

THE PERMAFROST PROBLEM.

The Arctic is warming nearly four times faster than the global average, accelerating a host of environmental hazards and catastrophic impacts. Permafrost thaw, which describes the loss of perennially frozen ground, is among the most severe, yet overlooked, consequences and drivers of Arctic warming. Underlying roughly 15% of exposed land surface in the Northern hemisphere, permafrost soils contain approximately 1.4 trillion tons of carbon (twice the amount currently in the atmosphere). As it thaws, permafrost has the potential to destabilize local ecosystems, causing costly damage to critical infrastructure, permanently altering the natural landscape and displacing communities. Especially when combined with other extreme hazards in the region, like wildland fires, permafrost thaw may also release greenhouse gas emissions on par with the highest-emitting countries. Yet due to complex geopolitical dynamics and conflicting national priorities, the US government is no longer leading pan-Arctic science research and discovery of solutions to avoid the worst permafrost loss.

THE PERMAFROST POLICY PATHWAYS.

Permafrost Pathways recognizes that actions of US leaders today can determine the state of the Arctic tomorrow.

PATHWAY 1. SUPPORT ARCTIC SCIENCE RESEARCH & RESPONSE TO INTENSIFYING ENVIRONMENTAL THREATS.

US congressional and federal agency leadership should enhance efforts to monitor, measure, and mitigate dangerous changes to the Arctic landscape, including permafrost thaw and Arctic-boreal wildfires, which release major greenhouse gases (GHG) and pose other threats to both local and global public and ecosystem health.

PATHWAY 2. LEGISLATIVE SOLUTIONS FOR PERMAFROST-RELATED RISK MITIGATION AND RESILIENT RESPONSES.

US congressional leaders should seek to mitigate the worst environmental harms from the Arctic and to direct interagency coordination with communities leading adaptation and resilient responses, including managed retreat and relocation, consistent with principles of self-determination and Tribal sovereignty.

PATHWAY 3. EXPERT CONTRIBUTIONS TO POLICY DISCOURSE ON ARCTIC SCIENCE AND SECURITY.

US congressional and federal agency leadership should inform decisions on Arctic science, strategies, and security at critical forums, like the Arctic Council. Permafrost Pathways scientists at Woodwell Climate Research Center are available to provide peer-reviewed research, articles, briefings, official testimony, or informal advice upon request.

CONSULT OUR SCIENCE.

Permafrost Pathways harnesses the combined expertise of leading research institutions and on-the-ground organizations specializing in climate science, policy, and environmental justice to inform and develop adaptation and mitigation strategies to address permafrost thaw.



Photo: Sue Natali; Amautiuaq.

PATHWAY 1. Support Arctic Science Research & Response to Intensifying Environmental Threats

Woodwell Climate Research Center recognizes that Arctic science research programs are not exempt from recent and proposed budgetary decisions of the federal government. As the US government seeks to develop its next 5-year Arctic Research Plan, Permafrost Pathways strongly recommends that government leadership dedicate resources for agencies and programs that are essential to supporting Arctic science and response—especially in light of new and intensifying environmental hazards. Permafrost Pathways respectfully suggests safeguarding the following targets to continue US leadership in Arctic research:

Priority 1: INVESTING IN THE BEST AVAILABLE ARCTIC SCIENCE

National Science Foundation - Office of Polar Programs.

The section for Arctic Sciences within the Office of Polar Programs/Directorate for Geosciences (the largest NSF polar budget account) catalyzes research into biological, geophysical, chemical, and sociocultural processes, and interactions of ocean, land, atmospheric, biological, and human systems. NSF-backed projects help to reduce scientific uncertainty about future landscape changes – including those pertaining to permafrost thaw and wildfires.

→ [Permafrost Pathways notes with concern the substantial budget cuts proposed for NSF](#), which may undermine efforts to conduct longer-term Arctic projects, develop Earth System Models that include underrepresented Arctic processes, like permafrost thaw and permafrost-wildfire interactions, and otherwise support the next generation of Arctic researchers.

National Oceanic and Atmospheric Administration - Office of Oceanic and Atmospheric Research; National Environmental Satellite, Data, and Information Service; National Weather Service.

NOAA components deliver Arctic-focused data on weather patterns, sea ice and coastal conditions, and other trends that inform predictive technologies and tools. Robust research services based in Alaska and consolidation efforts like the publication of the Arctic Report Card provide the best available information to researchers and decision-makers seeking to implement safeguards for the region. NOAA is vital to Arctic resilience, and is a substantial employer in the state.

→ [Permafrost Pathways notes with concern the substantial budget cuts proposed for the research programs of NOAA](#), which will directly undermine the operations of the Arctic Data Science Center, key satellite programs, and other functions that are enabling the US to predict and mitigate impacts of environmental threats to Alaska.

Priority 2: INNOVATING NEW WILDFIRE MANAGEMENT APPROACHES

Department of Interior - National Wildlife Refuge System; Office of Wildland Fire Management.

As extreme fire regimes intensify across the U.S., there is an urgent need to better understand the public health and climate impacts of intensifying fires in permafrost-rich boreal forests of the Arctic region. Dedicating resources to allow for standardized monitoring of wildfires in Alaska's wildlife refuges provides a cost-effective solution for researching alternative approaches to wildfire management in the permafrost region.

→ [Permafrost Pathways notes with concern the proposals to minimize scientific research components of wildfire management](#), including as part of efforts to consolidate wildfire response; but does recognize the need for improved interagency coordination across the federal government.

Priority 3: INCREASING THE RESILIENCE OF PERMAFROST-AFFECTED COMMUNITIES

Department of Agriculture - Natural Resources Conservation Service.

The USDA Natural Resources Conservation Service (NRCS) has effectively leveraged its programs, including the **Emergency Watershed Protection (EWP) Program**, to support planning and implementation for Alaska Native communities facing imminent environmental threats. NRCS Alaska also anticipates that the **Watershed Flood Prevention Operations (“Watershed”) program** may become critical in assisting proactive and large-scale managed retreat and/or community-wide relocation projects in the most at-risk rural communities. This is the only federal program that effectively delivers both co-produced adaptation planning and engineering of new infrastructure with the goal of hazard mitigation—but requires adequate funding to execute projects in AK.

Bureau of Indian Affairs - Tribal Climate Resilience Program.

BIA's TCR branch has successfully provided direct technical assistance and support to Alaska Native Villages facing imminent threats arising from permafrost thaw and other slow-onset disasters—including those which are causing the need for managed retreat and/or community-driven relocation.

→ [Permafrost Pathways notes with concern the recent uncertainty that many TCR award recipients have faced in response to actual or potential award cancellations](#); [Permafrost Pathways also notes with concern proposed budget cuts to BIA programs](#), which may hinder operations of those who rely on TCR resources to assess and implement adaptation projects.

Denali Commission- Village Infrastructure Protection Program.

The Denali Commission's Village Infrastructure Protection (VIP) program is only one of two federal programs that is statutorily authorized to assist environmentally-threatened Tribal Communities that are facing climate-forced displacement. It is the only program that exclusively supports Alaska Native Communities to which the U.S. owes a Federal Trust responsibility.

→ Permafrost Pathways notes with concern proposals to eliminate regional commissions, like the Denali Commission, as well as fact that the VIP program does not receive regular appropriations, and thus, the Denali Commission does not have sufficient funds to deliver VIP grants that meet the size or scale of community adaptation needs.

Priority 4: INFORMING GLOBAL STRATEGIES FOR A SAFE AND SECURE ARCTIC REGION

The Department of State - Office of Ocean and Polar Affairs.

The Office of Ocean and Polar Affairs within the State Department's Bureau of Oceans and International Environmental and Scientific Affairs (OES) is responsible for developing and implementing US foreign policy as it relates to the Arctic region and leads US participation in the Arctic Council. Permafrost Pathways recognizes that the Arctic Council has not operated to its fullest extent in recent years, but notes the efforts of the previous Chairship under Norway and now the Kingdom of Denmark to maintain Arctic governance and coordination to the extent possible. Permafrost Pathways also recognizes the opportunity for the Arctic Council to help facilitate scientific cooperation and knowledge sharing amongst Arctic scientists during challenging geopolitical times.

→ Permafrost Pathways notes with concern that, withdrawal of US participation from global climate negotiations and other key forums, like the Arctic Council, will delay necessary and coordinated actions to mitigate Arctic warming and associated hazards, including permafrost thaw, glacial melt, sea level rise, intensifying wildland fires, species collapse, and carbon emissions.

The U.S. Arctic Research Commission.

Established by the Arctic Research and Policy Act of 1984, the independent US ARC has consistently played a critical role in recommending Arctic research priority areas and building cooperative links between the US federal government and international community on the implementation of this research. Ahead of the Interagency Arctic Research and Policy Committee's preparation of the next Arctic Research Plan, US ARC has released a short statement on the "research needs" for a safe Arctic region –confirming that the topics of military, community, energy, and economy are all priorities– but further noting the mutual reinforcing nature of research conducted in the region.

→ Permafrost Pathways notes with concern that, despite operating with only an annual budget of less than \$2 million, and providing an essential throughline for global Arctic research, the Administration has scrutinized its function as "non-statutory" (described in the same Executive Order cutting operations of the Wilson Center's Polar Institute).

Permafrost Pathways offered budget and report language recommendations pertaining to several of these priorities in FY26 appropriation requests. ■

PATHWAY 2. Legislative Solutions for Permafrost-Related Risk Mitigation and Resilient Responses

Woodwell Climate Research Center recognizes the challenge of achieving congressional consensus on issues most critical for climate mitigation and adaptation in the near future. Permafrost Pathways experts nevertheless appreciate and acknowledge the efforts of many congressional champions who continue to introduce legislative proposals and expressions of political will that seek to advance Arctic science, safety, and resilience.

To address the persistent and escalating risk of climate-forced displacement across Alaska, and the need for greater government support of community-led adaptation responses to permafrost thaw, flooding, and erosion:

Permafrost Pathways urges Congress to enact national legislation that provides a whole-of-government response to pervasive environmental threats, including permafrost thaw, flooding, and erosion. Permafrost Pathways respectfully refers Congress to the findings of the federal interagency Community-Driven Relocation (CDR) Subcommittee formed under the previous Administration, and recommends a legislative solution that achieves the following:

Permanently authorizes an interagency working group to align federal adaptation programs and enumerate a process for initiating community-driven relocation in response to climate-forced displacement.

The CDR Subcommittee's brief operations may be considered as proof of concept for an interagency working group that could be permanently authorized under statute to oversee the federal government's response to climate-forced displacement. Under the leadership of DOI and FEMA, Congress could establish an interagency working group to coordinate federal assistance from multiple agencies for purposes of supporting managed retreat and community-led relocation, and establish a standardized process for pursuing these longer-term adaptation responses.. The federal government has previously recognized the need to establish a coordination entity to support community-led adaptation (legislative proposals have allocated this role to the Department of Interior—and other experts have suggested that the Denali Commission would have been well-equipped to oversee community-led adaptation in Alaska due to its flexible funding structure and adaptation-focused mandate). However, to date, no single agency has explicit statutory authority to execute this task and the process for implementing such a complex endeavor remains largely undefined outside of the CDR Subcommittee's findings. Given the efforts of the CDR Subcommittee to evaluate programmatic alignment and gaps in relocation assistance, formally establishing this working group would enable the implementation of the CDR Subcommittee's recommendations and provide a receiving entity for dedicated funding.

Establishes a single, committed funding source to cover costs of protection-in-place, managed retreat, and community-driven relocation of environmentally-threatened Alaskan communities.

Despite funding authorized through the Bipartisan Infrastructure Law and Inflation Reduction Act for hazard mitigation, climate resilience, and community-driven relocation, there is an estimated funding gap of \$80 million (in 2019 dollars) per year over the next 10 years to meet the needs of the most environmentally threatened communities in Alaska. This estimate is based on the conclusion that at least \$4.3 billion dollars over the next 50 years are required to protect the 144+ environmentally threatened communities in Alaska from flooding, erosion, and permafrost thaw. Unfortunately, most federal funds are not reaching permafrost-affected areas in Alaska, where project costs exceed those in the lower 48 and financial resources of tribal and local governments are comparatively lower (as most do not own taxable property). Moreover, not all of these awards have been received or obligated to communities. To address the funding gap, Congress should provide for a committed funding source to support community-led environmental data collection and risk assessments, and provide technical assistance to environmentally-threatened communities pursuing managed retreat and relocation.

Proposes to amend (or instruct agencies to waive) hazard mitigation planning, eligibility, and funding thresholds for federal grant programs that are inaccessible to rural and insular Alaska Native communities.

Where Federal agencies have the discretion to do so, they should systematically waive programmatic requirements that are posing undue burdens on the most environmentally threatened Alaska Native communities. These include: Maintaining valid (non-expired) FEMA-approved Hazard Mitigation Plans, as is required under the Stafford Act; securing other funding sources before pursuing HUD's Indian Community Development Block Grant Imminent Threat resources; satisfying prohibitively high cost-share requirements of the FEMA BRIC program and non-federal match requirement for US ACE programs; and receiving reimbursement for subsistence infrastructure and equipment (such as fish camps) under FEMA's Individual Assistance program, despite recent equity rule changes. To date, regulatory reforms have failed to effectively configure programs to address the unique challenges facing Alaska Native villages. Where these requirements are imposed in statute, Congress should eliminate requirements for insular and rural communities or provide waiver flexibilities to allow agencies to provide equitable assistance that serves the needs of Alaska Native constituents.

Convenes an interagency task force to analyze and propose a more effective methodology for assessing risks from compounding and slow-onset environmental hazards (including permafrost thaw, erosion, flooding, and "Usteq").

Environmental threats to Alaska Native communities are unique to those living in the lower 48, due largely to the existence of permafrost and the interaction of permafrost thaw with other natural disturbances. Alaska-specific reports, such as the 2019 Statewide Threat Assessment, seek to account for these risks by ranking communities according to environmental

vulnerabilities. As rates of permafrost thaw, erosion, flooding, and land degradation will vary, such ranking systems have the potential to mislead government funding efforts. Assigning funding for an inter-agency task force to work with independent researchers on a more effective set of parameters for assessing these slow-onset risks that pose both protracted and immediate threats to the health and safety of communities may help to increase the efficacy and accessibility of key federal programs. The Denali Commission and US Army Corps of Engineers are currently working to update this Statewide Threat Assessment—the timeline for completion and methodology, however, remain unknown.



Inventories of public lands suitable and available for transfer, exchange, and subsistence and cultural use, in partnership with local and Indigenous knowledge-holders.

As environmentally-threatened communities in Alaska (and elsewhere in the US) pursue managed retreat or community-driven relocation, there is a need to identify areas of land with lower risk from flooding, erosion, and/or degradation due to permafrost thaw. Congress should direct state and federal agencies, in consultation with local communities, to develop a geospatial inventory of public lands that are located outside of hazard zones, and thus may be suitable for managed retreat and relocation. Considerations may include permafrost depth and soil composition, the existence of or potential to construct critical infrastructure and utilities, and the natural and community resource values relevant to subsistence practices and traditional ways of life. Recognizing that these lands may fall under federal, state, municipal, or ANC control, additional protocols for facilitating land transfers, exchanges, easements, leasebacks, and other access rights will be required. A Congressionally-mandated inventory that is maintained and updated annually by Alaska Native communities, and federal and state agencies, and which contains the latest site assessments is an important foundational step for advancing community-led adaptation.

Permafrost Pathways recognizes that other entities have generated resources that provide a basis for legislative action and policy design for community-led adaptation and community-driven relocation. We recommend the following:

DOI and FEMA (CEQ, OSTEP), Opportunities for Federal Support of Community-Driven Relocation; and Community Driven Relocation: Guide for Communities to Federal Programs and Resources (produced by the federal interagency Community-Driven Relocation Subcommittee, 2024).

GAO. (2022). GAO-22-104241 Alaska Native Issues: Federal Agencies Could Enhance Support for Native Village Efforts to Address Environmental Threats. Washington, D.C.: U.S. Government Accountability Office, <https://www.gao.gov/assets/gao-22-104241.pdf>

ANTHC [Alaska Native Tribal Health Consortium]. (2024). Unmet Needs of Environmentally Threatened Alaska Native Villages: Assessment and Recommendations, https://www.anthc.org/wp-content/uploads/2024/01/Unmet_Needs_Report_22JAN24.pdf.

UAF, USACE, CRREL. (2019). Statewide Threat Assessment: Identification of Threats from Erosion, Flooding, and Thawing Permafrost in Remote Alaska Communities. Anchorage: Denali Commission.

National Academies of Sciences, Engineering, and Medicine. (2024). Community-Driven Relocation: Recommendations for the U.S. Gulf Coast Region and Beyond. Washington, DC: The National Academies Press. doi: 10.17226/27213.

A NOTE ON OTHER LEGISLATIVE SOLUTIONS. Permafrost Pathways also supports legislative proposals and amendments that purport to achieve the following:

- A.** Enable more transparent and equitable data access, geospatial information, and mapping tools for Arctic researchers and knowledge-holders (consistent with principles of data sovereignty and open science); and
- B.** Enable research into alternative, evidence-based, and Indigenous-led approaches to managing wildfires originating from the Arctic-boreal region and the impacts of these fires on public and ecosystem health..

Additional information on these proposals and specific recommendations for both regulatory and statutory solutions are set forth in supplemental materials (available upon request). ■

PATHWAY 3. Expert Contributions to Policy Discourse on Arctic Science and Security

Permafrost Pathways scientists at Woodwell Climate Research Center are available to provide peer-reviewed research, articles, briefings, official testimony, and/or informal advice to congressional and agency leaders on Arctic science, strategies, and climate security. Specific areas of expertise include:



Indigenous-led/co-produced environmental monitoring and geospatial mapping of climate impacts in Alaska

Permafrost Pathways scientists are monitoring Arctic environmental changes under the direction of and collaborating with Indigenous knowledge-holders in the Alaska Native villages of Akiak, Akiachak, Chevak, Golovin/Chinik, Kipnuk, Kuigilnguq, Kwinhagak, Kwethluk, Nunapicuaq, and Nelson Lagoon. Monitoring activities include: weather station installation, soil composition assessment, permafrost coring, water quality testing, and geospatial mapping of past and current changes to the landscape. We can speak to guidelines to operationalize federal requirements for co-produced Arctic research, the integration of Western science and Indigenous Knowledge, and balancing principles of open science and data sovereignty of Tribes.



Impacts of permafrost thaw and slow-onset disasters on critical infrastructure and Alaska communities

Permafrost Pathways is regularly engaging with community partners in the Yukon-Kuskokwim delta that are most affected by slow-onset disasters, such as permafrost thaw, and coastal storms, to assess resilience and adaptation solutions. We can speak to the impacts of permafrost thaw-induced degradation of critical infrastructure and public utilities, ongoing efforts to engineer solutions, and examples of landscape degradation. We can also speak to challenges associated with addressing permafrost thaw and other slow-onset environmental threats in Alaska within existing disaster governance frameworks and regulatory programs. We can also speak to the importance of new community-driven relocation pilot projects in Alaska and the value of interagency collaboration. .



Pan-Arctic carbon flux monitoring (carbon and methane emissions) and new technologies

Permafrost Pathways is working with an international team of scientists who work across the permafrost region to install strategically placed eddy covariance towers used to measure carbon fluxes (methane and carbon) from permafrost thaw, supporting existing towers, and learning best practices for consulting with Arctic communities living near tower installations. We are also working to combine ground measurement data with synthesized flux data from across the Arctic, satellite remote sensing products, and machine learning to extrapolate and map carbon fluxes at a larger scale. We can speak to these technical efforts and the importance of scientific cooperation to close greenhouse gas (GHG) monitoring gaps and sustain Arctic environmental observations.



Terrestrial ecosystem models and predictive climate models with improved Arctic representation

Permafrost Pathways is developing the first-of-its-kind data assimilation model of Arctic carbon that includes permafrost-related ecosystem processes to improve historical assessments, near-term forecasts, and longer-term projections. We are also integrating permafrost processes into a compact Earth system model (OSCAR) to provide timely information on the impact of permafrost carbon emissions on global climate and remaining anthropogenic carbon budgets. We can speak to the importance of considering permafrost-carbon feedbacks and other Arctic processes that generate warming-induced emissions into future climate projections and policy decisionmaking.



Arctic-boreal wildfire management, cultural burning, and emerging research on permafrost-fire interactions

Permafrost Pathways is collaborating with federal land management agencies, Alaska fire managers, Indigenous Knowledge-holders, and other experts to research cost-effective and climate-protective alternative fire management strategies in the tundra and boreal forests. We continue to connect with federal agencies and Alaska Native tribes to discuss opportunities for prioritizing permafrost/carbon and public health protection as part of fire management decisionmaking. We can speak to the often-overlooked GHG emissions from boreal forest fires, the significance of boreal forests as a carbon source/sink, and the opportunities for innovative and community-led fire management approaches..



Subsistence fishing and salmon decline in permafrost-affected areas of the Yukon-Kuskokwim region.

Permafrost Pathways is raising awareness of salmon declines and disruptions to subsistence practices in the Yukon-Kuskokwim region, where communities are also impacted by permafrost thaw and other environmental threats. Our Alaska subsistence fishery experts can speak to ongoing challenges associated with dual management in Alaska, efforts to Indigenize salmon and protect traditional ways of life, and opportunities for the federal government to more effectively uphold Tribal governance and subsistence rights. ■