrain, permafrost, hydrology, and vegetation in the 1002 Area, Arctic National Wildlife Refuge, Alaska. Alaska Geobotany Center Publication AGC 19-01. University of Alaska Fairbanks, Fairbanks, Alaska, USA.* 2019.
20. CRS, *[Congressional Research Service] Changes in the Arctic: background and issues for Congress. ii + 135 pages. Available at https://crsreports.congress.gov/product/pdf/R/R41153. Accessed 20 September 2020*. 2020.
21. IPCC, *[International Panel on Climate Change] Summary for policymakers*, in *Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*, V. Masson-Delmotte, et al., Editors. 2018, World Meteorological Organization: Geneva, Switzerland. p. 3-24.
22. Post, E., et al., *Ecological dynamics across the arctic associated with recent climate change.* Science, 2009. **325**(5946): p. 1355-1358.
23. Post, E., et al., *The polar regions in a 2 degrees C warmer world.* Science Advances, 2019. **5**(12): p. eaaw9883.
24. Saros, J.E., et al., *Arctic climate shifts drive rapid ecosystem responses across the West Greenland landscape.* Environmental Research Letters, 2019. **14**(7): p. 074027.
25. Raynolds, M.K., et al., *Landscape impacts of 3D-seismic surveys in the Arctic National Wildlife Refuge, Alaska.* Ecological Applications, 2020.
26. Gibbs, W.W., *The Arctic Oil and Wildlife Refuge.* Scientific American, 2001. **284**(5): p. 63-69.
27. Griffith, B., et al., *Section 3: The porcupine caribou herd*, in *Arctic refuge coastal plain terrestrial wildlife research summaries* D.E. Douglas, P.E. Reynolds, and E.B. Rhode, Editors. 2002, U. S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001. p. 8-37.
28. Pearce, J.M., et al., *Summary of wildlife-related research on the coastal plain of the Arctic National Wildlife Refuge, Alaska, 2002–17*, in *Open-File Report*. 2018: Reston, VA. p. 36.
29. BLM, *[Bureau of Land Management] Coastal plain oil and gas leasing program final environmental impact statement. Vol. 1. Available at https://eplanning.blm.gov/eplanning-ui/project/102555/570. Accessed 8 September 2020.* 2019.
30. Sovacool, B.K., *Environmental damage, abandoned treaties, and fossil-fuel dependence: The coming costs of oil-and-gas exploration in the "1002 Area" of the Arctic National Wildlife Refuge.* Environment Development and Sustainability, 2007. **9**(2): p. 187-201.

31. Canada and the United States, *Agreement between the Government of Canada and the Government of the United States on the Conservation of the Porcupine Caribou Herd*. 1987, T.I.A.S. No. 11259. Available at https://www.treaty-accord.gc.ca/print-imprimer.aspx. Accessed 6 September 2020.
32. USFWS, *[U.S. Fish & Wildlife Service] Arctic National Wildlife Refuge: Wildlife & Habitat: Caribou. Available at https://www.fws.gov/refuge/arctic/caribou.html. Accessed 4 September 2020.* 2016.
33. PCMB, *[Porcupine Caribou Management Board] Habitat. Available at https://www.pcmb.ca/habitat#habitat. Accessed 2 September 2020.* 2020.
34. Clough, N.K., P.C. Patton, and A.C. Christiansen, eds. *Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment-Report and recommendation to the Congress of the United States and final legislative environmental impact statement*. 1987, U.S. Fish and Wildlife Service, U.S. Geological Survey, and Bureau of Land Management, v. 1 (Report)-xviii + 208 p., 5 pis., 32 figs., 26 tables; v. 2 (Appendix- Public comments and responses)-!! + 998 p.: Washington, D. C.
35. Russell, D.E., A.M. Martell, and W.A.C. Nixon, *Range ecology of the Porcupine caribou herd*. 1993, Rangifer, Special Issue 8, 168 pages.
36. Whitten, K.R., et al., *Productivity and early calf survival in the Porcupine Caribou Herd.* Journal of Wildlife Management, 1992. **56**(2): p. 201-212.
37. Helle, T. and L. Tarvainen, *Effects of insect harassment on weight gain and survival in reindeer calves.* Rangifer, 1984. **4**: p. 24-27.
38. Wolfe, S.A., B. Griffith, and C.A. Gray Wolfe, *Response of reindeer and caribou to human activities.* Polar Research, 2000. **19**(1): p. 63-73.
39. Johnson, H.E., et al., *Caribou use of habitat near energy development in Arctic Alaska.* Journal of Wildlife Management, 2020. **84**(3): p. 401-412.
40. Wolfe, S.A., *Habitat selection by calving caribou of the Central Arctic herd, 1980-95*. 2000, Thesis, University of Alaska, Fairbanks, Alaska, USA.
41. Russell, D. and A. Gunn, *Vulnerability analysis of the Porcupine Caribou Herd to potential development of the 1002 lands in the Arctic National Wildlife Refuge, Alaska. Report prepared for: Environment Yukon, Canadian Wildlife Service, and GNWT Department of Environment and Natural Resources. 143 pp. Available at https://yukon.ca/en/vulnerability-analysis-porcupine-caribou-herd-potential-development-1002-lands-arctic-national. Accessed 8 September 2020.* 2019.
42. BLM, *[Bureau of Land Management] Coastal plain oil and gas leasing program draft environmental impact statement.* 2018.
43. Reynolds, P.E., K.J. Wilson, and D.R. Klein, *Section 7: Muskoxen*, in *Arctic refuge coastal plain terrestrial wildlife research summaries*, D.E. Douglas, P.E. Reynolds, and E.B. Rhode, Editors. 2002, U. S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001. p. 54-64.
44. Klein, D.R., *The establishment of muskox populations by translocation*, in *Translocation of wild animals*, L. Nielsen and R.D. Brown, Editors. 1988, Wisconsin Humane Society, Inc.: Milwaukee, Wisconsin, USA. p. 298-317.
45. Arthur, S.M. and P.A. Del Vecchio, *Effects of oil field development on calf production and survival in the Central Arctic herd. Alaska, Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration, Final Research Technical Report, Grants W-27-5 and W-33-1 through*

W-33-4, Project 3.46. Juneau, Alaska, USA. Available at http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/research_pdfs/ca-oil_finaltr.pdf. Accessed 8 September 2020. 2009.

46. Reynolds, P.E., *Seasonal distribution, activity and habitat use of muskoxen in northeastern Alaska. Chapter 2 in Ecology of a reestablished population of muskoxen in northeastern Alaska. Unpublished PhD dissertation*. 1998, University of Alaska: Fairbanks, Alaska, USA.
47. Wilson, K.J. and D.R. Klein, *The characteristics of muskox late winter habitat in the ArcticNatinoal Wildlife Refuge Alaska.* Rangifer, 1991. **11**(2): p. 79-80.
48. USFWS, *[U.S. Fish & Wildlife Service] Endangered and threatened wildlife and plants; determination of threatened status for the polar bear (Ursus maritimus) throughout its range.* Federal Register, 2008. **73**: p. 28212-28303.
49. USFWS, *[U.S. Fish & Wildlife Service] Endangered and threatened wildlife and plants; review of native species that are candidates for listing as endangered or threatened; annual notice of findings on resubmitted petitions; annual description of progress on listing actions.* Federal Register, 2008(73): p. 75176-75244.
50. USFWS, *[U.S. Fish & Wildlife Service] Endangered and threatened wildlife and plants; special rule for the polar bear.* Federal Register, 2008. **73**: p. 76249-76269.
51. Amstrup, S.C. and C. Gardner, *Polar bear maternity denning in the Beaufort Sea.* Journal of Wildlife Management, 1994. **58**(1): p. 1-10.
52. Amstrup, S.C., *Human disturbances of denning polar bears in Alaska.* Arctic, 1993. **46**(3): p. 246-250.
53. Durner, G.M., S.C. Amstrup, and K.J. Ambrosius, *Polar bear maternal den habitat in the Arctic National Wildlife Refuge, Alaska.* Arctic, 2006. **59**(1): p. 31-36.
54. USFWS, *[U.S. Fish & Wildlife Service] Designation of critical habitat for the polar bear (Ursus maritimus) in the United States.* Federal Register, 2010(75): p. 76086–76137.
55. Durner, G.M., et al., *Predicting 21st-century polar bear habitat distribution from global climate models.* Ecological Monographs, 2009. **79**(1): p. 25-58.
56. Larson, W.G., T.S. Smith, and G. York, *Human interaction and disturbance of denning polar bears on Alaska's North Slope.* Arctic, 2020. **73**(2): p. 195-205.
57. Rode, K.D., et al., *Variation in the response of an Arctic top predator experiencing habitat loss: Feeding and reproductive ecology of two polar bear populations.* Global Change Biology, 2014. **20**(1): p. 76-88.
58. Regehr, E.V., et al., *Survival and breeding of polar bears in the southern Beaufort Sea in relation to sea ice.* Journal of Animal Ecology, 2010. **79**(1): p. 117-27.
59. Regehr, E.V., et al., *Effects of earlier sea ice breakup on survival and population size of polar bears in western Hudson Bay.* Journal of Wildlife Management, 2007. **71**(8): p. 2673-2683.
60. Rode, K.D., et al., *Can polar bears use terrestrial foods to offset lost ice-based hunting opportunities?* Frontiers in Ecology and the Environment, 2015. **13**(3): p. 138-145.
61. Wilson, R.R. and G.M. Durner, *Seismic survey design and effects on maternal polar bear dens.* Journal of Wildlife Management, 2020. **84**(2): p. 201-212.
62. IPCC, *[International Panel on Climate Change] Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. (edited by V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R.*

Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield). Available at https://www.ipcc.ch/sr15/. Accessed 12 September 2020. 2018.