THE ARCTIC'S PLASTIC CRISIS:
TOXIC THREATS TO HEALTH, HUMAN RIGHTS, AND INDIGENOUS LANDS FROM THE PETROCHEMICAL INDUSTRY

April 2024

ACAT Alaska Community Action on Toxics

IPEN for a toxics-free future

> "Worldwide we are not prepared for catastrophic disasters. Rural Alaska, rural communities, indigenous tribes all over the world are under assault… We are overwhelmed with concern about the health harms associated with climate change, the loss of sea ice and melting permafrost, and the mobilization of chemicals and plastics — these are all interconnected. We are running out of time!"

DELBERT PUNGOWIYI, YUPIK ELDER, ARCTIC INDIGENOUS LEADER, AND HUMAN RIGHTS ADVOCATE FROM SIVUQAQ, ALASKA

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ACAT's mission is to assure justice by advocating for environmental and community health. ACAT believes that everyone has a right to clean air, clean water, and toxic-free food.

www.akaction.org

IPEN is a network of over 600 non-governmental organizations working in more than 125 countries to reduce and eliminate the harm to human health and the environment from toxic chemicals.

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FOREWORD

COMPOUNDING TOXIC THREATS

Though I have repeatedly used the term compounding in relation to the threats to our traditional territory as Arctic Indigenous Peoples, on the heels of the Arctic Science Summit Week 2024 and the Plastics Treaty talks thus far, I am convinced now more than ever that we face conditions beyond a red alert. Scientists underscored both visually and verbally multiple context-specific threats. On a global scale, the term compounding becomes even more acute. The verb itself is elementary -- to "make (something bad) worse; intensify the negative aspects of" or "to make something bad become even worse by causing further damage or problems."

This report, like the many conclusions shared through Indigenous Knowledge holders and science, highlights the "combined effects of chemicals and plastics in the Arctic that are exacerbated by rapid climate warming." At the same time, without adequately addressing these threats, it is perplexing that the United Nations is promoting its Sustainable Development Goals, and the distinct aim to "prevent dangerous anthropogenic (human-induced) interference with the climate system" as well as affirming through international law "a universal framework of minimum standards for the survival, dignity, wellbeing and rights of the world's Indigenous Peoples."

Against this backdrop, Inuit, as Arctic Indigenous Peoples that have been sustained by the coastal seas and Arctic Ocean, will participate in the upcoming negotiations to establish an international Plastics Treaty. They will be joining advocates from around the world and especially those most impacted by toxic plastics in calling for caps on the manufacture of new plastics and a human rights-based approach in the Plastics Treaty, and more specifically, an approach that affects the interrelated human rights of Arctic Indigenous Peoples.

Because of the role of the Arctic in planetary health and the rights of Indigenous Peoples, like the Stockholm Convention on POPs and Minamata Convention on Mercury, both should be highlighted in the Plastics Treaty. For these and many other reasons highlighted in this report, UN Member States, resistant to recognition of the right of self-determination of Indigenous Peoples, should, at a minimum, flex their muscle, and exercise their right of self-determination rather than behave as though they are solely at the mercy of industry and free of the solemn international legal commitments that they have explicitly made in relation to our planet and Indigenous Peoples as knowledge holders and the originators of sustainable development, especially those of the cryosphere. Refusing to deliberately lean into each of these imperatives will only result in further compounding the toxic threats that we face. Yet, the upcoming negotiations offer the world community an opportunity to align us with powerful legal and moral imperatives.

Dalee Sambo Dorough
Senior Scholar and Special Advisor
on Arctic Indigenous Peoples
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KEY TAKEAWAYS

Damage to the Arctic from the fossil fuel/petrochemical industry includes threats from chemicals, plastics, and climate. These have combined to poison lands, waters, and traditional foods of Arctic Indigenous Peoples, with ongoing health effects that threaten their cultures and communities.

This report highlights the voices and testimony of Indigenous leaders who have witnessed these threats and who are engaged in local and global efforts to protect their land and People.

SOME KEY TAKEAWAYS INCLUDE:

- **There is a long history of resource exploitation and colonization of Arctic Indigenous Peoples' lands and waters, including by the fossil fuel/petrochemical industry.** More than 13 million people from over 40 ethnic groups inhabit the circumpolar north region and are at risk from plastics, chemicals, and climate change.
- **Rapid warming of the Arctic is forcing climate-induced community displacement and threatening food security.** Indigenous Peoples are being pushed out of their traditional lands and losing access to traditional foods, sacred places, and other cultural practices due to the interlinking consequences of chemicals, plastics, and fossil fuels.
- **Many of the multinational oil and gas corporations active in Alaska have long track records of environmental violations.** Air pollution in the Arctic from their operations and their oil spills and releases of hazardous substances harm the environment and threaten Arctic Peoples' health, yet the costs of this damage have never been calculated.
- **The report provides an overview of how the Arctic is at risk from chemicals and plastics throughout their toxic life cycle**—from extraction and production through transport, use, and disposal. Toxic chemicals are released from plastics throughout their life cycle, including through plastic recycling, which further spreads toxic chemicals.
- **The production and use of fossil fuels is the starting point for the problems faced by the Arctic related to plastics, chemicals, and climate change.** Plastics are made from fossil fuels and chemicals (mostly petrochemicals, chemicals derived from fossil fuels). More than 16,000 chemicals are used in plastics: 25% are known to be toxic and 66% lack hazard information. Chemicals and plastics are a global health and environmental crisis.
- **Plastics and chemicals produced all over the world deposit and accumulate in the Arctic, making the Arctic a "hemispheric sink" for chemicals and plastics.** This concentration of plastics and chemicals threatens food security, environment, and Arctic Peoples' health.
- **Plastics carry toxic chemicals, including harmful chemicals that are known to persist in the environment, into the Arctic.** Plastics also sorb toxic chemicals in the environment and transport the chemicals to the Arctic and other remote areas. Evidence shows that climate warming exacerbates the threats to the Arctic from chemicals and plastics and accelerates the rate at which these materials move and accumulate there.
- **As much of the economy begins shifting from fossil fuels to electrification, the industry is seeking to maintain and grow its operations by focusing on increasing plastics and chemical production.** Several large oil corporations that operate in Alaska produce petrochemicals, and industry projections suggest that oil and gas used for petrochemicals will increase from less than 20% today to as much as 50% by 2050. The industry's plan to increase fossil fuel operations in the Arctic is tied to their intent to focus on producing more plastics and chemicals, regardless of the harmful impacts on Arctic Peoples or the climate. Further, climate warming and melting sea ice in the Arctic is opening new areas for exploration and development.

- **Chemicals in plastics threaten the environment and health of Arctic People.** Production, use, transport, and disposal of the fossil fuel/petrochemical industry's products releases chemicals linked to serious health conditions, including, among others:
  - **Polyaromatic hydrocarbons** (PAHs) are linked to cancer, heart disease, and hormone disruption.
  - **Per- and polyfluoroalkyl substances** (PFAS), known as "forever chemicals," are linked to cancer, adverse reproductive health outcomes, liver and thyroid disease, immune system impairment, and other serious health problems.
  - **Chlorinated paraffins** are endocrine-disrupting chemicals (EDCs) and have been linked to kidney impairment, thyroid disruption, neurobehavioral effects, and some may cause cancer.
  - **Phthalates** are EDCs, neurodevelopmental toxicants, and have been linked to cancer and infertility.
  - **Polybrominated diphenyl ethers** (PBDEs, also called brominated flame retardants) are EDCs, neurotoxicants, and adversely affect the reproductive system.
  - **Bisphenols** are EDCs and are linked to obesity and cancer.
  - **Benzotriazole UV-stabilizers**, like UV-328, which is an EDC that is toxic to mammals, especially their livers and kidneys.
  - **Polychlorinated biphenyls** are linked to cancer, diabetes, lower testosterone levels, altered menstrual cycles, and neurodevelopmental harm.

RECOMMENDATIONS IN BRIEF

The report offers recommendations toward a regenerative economy and a Just Transition, underlined by the principle that a healthy economy and a clean environment should co-exist. The process for achieving a just transition should be a fair one that does not cost workers or community residents their health, environment, jobs, or economic assets. The report further recommends:

- **Ending government subsidies to the fossil fuel and petrochemical industries and supporting clean, renewable energy and a toxics-free materials economy.**
- **Stopping fossil fuel and petrochemical industry expansion and accelerating the shift to a clean, renewable energy future.**
- **Adopting policies and practices as defined in the Louisville Charter for Safer Chemicals and eliminating the production, use, and disposal of toxic chemicals and plastics.**
- **Integrating the principles of the Just Transition framework.**
- **Strengthening and ensuring strong implementation of the international Stockholm Convention on Persistent Organic Pollutants ("POPs Treaty") and instituting an effective, legally binding global Plastics Treaty.**

EXECUTIVE SUMMARY

In Alaska and the circumpolar Arctic, the combined effects of destructive extraction of fossil fuels, releases of oil and toxic chemicals associated with exploration and production of fossil fuels, and climate change are harming the health and well-being of communities. Indigenous Peoples' lands, waters, and health are damaged through exploitation for minerals, oil, and gas, coupled with a rapidly warming climate. Food security, environment, and human health are threatened by climate change and the increasing concentrations of toxic chemicals and plastics accumulating in fish, wildlife, and people from local and global sources.

While distinct and challenging in their own realms, the problems of plastics, toxic chemicals, and climate change are interconnected and attributable to fossil fuel production and use. Almost all plastics are produced from fossil fuels. And the fossil fuel industry is looking to dramatically increase its production of petrochemicals and plastics as the transition to renewable energy lessens the demand for direct combustion of fossils fuels. Meanwhile, the burning of fossil fuels exacerbates the devastating consequences of climate warming, particularly in the Arctic. This region is warming at a rate nearly four times faster than the rest of the world.

This report explains how the Arctic is a hemispheric sink for chemicals and plastics that are transported on atmospheric and oceanic currents from lower latitudes through a process known as global distillation or the "grasshopper effect." It also summarizes scientific information concerning the association and combined effects of chemicals and plastics in the Arctic that are exacerbated by rapid climate warming, all of which are consequences of destructive exploitation by the fossil fuel, chemicals, and plastics industries. The report shows how Alaskan communities are laying the groundwork in creating a post-extractive future for the state focused on reconnecting with traditional Indigenous values. Transformational changes are urgently needed from the local to international levels to prevent further harm and to advance solutions. For this reason, we advocate for a Just Transition framework that is specifically oriented toward shifting Alaska and the world from an extractive to a regenerative economy that fosters healthy, equitable communities. We include recommendations that include the key elements necessary for a strong new treaty on plastics and measures to eliminate harm from the entire life cycle of plastics from production to disposal.

INTRODUCTION

This report provides an overview of how chemicals and plastics produced from fossil fuels affect Alaska and the Arctic throughout their toxic life cycle (**Figure 1**). The report offers recommendations toward a just transition and a regenerative economy and suggests that policymakers should stop favoring corporate interests and instead prioritize protecting Indigenous cultures and communities, preserving biodiversity, and nurturing the vital climate-protective role that Alaska and the circumpolar Arctic play in carbon storage.

As noted by Vynne and co-authors in 2021,

> Alaska is globally significant for its large tracts of intact habitats, which support complete wildlife assemblages and many of the world's healthiest wild fisheries, while also storing significant amounts of carbon. Alaska has one-third of United States' federal lands, the bulk of the United States' intact and wild lands, and over half of the country's total terrestrial ecosystem carbon on federal lands. Managing Alaska's public lands for climate and biodiversity conservation purposes over the next 30–50 years would provide meaningful and irreplaceable climate benefits for the United States and globe.

An estimated 62% of the terrestrial ecosystem carbon stocks on federal lands in the U.S. are located within Alaska (Merrill et al. 2018). The state is home to 229 federally recognized tribes and the nation's highest proportion of Indigenous Peoples , with rich cultural heritages intrinsically linked to the lands and waters.

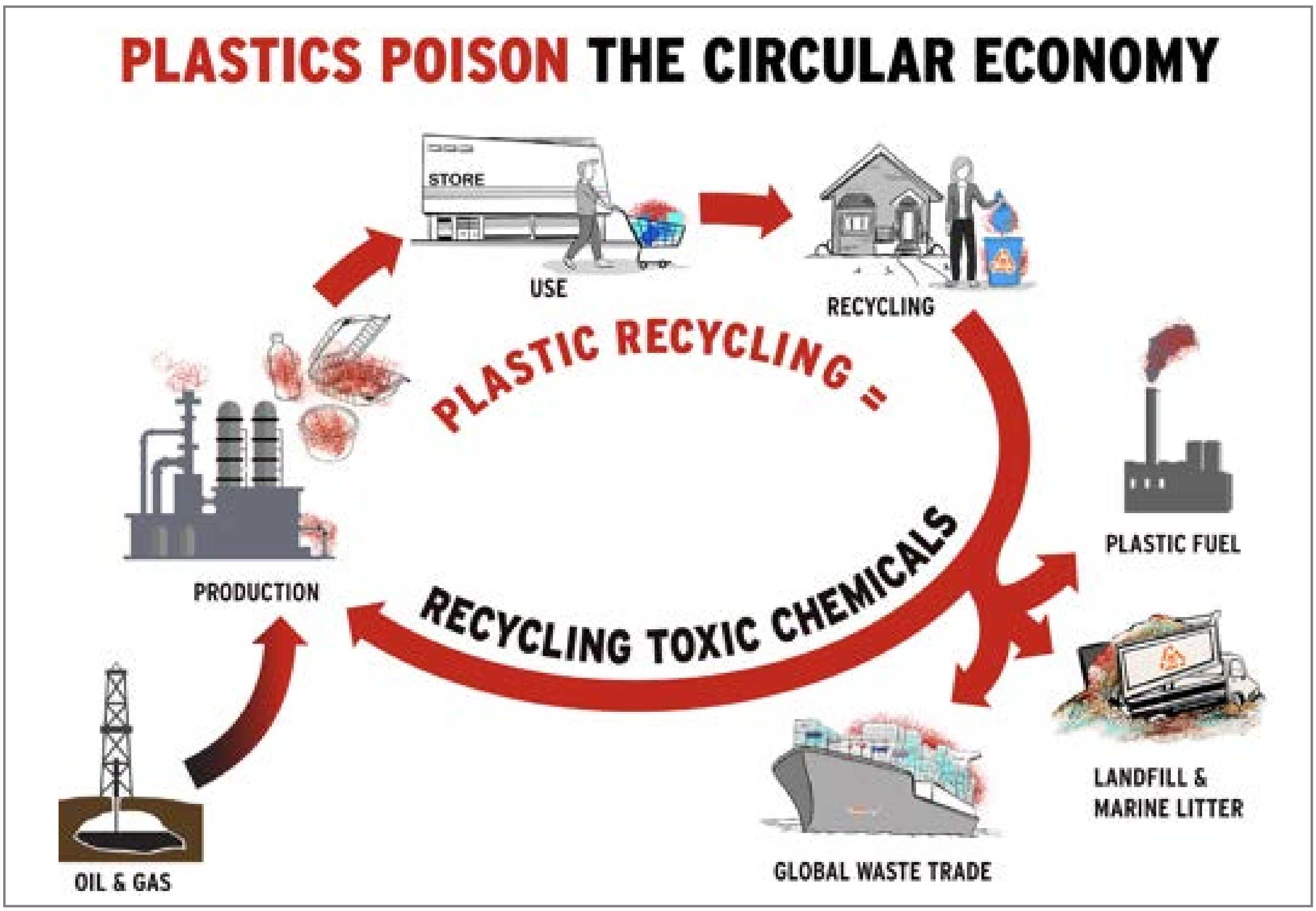


Figure 1 Toxics and plastics life cycle

The Arctic is warming nearly four times faster than the planet as a whole (Rantanen et al. 2022). Significant temperature increases have resulted in melting permafrost, loss of sea and land ice, increases in extreme weather, and the necessity to re-locate communities that are unstable due to increasing erosion, storm surges, and permafrost thaw. Scientists have shown that climate warming exacerbates the mobilization of chemicals and plastics that are sequestered in sea ice, permafrost, and glaciers. Climate warming also accelerates the rate of global distillation (i.e., a transport mechanism for persistent organic pollutants) and deposition of chemicals and plastics transported from lower latitudes into the Arctic (AMAP 2021; Cozar et al. 2017; Bergmann et al. 2022; de Wit et al. 2022; Jenssen et al. 2006).

Currently, a new global treaty on plastics is being negotiated, offering an opportunity for bold global action to address all stages of the plastics life cycle and the harms to health and human rights from plastic pollution. Marcos Orellana, the United Nations Special Rapporteur on Toxics and Human Rights, said, “Plastics are a global threat to human rights, including not only the right to a healthy environment but also the rights to life, health, food, water and an adequate standard of living.” Orellana and David Boyd, Special Rapporteur on Human Rights and Environment, further stated,

> Each stage of the plastics cycle has direct and adverse impacts on the enjoyment of human rights. This includes extraction and transport of fossil fuels that are used to make virgin plastic; the release of hazardous substances during plastics production that affect fenceline communities; the exposure during use to the hazardous chemicals added to plastics; and the mountains of plastics and microplastic waste that is mismanaged. To be effective, the plastic treaty must address all stages of the plastics cycle. (UN OHCHR 2022)

"The chemicals present in our bodies are passed on to our Indigenous children and harm their ability to learn our languages, songs, stories, and knowledge."

VI PANGUNNAAQ WAGHIYI, YUPIK MOTHER AND GRANDMOTHER, MEMBER OF THE WHITE HOUSE ENVIRONMENTAL JUSTICE ADVISORY COUNCIL, FROM SIVUQAQ, ALASKA

FOSSIL FUEL EXTRACTION AND PETROCHEMICALS IN ALASKA

Oil extraction follows a long history of resource exploitation and colonization of Alaska Native peoples' lands and waters. For centuries, outside interests have sought to commercialize Alaska's natural resources, including timber, fish, marine mammals, coal, gold and other minerals, as well as oil and gas.

The first commercial oil production in Alaska began in 1902 at Katalla, on the coast of the Gulf of Alaska about 47 miles southeast of Cordova, within the traditional territory of the Eyak people. A small refinery operated at Katalla until 1937 and the field produced about 140,000 barrels of oil over a 30-year period (AOGCC 2008). For thousands of years, the Eyak people inhabited the village called Qaataalah at what became known as Katalla. "They were displaced from their lands and nearly destroyed by the discovery of oil at Katalla, the settlement of Cordova in 1909, and the building of the Copper River & Northwestern Railroad between Cordova and the Kennecott copper mines (completed in 1911)" (Howery 2014).

In a 2019 letter to the State of Alaska opposing new oil and gas exploration in Katalla and Controller Bay, the Eyak Preservation Council noted that the harm caused by the oil production in the early 1900s persisted to the present day and has "...resulted in abandoned machinery, uncontained oil pits and unnecessary environmental destruction. Our concerns about future exploration stem from the economic, ecological, cultural, and spiritual values of the area coupled with the challenges for oil spill response in this particularly dangerous and unpredictable marine environment" (Hoover 2019).

The first major discovery of oil in Alaska occurred in 1957 on the Kenai Peninsula of Alaska on the traditional lands of the Kahtnuht'ana Dena'ina people (Kenaitze Tribe), an area designated by the federal government as the Kenai National Wildlife Refuge. The development of the Swanson River oil field helped propel Alaska into statehood by 1959 (AOGA 2021). The state held the first offshore oil and gas lease sale in Cook Inlet in 1962. Oil production peaked in Cook Inlet in 1970. Since the early days, the Cook Inlet region has produced more than 1.4 billion barrels of oil and 5 trillion cubic feet of natural gas (Cook Inletkeeper 2024). In 2022, the Inflation Reduction Act passed by Congress required that the U.S. Department of the Interior hold an oil and gas lease sale in Cook Inlet in federal waters. As a measure of the lack of interest in the lease sale held on December 30, 2022, Hilcorp Alaska was the sole bidder. The company bid $63,983 on a 2,304-acre tract within the nearly one million acres offered by the Department of the Interior lease sale (Poux 2023). The lease sale is being challenged by environmental health and justice organizations, including Cook Inletkeeper, Alaska Community Action on Toxics, Center for Biological Diversity, Kachemak Bay Conservation Society, and the Natural Resources Defense Council.

On March 13, 1968, Atlantic Richfield Company (ARCO) and Humble Oil (now Exxon Corporation) announced the discovery of oil in Prudhoe Bay on the North Slope of Alaska . The prospect of major oil reserves on the North Slope provided an incentive for Congress to pass the Alaska Native Claims Settlement Act (ANCSA) in 1971 to resolve land claims. This paved the way for the construction of the Trans-Alaska Pipeline. ANSCA "extinguished by legislation the aboriginal title Alaska Natives held to their lands throughout Alaska, and it extinguished also their aboriginal right to hunt and fish on these lands" (Berger 1985). The Act required the formation of twelve private, for-profit Alaska Native regional corporations and over 200 private, for-profit Alaska Native village corporations (ANCSA 2024). The state and federal governments appropriated 90% of the lands in Alaska while promising title to 44 million acres to Alaska Native regional and village corporations, about 10% of Alaska's lands. In compensation for the 321 million acres of land appropriated by the state and federal governments, ANCSA provided for payment of $962.5 million to the newly established Alaska Native corporations for lands taken in the settlement agreement, a rate of about three dollars per acre (Berger 1985; Ongtooguk 2012).

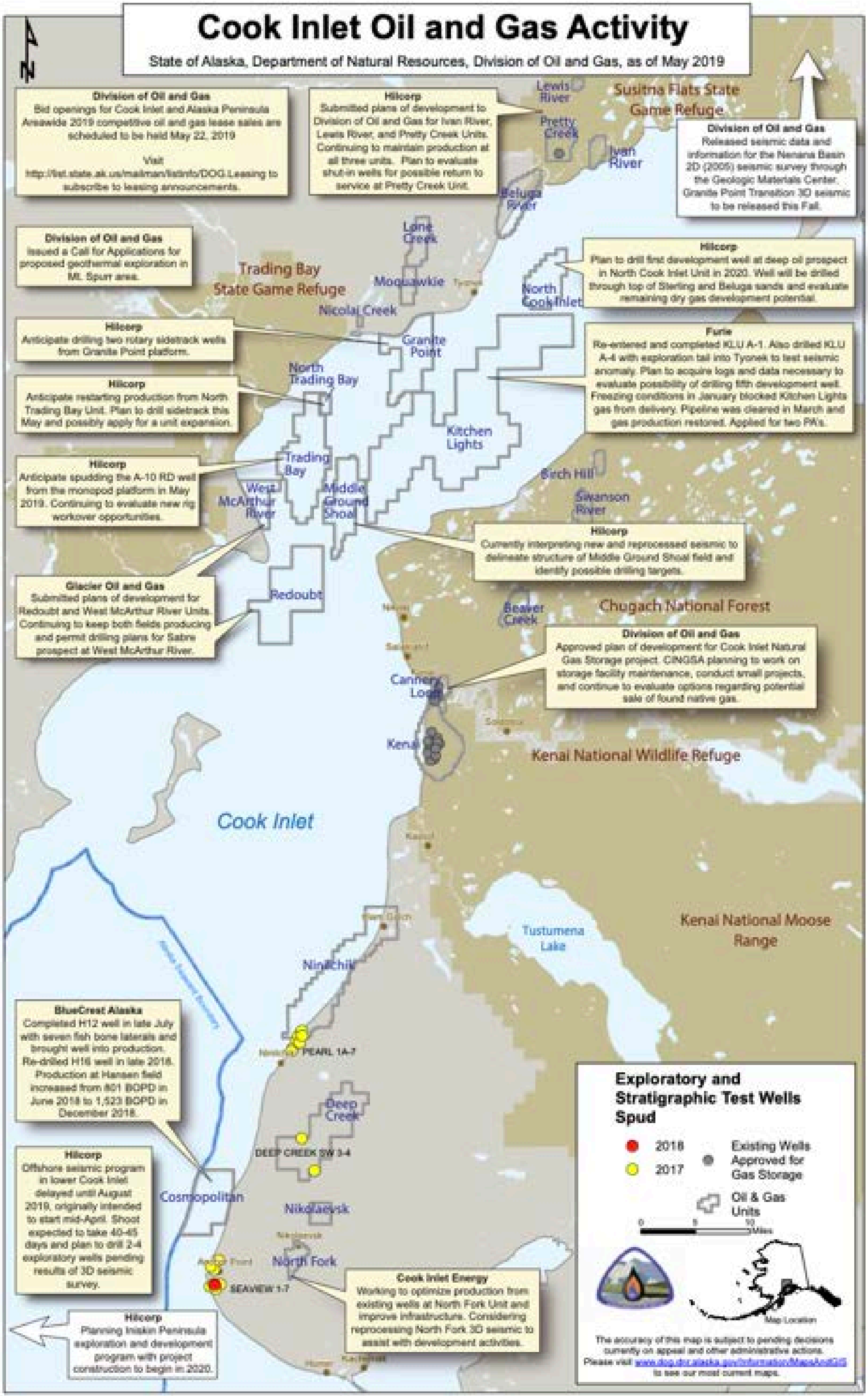
As Iñupiat scholar Paul Ongtooguk said,

> ANCSA is criticized both in terms of product and process, i.e., it yielded too little, and the process did not meet a reasonable bar for inclusion. Most condemning for some is that as Native corporations, created in the image of a Western corporate model, have prospered, many Alaska Natives see ANCSA as a vehicle for assimilation. In this view the quest for profits has trumped the quest for culture. (Ongtooguk 2012)

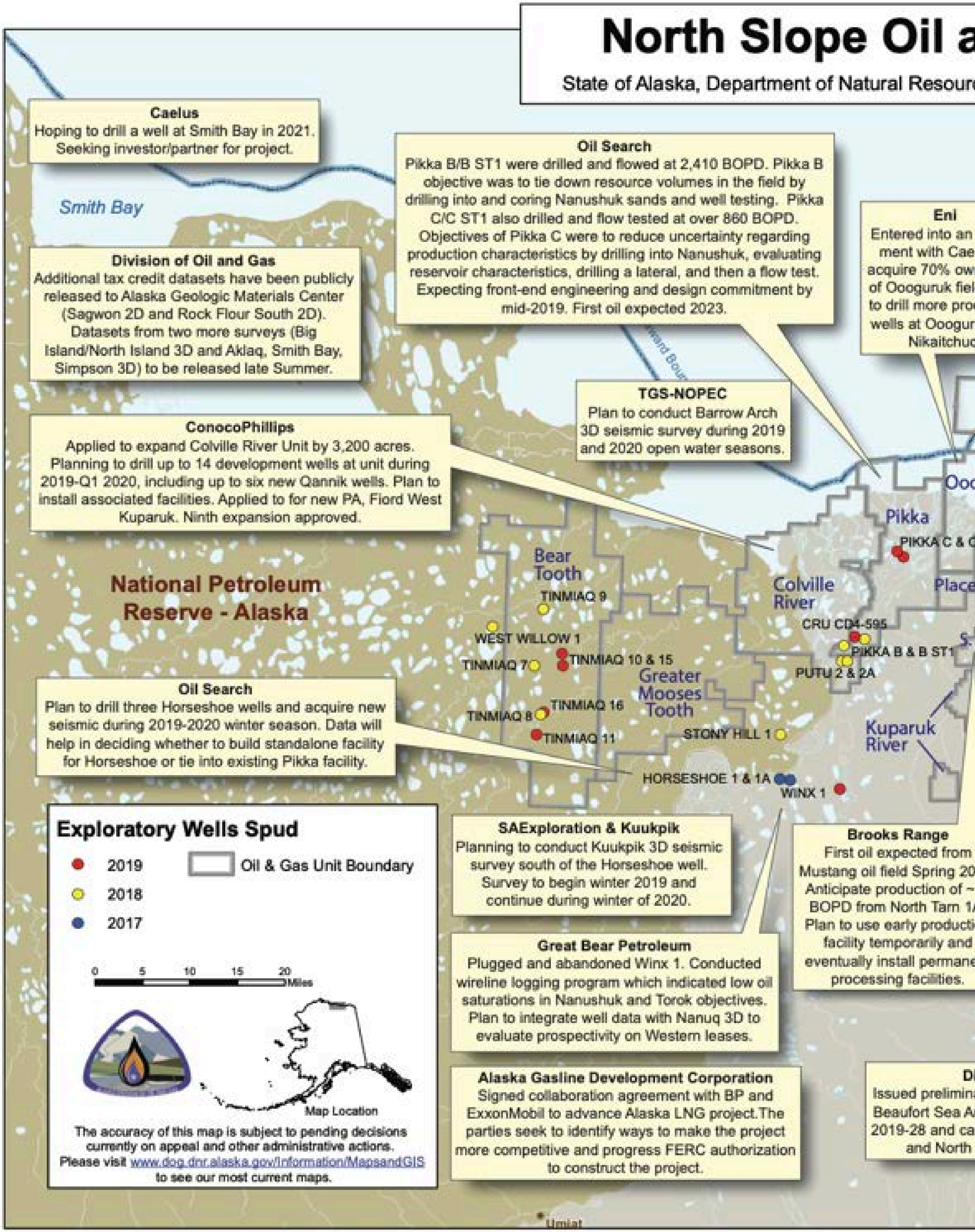
By 1969, the state had received $900 million from the sale of North Slope leases. In 1973, the passage of the Trans-Alaska Pipeline Authorization Act removed legal barriers and allowed construction of the 800-mile pipeline to expedite the shipment of oil (AKRDC 2020). Production of oil from the Prudhoe Bay oil field and flow through the Trans-Alaska Pipeline began operating in 1977. Today, the pipeline carries oil from the North Slope to the tanker terminal in Valdez, Alaska, where it is transported by tankers to refineries in the lower 48 states (the forty-eight contiguous US states, excluding Alaska and Hawaii) and to markets in other countries. The warming climate in the Arctic is opening new areas for exploration, production, and shipping (EIA 2022).

Development of additional major oil fields on the North Slope followed Prudhoe Bay, including Kuparuk, second to Prudhoe Bay as North America's largest oil field. By 1981, the Alaska North Slope accounted for nearly 18% of all U.S. oil production (Dschaak 2020). By 2020, oil production on the North Slope constituted only 4% of all oil production in the United States (Marohl 2021).

Over 19 billion barrels of oil and nearly 129 billion cubic feet of gas have been produced in Alaska; however, oil production peaked on the North Slope in 1988 and is continuing to decline. Although industry is planning for additional production in this region, reliance on further oil and gas extraction makes for an unstable and volatile economy and, given the climate crisis, contradicts the need for rapid shift to renewable energy sources.



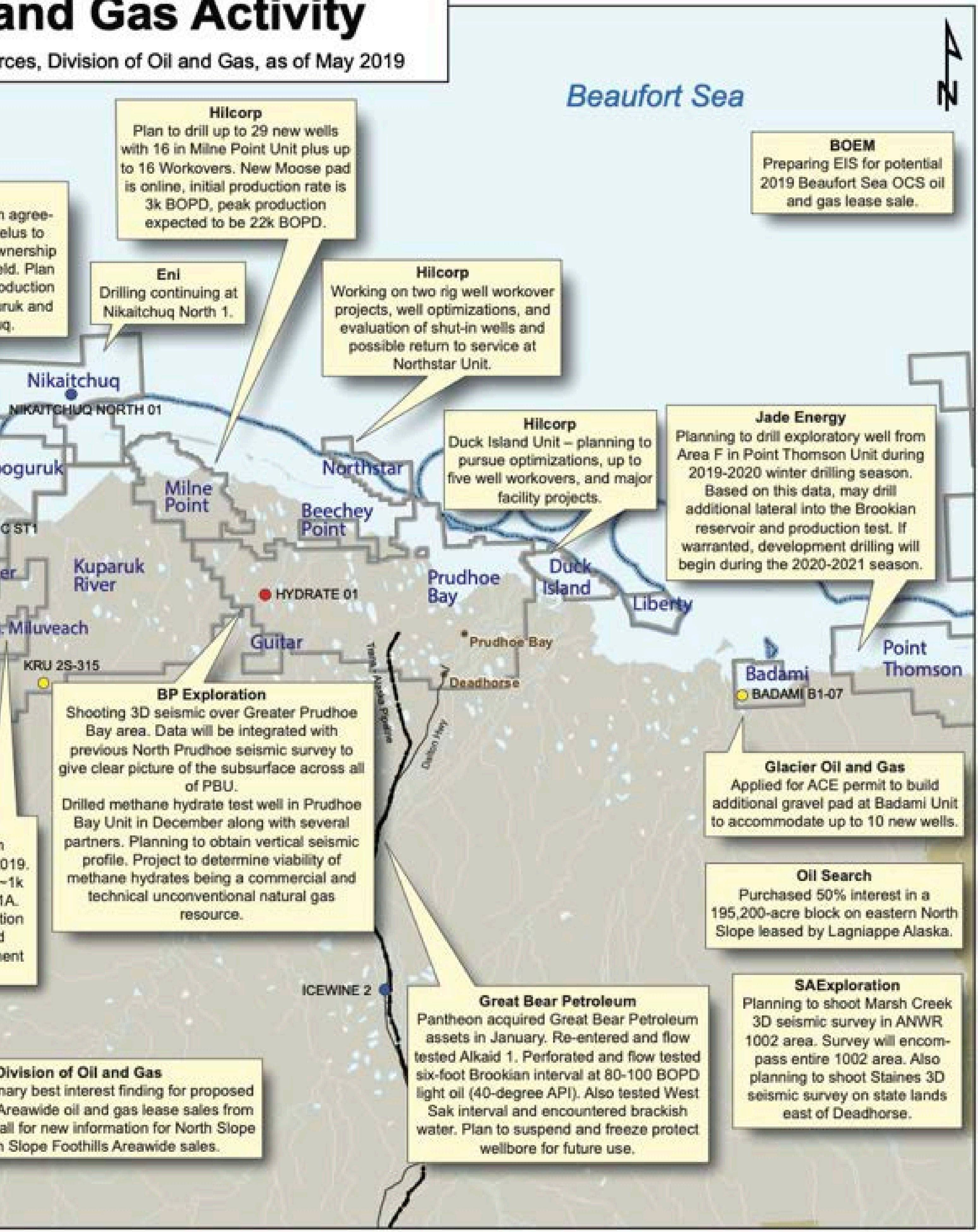
Map 1 Map of oil and gas development in Cook Inlet
Source: Alaska Department of Natural Resources

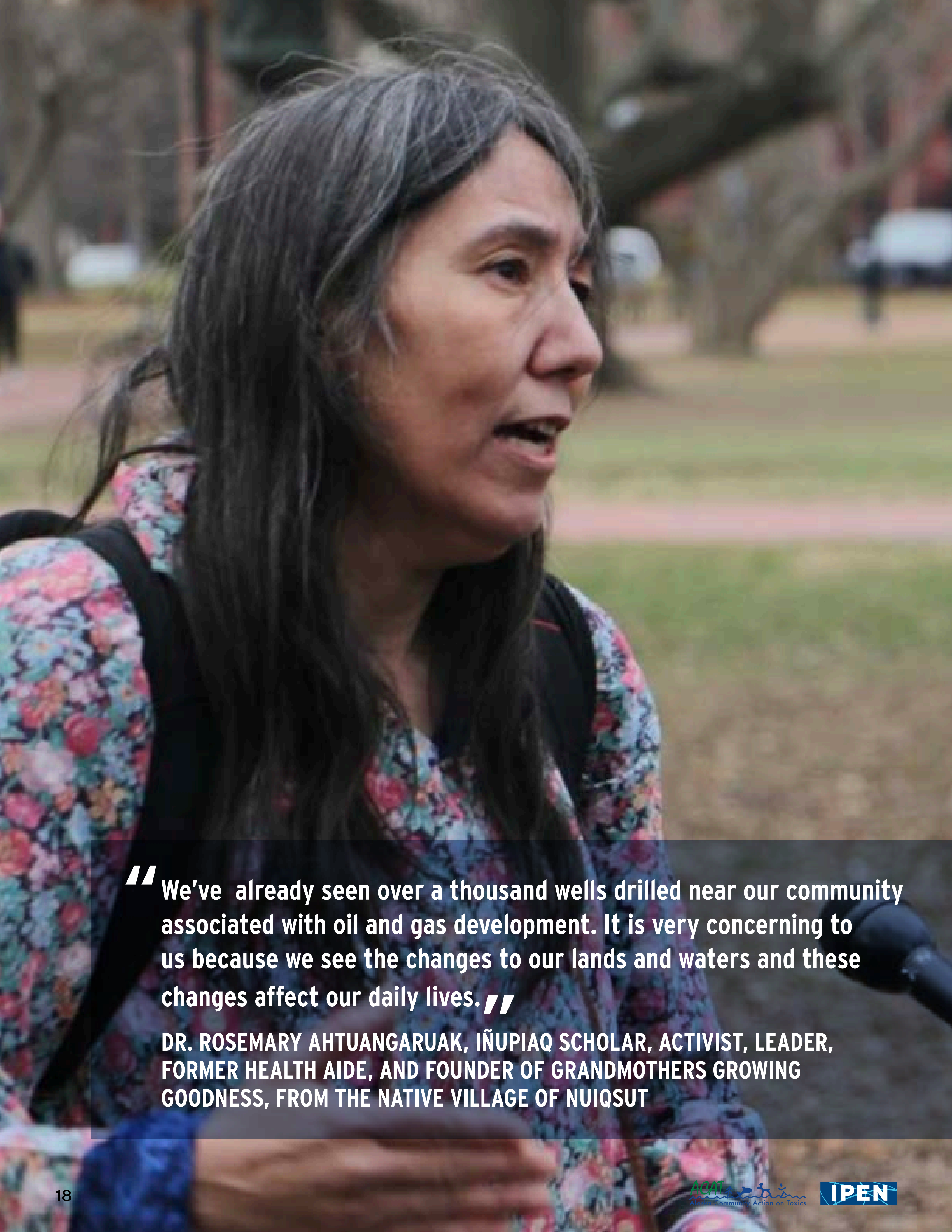


Map 2 Map of North Slope oil and gas development Source: Alaska Department of Natural Resources

and Gas Activity

rces, Division of Oil and Gas, as of May 2019





"We've already seen over a thousand wells drilled near our community associated with oil and gas development. It is very concerning to us because we see the changes to our lands and waters and these changes affect our daily lives."

DR. ROSEMARY AHTUANGARUAK, IÑUPIAQ SCHOLAR, ACTIVIST, LEADER, FORMER HEALTH AIDE, AND FOUNDER OF GRANDMOTHERS GROWING GOODNESS, FROM THE NATIVE VILLAGE OF NUIQSUT

SOMETHING BEAUTIFUL OVER THE HORIZON

Nuiqsut is an Iñupiat community of about 500 people located near the Beaufort Sea coast in the Colville River Delta on the North Slope of Alaska. Nuiqsut is an Iñupiaq word meaning "something beautiful over the horizon" (Harball 2019). Based on hundreds of years of cultural and spiritual traditions, people are reliant on foods from the land and sea including seals, walrus, whales, fish, caribou, and birds. The community is now surrounded by a complex array of active oil and gas exploration, production, and processing facilities. Industrial activities are affecting migratory routes and habitats of species such as caribou, birds, and whales, resulting in decreased food security. Coupled with the rapid rate of development, climate warming is resulting in changes to the landscape and waters that further imperil fish, wildlife, and the traditional way of life for people living in Nuiqsut. These changes include decreasing water levels in rivers and streams, warming water temperatures, melting permafrost and sea ice, and erosion.

In March 2023, the Biden Administration approved the largest proposed oil and gas project on federal lands in the United States, the Willow project. The Biden Administration made this decision despite a campaign promise of "no more drilling on federal lands, period" (Stevens 2023) and a commitment to "tackling the climate crisis with the urgency that science demands" (The White House 2021). The proposed Willow project is located about 36 miles from the community of Nuiqsut within the National Petroleum Reserve-Alaska and the "largest tract of undisturbed public land in the United States" (Valdmanis 2023). It is also within the Teshekpuk Lake Special Area, a critical cultural area for traditional fishing and hunting. Teshekpuk Lake is the largest lake in the Alaskan Arctic and one of the most significant wetland complexes in the Arctic, serving as critical habitat for breeding birds and calving grounds for the Teshekpuk Lake caribou herd.

Rosemary Ahtuangaruak, former mayor and community health aide in Nuiqsut, said, "The Biden Administration is moving forward with a massive oil and gas project that is a climate disaster waiting to happen while refusing to listen to the voices of my constituents and community, who will bear the burden of this project with our health and our livelihoods" (Ahtuangaruak 2022). The Willow project would result in construction of up to 250 oil wells, nearly 400 miles of pipelines, 37 miles of roads, airstrips, and associated processing facilities (Rowland-Shea 2022). It is projected to produce 629 million barrels of oil over a 30-year span, the combustion of which would release the equivalent of 277 million tons of carbon dioxide into the Earth's atmosphere (Gordon 2023). If the Willow project proceeds, it would increase exploitation of oil and gas on lands in this region of the Arctic where such operations have previously been inaccessible or too costly for industry. Indigenous and environmental organizations continue to challenge the legality of the Willow project, citing the federal government's failure to comply with fundamental environmental laws, including consideration of the significant greenhouse gas emissions and associated climate impacts.

Leaders of the Native Village of Nuiqsut and City of Nuiqsut wrote to the Secretary of the U.S. Department of the Interior, Deb Haaland, about the proposed Willow project stating,

> It is a matter of our survival. We are at ground zero for the industrialization of the Arctic. The environmental racism and injustice of oil development on the North Slope must stop. The government also has an obligation to protect us from the harms of the oil industry and must stop expecting us to sacrifice our own lives 'in the national interest.' Fenceline communities have been asked to do so for too long, and environmental justice requires a new approach. (Ahtuangaruak et al. 2023)

AIR POLLUTION

Rosemary Ahtuangaruak has long witnessed adverse health problems that have dramatically increased over the years of industrialization by the oil and gas industry surrounding Nuiqsut, including respiratory illnesses and thyroid disorders. She said,

> Our people's health is also harmed by the air pollution resulting from these oil and gas activities, with flaring being a particularly big concern for our air quality. I noticed as a health aide that there were increased numbers of people who needed help to breathe and have suffered from respiratory illnesses with all the development. We have had a tremendous number of people who have needed treatment for respiratory illnesses. We need emissions of greenhouse gases and other air pollutants to decrease to protect our health. We do not need more empty promises that there will be monitoring or measures in the future to address the impacts already occurring now. We need the continuous flaring, which can last for months on end, to stop. (Ahtuangaruak 2022)

An analysis of air emissions from North Slope oil and gas operations using data from the National Emissions Inventory of the Environmental Protection Agency found that massive quantities of hazardous air pollutants are released annually, including (Stepanyan & Estrella 2021):

- Nitrogen oxides 69,947,002 pounds/year
- Carbon monoxide 13,971,120 pounds/year
- Volatile organic compounds 2,842,863 pounds/year
- Sulfur dioxide 2,416,142 pounds/year
- PM10 2,108,288 pounds/year
- PM2.5 583,894 pounds/year
- Formaldehyde 199,387 pounds/year
- Toluene 35,978 pounds/year
- Xylenes 17,711 pounds/year
- Acetaldehyde 11,110 pounds/year

Adverse health effects associated with these hazardous air pollutants include respiratory and cardiovascular disease, lower birth weight and pre-term birth, neurodevelopmental harm, genetic damage, and certain cancers (Stepanyan & Estrella 2021). Flaring from oil and gas extraction is an important source of black carbon, an air pollutant that includes a significant portion of particulate matter (PM) and contributes to climate warming because it absorbs heat and hastens melting of snow and ice (Schmale et al. 2018). Exposure to black carbon through inhalation is associated with adverse health effects such as respiratory and cardiovascular disease and cancer (De Laender et al. 2011; Janssen et al. 2012). Scientists studying air pollution in the Arctic observe that "local Arctic air pollution can be severe and significantly exceed air quality standards, impairing public health and affecting ecosystems."

SPILLS AND RELEASES

Although the oil and gas industry has brought significant revenue to the state, the costs of oil in the form of harm to the environment and health have not been calculated. The industry receives substantial benefits including direct subsidies and tax incentives paid by public funds. Lax laws and permits and poor oversight of the industry in Alaska enable it to externalize costs to the public for the environmental and health problems associated with emissions of greenhouse gases and other hazardous air pollutants, spills and releases of oil, and other harms related to toxic chemicals released from extraction and combustion.

The Alaska Department of Environmental Conservation (ADEC) maintains a database that accounts for thousands of spills and other releases of hazardous substances from oil and gas industry operations in Cook Inlet and the North Slope. The ADEC database documented 2,259 crude oil spills, 790 drilling mud spills, and 99 releases of natural gas and methane since the agency began systematic record-keeping in 1995 (ADEC 2024). Most famously, the Exxon Valdez oil tanker spill of 1989 released at least 11 million gallons of crude oil into the Prince William Sound, causing major and lasting harms to Alaska's wildlife, Indigenous communities, commercial fisheries, and oil spill workers (EPA 2023; Leahy 2019; Esler et al. 2018; Barron et al. 2020; Lindeberg et al. 2018). The spill changed both public and political perception of the oil industry (Leahy 2019) and resulted in passage of the Oil Pollution Act of 1990, requiring the U.S. Coast Guard to strengthen regulations on oil tanker owners and operators (EPA 2023). It is the second largest spill in U.S. history, surpassed in volume only by British Petroleum's Deepwater Horizon spill in 2010. The opening of new shipping routes in Alaska and throughout the circumpolar Arctic with the decline of sea ice resulting from climate warming increases the risk of oil and chemical spills. Industry is not equipped to clean up spills in this region of severe weather and sea ice.

A special exemption under the Clean Water Act allows the oil and gas industry in Cook Inlet to legally dump up to two billion gallons of toxic waste each year, the only such exemption for oil and gas facilities operating in coastal waters in the nation (DeMarban 2019). There are real-world examples of the consequences of such lax regulation and oversight in Alaska. For example, in 2017, a Hilcorp Energy Company underwater gas pipeline leaked for over three months, releasing about 200,000 cubic feet of almost pure methane into Cook Inlet (Shankman 2017), and gas leaks occurred again from the same pipeline in 2019 and 2021 (Parshley 2022). In another incident, in late February and March 2022, 7.2 million cubic feet of natural gas leaked from multiple wellheads in the Conoco Phillips Alpine oilfield located 8 miles from the Native Village of Nuiqsut, forcing evacuation of about 300 oil company personnel and a shutdown (Ishmail 2020). No provisions were made to evacuate residents of Nuiqsut.

Natural gas is composed primarily of methane, which carries over 80 times the climate warming effect of carbon dioxide over a 20-year time period. U.S. oil and gas operations release 13 million metric tons of methane per year through leaks and flaring, almost 60 percent more than had been estimated by the U.S. EPA (MacDiarmid 2018). On the North Slope, the Prudhoe Bay oil field is the primary source of methane emissions, with approximately 2-5 times greater emissions (even by company accounting which is routinely underreported) than the sum of all sources reported to the EPA Greenhouse Gas Reporting Program (Floerchinger et al. 2019). In addition to methane from oil and gas operations, warming of the Arctic is also accelerating the release of carbon dioxide and methane from melting permafrost and further exacerbating global climate change (Bykova 2020).

PLASTICS AND OTHER PETROCHEMICALS

Petrochemicals are derived from fossil fuels—oil, gas, and coal—and used to make industrial chemicals, pesticides, plastics, plastic additives, and fertilizers. They are broadly divided into two main types of derivatives: olefins and aromatics. Examples of olefins include ethylene, propylene, and butadiene. Common aromatics include benzene, toluene, and xylene. These "building blocks" are used to make a wide array of synthetic chemicals and plastics.

There are more than 350,000 chemicals and mixtures of chemicals that have been registered for use and production (Wang et al. 2020). Many chemicals disrupt the endocrine system, cause cancer, impair immune system function, and/or harm the neurological system, among other health effects. In 2019, the World Health Organization estimated that over 53 million years of life were lost due to exposures from just some of these chemicals (WHO 2021). A 2024 study published in the Journal of the Endocrine Society assessed the burden of disease and health care costs associated with chemicals in plastics, focusing on four groups of chemicals used in plastics: polybrominated diphenyl ethers (flame retardants), phthalates (plasticizers), bisphenols (used to make polymers and resins), and per- and polyfluoroalkyl substances (PFAS, stain and stick resistant chemicals) (Trasande et al. 2024). The report states, "Our study found plastics contribute substantially to disease and associated social costs in the U.S., about $250 billion in 2018 alone. These costs are equivalent to 1.22% of the Gross Domestic Product. The diseases due to plastics run the entire life course from preterm birth to obesity, heart disease and cancers" (Trasande et al. 2024).

Recently, scientists established that we have surpassed the planetary boundaries for chemicals (Persson et al. 2022), meaning that we are operating outside the safe space for humans and the environment. Furthermore, we lack fundamental knowledge concerning health and environmental effects of most chemicals. Only an estimated 1% of the chemicals on the market have been adequately assessed for safety (Brander 2022). Still, more than 2,000 new chemicals, of which we often know even less, enter the market every year (Brander 2022) and production is expected to continue to increase (IEA 2018).

Several of the large oil companies that operate in Alaska, such as ExxonMobil, Shell, and Chevron (AOGA 2022) also produce petrochemicals (CIEL 2021). Refineries located in Alaska primarily produce gasoline, diesel fuel, and jet fuel for the Alaska market; however, oil from Alaska is also exported to other refinery sites in other U.S. states along the west coast and in Asia (AKRDC 2023; Simonelli 2018). These refineries are often situated in and disproportionately harm poor communities and communities of color (Donaghy and Jiang 2021). Moreover, many of the companies that are active in Alaska have long track records of environmental violations (Violationtracker 2022).

According to an International Energy Agency analysis, "Petrochemicals are rapidly becoming the largest driver of global energy consumption" (IEA 2018). As the transition to renewable energy systems is progressing and the demand for fossil fuels as energy sources is set to peak in 2030 (IEA 2023), the fossil fuel industry is investing significantly more in the use of oil and gas as feedstock for petrochemicals and plastics. Oil industry projections show that the percentage of total oil demand for petrochemical feedstock will increase from its current level of less than 20% to as much as 50% by 2050 (BP 2022). As noted by the public interest nonprofit law firm Earthjustice,

> As we move towards zero-emissions and 100% clean energy, the oil and gas industry is launching a last-ditch effort to protect its profit, betting big on petrochemicals: toxic chemicals made from oil and gas that are used to make plastics, industrial chemicals, and pesticides. In the U.S., the industry is planning a massive build-out of petrochemical plants. Many of these facilities are planned in low-income communities and communities of color already overburdened by pollution and a long history of environmental racism. If the build-out goes forward, it will lock in more climate pollution, plastic waste, and toxic chemicals that poison our communities. (Earthjustice 2024)

One large group of petrochemicals is plastics. Plastics are chemicals composed of chemical polymers, additives, and known by-products (often called non-intentionally added substances). The vast majority of chemicals used in plastics are made from fossil fuels, mainly oil and gas (Table 1). For 2019, plastic production was estimated at between 340 and 460 million tonnes, and projections suggest that the production volumes will triple by 2060 (OECD 2023; PlasticsEurope 2022) (**Figure 2**).

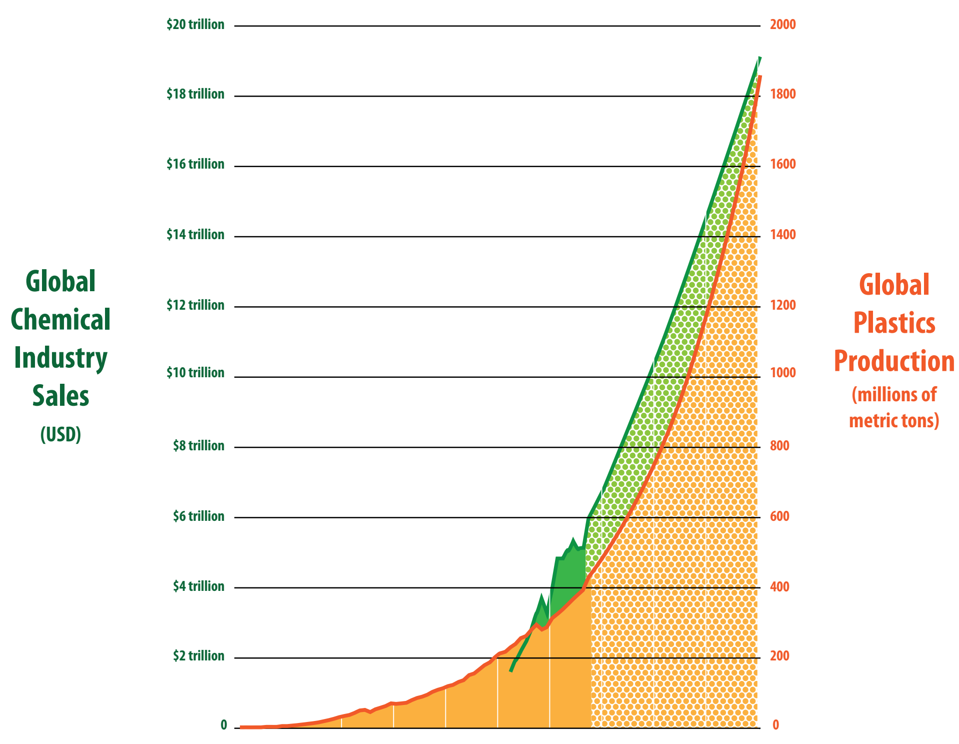


Figure 2 Derived from GRID Arendal at https://www.grida.no/resources/15041 and UNEP at https://www.unep.org/resources/report/global-chemicals-outlook-ii-legacies-innovative-solutions?_ga=2.195946412.1260026922.1712758719-1671529901.1697624642

Table 1 Examples of plastics that are made from oil and natural gas (Werpy & Petersen 2004).

	OIL	NATURAL GAS
EXAMPLES OF PLASTICS	Polystyrene, nylon, polyurethane, bisphenols, polyester, polybutadiene, styrene butadiene rubber	Polyester, resins, polypropylene, polyethylene, polyvinyl chloride

Plastics consist of chemical polymers, created through the synthesis of chains or matrices of monomers, and chemical additives. For example, polyethylene terephthalate (PET), a plastic polymer consisting of the monomers ethylene glycol and dimethyl terephthalate, is used to make beverage bottles, food packaging, and many other products. High density polyethylene (HDPE) consists of ethylene monomers and is used in many applications, including beverage bottles, shampoo bottles, bleach bottles, cutting boards, and pipes. Polyvinyl chloride consists of vinyl chloride monomers and is used in construction materials such as siding and pipes, toys, cable coatings, and medical devices.

According to the 2024 State of the Science of Hazardous Chemicals in Plastics report, there are 16,325 plastic chemicals, with 25% of these classified as hazardous and 66% not assessed for safety. The report concludes that no plastic chemical can be classified as safe (Wagner 2024). Many toxic plastic substances are not chemically bound to the polymers and are released throughout the plastics life cycle—from production, transportation, use, and disposal—and result in environmental pollution and human exposures. Harmful health outcomes have been documented for workers in the plastics production and recycling industries, consumers, and communities as has pollution of the environment near to production and recycling facilities (Wiesinger et al. 2021; Chen et al. 2018; Flaws et al. 2020). Almost one thousand chemicals used in plastics are linked to cancer, DNA mutations, or harm to reproduction, and more than one thousand are known to be toxic to the aquatic environment, while less than 1% of chemicals in plastics are subject to international regulation (Wiesinger et al. 2021). Plastics additives include flame retardants, antioxidants, plasticizers, pigments, and UV stabilizers. Other chemicals are used in plastics production such as solvents, catalysts, and lubricants (Deanin 1975; Wiesinger et al. 2021). While these additives increase the functionality and durability of plastic products, these same attributes also make plastics increasingly persistent and harmful to the environment and human health (Vethaak & Leslie 2016). Many of the additives are also classified as persistent organic pollutants (POPs), substances that are toxic at extremely low exposure levels, bioaccumulate in the food web, and persist in the environment.

PLASTIC WASTES

Estimates suggest that only 9% of all the plastic produced up to 2015 was recycled (Geyer et al. 2017), and even this number is likely high, given that data are often based on the volume of plastic sent to recycling facilities whether recycling was documented or not. The Organization for Economic Cooperation and Development (OECD) Global Plastics Outlook report finds that, while only 9% of plastic is recycled, "19% is incinerated, 50% ends up in landfill and 22% evades waste management systems and goes into uncontrolled dumpsites, is burned in open pits or ends up in terrestrial or aquatic environments, especially in poorer countries" (OECD 2022b). The recycling rate for plastic in the U.S. is even less at 5% (Beyond Plastics & The Last Beach Cleanup 2022). Recycling statistics from Alaska are limited; however, estimates suggest that the recycling rate of plastic packaging and containers is around 1% (Eunomia 2023). In general, other types of plastics, for example building materials, are even less likely to be recycled (Ljungkvist Nordin & Westöö 2019), so the total percentage of recycled plastics is likely to be even smaller.

Many common types of plastics have very little value and there is not a strong market for recycled plastics. While some communities have recycling programs, services are limited especially for plastic wastes (State of Alaska 2021). Recycling is not a solution to current plastic waste stockpiles or the increasing volumes of plastics that are produced. Because plastics contain toxic chemicals, including banned or restricted chemicals, recycling spreads these toxic substances into products used in our homes and workplaces. Plastic recycling therefore inherently contradicts the idea of a circular economy, in which safe products can be safely reused and recycled (Digangi et al. 2017; Gorai & Jana 2003; Kajiwara et al. 2022; Brosché et al. 2021). Finding hundreds of toxic chemicals in recycled plastic pellets, the author of a recent study noted, "Plastic recycling has been touted as a solution to the plastics pollution crisis, but toxic chemicals in plastics complicate their reuse and disposal and hinder recycling" (University of Gothenburg 2023).

Plastics are used extensively for packaging food and other goods that are shipped to remote communities in Alaska via air or boat. This has led to waste management challenges throughout the state. There are regular exemptions for designing solid waste management sites in Alaska (Mutter 2014). Thus, the vast majority of the landfills in Alaska are unlined and are essentially uncontrolled dumpsites (Karidis 2021), often located near the ocean or other bodies of water. This results in harmful chemicals and plastics being released directly into the environment.

Solid wastes including plastics are also combusted in "burn boxes" or incinerators sited within or near local communities, often without emission controls. Burning plastic results in emissions of highly toxic dioxins, furans, mercury, polychlorinated biphenyls (PCBs), and other toxic chemicals (Baca et al. 2023). Moreover, open dumpsites are common in rural Alaska, and some communities lack waste management services. Research has shown links between mothers residing close to open dumpsites in Alaska and adverse birth outcomes, including lower birth weights, premature births, and intrauterine growth restriction compared to births from mothers residing in lower risk areas (Gilbreath & Kass 2006).

LONG-RANGE TRANSPORT OF PLASTICS AND OTHER PETROCHEMICALS TO ALASKA AND THE CIRCUMPOLAR ARCTIC

The Arctic is a hemispheric sink for persistent chemicals and plastics that are transported on atmospheric and oceanic currents from lower latitudes through processes known as global distillation and the "grasshopper effect." The "grasshopper effect" refers to the way that persistent chemicals move from warmer, temperate regions toward the colder polar regions. Chemicals volatilize from places of production, use, and waste disposal, then move through the air toward the northern and southern polar regions on prevailing atmospheric currents. They re-deposit to the ground when they meet colder air masses, then remobilize to the air with warming temperatures—thus "hopping" their way to the Arctic or Antarctic. Global distillation means that these toxic chemicals move toward and concentrate in colder climates, including within the food web. This is why the Arctic is referred to as a "hemispheric sink" or "cold trap" for chemicals that may concentrate in higher levels in the bodies of fish, wildlife, and people of the north (**Figure 3**).

The Arctic is also warming at a rate nearly four times faster than the rest of the world. While distinct and challenging in their own realms, the problems of plastics, toxic chemicals, and climate change are interconnected and attributable to fossil fuel production and use. Climate warming is exacerbating the mobilization and transport of chemicals and plastics within and into the Arctic. Accelerated melting of sea ice, permafrost, and glaciers is mobilizing sequestered contaminants and microplastics, threatening the health of our oceans, fish, wildlife, and peoples of the north. Microplastics carry toxic chemical additives and sorbents into remote regions such as the Arctic and are a source of exposure within the food web. Food security, environment, and human health—particularly the health of Indigenous Peoples who are reliant on traditional foods from the land and sea—are threatened from climate warming and from increasing concentrations of toxic chemicals and plastics from local and global sources accumulating in fish, wildlife, and people.

PERSISTENT ORGANIC POLLUTANTS (POPs)

Persistent organic pollutants (POPs) are a large group of chemicals that are persistent, bioaccumulative, prone to long-range transport, and pose a threat to health (Lohmann et al. 2007). POPs include pesticides and industrial chemicals, many of which are found in household products such as plastics (Stockholm Convention 2019). POPs are characterized by the following traits: environmental stability, low solubility in water, lipophilic, hydrophobic, and slow to metabolize. Due to their persistence, these chemicals can stay in the environment for many generations. POPs are known to adversely affect the health of wildlife and humans. Scientific evidence demonstrates that even low-level exposure to POPs can lead to increased risks of certain cancers, reproductive disorders, immune system impairment, neurodevelopmental harm, endocrine disruption, genotoxicity, cardiovascular disease, and birth defects (Carpenter 2011; UNEP 2024).

Far from pristine, the Arctic contains some of the most highly contaminated animals and people in the world (AMAP 2009; AMAP 2015). The Arctic is subject to atmospheric deposition of globally-distilled POPs, acting as a "cold trap" and hemispheric sink for POPs that are transported from lower latitudes (MacDonald et al. 2000; Rigét et al. 2010). It is an important indicator region for assessing the properties and effects of POPs (deWit et al. 2010; AMAP 2014). Once POPs enter the Arctic, their deterioration is slowed due to low temperatures and low intensity sunlight, making them available for long-term incorporation into biological systems (Pacyna et al. 2015). POPs bioaccumulate and biomagnify in the lipid-rich Arctic food webs, in some cases to dangerous levels (Barrie et al. 1992; Wania and Mackay 1993; Tennebaum 1998; AMAP 1998, 2004, 2009; Tartu 2014). These problems are exacerbated by the rapid pace and magnitude of climate change in the Arctic (Serreze and Barry 2011; McKinney et al. 2015). Due to a combination of a warming climate and increased mobilization of POPs, rates of global distillation and deposition in the Arctic are expected to accelerate (Jenssen 2006), causing combined effects with large-scale ecological consequences and leading to higher health risks for wildlife and people (UNEP/AMAP 2011; Jenssen et al. 2015). Moreover, it is predicted that accelerated melting of polar snow, ice, and permafrost will lead to remobilization of sequestered contaminants and enhanced air-to-sea exchange, rendering greater bioavailability of contaminants within Arctic food webs (Noyes et al. 2009; Ma et al. 2011; Grannas et al. 2013; Noyes and Lema 2015). Climate change also results in dietary and trophic level changes for some Arctic species, including seabirds and polar bears, and this affects their exposures to POPs. Climate change effects on POPs in recent years are more enhanced, indicating that climate-related effects over longer periods of time may in the future become even more important (Vorkamp et al. 2022). A 2021 Arctic Monitoring and Assessment Programme report found that "…climate change perturbations are resulting in the remobilization of POPs within and between air, water, ice, snow, soils, and sediments in the Arctic" (AMAP 2021).

Local point-sources of POPs include airports, military bases, mining sites, oil and gas operations, and landfills. These facilities release harmful chemicals from their operations into the air, soil, and surface and groundwaters, thus posing a threat to drinking water sources, traditional fishing and hunting areas, and public health. However, chemicals from local point-sources do not fully explain why the Arctic contains some of the most contaminated animals and people in the world. Instead, the primary source is long-range chemical transport. Some POPs that have been banned for decades are still spreading to and accumulating in the Arctic.

POPs are easily transported and can travel thousands of miles by way of atmospheric and oceanic circulation (Dudarev et al. 2019). One important transport pathway, especially for more volatile POPs, is atmospheric transport. The chemicals are transported by air currents and deposited in the Arctic (Burkow and Kallenborn 2000). POPs that travel into the Arctic via air masses are trapped there by cold conditions, resulting in increased deposition from the atmosphere to the ocean, freshwater systems, and the terrestrial environment within the Arctic, thus creating a higher burden of POPs pollution (AMAP 2002).

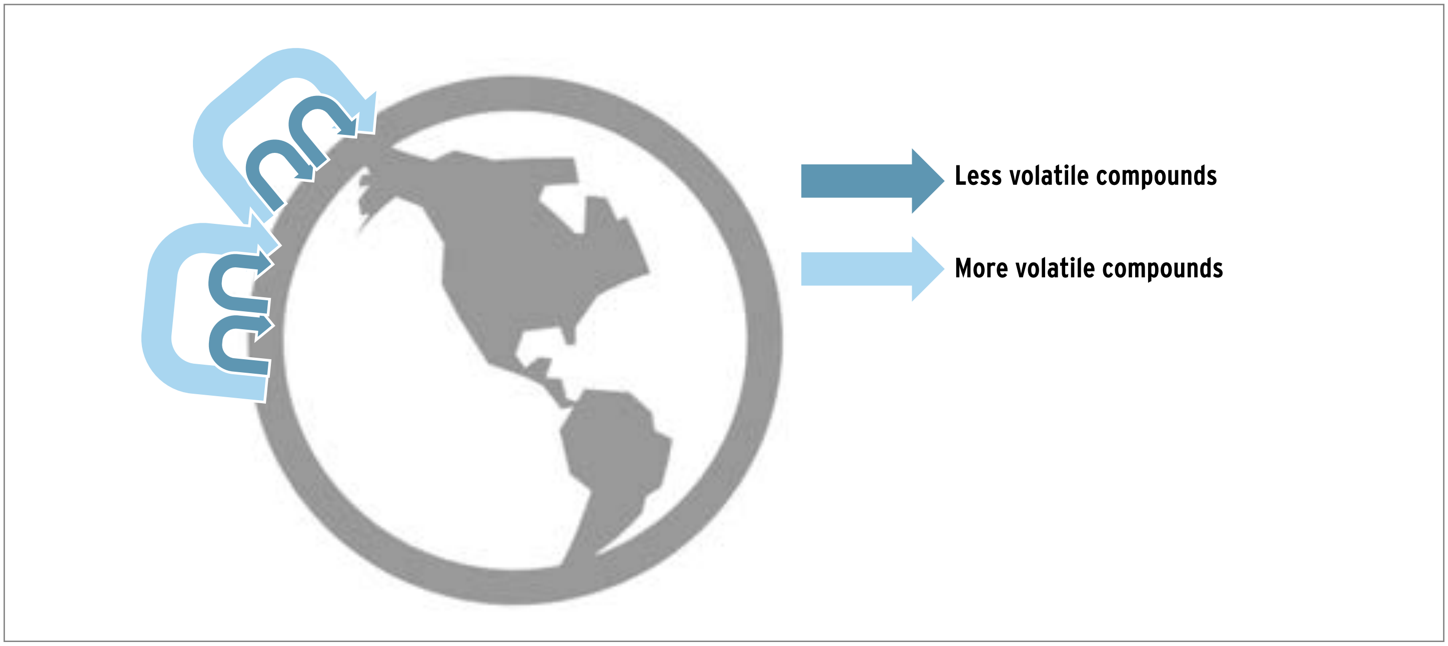


Figure 3 Atmospheric transport of POPs to the Arctic

Oceanic currents, movement within sea ice, and riverine inputs are important pathways for pollutants to the Arctic Ocean (Burkow & Kallenborn 2000). Global ocean circulation patterns carry water masses from lower latitudes into higher latitudes through thermohaline circulation, a process driven by differences in water densities based on temperature (thermo) and salinity (haline) on the ocean surface (**Figure 4**), and by wind driven currents. This creates a great overturning motion from deep in the ocean (Rahmstorf 2006). Oceanic and atmospheric transport processes lead to accumulation of POPs in the Arctic, thus resulting in the Arctic as a hemispheric sink.

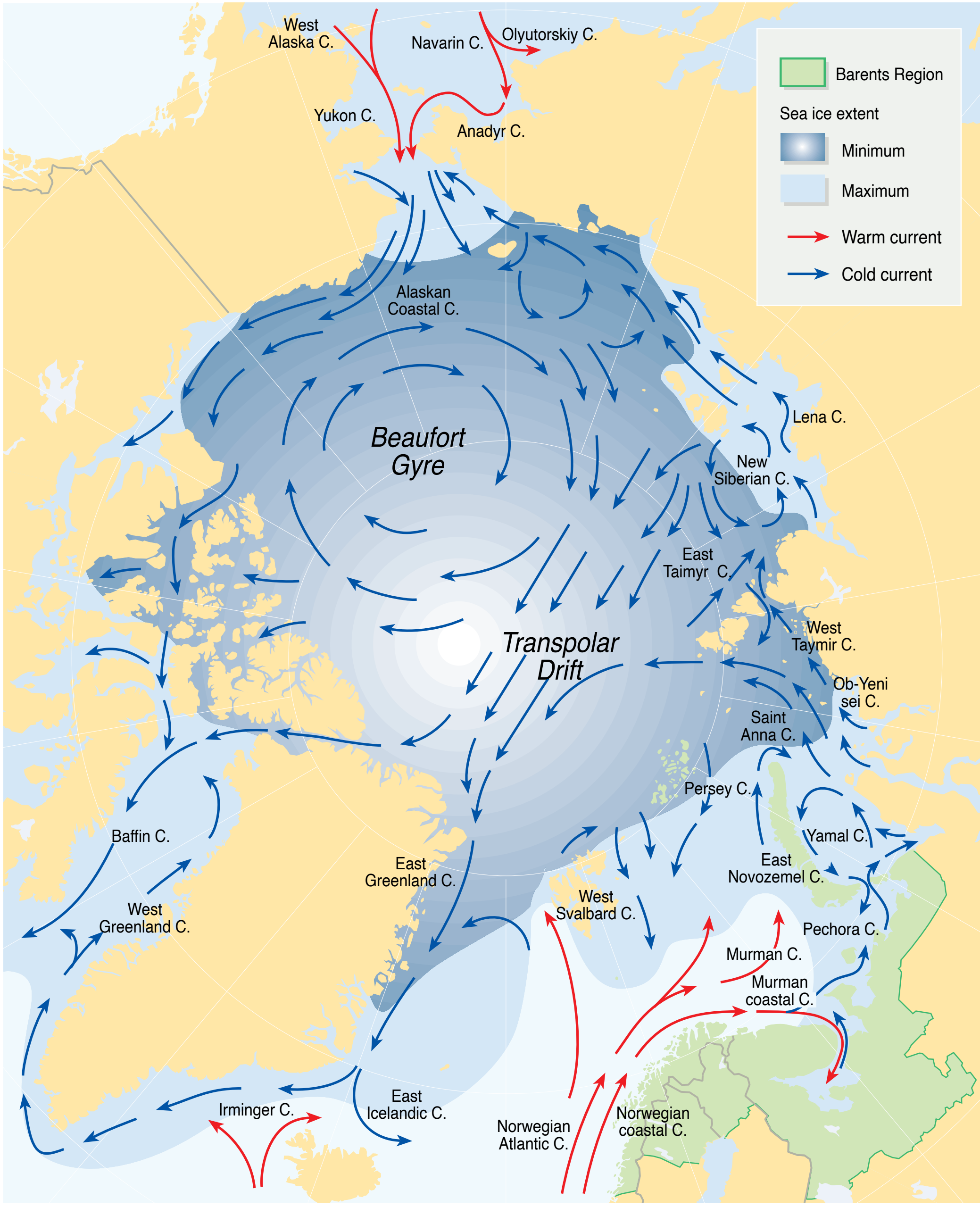


Figure 4 Ocean currents to and within the Arctic. Source: GRID-Arendal resources library, Philippe Rekacewicz www.grida.no/resources/7472

Once POPs reach the Arctic, they bioaccumulate and biomagnify in the lipid-rich food web and in the bodies of fish, wildlife, and people (Adams et al. 2019). In the Arctic, animals have a higher fat content to help them survive in the cold environment. POPs tend to concentrate in fatty (lipid-rich) tissues which leads to higher concentrations in marine mammals, fish, and seabirds (Gabrielsen 2007) (**Figure 5**). Bioaccumulation of POPs may lead to adverse effects for the organisms and for the health of Indigenous Peoples who are reliant on these animals that are critical to their traditional diet.

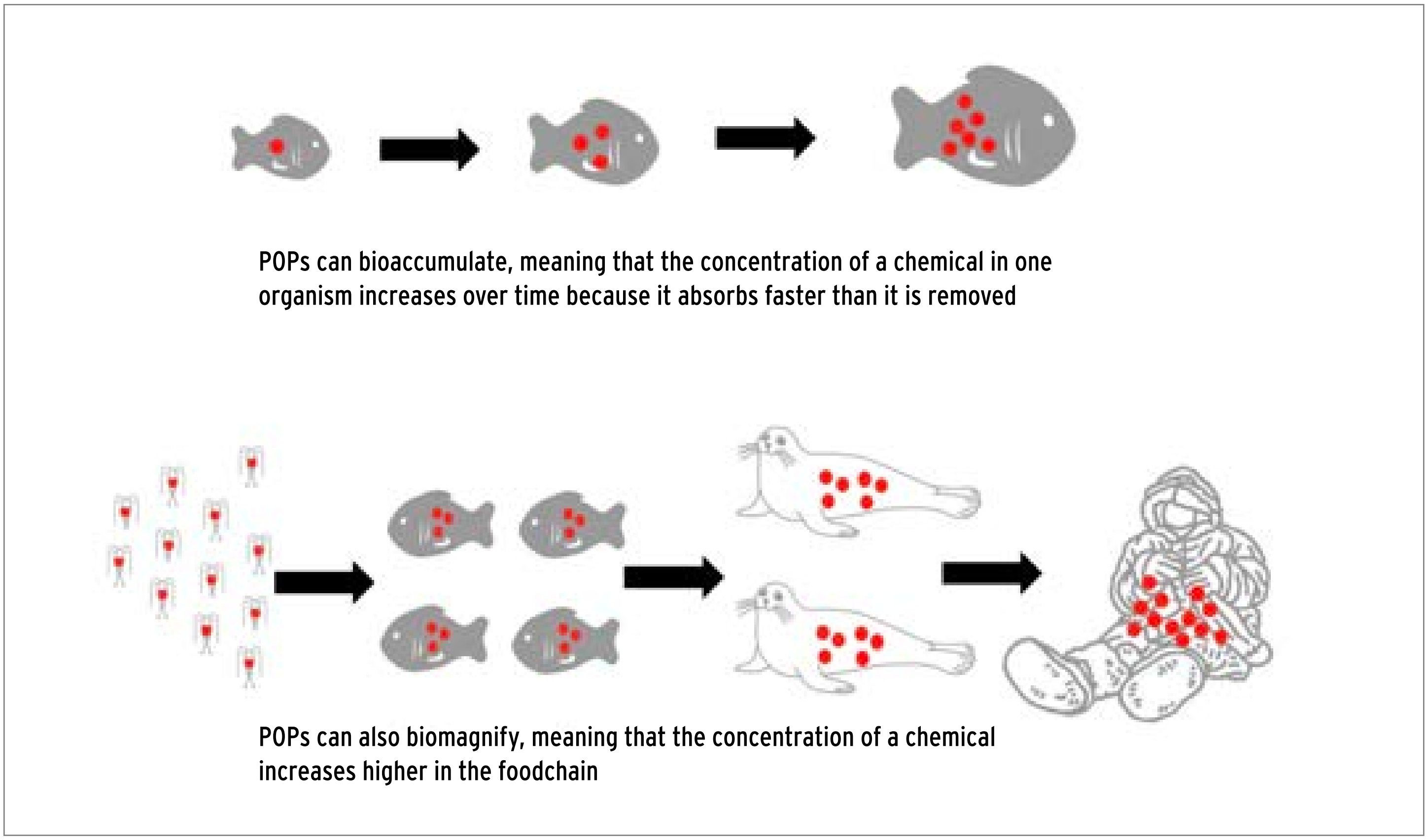


Figure 5 Bioaccumulation and biomagnification

The Stockholm Convention on Persistent Organic Pollutants ("POPs Treaty") is the only global legally binding treaty aimed at eliminating the world's most dangerous chemicals. The Preamble of the Stockholm Convention recognizes the special vulnerability of Arctic Indigenous Peoples and states: *"Acknowledging that the Arctic ecosystems and indigenous communities are particularly at risk because of biomagnifications of persistent organic pollutants and that contamination of their traditional foods is a public health issue"* (Secretariat of the Stockholm Convention 2020). As Carol Nagaruk, Iñupiaq, Native Village of Elim, Alaska, told the Stockholm Convention in 2017,

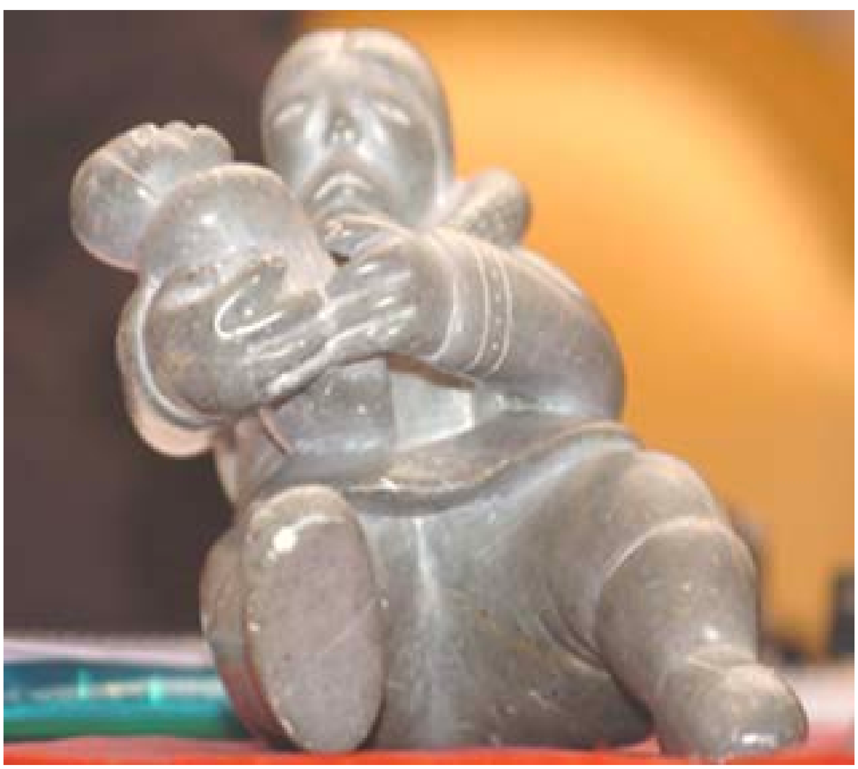
> POPs are found in our women and passed on to our children. At low concentrations, they disrupt endocrine function, and can cause birth defects and cancers. Alaska children have twice the rate of birth defects than the rest of the United States, and our Alaska Native children have twice more than non-natives in the state. POPs also cause learning disabilities in our children. How will our children learn our languages, cultures, our creation stories, our songs and dances, and our way of life? Indigenous Peoples bear a burden that we did not create. POPs reach us from global sources and we do not have the capacity to deal with this on our own. Due to special vulnerability of our Arctic Indigenous Peoples, we emphasize the importance of total elimination of POPs. I respectfully urge you to take immediate action to protect our health and well-being, our lands and territories globally.

One of the strengths of the Convention is that additional chemicals may be listed for global elimination if they meet scientific criteria for persistence, bioaccumulation, long-range transport, and adverse effects. Parties (i.e., countries) to the Convention may nominate new POPs that are then reviewed in a three-stage evaluation process by an expert scientific committee known as the POPs Review Committee (POPRC).

Certain listed POPs are or have been used in plastics. Thus far, 34 chemicals or chemical groups have been listed for elimination under the Stockholm Convention, and many of those chemicals/chemical groups have been used in plastics or have been released from plastics production and plastic waste management operations. Another three chemicals used in plastics are currently being evaluated for listing (**Table 2**) (UNEP & Secretariat of the Stockholm Convention 2019; BRS Conventions 2022).

While the Stockholm Convention has been a powerful tool for developing protections from POPs, it can be strengthened by adopting some simple adaptations. For example, rather than taking up each member of a class of chemicals one by one, a process that typically takes decades, chemicals should be regulated as groups or classes. This would avoid the industry practice of poisonous (so-called regrettable) substitution, in which one banned toxic chemical is replaced by a closely related substance that may have the same or even more problematic health and environmental effects. Bans on toxic chemicals should be issued without exemptions to avoid production and use of harmful chemicals for years or even decades after the bans are instituted. If an exemption is truly critical for the functioning of society, those exemptions should only be granted for narrow, clearly defined applications and for short terms. Provisions of the Convention's Article 6 that aim to eliminate releases from stockpiles and wastes must be implemented through labeling and other means of identification that make it possible to trace the use of POPs throughout their life cycle for producers, retailers, users, and waste managers.

Arctic Indigenous Women's delegation at the Stockholm Convention--from left to right: Leigh Takak, Carol Nagaruk (holding Inuit statue), Erika Apatiki, and Vi Waghiyi.



Soapstone carving of woman and child presented to Chair John Buccini of the International Negotiating Committee (INC-2) by Shiela Watt Cloutier, then president of the Inuit Circumpolar Conference, Canada.

Table 2 POPs that have been listed under the Stockholm Convention or are under review for listing.

	GROUP	USED IN/TO PRODUCE PLASTICS	YEAR OF LISTING
ANNEX A ELIMINATION			
Aldrin	Pesticide		2004
Chlordane	Pesticide		2004
Chlordecone	Pesticide		2009
Decabromodiphenyl ether (Commercial mixture, c-decaBDE)	Industrial chemical	x	2017
Dicofol	Pesticide		2019
Dieldrin	Pesticide		2004
Endrin	Pesticide		2004
Heptachlor	Pesticide		2004
Hexabromobiphenyl	Industrial chemical	x	2009
Hexabromocyclodecane (HBCDD)	Industrial chemical	x	2013
Hexabromodiphenyl ether and heptabromodiphenyl ether	Industrial chemical	x	2009
Hexachlorobenzene (HCB)	Industrial chemical and pesticide	x	2004
Hexachlorobutadiene	Industrial chemical		2015
Alpha hexachlorocyclohex-ane	Pesticide		2009
Beta hexachlorocyclohexane	Pesticide		2009
Lindane	Pesticide		2009
Mirex	Pesticide	x	2004
Pentachlorobenzene	Industrial chemical and pesticide	x	2009
Pentachlorophenol and its salts and esters	Pesticide		2015
Polychlorinated biphenyls	Industrial chemical	x	2004
Polychlorinated naphthalenes	Industrial chemical	x	2015
Perfluorooctanoic acid (PFOA), its salts and PFOA related compounds	Industrial chemical	x	2019
Short-chain chlorinated paraffins (SCCPs)	Industrial chemical	x	2017
Technical endosulfan and its related isomers	Pesticide		2011
Tetrabromodiphenyl ether and pentabromodiphenyl ether	Industrial chemical	x	2009

Table 2, continued POPs that have been listed under the Stockholm Convention or are under review for listing.

	GROUP	USED IN/TO PRODUCE PLASTICS	YEAR OF LISTING
ANNEX A ELIMINATION, CONTINUED			
Toxaphene	Pesticide		2004
Perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS related compounds	Industrial chemical	x	2004
Dechlorane Plus	Industrial chemical	x	2023
UV-328	Industrial chemical	x	2023
Methoxychlor	Pesticide		2023
ANNEX B RESTRICTION			
DDT	Pesticide		2004
Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride (PFOS)	Industrial chemical and pesticide	x	2009
ANNEX C UNINTENTIONALLY PRODUCED		**RELEASE ASSOCIATED WITH PLASTICS**	
Hexachlorobenzene (HCB)		x	2004
Hexachlorobutadiene (HCBD)		x	2015
Pentachlorobenzene		x	2009
Polychlorinated biphenyls (PCBs)		x	2004
Polychlorinated dibenzo-p-dioxins (PCDD)		x	2004
Polychlorinated dibenzofurans (PCDF)		x	2004
Polychlorinated naphthalenes		x	2015
UNDER REVIEW		**USED IN/TO PRODUCE PLASTICS**	
Medium chained chlorinated paraffins (MCCPs)	Industrial chemical	x	Decision expected in 2025
Long chain PFCAs	Industrial chemical	x	Decision expected in 2025
Chlorpyrifos	Pesticide		Decision expected in 2025

LONG-RANGE TRANSPORT OF PLASTICS

In 2017, the Arctic Council asserted the Fairbanks Declaration, citing "…growing concerns relating to the increasing levels of microplastics in the Arctic and potential effects on ecosystems and human health" (AMAP 2021b). Microplastics are defined as plastic particles less than five millimeters in diameter. As with POPs, plastics are also transported to the Arctic by oceanic and atmospheric currents. Scientists estimate that 19-23 million metric tons of plastic waste per year enter water from land-based sources globally (Borrelle et al. 2020). Modeling studies estimate that there are at least 62,000 tons of plastic entering the Arctic Ocean every year (Zarfl & Matthies 2010), and a study on the global microplastic transportation patterns revealed that the concentrations of microplastics are higher in the Arctic Basin than any other ocean basin in the world (Barrows et al. 2018). This means that in addition to the local sources, large quantities of plastics are transported into the Arctic from lower latitudes, and the Arctic Ocean is increasingly accumulating plastics (Cózar et al. 2017; Tekman et al. 2017).

A 2023 study highlights the need for drastic production limits on plastics (Kim et al. 2023). The researchers found that microplastic contamination is accumulating exponentially and in parallel with the rapid growth in plastics production. They also determined that microplastic levels are doubling in sediments of the Arctic Ocean every 23 years. The western Arctic includes the Beaufort and Chukchi Seas off the coast of Alaska, an area that encompasses about 13% of the total area of the Arctic Ocean. In this region, researchers analyzed seawater and sediments and found an accumulation of 210,000 metric tons of microplastics in seawater, sea ice, and sediment layers. They found the highest concentrations of microplastics in areas of the most rapid melting of sea ice, which are productive ecological zones and are vital for traditional fishing and hunting. The researchers found that sea ice is a "major historic global sink of man-made particulates." Microplastics are concentrated in the formation of sea ice that then serves as a medium for the transport of plastics within and into Arctic marine environments. Plastics are re-mobilized when sea ice melts. Dramatic declines in the extent and thickness of sea ice have been observed in recent years. Scientists calculated that melting of 2.04 trillion m3 of ice over a decade-long period could release over one trillion microplastic particles (Obbard 2014) and anticipate increased pollution from microplastics as sequestered particles are released from melting sea ice. While plastics are known to be very persistent in any environment, the environmental conditions of the Arctic extend the lifespan of plastics because they degrade more slowly in colder waters and lower sunlight levels (Barnes et al. 2009).

Studies provide substantial evidence of the negative physical effects of macroplastics in the marine environment (Bucci et al. 2020). Animals, including fish, birds, and marine mammals, can become entangled in plastic debris, leading to strangulation and suffocation. For microplastics, the physical effects are more complicated and dependent on the characteristics of the particles. Microplastics are frequently ingested by a wide range of marine organisms (reviewed in Bajt 2021; Wootton et al. 2021; Lusher 2015). Researchers found that 386 marine fish species have consumed microplastics, with 54% considered fish species of commercial importance. Studies show that the incidence of plastics found in fish has doubled over the past decade (Savoca et al. 2021). A 2020 review showed that of the 51 Arctic bird species that have been examined for plastic ingestion, over half had ingested plastics (Baak et al. 2020). Microplastics have also been found in the tissues of marine mammals in Alaska including the bearded seal, ringed seal, spotted seal, beluga whale, fin whale, gray whale, humpback whale, and minke whale. Evidence has shown translocation of microplastics (i.e., particles moving from one site to another within the organism) in mammals to at least four tissue types: blubber, lung, melon, and acoustic fat pad. As the researchers note, "The presence of microplastics embedded in internal organs underscores the ubiquity of the pervasive plastic pollution problem afflicting the oceans and its inhabitants with rippling implications for humans" (Merrill et al. 2023). In findings published in 2024, researchers reported microplastics for the first time in the blubber, muscle, and liver tissues of the Pacific walrus of the Bering and Chukchi Seas, an animal critical to the traditional diet of Indigenous Peoples of this region (Blade & Horstmann 2024). Microplastics and associated chemicals threaten marine ecosystems, food security, and the health of Indigenous Peoples, especially in the rapidly warming Arctic.

Although some organisms can eliminate ingested particles through their feces, retained particles can affect the organism's health through decreased nutrient uptake, reduced feeding activity, and abrasions or perforations (Khalid et al. 2021; Bucci et al. 2020; Jovanovic 2017). There is also evidence of the translocation of smaller microplastics and nanoplastics within organisms (Ma et al. 2021). Microplastics have been found

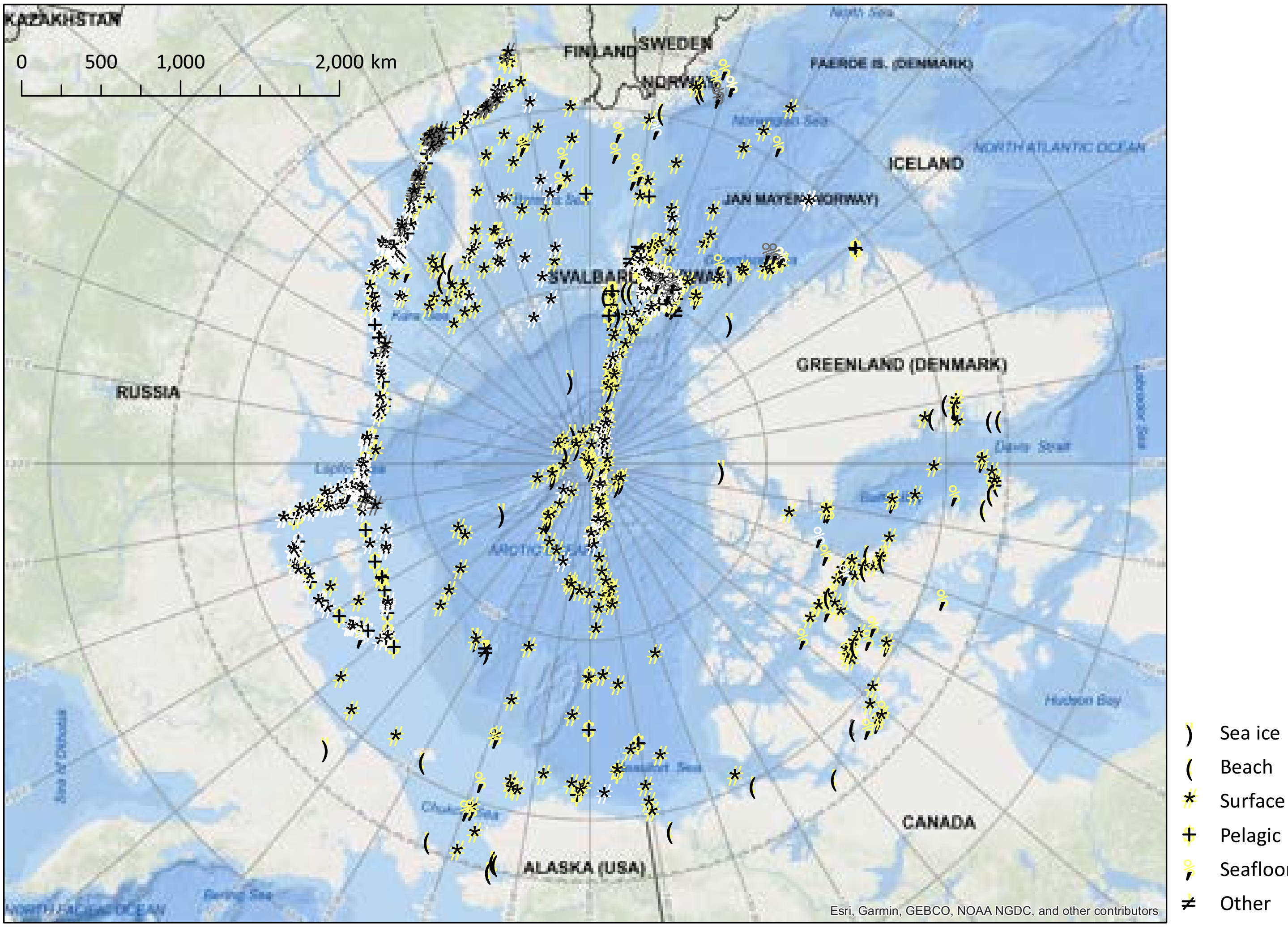
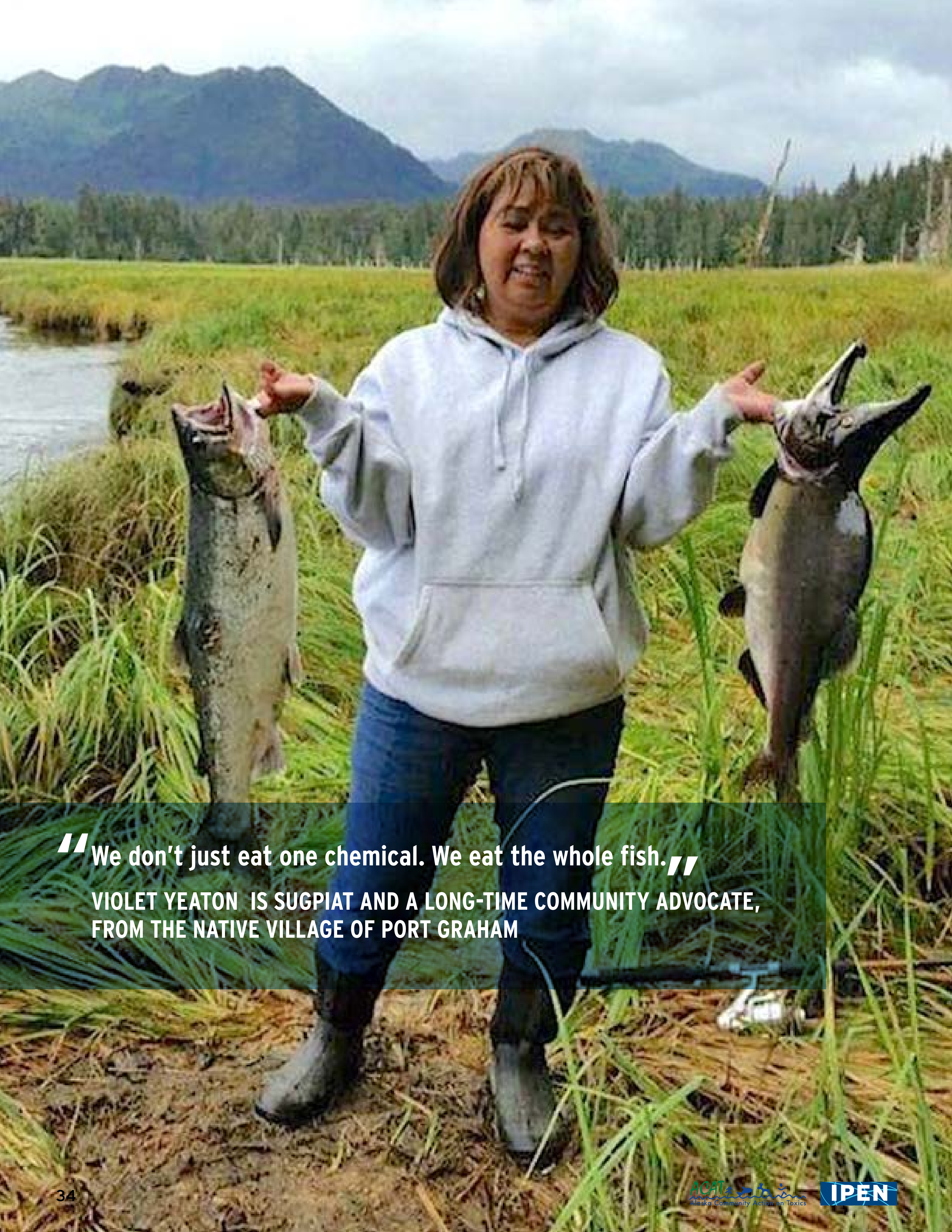


Figure 6 Documented concentrations of plastic litter, including microplastics, throughout the Arctic. Reprinted with permission of Dr. Melanie Bergmann, Alfred Wegener Institute.

in the gastrointestinal tract (Yee et al. 2021), blood (Leslie et al. 2022; Wang et al. 2021), lungs (Pauly et al. 1998), placenta (Ragusa et al. 2021), and other tissues of animals and humans (Ali et al. 2023). Exposure to micro- and nanoplastics may result in adverse health outcomes, including "oxidative stress, inflammation, impaired immune function, alteration in cellular and energy metabolism, inhibition in cell proliferation, tissue degeneration, abnormal organ development and dysfunction, alteration in biochemical parameters and even cause genotoxicity and carcinogenicity" (Ali et al. 2023).

Aside from the physical damage that can be caused by larger plastic debris and microplastics, plastics have been shown to carry disease-causing microbes (Jiang et al. 2018; Oberbeckman et al 2018) and invasive species (Andrady 2011; Kirstein et al. 2016). They are also known to carry chemicals, such as POPs, that sorb to them in the environment (Khalid et al. 2021; Karlsson et al 2021; Tanaka et al. 2020; Yamashita et al. 2021; Yamashita et al. 2018; Rice & Gold 1984).

Moreover, plastics can carry toxic chemical additives into remote regions (Mato et al. 2001; Teuten et al. 2009; Rochman 2016; Karlsson et al. 2021; Andrade et al. 2021) and chemicals that they absorb during transport. These chemicals can leach into the environment and some have been shown to contaminate organisms that ingest microplastics (Tanaka et al. 2020; Yamashita et al. 2021). For example, in a study on seabirds collected in Alaska, phthalates (a common plastic additive) were found in 100% of ten different species of seabirds (n=115) collected along more than 1,700 kilometers of the Aleutian Archipelago. Levels of phthalates were significantly higher in diving, plankton-feeding seabirds. The presence of microplastics in 36.5% of randomly subsampled seabird stomachs indicates plastic ingestion as a likely route of phthalate exposure (Padula et al. 2020). Recent estimates show that thousands of tonnes of chemical additives are transported with floating plastics and that between 1,900 and 7,400 tonnes of additives may be transported with plastic debris to the Arctic every year (Andrade et al. 2021).



"We don't just eat one chemical. We eat the whole fish."

VIOLET YEATON IS SUGPIAT AND A LONG-TIME COMMUNITY ADVOCATE, FROM THE NATIVE VILLAGE OF PORT GRAHAM

HEALTH EFFECTS AND BODY BURDEN OF PETROCHEMICALS IN THE ARCTIC

BACKGROUND

Due to the combination of intensive historic and ongoing fossil fuel industry and military contamination, inadequate waste management, and the added burden of long-range transport of hazardous chemicals and plastics from lower altitudes, Alaska is immensely impacted by petrochemicals throughout their life cycle (**Figure 7**).

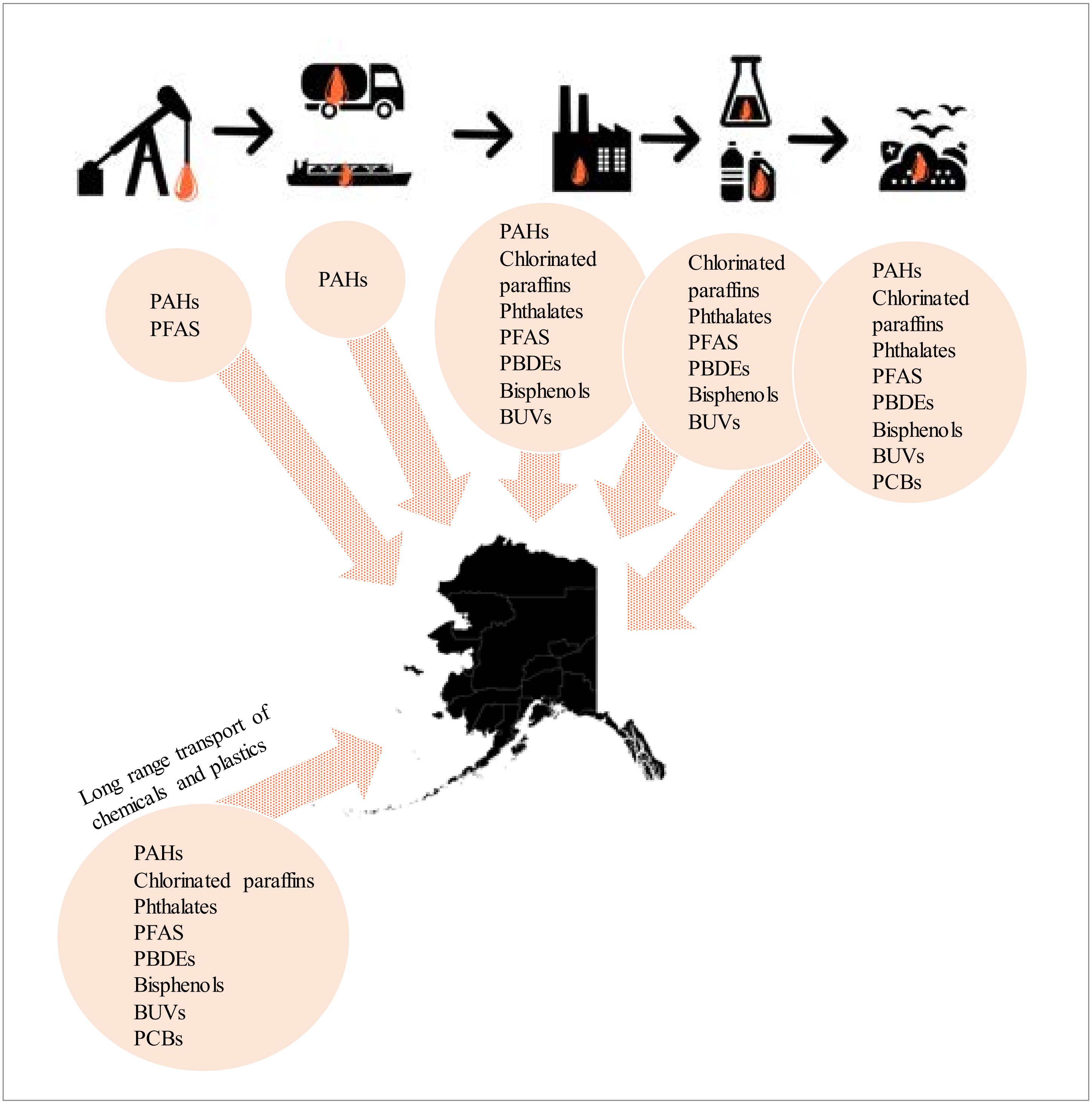


Figure 7 Examples of sources of petrochemical pollutants in Alaska

Alaska Native and other Arctic Indigenous communities are therefore experiencing disproportionate exposures to the environmental and health effects of toxic chemicals (Collard & Ask 2021; Fernández-Llamazares et al. 2020). One study found that the Sivuqaq (the traditional name for St. Lawrence Island) Yupik People have 4 – 10 times higher concentrations of PCBs in their blood than the average person in the lower 48 states (Carpenter et al. 2005). Another study found that Nunavik Inuit had higher levels of bisphenol A, several phthalates, and one plasticizer than non-Indigenous people in Canada. The concentrations were especially high among women (Aker et al. 2022).

Because most POPs are endocrine disrupting chemicals (EDCs) and many are also neurotoxicants, high exposures present an important public health concern for Arctic People. Indigenous Peoples of the Arctic rely on a traditional diet that includes a high proportion of fatty foods such as fish and marine mammals. Thus, they are chronically exposed to dangerous levels of POPs that concentrate in fat (Dewailly et al. 1989, 1999; Ayotte et al. 1996, 1997; Walker et al. 2003; Suk et al. 2004; Welfinger-Smith et al. 2011). The harvest and consumption of traditional foods is central to the nutritional, cultural, and economic health of Arctic Indigenous Peoples (Donaldson et al. 2010). Epidemiological studies in the Arctic have shown effects of contaminants on immune system function, oxidative stress, neurodevelopment, and the hypothalamic-pituitary-gonadal (HPG) axis (Donaldson et al. 2010). Additional risks include cancers, metabolic diseases, and disorders of the thyroid and reproductive development (AMAP 2009; Scheringer 2009; Donaldson 2010; Singh et al. 2014; Pacyna et al. 2015).

Concerns surrounding the consumption of potentially contaminated traditional foods could shift Arctic communities away from these highly nourishing foods, replacing them with processed foods which carry an entirely new set of health risks, including high concentrations of sodium, sugar, and contaminants in food packaging (Adams et al. 2019). In many Arctic communities, store-bought foods are not only generally less nutritious than traditional foods but are also expensive due to shipping costs. In conducting research on contaminants in traditional foods and potential adverse human health outcomes, it is necessary to use a community-based research approach that is inclusive of the community in the design, conduct, and interpretation and discussion of results so that people can make their own informed decisions about the consumption of traditional foods (Miller et al. 2013; Miller 2023; Welfinger-Smith et al. 2011; Byrne et al. 2022). As stated by Yupik researcher Vi Waghiyi, "We are being contaminated against our will. Our people still feel the benefits outweigh the risks. It is our identity. We're intricately tied to our lands and waters and wildlife that have sustained our people since time immemorial" (Rosen 2022).

CHEMICAL THREATS FROM THE OIL AND GAS INDUSTRY

This section of the report highlights some of the toxic chemicals and chemical classes that are produced from oil and gas and that threaten the health of people living in Alaska.

POLYAROMATIC HYDROCARBONS (PAHs)

Fossil fuels contain a wide range of polyaromatic hydrocarbons, chemicals linked to tumor development in skin, lungs, pancreas, bladder, colon, and breasts. Several PAHs are listed as carcinogens and exposure has been linked to cardiovascular disease (Mallah et al. 2022). Some PAHs share similarities with steroid hormones and have been shown to have estrogenic or antiestrogenic effects (Santodonato 1997; Zhang et al. 2016).

Oil spills and burning of fossil fuels have created widespread PAH contamination in Alaska (Wagner & Barker 2019). Globally, PAH emissions are expected to decrease in the future, but models suggest that the same decline will not be seen in the Arctic. Exposure to PAHs in the Arctic is expected to be further exacerbated because of revolatilization (released again into the atmosphere) of PAHs from climate warming (Balmer et al. 2019). In 2011, a study documented increasing concentrations of PAHs in fish and mussels in the Arctic, with 10-to-30-fold increases over a 25-year period (De Laender et al. 2011). More recent atmospheric studies have shown that despite global controls, PAHs have not decreased in the Arctic air (Yu et al. 2019).

PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Per- and polyfluoroalkyl substances (PFAS) are a class of nearly 15,000 chemicals (U.S. EPA 2024) that share the common trait of having multiple carbon-fluorine bonds, one of the strongest covalent bonds in organic chemistry, making them incredibly persistent. PFAS chemicals can persist in the environment for such a long time that they are known as “forever chemicals” (Cordner et al. 2021). The handful of companies that produce the basic components of PFAS have known about the dangers of PFAS since the 1970s but have continuously increased production over time (Cordner et al. 2021; Richter et al. 2018). As the deleterious effects of the chemicals have become increasingly tangible in communities all over the world, the number of court cases regarding environmental and human health damages from PFAS have skyrocketed. Between 2005 and 2022, over 6,400 PFAS-related lawsuits were filed in the U.S. alone (Wallender 2022). Several subgroups of PFAS have been listed under the Stockholm Convention for global elimination (**Table 1**).

Still, PFAS are produced in alarming quantities and used in a wide range of products, such as firefighting foams, water repellent fabrics and carpets, non-stick cookware, food packaging, and personal care products. PFAS can repel water, grease, and oil (Gillet et al. 2010), and they are frequently added to plastic products for their non-stick characteristics (Kärrman et al. 2010). PFAS are also used in engine oils and lubricants (Zhu & Kannan 2020) and during oil and gas drilling as surfactants to increase oil production (Glüge et al. 2020). People are exposed to PFAS through contaminated drinking water, food, and household dust. PFAS have been found in the blood of animals and people throughout the world (ATSDR 2024).

Production of PFAS is increasing even though low-level exposures to PFAS are associated with serious health effects. In the U.S., the cost of PFAS exposure and resulting health impacts has been estimated at $37-59 billion annually, and while the industry is earning money from producing PFAS, the health and environmental costs from PFAS are paid by the public (Cordner et al. 2021).

There are few studies of PFAS levels in Arctic Indigenous peoples (Powers et al. 2021); however, some studies demonstrate that concentrations of several PFAS are elevated in Alaska Natives despite low concentrations of PFAS in household dust (Byrne et al. 2018b). Higher concentrations of PFAS among Alaska Natives may be due to their consumption of traditional foods (Byrne et al. 2018b). A recent study showed that PFAS concentrations in well water and blood serum in an Alaskan community were positively associated (Babayev et al. 2022). Moreover, PFAS contamination is frequent in and around military installations, and analyses of water in wells near military sites in Alaska have shown that the concentrations are often above EPA health advisory levels (Powers et al. 2021; Steele et al. 2018). In Alaska, the dispersive use of PFAS-based firefighting foams known as aqueous film forming foams (AFFF) on military bases and airports has contaminated surface and groundwater sources of drinking water in communities throughout the state. PFAS contamination in Alaska has been confirmed at nearly every site that has been investigated in which AFFF has been or is currently being used (ACAT 2023). According to the Alaska Department of Environmental Conservation, there are 469 sites in Alaska where PFAS contamination has been identified in soil and water (ADEC 2024).

PFAS blood serum concentrations among Alaska Natives have shown to disrupt thyroid homeostasis (Byrne et al. 2018b). There is also strong evidence supporting associations between PFAS exposure and gestational diabetes and reduced semen quality (Kahn et al. 2020). Once PFAS are present in the human body, they bind to and then both inhibit and induce peroxisome proliferator-activated receptors (Kennedy et al. 2004; Ishibashi et al. 2019). These are receptors involved in lipid and glucose metabolism and inflammatory response (Schoonjans et al. 1997). PFAS in combination with a high-fat diet have been linked to the progression of prostate cancer (Imir et al. 2021).

Exposure to PFAS in drinking water is linked with kidney and testicular cancers, ulcerative colitis, adverse reproductive health outcomes, liver diseases, thyroid disease, high cholesterol, and immunotoxic effects (Barlow et al. 2019). Exposure has also been linked to increased breast cancer risk (Tsai et al. 2020; Wielsoe et al 2017). A recent review of cancer incidence and PFAS exposure concluded that the strongest evidence demonstrates associations with PFAS and testicular and kidney cancers (Steenland & Winquist 2021).

CHLORINATED PARAFFINS

Chlorinated paraffins are another major group of plastic additives. They are made from petroleum distillates and used in a wide variety of applications, principally in plastics and in metal-working industries. Short-chained chlorinated paraffins were globally banned under the Stockholm Convention in 2017, and medium-chained chlorinated paraffins (i.e., with over 45% chlorine content, the technical definition used by the Convention's expert committee to determine which MCCPs should be included in the listing) are currently being evaluated for listing. Over one million tonnes of chlorinated paraffins are produced every year, making them one of the highest production volume chemicals in the world.

Chlorinated paraffins have been found in a wide range of Arctic animals, including fish, birds, ringed seals, and polar bears (Glüge et al. 2018). In several biota samples, the concentrations of chlorinated paraffins far exceeded the concentrations of other POPs such as PBDEs and PCBs (Zhou et al. 2016).

Chlorinated paraffins have been linked to kidney impairment in humans. They can also act as endocrine disruptors and are associated with adverse thyroid effects (Sprengel et al. 2021). Another study examining the prenatal exposure effects from chlorinated paraffins on zebrafish found that all chain lengths of chlorinated paraffins exhibit neurobehavioral effects (Ren et al. 2019).

Several chlorinated paraffins have been classified by the International Agency for Research on Cancer (IARC 1990) as potential carcinogens. The carcinogenic potential for chlorinated paraffins is further supported by more recent studies on rodents (Wang et al. 2019).

PHTHALATES

Phthalates are made from phthalic anhydride, which is produced from orthoxylene or naphthalene, both of which are derived from fossil fuels. Phthalates are a family of additives common in plastics (Meeker et al 2009), such as PVC.

Phthalates are not covalently bound to the plastics, and when they are exposed to heat, the probability that they will migrate into food is high (De Toni et al. 2018; Rowdhwal & Chen 2018). Even when not subject to heat, phthalates have been shown to leach. A review of studies on phthalates in bottled water showed that across the 379 brands, 68% contained the phthalate DBP and 62% contained DEHP. When the authors compared the concentrations with the recommended limits from WHO and U.S. FDA, 13.9% and 14.2 %, respectively, were above the limit (Luo et al. 2018). Phthalates also leach from rural landfills in Alaska (Mutter 2014). A study along the Aleutian Islands found phthalates in the muscle tissue of ten different seabird species (Padula et al. 2020).

Phthalates have long been known for their toxic effects on the endocrine system, especially around the production of the hormone testosterone. Phthalates have been associated with decreased birthweight of infants born in Greenland (Lenters et al. 2016), breast cancer amongst Alaska Native women (Holmes et al. 2014) and have been shown to negatively affect male reproduction (Lenters et al. 2015). Phthalates are also known obesogens (Gupta et al. 2020), that is, substances that can disturb the metabolism of fats, which may be associated with a higher risk of obesity.

POLYBROMINATED DIPHENYL ETHERS

Polybrominated diphenyl ethers (PBDEs) are a class of flame retardants (brominated flame retardants) that have frequently been used as additives in plastics, especially plastics that serve as insulation foams and in plastic components of computers and other electronics (Lloyd-Smith & Immig 2018).

Several types of PBDEs have been shown to bioaccumulate in Arctic food webs. PBDEs have been observed in higher concentrations in marine Arctic wildlife, such as orcas and seabirds, when compared to terrestrial Arctic wildlife (de Wit et al. 2010). A study of marine mammals of the northern Bering Sea found that PBDEs were frequently detected in all species and tissues analyzed including bowhead whale, Pacific walrus, bearded seal, ribbon seal, and spotted seal. The study found that PBDE concentrations were generally highest in the fatty tissues of seals. Researchers concluded that "...this and other studies demonstrate that POPs such as PBDEs are present in tissues of traditional food animals from Sivuqaq (St. Lawrence Island), as they are throughout the Arctic, and consumption of these animals likely contributes to exposure among Arctic Indigenous Peoples" (Byrne et al. 2022). A study in Yupik communities of Sivuqaq (St. Lawrence Island) found elevated levels of certain PBDEs and significant associations between thyroid stimulating hormone levels and exposure to certain brominated flame retardants (Byrne et al. 2018a).

PBDEs are neurotoxic (i.e., substances that alter the physical structure or bodily function of the nervous system), endocrine disruptors, and adversely affect the reproductive system (Lloyd-Smith & Immig 2018; Liu et al. 2019). Rodent studies on the flame retardant decaBDE have shown that exposure can cause liver damage as it leads to liver toxicity, exacerbates hyperglycemia, affects the metabolism of glucose, and impairs neurodevelopment in motor and cognitive regions of the brain (Sun et al. 2020; Yanagisawa et al. 2019; Zhu et al. 2019; Xu et al. 2018). Studies have demonstrated that exposures to another flame retardant pentaBDE are linked to pro-inflammatory proteins in lung tissue and toxicity and cancer development in the liver (Koike et al. 2014; Dunnick et al. 2020). Another brominated flame retardant is hexabromocyclodecane (HBCDD) used in thermoplastic polymers including polystyrene insulation foam, textile coatings, and polyvinyl chloride cable coatings (National Research Council 2000). In mice, HBCDD has been shown to cause cell death in stem cell models and affect dopamine neurotransmission, especially in the hippocampus (Genskow et al. 2015; Pham-Lake et al. 2017). Moreover, HBCDD and tetrabromobisphenol A (TBBPA), also a brominated flame retardant, have been shown to affect the development of sperm (Steves et al. 2018).

Octabromodiphenyl ether (octaBDE) is another flame retardant that has been widely used in plastic components of electronics. In animal studies, octaBDE exposure has been shown to lead to oxidative stress and, like pentaBDE, promotes the expression of pro-inflammatory proteins in lung tissue, and prenatal exposure to octaBDE is linked to disruptions in the vasopressinergic system, a system that regulates many central nervous system functions (Koike et al. 2014; Bruchajzer et al. 2014; Alvarez-Gonzalez et al. 2020).

BISPHENOLS

Bisphenols are made from acetone and phenols, which in turn are made from benzene and propylene, which are derived from fossil fuels. Bisphenols are primarily used in plastics, with bisphenol A (BPA) being the most well-known form. BPA is a frequently used monomer in plastics with approximately 2-3 million metric tons of the chemical being produced every year (Pubchem 2023). A 2020 study found that about ten million tons of BPA are produced annually, making it one of the most highly produced chemicals by volume worldwide (Abraham, 2020). It has been used in the production of epoxy resins and polycarbonate plastics since the 1960s (Kimber 2017; CheBI 2017).

Polycarbonate plastics have a broad range of applications. They are used in food and beverage packaging, water bottles, baby bottles, compact discs, impact-resistant equipment, medical equipment, and sports equipment, among many other products. Epoxy resins are used to coat products made of metal, including canned food and water supply pipes (Gupta et al. 2020). BPA is also commonly added to other plastics, such as polyvinyl chloride (PVC) and polyethylene terephthalate (PET) (Gupta et al. 2020).

A recent study on BPA in urine samples from participants from Nunavik discovered particularly high levels of BPA compared to the general Canadian population. The concentrations were especially high among women (Aker et al. 2022). BPA is an EDC that has been found to mimic the structure and function of estrogen. By regulating the expression of genes, BPA has been shown to increase the number and size of adipocytes which can ultimately lead to obesity (Gupta et al. 2020). Furthermore, exposure to BPA causes a drop in the release of adiponectin. This drop deactivates the combustion of fat, leading to obesity-related metabolic syndrome (Gupta et al. 2020). Studies on rodents have shown evidence suggesting that BPA can be a human carcinogen for breast and prostate cancers (Seachrist et al 2016), and studies also suggest that it can act as a carcinogen for breast cancer, even at low doses (Wang et al. 2017).

Concerns about BPA over two decades have resulted in bans or restrictions on the chemical by some countries, resulting in industry using close relatives of BPA in its place. Though there are limited data on human exposures and health outcomes associated with other bisphenols, existing evidence from animal studies and human cross-sectional studies of bisphenol B, an analog of BPA sometimes used as a replacement for BPA, provide evidence that bisphenol B is an EDC (Serra et al. 2019). The collective literature on BPB toxicity indicates that BPB may be as toxic to human health as BPA (Serra et al. 2019). Like BPB, Bisphenol F (BPF) is also an analog of BPA and is the main chemical used to replace BPA in plastics (Ullah et al. 2019). A growing body of knowledge suggests BPF is not a safe alternative. In a study in rats, BPF exposure was shown to alter testicular formation and function and decrease testicular testosterone levels (Ullah et al. 2019). In zebrafish, waterborne BPF exposure resulted in genetic alteration of the hypothalamic-pituitary-thyroid (HPT) axis and levels of thyroid hormones (Huang et al. 2016). Finally, Bisphenol S (BPS) is another common bisphenol that is added to plastics. In vitro studies have shown that BPS can lead to oxidative stress in human red blood cells (Macczak et al. 2017) and several studies demonstrate the adverse effects that BPS has on the endocrine system (Skledar et al. 2016; Naderi et al. 2014; Ullah et al. 2016).

BENZOTRIAZOLE UV-STABILIZERS (BUVs)

Benzotriazole UV-stabilizers are a group of chemicals used to make plastics, paints, and cosmetics more stable in sunlight. They have been commercially produced since the 1950s. In the EU, four BUVs are considered substances of very high concern (UV-320, UV-327, and UV-350). An additional five (UV-P, UV-234, UV-326, UV-329, UV-928) are being assessed as persistent, bioaccumulative, and toxic (PBT). UV-328 has been evaluated for a global ban under the Stockholm Convention. During the evaluation, the expert committee found that UV-328 can be transported in marine litter via water and that UV-328 leaches out of the plastics throughout their life cycle. Recent research has also shown that birds take up UV-328 when they ingest plastic litter containing the chemical (Tanaka et al. 2020; Yamashita et al. 2021) and that recorded levels in some seabirds (Tanaka et al. 2020) are in the same order of magnitude as the levels known to be associated with adverse effects for their mammalian predators. (ECHA 2020). UV-328 is toxic to mammals, especially their livers and kidneys. It can also act as an endocrine disruptor (Zhuang et al. 2017; Sakuragi et al. 2021). The review committee concluded that it is persistent, toxic, bioaccumulative, and that it undergoes long-range transport; thus, they recommended a global ban. UV-328 was listed in 2023 under the Stockholm Convention for global elimination.

POLYCHLORINATED BIPHENYLS (PCBs)

Polychlorinated biphenyls (PCBs) are a group of synthetic compounds that were used for decades as plasticizers in paints, plastics, and rubber, and in electrical, heat transfer, and hydraulic equipment (Gupta et al. 2020). PCBs were banned in 1979 in the U.S. and banned globally under the Stockholm Convention in 2004 when the treaty went into force.

Stockpiles of PCBs still exist throughout the world, and they are prevalent in the environment because of their extreme persistence. PCBs are thermodynamically stable and persistent, allowing them to easily leach into the environment and thus enter the food chain. In animals and humans, PCBs are stored in fatty and liver tissues, with an elimination half-life of 10-15 years in people (Gupta et al. 2020). This means that it takes between 10 and 15 years for the concentration of PCBs stored in human tissue to be reduced by half. Since their ban, levels in human blood serum have declined, but new health effects have been uncovered at increasingly low levels (Longnecker et al 1997).

In Alaska, the measured levels of PCBs remain high, and elevated PCB levels in Alaska have been linked to long-range transport and contamination from military sites (Jordan-Ward et al. 2022). Analysis of PCB levels in certain traditional foods, particularly marine mammals in Alaska, revealed such high concentrations of POPs, especially PCBs, that consumption advisories were warranted. The authors compared their results to U.S. EPA consumption guidance documents and found that all the tested species had such high concentrations of PCBs that severe restrictions on consumption would be warranted (Hardell et al. 2010).

Polychlorinated biphenyls (PCBs) exhibit obesogenic effects and additional endocrine disrupting effects. PCB exposure has been linked to type 2 diabetes, lower testosterone levels, altered menstrual cycles, and neurodevelopmental harms including on memory-functioning (Meltzer et al. 2020). Individuals with higher PCB concentrations have been found to have higher body mass indices and fat mass percentages, indicating that increased exposures induce increased obesogenic effects (Dirinck et al. 2011). PCBs have also been linked to increased cancer incidence (Longnecker et al. 1997).

CLIMATE CHANGE IN THE ARCTIC

In addition to toxic chemicals, plastic and other petrochemicals also emit greenhouse gases throughout their entire life cycle, from production through use and disposal. It has been estimated that in 2019, 1.8 billion tonnes of greenhouse gases were emitted throughout the life cycle of plastics (OECD 2022). This corresponds to 3.4% of total global emissions (OECD 2022). Waste management is also a key driver of emissions, and incineration of some types of plastics emit fluorocarbons, which are potent and persistent greenhouse gases (Ellis et al. 2001).

Lasting global climate impacts are felt most profoundly in Arctic regions, with Arctic regions warming nearly four times faster than other parts of the world (AMAP 2021; Rantanen et al. 2022). Along with the impacts of climate change which disrupt access to traditional foods such as fish, caribou, and marine mammals as well as water supplies, the extraction of oil and gas presents its own public health challenge for Alaska Native communities located near industrial facilities.

Dramatic loss of the Arctic cryosphere—sea ice, permafrost, and glaciers—is having profound effects on the ecology and human communities of the North. As a result of rapidly warming temperatures in the Arctic, the extent of summer sea ice is diminishing by 12.2% per decade (NASA 2024). Scientists forecast the disappearance of summer sea ice as early as 2035, thus making coastal communities more vulnerable to storm events and erosion (NSIDC 2023). Melting sea ice accelerates climate warming in the North because as sea ice melts, the reflective surface diminishes, and the ocean absorbs more heat. This results in a feedback loop of further acceleration of sea ice thawing. Carbon stores in the form of carbon dioxide and methane are released to the atmosphere as permafrost melts, creating a feedback loop of further warming and thawing. Methane is about 25 times more potent than carbon dioxide as a greenhouse gas. As temperatures increase in the north, melting permafrost will release more carbon dioxide and methane, thus accelerating the rate of climate warming (NASA 2013; Schurr 2019). The loss of permafrost causes subsidence (i.e., sinking) and increased erosion, threatening homes, community buildings, roads, water and sewer lines, landfills, and pipelines. Both the loss of sea ice and permafrost further threaten food security and safety by increasing distances and access to critical traditional fishing and hunting locations (**Figure 8**).

In the Arctic, the impacts of climate change are influencing the patterns of wildlife migration and hibernation, leading to changes in food web systems and alterations of traditional hunting patterns (Descampts et al. 2017). Warming has led to longer mosquito development seasons and higher risk for vector-borne diseases (Waits et al. 2018). Thawing permafrost also threatens to expose long-frozen pathogens which may threaten the health of wildlife and humans (Waits et al. 2018). Along with changes in the terrestrial landscape, increasing temperatures impact levels of precipitation and ocean circulation, potentially disrupting large food webs. Melting sea ice is also opening new shipping routes, which creates environmental and public health threats to Arctic communities (Ng et al. 2018), including the potential for an increased risk of oil and chemical spills, air and noise pollution, ocean dumping, harm to marine mammals, and disruption of traditional fishing and hunting.

Climate change is exacerbating the challenges that Arctic Indigenous Peoples are already facing, altering their way of life, disrupting their deep connections to their homeland, and thus threatening centuries of ingrained knowledge. The impacts of climate change violate the rights of Indigenous Peoples to their traditional lands, territories, and resources. Coastal erosion and melting permafrost threaten important archaeological sites, and villages such as Kongiganak and Kwigillingok in Alaska have stopped burying their dead because their cemeteries are sinking (Cotsirlos 2017).

More than 80% of Alaska is underlain by permafrost which is rapidly degrading with climate warming and affecting the stability of communities. Climate warming is also leading to increasing storms and storm intensity, with devastating consequences landscapes and community safety. In 2009, village officials identified 31 places that faced “imminent threats” from climate change (Mittal 2019). In 2019, over 70 of 200 Alaska Native villages were identified as facing significant environmental threats due to flooding, thawing permafrost, and erosion (GAO 2022). Alaska Native people are therefore among the world’s first climate refugees (McCarthy 2017).

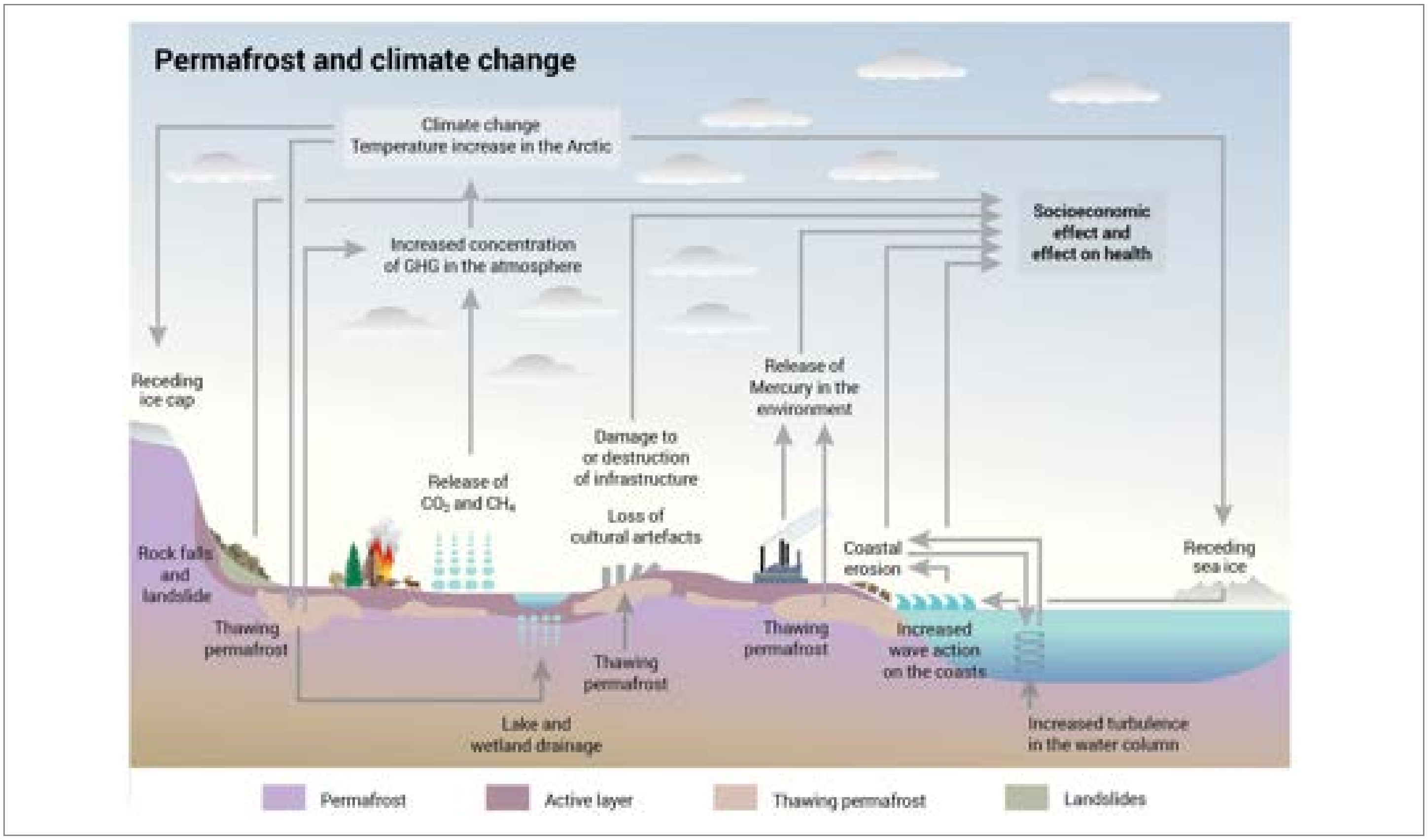


Figure 8 Permafrost and climate change. Source: Riccardo Pravettoni and Philippe Rekacewicz, Grid Arendal at https://www.grida.no/resources/13348

Arctic Indigenous Peoples rely on snow and ice pack to travel among communities and traditional hunting grounds. Many of these communities are in places where infrastructure is dependent on permafrost stability. As sea ice retreats, storm surges intensify and increase erosion of shorelines where many communities are located. Loss of sea ice also threatens populations of ice dependent wildlife species and the food security of Indigenous Peoples. Hunting, fishing, and harvesting are how Indigenous cultures pass their knowledge, skills, and values intergenerationally. This passing and sharing of knowledge has helped Arctic Indigenous communities not only survive but thrive in these harsh environments.

Even though the cultural dimensions of traditional practices are protected by international human rights law (Kirchner 2021), places of cultural importance are no longer accessible and knowledge that has been passed down through generations is being lost. Weather patterns are no longer easily predicted. Arctic People are experiencing reduced access to and availability of traditional foods, such as whales, walruses, and caribou. In the Canadian Arctic, more than one-third of households no longer have access to healthy and safe food (Struzik 2016). In Nunavik communities, half of the children experience food insecurity, with links to slower maturation (Pirkle et al. 2014). As environmental and climatic conditions reduce access to local food, many Arctic Indigenous communities are increasingly forced to rely on retail foods, which are expensive and generally less nutritious. Retail foods cannot replace the higher quality nutrients that traditional foods inevitably provide (Rosol et al. 2016; Rosen, 2014).

For millennia, Alaska Native peoples have relied on traditional ways of hunting seals, fish, and whales (Struzik 2016). Hunting, harvesting, and the sharing of traditional foods promotes social engagement and is a critical component of social cohesion and cultural continuity (Rosol et al. 2016). Traditional foods are high in antioxidants, omega-3 fatty acids, monounsaturated fatty acids, and proteins, as well as micronutrients, including iron, riboflavin, zinc, copper, magnesium, potassium, selenium, thiamine, niacin, and vitamins A, D, E, B6, and B12 (Rosol et al. 2016). Arctic communities are therefore especially susceptible to a shift in the nutritional composition of their diet and overall health and well-being (Rosol et al. 2016). A study of 2,595 adults aged 18 years or older across 36 Canadian Arctic communities revealed that caribou, fish, and seal were consistently the least abundant traditional foods consumed in the previous 12 months, showing the shift to retail-purchased food (Rosol et al. 2016).

There are approximately 13.1 million people and over 40 different ethnic groups inhabiting areas of the circumpolar North (Arctic Centre 2021). Their distinct languages, cultures, and traditional livelihoods face extinction. The impacts of climate change threaten the rights of Indigenous Peoples to their traditional lands, territories of cultural importance, resources, and their right to maintain and sustain their spiritual connection to the land. Among Inuit communities, "ecological grief" characterized by "experienced or anticipated ecological losses" and loss of identity are linked to the reduced ability to engage in traditional activities that ensure food security and uphold cultural norms (Coggins 2021).

The psychological and emotional impacts of climate change include mental and emotional distress from direct experiences with climate disasters, anxiety about the likelihood of future disasters, loss of food security, drought, air pollution from wildfires, and chronic stress from heat. Mental health outcomes of extreme climate change-related events extend from distress to clinical disorders, including sleep disorders, anxiety, depression, and post-traumatic stress disorder (Brubaker et al. 2011; Cunsulo et al. 2015; Cianconi et al. 2020). Anticipating and knowing how to appropriately respond to climate change is inherently stressful. A marked difference in vulnerability between genders has even been indicated: women, young people, and people of lower socioeconomic status are more susceptible to anxiety and mood disorders related to natural disasters (Cianconi et al. 2020). Ultimately, the most vulnerable groups include children, the elderly, the chronically ill, people who have mobility impairments, pregnant and postpartum women, people with mental illness, and people of lower socioeconomic status (Cianconi et al. 2020).

JUST TRANSITION FRAMEWORK

Effectively addressing the triple planetary threat of pollution, climate change, and biodiversity loss (Almroth et al. 2022) relies on a rapid shift away from fossil fuel-based production and consequent chemicals and plastics manufacturing. The climate crisis is directly linked with the production and combustion of fossil fuels, and the concomitant increasing levels of atmospheric CO_2, methane, and other greenhouse gases. There is still time to prevent the worst possible ecological and human health consequences.

Labor unions and environmental justice organizations have long recognized the need to protect workers, communities, and global health through phasing out destructive industries and transitioning to a new healthful and regenerative economy. The Just Transition Alliance, founded in 1997, is a leader in the movement toward a just transition. They define “Just Transition” as “a principle, a process, and a practice. The principle of just transition is that a healthy economy and a clean environment can and should co-exist. The process for achieving this vision should be a fair one that should not cost workers or community residents their health, environment, jobs, or economic assets” (Just Transition Alliance 2024).

The Alaska Just Transition Collective (Just Transition Alaska 2024) is an expanding collective of Alaska-based organizations working toward “a just and equitable transition away from an extractive economy into a resilient one based in care” (Just Transition Alliance 2024) and rooted in the knowledge, wisdom, experience, and guidance of the Indigenous Peoples of these lands. The groups have defined a framework to facilitate the shift to “...an economy that is ecologically sustainable, equitable, and just for all Alaskans” (Just Transition Alaska 2024). Applying the principles of the just transition framework into policies, investments, and other practices will be instrumental in protecting the Arctic and its residents. Although Alaska holds great promise for the development of vast renewable energy resources (Wier 2022) and jobs in the clean energy sector, it will take swift and concerted state, national, and international efforts to curtail the global production of fossil fuels, chemicals, and plastics that contribute to heightened climate warming and contamination of the Arctic.

In addition, The Louisville Charter for Safer Chemicals should be adopted to protect workers and communities. The Charter is a roadmap to fundamentally transform the petrochemical industry so that it is no longer a source of greenhouse gas emissions and toxic harm. Initiated in 2004, the Charter was updated in 2021 to “more explicitly confront the chemical industry's massive contribution to the climate crisis and provide principled guidance for advancing environmental justice in communities disproportionately impacted by harmful and cumulative chemical exposure, while avoiding false solutions.” It also calls for a just transition for workers in the impacted sectors.

The updated Louisville Charter has been endorsed by over 100 organizations representing environmental justice and grassroots communities, environmental and health nonprofits, and leaders in the medical, public health, business, science, and research communities.

"My role has been to be an advocate, to inform people about the routes of contamination.... (it's important) to be open to learning and be open to finding opportunities for the community, because it only takes one person to see an opportunity and bring it to the table for everybody."

**JASMINE JEMEWOUK, INDIGENOUS LEADER,
IÑUPIAQ AND CHEROKEE NATIVE FROM ELIM, ALASKA**

RECOMMENDATIONS

This report describes how the Arctic acts as a hemispheric sink for pollutants, which in combination with climate change is causing devastating effects for the environment and human health. The findings in this report therefore highlight the urgency for swift national and global actions to drastically curb production of fossil fuels and eliminate toxic chemicals.

We therefore offer the following recommendations:

- **Ending government subsidies to the fossil fuel and petrochemical industries and supporting clean, renewable energy and a toxics-free materials economy.** Subsidies enable dirty energy and petrochemical production at the expense of taxpayers and undermine commitments to stabilize the climate, causing further harm to environmental and public health. In the U.S., direct subsidies to the fossil fuel industry are estimated at $20 billion per year (Oil Change International 2021). On a global scale, an International Monetary Fund study found subsidies, tax credits, and grants to the fossil fuel and petrochemical industry were $7 trillion in 2022 (Behboodi 2023). Governments must stop funding industries that destroy the planet and threaten our lives and instead invest in clean energy solutions and toxics-free alternatives to plastics and hazardous chemicals.
- **Stopping fossil fuel and petrochemical industry expansion and accelerating the shift to a clean, renewable energy future.** Reject permits for new fossil fuel projects and revoke illegally granted permits. Eliminate fossil fuel production on public lands and waters. Prevent planned expansion and halt permitting processes for new petrochemical and plastics production facilities. Corporations must be held accountable for disrupting Indigenous cultures, communities, and biodiversity, and endangering the health of Arctic Peoples.
- **Adopting policies and practices as defined in the** Louisville Charter for Safer Chemicals **to protect the health of children, workers, communities, and our living environment and eliminating the production, use, and disposal of toxic chemicals and plastics.** As stated in a recent paper *Transitioning the Chemical Industry*, “The time has come to forge a modern, post-fossil fuel chemical industry that is innovative, versatile, socially and economically just, and aligned with planetary limits” (Tickner et al. 2022). Policymakers must create strong environmental and health protections from toxic chemicals and develop policies that preserve carbon storage in Alaska and the circumpolar Arctic.
- **Integrating the principles of the Just Transition framework.** The framework should be included in national and international policies, investments, and practices to protect the health and well-being of Indigenous Peoples, workers, fenceline and environmental justice communities, children, and women.
- **Strengthening and ensuring strong implementation of the international Stockholm Convention on Persistent Organic Pollutants (“POPs Treaty”) and instituting an effective, legally binding global Plastics Treaty to protect human health and the environment from impacts of plastics throughout the life cycle.** We need immediate steps to curb the production and use of plastics, end the use of toxic chemicals in plastics, and achieve a fundamental shift in our materials economy to replace them with safer, sustainable materials that promote a healthy circular economic future.

- **An effective Plastics Treaty will:**
    - Protect health and the environment
    - End the production and use of toxic chemicals in plastics, including toxic polymers such as polyvinyl chloride and polystyrene
    - Remove toxic impacts at all stages of the lifecycle of plastics
    - Ban recycling of plastics containing hazardous chemicals
    - Protect the public’s right to know about chemicals in plastics and information on plastic production and waste exports
    - Charge plastic producers to finance the treaty
    - Promote safer, more sustainable materials for a toxics-free circular economy
    - Curb toxic and climate pollutants

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