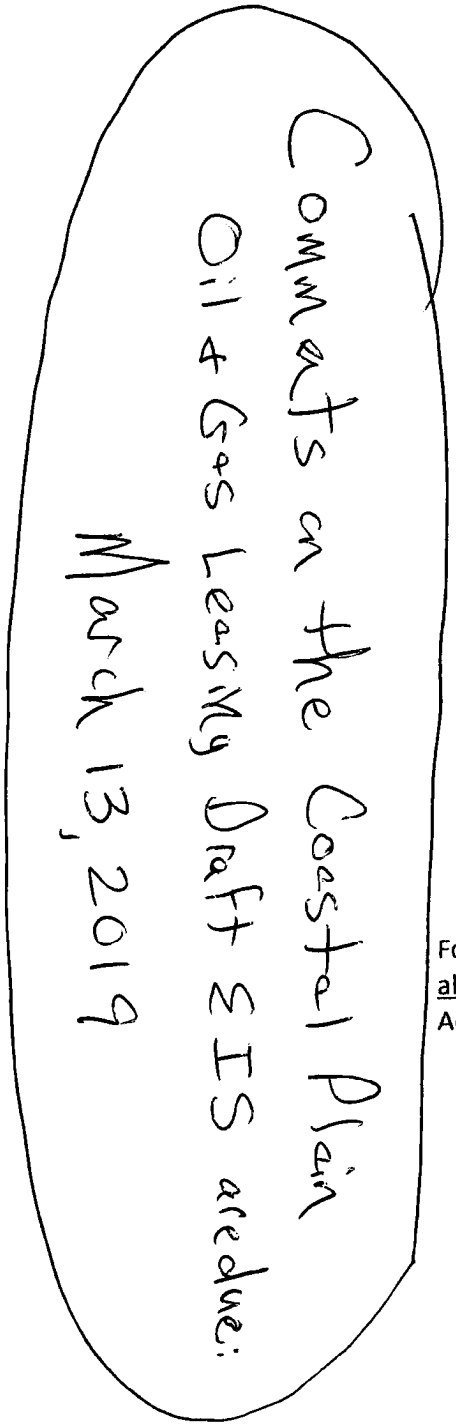


What YOU can do to help protect the coastal plain of the Arctic National Wildlife Refuge

1) Comment on the draft Environmental Impact Statement (EIS) regarding the oil and gas leasing proposal. Comments will be accepted through **Mar. 13, 2019** and can be sent by any of the following methods:
   - Website: www.blm.gov/Alaska/Coastal-Plain-EIS
   - Mail: Coastal Plain Oil and Gas Leasing Program EIS
     222 West 7th Ave, Stop #13
     Anchorage, Alaska 99513

2) Sign the petition to speak out against leasing our precious Arctic Refuge Coastal Plain to oil developer. Go to: https://act.audubon.org/onlineactions/jhAgYIERqUyEWxgC-iPZFA2?ms=policy-adv-web-website_nas-engagementcard-20181220_arcticrefuge_alert

3) Contact your local elected Federal representatives providing comments and concerns regarding the EIS and ask your member of the House of Representatives to join Rep. Jared Huffman and co-sponsor the Arctic Cultural and Coastal Plain Protection Act. Best results by 1) in person; 2) phone; and 3) mail. Let them know you live in their District and VOTE!

4) Share with friends, post on Facebook, and spread the word every way possible.

For More information see this excellent article: https://www.audubon.org/magazine/winter-2018/a-journey-heart-alaskas-pristine-and-imperiled.
Access the presentation slideshow at: http://www.ncwaudubon.org/conservation.html

ALASKA WILDERNESS

Arctic National Wildlife Refuge: The Path Ahead

In 2017 Congress opened the Arctic National Wildlife Refuge to oil and gas development, without full and fair debate, as part of the Tax Reform Act of 2017. This is the first time the Refuge has been open to development in its half-century history of protection. **Fortunately, it is not too late to protect our nation's largest and wildest Refuge. Help us protect the Arctic Refuge and restore legislative protections for this iconic corner of Alaska's Arctic.** Here's how you can get involved:

Speak out against the administration's aggressive efforts toward development:

Oil and Gas Lease Sales: We are building a robust record of opposition to the Trump administration's efforts to lease the Coastal Plain to oil and gas companies. During the comment period on the Leasing Draft Environmental Impact Statement, we must build a diverse record of opposition, adding to the 700,000 voices that opposed drilling during the scoping period. *This comment period ends on March 13.*

Seismic Testing Permits: At any moment, the administration may announce plans to allow seismic exploration on the Refuge's Coastal Plain. This seismic activity would involve an army of vehicles, some weighing 90,000 pounds, that could leave tens of thousands of miles of seismic trails across the fragile tundra. These trucks would send strong vibrations into the ground causing significant disturbance, and possible fatalities, to an already stressed polar bear population. We need you to speak out against these plans.

As we fight back against aggressive administrative actions above, our goal remains clear: We must tell Congress to pass legislation restoring Arctic Refuge protections:

Arctic Cultural and Coastal Plain Protection Act: In 2019, not only did a pro-environment majority take over the House, but we gained a new class of elected lawmakers ready to help restore Arctic Refuge protections. With Congressional champions on our side, we are on the path to restoring protections for the Arctic Refuge Coastal Plain. Help us show our strong support for this effort. You can weigh in now by contacting your Member of Congress and telling them that you support legislation to restore protections for the Arctic Refuge.

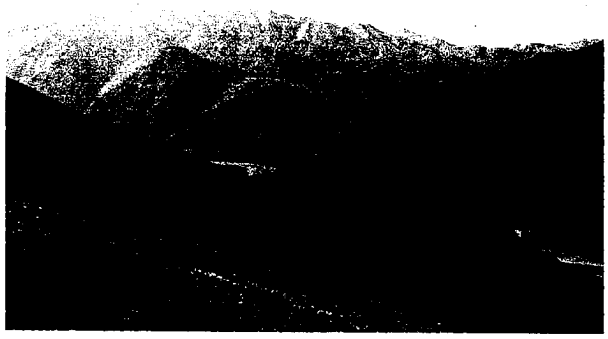
We are on the road to victory. It won't be easy, but we have the facts, and the majority of Americans on our side. Public lands should be forever. They should be a promise we make today to future generations, and we ask that you to join with us at this critical moment for this iconic corner of Alaska, that we all hold in common.

Questions or want to get involved? Contact Lois Norrgard our National Field Organizer: lois@alaskawild.org

ALASKA WILDERNESS

The Arctic National Wildlife Refuge

The Arctic National Wildlife Refuge is America's largest wildlife refuge, comprising 19.6 million acres of one of the wildest corners left in North America. Its biological heart, the 1.6 million acre coastal plain, is home to countless species of birds and numerous land mammals like caribou, musk oxen, and polar bears. It is sacred land for the Gwich'in people, who today rely on caribou for their sustenance, as they have for thousands of years. For adventurers, a visit to the Arctic Refuge is the wilderness experience of a lifetime.



Today, for the first time in decades, the Coastal Plain faces potential oil and gas leasing, which would forever change this landscape. In 2017, Alaskan Senator Lisa Murkowski snuck two pages of drilling text into the final Tax Act, undermining decades of thoughtful management and protections. Today, the Trump Administration is pushing forward in an unprecidented mad dash to hold oil and gas lease sales by fall, before the true impacts of Arctic Refuge drilling can be understood.

What's At Stake:

-The Porcupine Caribou Herd. The Coastal Plain is critical calving and post calving grounds for the 200,000 caribou that migrate over 1,500 miles annually in the longest land mammal migration on earth.

-The Gwich'in Way of Life. The Gwich'in residents of 15 villages in the US and Canada rely on the Porcupine Caribou Herd for their subsistence way of life, and have fought to protect the area since Congress first attempted to open the area to drilling decades ago.

-Internationally Significant Wildlife & Bird Populations. The Arctic Refuge is home to every species of bear, along with wolves, musk ox, wolverines and caribou. 250 species of birds rely on the Refuge during summer months, migrating to every state in the U.S. and across six continents each winter.

-America's Iconic Wilderness. Few travel to this remote corner of Alaska, but those who do have stories and images that have captured the minds of Americans for generations. It's no wonder that 2/3rds of Americans still oppose drilling the Arctic Refuge Coastal Plain, even though many will only experience it through stories, video, and images. From 2015 until today, over two million people have submitted formal comments to related agencies in favor of protecting the Arctic Refuge.

- Decades of Protection. The fight to protect this area began in the early twentieth century by a group of visionary conservationists led by Olaus and Margaret Murie. In 1960, President Dwight Eisenhower made their vision a reality by establishing the 8.9-million-acre Arctic National Wildlife Range specifically for its "unique wildlife, wilderness, and recreational values." In 1980, President Jimmy Carter continued this legacy by expanding the area, designating much of the land as Wilderness.

This iconic American wilderness is on the brink to be irreversibly destroyed, all for short term profit. If the government is willing to sacrifice a place as wild as the Arctic Refuge, are there any special places in America that will forever remain off limits to destruction?

ALASKA WILDERNESS

Issues with the Arctic Refuge Coastal Plain Draft EIS

The Draft EIS was released in December 2018, and comments are being accepted by BLM through March 13. Below you'll find some of the deficiencies we identified in reviewing the document. For the full document, visit: https://www.blm.gov/programs/planning-and-nepa/plans-in-development/alaska/coastal-plain-eis

Of greatest concern, ***the Draft EIS anticipates leasing the majority of the Arctic Refuge Coastal Plain to oil and gas corporations, going far beyond what was required in the Tax Act.*** BLM is required to consider a reasonable range of alternatives, and they failed to do so. While they developed a 'No Action' alternative, they also claim that they cannot select it, which is something we aim to fix in the years ahead. The 'No Action' alternative would keep the Coastal Plain in its current state, and it's the only alternative that keeps the Coastal Plain intact for future generations.

Other points to highlight related to the Draft EIS include:

It's a Refuge, not an oil field: While the Tax Act authorized drilling on the Coastal Plain, it didn't change the fact that the Arctic Refuge remains a National Wildlife Refuge... and it should still be managed like one. BLM failed to consider how oil and gas development will interfere with the U.S. Fish and Wildlife Service's administration of the Coastal Plain. It fails to guarantee that the wilderness, conservation, and subsistence purposes for which the Arctic Refuge was first set aside in 1960 will continue to be protected.

False 2,000 Acre Limit: It's long been a myth that only 2,000 acres would be impacted by oil and gas development, and the Draft EIS helps to debunk this 'promise' of drilling proponents. While the final Tax Act included a 2,000 acre limitation, BLM excluded infrastructure like pipelines and gravel mines that would create a spider web of impacts across the Coastal Plain. It also ignores the impacts of potential seismic exploration. This limited interpretation of 2,000-acre restriction would allow for more development and greater impacts than Congress voted on in 2017.

Harm to Polar Bears: Polar bears are listed as threatened under the Endangered Species Act, and 77% of the Coastal Plain is designated as Critical Habitat. The draft EIS acknowledges that all action alternatives would affect large areas of this Critical Habitat, and that oil and gas activities could cause injury or death to polar bears, but does nothing to mitigate or prevent this outcome.

Impacts to Clean Water: Fresh water is scarce on the Arctic Refuge Coastal Plain, and a key purpose of the Arctic Refuge is to protect water quantity. The draft EIS acknowledges that drilling an oil well could use nearly 2 million gallons of water, and constructing one mile of ice road could use 1 million gallons of water, but it fails to add up these impacts in a meaningful way to understand their impact. It also fails to fully evaluate the impacts to fish, habitat, vegetation, and hydrology from using these water resources for oil and gas development.

Impacts to Clean Air: BLM failed to meaningfully evaluate potential impacts to air quality that would result from oil and gas activities on the Coastal Plain. BLM made no attempt to quantify emissions of pollutants produced from oil and gas leasing and their impact on human health and the environment.

PL 115-97 excerpt Tax Act ANWR Section

(b) <<NOTE: 26 USC 864 note.>> Effective Date.--The amendment made by this section shall apply to taxable years beginning after December 31, 2017.

TITLE II

SEC. 20001. <<NOTE: 26 USC 3143 note.>> OIL AND GAS PROGRAM.

(a) Definitions.--In this section:

(1) Coastal plain.--The term ``Coastal Plain'' means the area identified as the 1002 Area on the plates prepared by

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the United States Geological Survey entitled ``ANWR Map - Plate 1'' and ``ANWR Map - Plate 2'', dated October 24, 2017, and on file with the United States Geological Survey and the Office of the Solicitor of the Department of the Interior.

(2) Secretary.--The term ``Secretary'' means the Secretary of the Interior, acting through the Bureau of Land Management.

(b) Oil and Gas Program.--

(1) In general.--Section 1003 of the Alaska National Interest Lands Conservation Act (16 U.S.C. 3143) shall not apply to the Coastal Plain.

(2) Establishment.--

(A) In general.--The Secretary shall establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain.

(B) Purposes.--Section 303(2)(B) of the Alaska National Interest Lands Conservation Act (Public Law 96-487; 94 Stat. 2390) <<NOTE: 16 USC 668dd note.>> is amended--

(i) in clause (iii), by striking ``and'' at the end;

(ii) in clause (iv), by striking the period at the end and inserting ``; and''; and

(iii) by adding at the end the following:

``(v) to provide for an oil and gas program on the Coastal Plain.''.

(3) Management.--Except as otherwise provided in this section, the Secretary shall manage the oil and gas program on the Coastal Plain in a manner similar to the administration of lease sales under the Naval Petroleum Reserves Production Act of 1976 (42 U.S.C. 6501 et seq.) (including regulations).

(4) Royalties.--Notwithstanding the Mineral Leasing Act (30 U.S.C. 181 et seq.), the royalty rate for leases issued pursuant to this section shall be 16.67 percent.

(5) Receipts.--Notwithstanding the Mineral Leasing Act (30 U.S.C. 181 et seq.), of the amount of adjusted bonus, rental, and royalty receipts derived from the oil and gas program and operations on Federal land authorized under this section--

(A) 50 percent shall be paid to the State of Alaska; and

(B) the balance shall be deposited into the Treasury

Here is the text that was slipped into the Tax Act

as miscellaneous receipts.

(c) 2 Lease Sales Within 10 Years.--

(1) Requirement.--

(A) In general.--Subject to subparagraph (B), the Secretary shall conduct not fewer than 2 lease sales area-wide under the oil and gas program under this section by not later than 10 years after the date of enactment of this Act.

(B) Sale acreages; schedule.--

(i) Acreages.--The Secretary shall offer for lease under the oil and gas program under this section--

(I) not fewer than 400,000 acres area-wide in each lease sale; and

(II) those areas that have the highest potential for the discovery of hydrocarbons.

(ii) Schedule.--The Secretary shall offer--

[[Page 131 STAT. 2237]]

(I) the initial lease sale under the oil and gas program under this section not later than 4 years after the date of enactment of this Act; and

(II) a second lease sale under the oil and gas program under this section not later than 7 years after the date of enactment of this Act.

(2) Rights-of-way.--The Secretary shall issue any rights-of-way or easements across the Coastal Plain for the exploration, development, production, or transportation necessary to carry out this section.

(3) Surface development.--In administering this section, the Secretary shall authorize up to 2,000 surface acres of Federal land on the Coastal Plain to be covered by production and support facilities (including airstrips and any area covered by gravel berms or piers for support of pipelines) during the term of the leases under the oil and gas program under this section.

SEC. 20002. LIMITATIONS ON AMOUNT OF DISTRIBUTED QUALIFIED OUTER CONTINENTAL SHELF REVENUES.

Section 105(f)(1) of the Gulf of Mexico Energy Security Act of 2006 (43 U.S.C. 1331 note; Public Law 109-432) is amended by striking ``exceed $500,000,000 for each of fiscal years 2016 through 2055.'' and inserting the following: ``exceed--

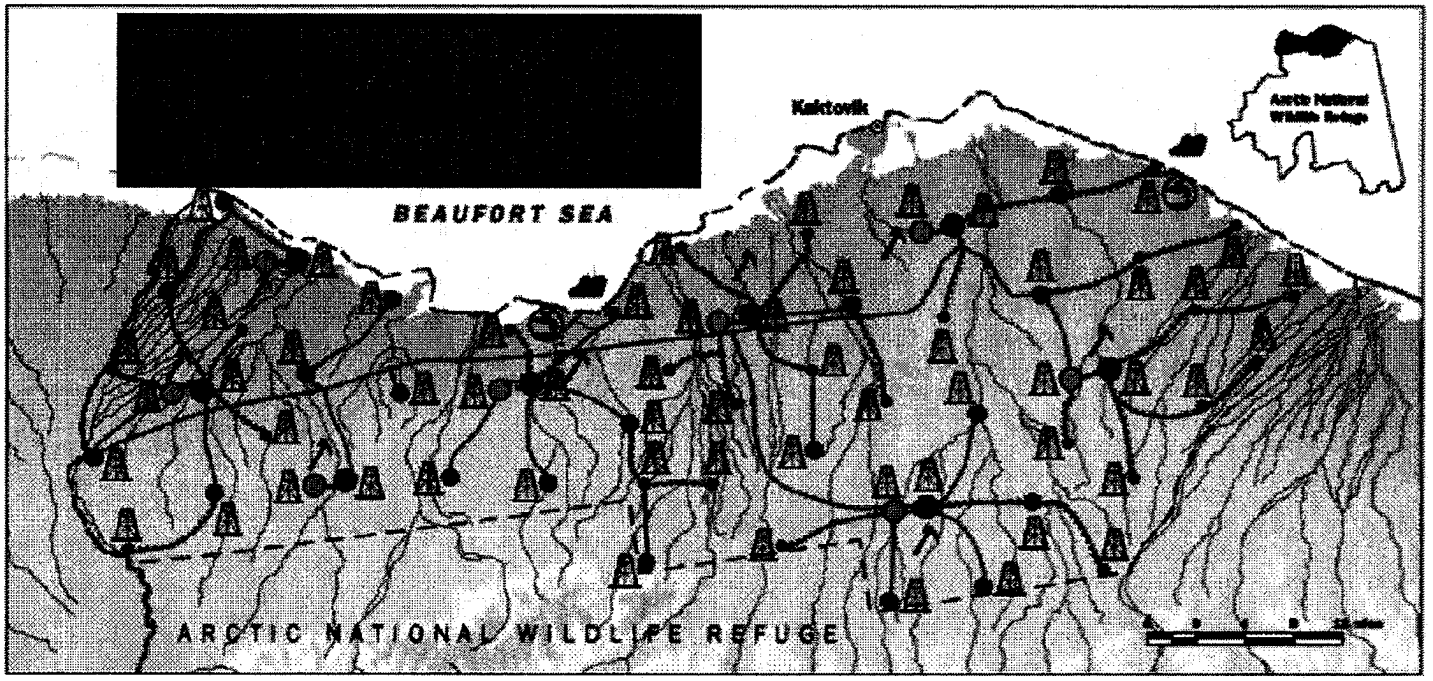
``(A) $500,000,000 for each of fiscal years 2016 through 2019;

``(B) $650,000,000 for each of fiscal years 2020 and 2021; and

``(C) $500,000,000 for each of fiscal years 2022 through 2055.''.

SEC. 20003. <<NOTE: 42 USC 6241 note.>> STRATEGIC PETROLEUM RESERVE DRAWDOWN AND SALE.

(a) Drawdown and Sale.--



Oil industry proponents claim that drilling in the Arctic National Wildlife Refuge would disturb only 2,000 acres of its 1.5-million-acre coastal plain. But as this scenario shows, with oil spread across the coastal plain in more than 30 small deposits, the massive industrial network needed to support drilling facilities would span the entire plain, fragmenting its vast, fragile wilderness.

Facilities in this roughly 2,000-acre scenario include:

- Oil fields
  - (8) Alpine-type fields at 82 acres each (central processing pad with housing, storage, drilling; second drill site ●; airstrip)
  - (19) Satellite fields at 37 acres each (drill site; airstrip or storage pad)
  - (26) Satellite fields at 11 acres each (drill site)
- (2) Docks at 5 acres each (1,100-foot solid-fill gravel causeway)
- (2) Seawater treatment plants at 100 acres each

Icons not to scale. Scenario assumes directional drilling reach up to 4 miles from drill sites.

Industrial facilities that would exceed the 2,000 acres include:

- ····· Roads
- ——— Pipelines
- (8) Gravel mines at 150 acres each

Not mapped:

- ▸ Seismic exploration trails
- ▸ Exploration and delineation trails
- ▸ Water reservoir excavations, water withdrawal sites
- ▸ Ice roads

- – – – Arctic Refuge Coastal Plain (1002 Area)
- —— Arctic National Wildlife Refuge

NRDC

Center for American Progress

ENERGY AND ENVIRONMENT

Interior Department Is Cutting Corners and Ignoring Science in the Arctic National Wildlife Refuge

By Kate Kelly, Matt Lee-Ashley, Jenny Rowland-Shea, and Sally Hardin | Posted on January 10, 2019, 9:01 am

Getty/Steven Kazlowski

A polar bear is seen with cubs at the Arctic National Wildlife Refuge in 2014, in North Slope, Alaska.

In the waning days of 2018, the U.S. Interior Department took a major step toward allowing oil drilling in the Arctic National Wildlife Refuge by releasing a draft environmental impact statement (DEIS) that downplays and underestimates the damage that would result from drilling one of the most wild places left on earth.* The review, required by law and conducted by a private contractor hired by the Interior Department, assesses the potential environmental impacts of auctioning off drilling rights on more than 1 million acres of the coastal plain in the Arctic Refuge.

A Center for American Progress review of the Interior Department's environmental analysis finds that it dramatically underestimates and discounts the permanent, irreversible damage that would result from drilling in the Arctic Refuge. Even through the assessment's rosy lens, it's clear that drilling would have terrible consequences for the refuge, its wildlife, and the indigenous populations who rely on it for subsistence.

The Trump administration is hurrying this inadequate assessment in an attempt to sell off drilling rights before Congress or a future administration can intervene to block destruction of the Arctic Refuge. Significantly, no new scientific data were collected for the DEIS—though an independent 2018 U.S. Geological Survey report found that there are many data gaps and a significant amount of outdated information on coastal plain resources and the potential impacts of oil and gas development in the refuge.

This column discusses five of the many areas where the rushed assessment fails to capture the full impacts of drilling in the Arctic Refuge: oil spills; destruction of polar bear and caribou habitat; increased carbon pollution; surface disturbance; and water consumption.

Oil spills

Based on historical oil and gas activity on Alaska's North Slope, the DEIS expects that development would result in up to 1,745 oil spills, including six large spills. Although these are striking numbers, the assessment downplays the risk, stating that the probability of a spill of more than 100,000 gallons is "low" because there were "only" three spills of that magnitude documented from 1985 to 2010.

If one examines oil spill data from across Alaska, however, the prospect of a major spill in the Arctic Refuge seems almost certain. From 1995 to 2005, North Slope oil fields averaged more than 400 oil spills per year. Across Alaska, there were 16 major spills from 2002 to 2016 that released at least 10,000 gallons of oil each into the environment; five of those released more than 100,000 gallons each. Most recently, in April 2017, a BP well in nearby Prudhoe Bay gushed oil and gas for three days before an emergency response team managed to kill the well.

Destruction of polar bear and caribou habitat

According to estimates used by the U.S. Fish and Wildlife Service, there are just 900 Southern Beaufort Sea polar bears left in the world—a stunning 50 percent decline from just 30 years ago. The DEIS tellingly fails to include an estimate of how many polar bears could be killed, injured, or displaced by drilling in the Arctic Refuge, but it does acknowledge that "the potential for injury or mortality could be high when developing new oil and gas projects."

More than 77 percent of the coastal plain—the area of the refuge under consideration for leasing—serves as critical denning habitat for polar bears, with a concentration of maternal dens in areas the DEIS identifies as having high oil and gas potential. The DEIS suggests that infrared cameras are an "effective means of locating dens" in order to avoid disturbance. Independent polar bear experts note, however, that this method of locating dens is very unreliable and that surveyors could miss up to 50 percent of dens due to poor weather conditions, hilly terrain, snow depth, and failure of industry to apply best practices—errors that could result in deaths of or injuries to polar bears.

The DEIS also suggests that 49 percent of the coastal plain that could be offered for leasing is sensitive calving grounds for porcupine caribou, a herd whose long-term health is inextricably linked to the Arctic Refuge. This statistic, however, vastly undercounts the value of the coastal plain to the caribou, who use virtually 100 percent of the area during calving and post-calving seasons—a statement supported, in part, by the review's own maps of the herd's historic movements.

Even with the downplayed numbers, the assessment does acknowledge that activity that moves the herd away from the coastal plain would be detrimental, citing a study predicting an 8 percent decline in calf survival due to displacement. While the DEIS acknowledges that the potential for disturbance and displacement of caribou could cover up to 633,000 acres—40 percent of the coastal plain—it offers a wholly insufficient solution to mitigate the impact: suspension of "major construction activities"—but not drilling—for a single month of the year. This is particularly problematic given the National Oceanic and Atmospheric Administration's 2018 Arctic Report Card, which found that overall, Arctic caribou populations have decreased by more than 50 percent in the past 20 years.

Increased carbon pollution

The DEIS significantly underestimates the greenhouse gas (GHG) emissions that would result from drilling the Arctic Refuge. Misleadingly, the analysis only calculates the fractional GHG emissions from the consumption and combustion of oil that would result from the net increase in oil demand that the analysis predicts would result from Arctic Refuge production. As a result, the Trump administration's analysis suggests that the indirect GHG emissions from combustion and downstream use of the oil would amount to 0.7 million to 5 million metric tons annually.

But if one calculates the total GHG emissions that would result from combustion of all the oil and gas that the DEIS predicts will be extracted from the Arctic Refuge, this number is magnitudes higher. CAP estimates that closer to 62 million metric tons of CO2 equivalent would be released into the atmosphere from the oil that the DEIS predicts will be produced from the Arctic Refuge—equal to the annual emissions of approximately 16 coal-fired power plants or 13 million cars.

Surface disturbance

The Trump administration's environmental assessment of drilling the Arctic Refuge performs some impressive twists in order to state that disturbance to land from oil and gas activity would be limited to fewer than 2,000 acres, as required by law. The DEIS creatively interprets the legislative language so that elevated pipelines and gravel pit mines do not

count as surface disturbance; it also does not count the disturbance from other activities such as seismic exploration or ice road construction. More than 200 miles of elevated pipelines would be constructed in the refuge, but the analysis only considers the posts that touch the ground—a vast undercount of a pipeline's footprint. Similarly, the analysis arbitrarily discounts the anticipated 325 acres of gravel pits.

Water consumption

The DEIS avoids providing a clear estimate of how much water will be required for energy development, but a CAP analysis of numbers scattered throughout the document finds the potential water consumption of drilling the Arctic Refuge to be staggering—billions of gallons per year—and inconsistent with the continued provision of clean water for fish and wildlife species in the area.

CAP estimates that up to 1.3 billion gallons of water—and perhaps far more—would be needed to drill the oil wells that the DEIS projects would be drilled. The DEIS states that drilling a single well requires 420,000 to 1.9 million gallons of water; all of the DEIS' development scenarios contain at least 21 production and satellite pads, with approximately 30 wells per pad. Beyond that, the DEIS states that 1 million gallons of water are needed to construct every mile of ice road, and 500,000 gallons of water are needed for every ice pad.

Most striking is the water required once production starts. Using the numbers from the DEIS, CAP calculates that 5.7 billion gallons of water per year would be needed just to support oil production. The DEIS estimates that producing 50,000 barrels of oil would require 2 million gallons of water per day; it also assumes that up to 142 million barrels of oil could be produced each year, on average.

Over the life of oil production on the coastal plain—which the DEIS estimates could extend from 50 years to 100 years—this all quickly adds up to an unthinkable amount of water. Available fresh water in the coastal plain is scarce and growing scarcer, and the U.S. Fish and Wildlife Service, which manages the refuge, has flagged concerns about the

"cumulative impacts of all stages of oil and gas development" on water and, subsequently, the "populations and habitats of fish and wildlife."

Conclusion

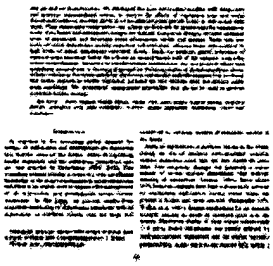
The wild and rugged rivers, plains, and coastline of the Arctic National Wildlife Refuge have been carved and shaped by millions of years of ice, wind, sun, and geologic change. But the Trump administration is offering just 45 days for the public to comment on the draft environmental review of sacrificing these lands for oil drilling.

In the brief window before February 11, it is vital that the public—including Alaska Natives, scientists, and everyone who values the survival of America's wildlife—call out the deceptive estimates, wishful thinking, and inadequate analysis that plagues the Trump administration's environmental review. The flaws in this analysis reaffirm how fundamentally wrong it would be to drill the Arctic Refuge, and they underscore the need for Congress, the courts, or a future administration to stop this heedless rush and protect America's last great wilderness.

** Authors' note: Specific page numbers for this column's references to the Interior Department's draft environmental impact statement—and the U.S. Fish and Wildlife Service's concerns about available fresh water on the coastal plain—are on file with the authors.*

Kate Kelly is the director of Public Lands at the Center for American Progress. Matt Lee-Ashley is a senior fellow and the senior director of Environmental Strategy and Communications at the Center. Jenny Rowland-Shea is a senior policy analyst for Public Lands at the Center. Sally Hardin is a research analyst for the Energy and Environment War Room at the Center.

Center for American Progress



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Abstract

In response to the increasing global demand for energy, oil exploration and development are expanding into frontier areas of the Arctic, where slow-growing tundra vegetation and the underlying permafrost soils are very sensitive to disturbance. The creation of vehicle trails on the tundra from seismic exploration for oil has accelerated in the past decade, and the cumulative impact represents a geographic footprint that covers a greater extent of Alaska's North Slope tundra than all other direct human impacts combined. Seismic exploration for oil and gas was conducted on the coastal plain of the Arctic National Wildlife Refuge, Alaska, USA, in the winters of 1984 and 1985. This study documents recovery of vegetation and permafrost soils over a two-decade period after vehicle traffic on snow-covered tundra. Paired permanent vegetation plots (disturbed vs. reference) were monitored six times from 1984 to 2002. Data were collected on percent vegetative cover by plant species and on soil and ground ice characteristics. We developed Bayesian hierarchical models, with temporally and spatially autocorrelated errors, to analyze the effects of vegetation type and initial disturbance levels on recovery patterns of the different plant growth forms as well as soil thaw depth. Plant community composition was altered on the trails by species-specific responses to initial disturbance and subsequent changes in substrate. Long-term changes included increased cover of graminoids and decreased cover of evergreen shrubs and mosses. Trails with low levels of initial disturbance usually improved well over time, whereas those with medium to high levels of initial disturbance recovered slowly. Trails on ice-poor, gravel substrates of riparian areas recovered better than

those on ice-rich loamy soils of the uplands, even after severe initial damage. Recovery to pre-disturbance communities was not possible where trail subsidence occurred due to thawing of ground ice. Previous studies of disturbance from winter seismic vehicles in the Arctic predicted short-term and mostly aesthetic impacts, but we found that severe impacts to tundra vegetation persisted for two decades after disturbance under some conditions. We recommend management approaches that should be used to prevent persistent tundra damage.

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Number of times cited according to CrossRef: 29

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