INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE BIENNIAL REPORT 2018–2019

A Report by the

INTERAGENCY ARCTIC RESEARCH POLICY COMMITTEE

A SUBCOMMITTEE OF THE COMMITTEE ON ENVIRONMENT

of the

NATIONAL SCIENCE & TECHNOLOGY COUNCIL

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About the National Science and Technology Council

The National Science and Technology Council (NSTC) is the principal means by which the Executive Branch coordinates science and technology policy across the diverse entities that make up the Federal research and development enterprise. A primary objective of the NSTC is to ensure science and technology policy decisions and programs are consistent with the President's stated goals. The NSTC prepares research and development strategies that are coordinated across Federal agencies aimed at accomplishing multiple national goals. The work of the NSTC is organized under committees that oversee subcommittees and working groups focused on different aspects of science and technology. More information is available at http://www.whitehouse.gov/ostp/nstc.

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About the Interagency Arctic Research Policy Committee

The Arctic Research and Policy Act of 1984 (ARPA), Public Law 98-373, July 31, 1984, as amended by Public Law 101-609, November 16, 1990, provides for a comprehensive national policy dealing with national research needs and objectives in the Arctic. The ARPA establishes an Arctic Research Commission (ARC) and an Interagency Arctic Research Policy Committee (IARPC) to help implement the Act. Since its inception, IARPC activities have been coordinated by the National Science Foundation (NSF), with the Director of the NSF as chair. A Presidential Memorandum issued on July 22, 2010, made the NSTC responsible for IARPC, with the Director of the NSF remaining as chair of the committee.

About this Document

This report was developed by the IARPC Staff Group and includes an overview of how the *Arctic Research Plan 2017-2021* supports the Administration's FY2019 research and development budget priorities and highlights IARPC accomplishments during the period 2018-2019. The report concludes with a summary of how the *Arctic Research Plan 2017-2021* responds to the most recent (2019-2020) recommendations of the U.S. Arctic Research Commission.

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Introduction

Recognizing the importance of Alaska and the Arctic to the Nation, and the need for research to increase scientific knowledge and understanding to inform decisions and policy, Congress passed the Arctic Research and Policy Act of 1984 (henceforth ARPA or the Act).[1] It established the U.S. Arctic Research Commission (USARC)[2] "to promote Arctic research and to recommend Arctic research policy" and the Interagency Arctic Research Policy Committee (IARPC)[3] to "develop a national Arctic research policy and a five year plan to implement that policy."

The Act also requires IARPC to submit to Congress, through the Executive Office of the President, a biennial report containing a statement of activities and accomplishments of the IARPC, and a statement "detailing with particularity the recommendations of the Commission with respect to Federal interagency activities in Arctic research and the disposition and responses to those recommendations." This biennial report addresses this requirement for the period 2018-2019, the second and third years of the implementation of the *Arctic Research Plan 2017-2021*.[4]

The report begins with a description of the *Arctic Research Plan 2017-2021* and how it is implemented, followed by select highlights of IARPC accomplishments during the period 2018-2019. The highlights are organized according to the four policy drivers of the *Arctic Research Plan 2017-2021*. The report continues with examples of how the work of IARPC is aligned with the OSTP vision for *America Leading the World in Science and Technology*[5] and how IARPC supports the Administration's FY2020 research and development budget (R&D) priorities[6]. The report concludes with a summary of how the *Arctic Research Plan 2017-2021* is aligned with the most recent USARC Report on the Goals and Objectives for Arctic Research 2019-2020[7].

The Arctic Research Plan 2017-2021

The United States is an Arctic Nation, and America's Arctic—the State of Alaska—has seen climate, environmental, and socio-economic changes that are testing the resilience and sustainability of communities and ecosystems. The changes that are occurring in the Arctic also have global consequences.

In December 2016, IARPC released the second comprehensive Arctic research plan—*Arctic Research Plan 2017-2021.*[8] Through the *Arctic Research Plan 2017-2021* (hereafter the Plan), IARPC continues to

[1] https://www.nsf.gov/geo/opp/arctic/iarpc/arc_res_pol_act.jsp
[2] https://www.arctic.gov/reports_goals.html
[3] The following Federal departments, agencies, and Executive Office of the President components comprise IARPC: Department of Commerce, Department of Defense, Department of Energy, Department of Health and Human Services, Department of Homeland Security, Department of the Interior, Department of State, Department of Transportation, Environmental Protection Agency, Marine Mammal Commission, National Aeronautics and Space Administration, National Science Foundation (Chair), Office of Management and Budget, Office of Science and Technology Policy, Smithsonian Institution, and U.S. Department of Agriculture.
[4] https://www.iarpccollaborations.org/uploads/cms/documents/iarpc_arctic_research_plan_2017-2021.pdf
[5] https://www.whitehouse.gov/articles/america-leading-world-science-technology/
[6] https://www.whitehouse.gov/wp-content/uploads/2019/08/FY-21-RD-Budget-Priorities.pdf
[7] https://www.arctic.gov/reports_goals.html
[8] The preparation of the *Arctic Research Plan 2017-2021* was informed by discussions with researchers and others in the U.S. Government, State of Alaska agencies, Alaska Natives, academia, non-governmental organizations, and the private sector. The draft plan was made available for public comment via the Federal Register in July 2016.

address the need for coordinated basic and applied research that will increase knowledge and understanding for science-informed decisions and policy for Alaska, the Arctic region, and planet Earth. The Plan has four policy drivers that support U.S. policy across a range of scales, from Arctic peoples and communities to the global scale:

1. Enhance the Well-being of Arctic Residents
2. Advance Stewardship of the Arctic Environment
3. Strengthen National and Regional Security
4. Improve Understanding of the Arctic as a Component of Planet Earth

As with its predecessor—the *Arctic Research Plan 2013-2017*—the Plan does not attempt to address all Arctic research supported by the Federal Government. The Plan deliberately emphasizes interagency collaboration; consequently, many important single agency efforts are not included.

The Plan has nine research goals:

1. **Health and Well-being:** Enhance understanding of health determinants and improve the well-being of Arctic residents.
2. **Atmosphere:** Advance process and system understanding of the changing Arctic atmospheric composition and dynamics and the resulting changes to surface energy budgets.
3. **Sea Ice:** Enhance understanding and improve predictions of the changing sea ice cover.
4. **Marine Ecosystems:** Increase understanding of the structure and function of Arctic marine ecosystems and their role in the climate system, and advance predictive capabilities.
5. **Glaciers and Sea Level:** Understand and project the mass balance of glaciers, ice caps, and the Greenland Ice Sheet, and their consequences for sea level rise.
6. **Permafrost:** Advance understanding of processes controlling permafrost dynamics and the impacts on ecosystems, infrastructure, and climate feedbacks.
7. **Terrestrial and Freshwater Ecosystems:** Advance an integrated, landscape-scale understanding of Arctic terrestrial and freshwater ecosystems and the potential for future change.
8. **Coastal Resilience:** Strengthen coastal community resilience and advance stewardship of coastal natural and cultural resources by engaging in research related to the interconnections of people and natural and built environments.
9. **Environmental Intelligence:** Enhance frameworks for environmental intelligence gathering, interpretation, and application toward decision support.

Like the *Arctic Research Plan 2013-2017*, the Plan is being implemented through IARPC Collaborations. IARPC Collaborations operates as a platform—a website[9] for information exchange and reporting on progress made implementing the Plan—and a practice—Federal and non-Federal stakeholders and collaborators working together on specific goals, objectives and performance elements. IARPC continues to welcome diverse participation in the implementation of its research plans and encourages all who want to address difficult research challenges in the Arctic to join forces to achieve more together than can be achieved acting alone.

[9] https://www.iarpccollaborations.org/index.html

Members of IARPC Collaborations work together in collaboration teams, one for each of the Plan's nine research goals. In addition, the Environmental Intelligence[10] Collaboration Team has three auxiliary teams responsible for each of the components—observations, models, data management—of Environmental Intelligence.

Comprehensive annual reports describing each collaboration team's accomplishments implementing the Plan in 2018[11] and 2019[12] , the period of this report, are available online at IARPC Collaborations. The next section provides a selection of highlights of those accomplishments.

Highlights of IARPC Accomplishments in 2018-2019

The four policy drivers listed in the previous section provide the framework for this selection of highlights of IARPC accomplishments during the period 2018-2019.

Policy Driver 1: Enhance the Well-being of Arctic Residents

Wildfires were common and extensive throughout the Arctic region in the summers of 2018 and 2019.[13] Those fires threatened infrastructure, disrupted transportation and communications, and posed significant risks to the health and well-being of residents. Consequently, a number of IARPC collaboration teams worked together to assess the exposure, vulnerability, and resilience of Arctic communities to wildfire smoke and its health effects. Efforts focused on observing system platforms and gaps in wildfire smoke detection and forecasting capabilities. The Local Environmental Observer (LEO) Network was examined as a possible means to improve smoke preparedness efforts and identify at-risk populations and to improve observational and fire forecasting capabilities. There are significant efforts to improve forecasting (e.g., the NOAA High-Resolution Rapid Refresh (HRRR) model for predicting smoke concentrations over Alaska), but work remains to be done on community vulnerability to wildfires and their effects.

Harmful Algal Blooms (HABs)—overgrowths of algae in freshwater and seawater—produce dangerous toxins that can sicken and kill people and animals.[14] Even non-toxic blooms hurt the environment and local economies.[14] Driven by diminishing sea ice and rising ocean temperatures, HABS are increasing in frequency and geographic extent in the Arctic, including in Alaskan Arctic waters, where harmful toxins are being detected in stranded and harvested marine mammals in the Bering, Chukchi, and Beaufort seas. HABs pose a threat to Alaskan Arctic coastal communities, and there are gaps in fundamental understanding of Arctic HABS, toxicity monitoring of subsistence food and safety protocols, and capacity to respond to future HABS. Recognizing those challenges, IARPC collaboration teams coordinated Federal agencies to respond to the Arctic HABs threat. The Environmental Intelligence Collaboration Team facilitated a coordinated research cruise and community sampling effort in 2018 and 2019 that realized an essential baseline understanding of HABs in the Bering Strait region. Disseminated quickly to communities and other entities (e.g., the Alaska Federation of Natives), this coordinated HABs research activity addresses the need for information on testing of natural resources

[10] Environmental Intelligence is a system through which timely, reliable and suitable information obtained, for example, by people, autonomous sensors and platforms, ships, airplanes and satellites, about a particular region or process is collected and integrated for the benefit of decision-makers.
[11] https://www.iarpccollaborations.org/about.html
[12] https://www.iarpccollaborations.org/about.html
[13] https://www.nesdis.noaa.gov/content/noaa-satellites-monitor-arctic-wildfires
[14] https://www.epa.gov/nutrientpollution/harmful-algal-blooms

and subsistence foods for algal toxins and potential impacts on human health through wild food consumption.

The health and well-being of Arctic residents is a topic that is particularly ripe for a co-production of knowledge approach to research. In the Arctic, the co-production of knowledge involves Indigenous knowledge holders and scientists working together as equals to define the problem, conduct the research, and publish the results, to develop a holistic understanding of the changing Arctic and its impacts that can inform policy-and decision-making.[15] The Coastal Resilience Collaboration Team took the lead in organizing a series of meetings, which included Alaska Native peoples, to address the importance of taking a co-production approach to the well-being of Indigenous peoples, and to discuss the meaning of co-production of knowledge in the Arctic and how to facilitate the process.

Policy Driver 2: Advance Stewardship of the Arctic Environment

Diminishing sea ice is nowhere more apparent and consequential than in the Bering Sea. This was dramatically illustrated in late winter and early spring of 2018, and again in 2019, when sea ice extent retreated to record low levels and the Bering Sea was almost entirely free of ice.[16] The ramifications of such a dearth of sea ice so early in the year for the marine ecosystem and the coastal communities that depend on it are significant. Consequently, IARPC formed a Bering Sea Action Team that is addressing the need to document the current state of knowledge and understanding of the changing sea ice and marine ecosystem, coordinate research cruises and observing activities, improve sea ice forecasting and notification systems for a variety of stakeholders, and identify decision support needs.

The Arctic Report Card,[17] prepared by a team of authors and editors from the United States (Federal and non-Federal) and overseas, was released in December 2018 and December 2019. Published annually since 2006, the Arctic Report Card describes the current state of different components of the Arctic environmental system relative to historical records. Arctic Report Card 2019[18] was notable for its focus on the Bering Sea and the first ever contribution from Alaska Native peoples, in this case Indigenous Elders of the region, who offered "their perspectives of living at the forefront of climate change."

MOSAiC (Multidisciplinary Drifting Observatory for the Study of Arctic Climate) is an international research expedition to study the physical, chemical, and biological processes that couple the Arctic atmosphere, sea ice, ocean and ecosystem. After almost a decade of planning and preparation, one of the largest and most complex scientific expeditions ever mounted in the Arctic got underway in September 2019, when the German research vessel (RV) *Polarstern* headed north and was then deliberately allowed to freeze into the sea ice in October. This began an anticipated 12-month drift across the central Arctic Ocean, from the edge of the Eurasian shelf to the North Atlantic Ocean. Conceived by an International Arctic Science Committee working group, MOSAiC involves many U.S. researchers, who, supported by DOE, NASA, NOAA, and NSF, have contributed to the science and implementation planning, and many more who will be deeply involved in the year-long research program aboard the ship and on the surrounding sea ice. By the time the MOSAiC drift concludes in late summer/early autumn 2020, those four IARPC agencies will have made it possible for 82 U.S. researchers and technical support staff (30% of the total from all 17 participating countries) to conduct research aboard the RV *Polarstern*.

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[15] Behe, C. and R. Daniel, 2018, Indigenous knowledge and the coproduction of knowledge process: Creating a holistic understanding of Arctic Change, Bulletin of the American Meteorological Society, vol. 99, no. 8, pp. S160-S161.

[16] https://www.nesdis.noaa.gov/content/bering-sea-appears-largely-ice-free-noaa-20

[17] https://www.arctic.noaa.gov/Report-Card

[18] https://arctic.noaa.gov/Report-Card/Report-Card-2019

The DOE Atmospheric Radiation Measurement (ARM) Program contribution to MOSAiC includes a "cloud observatory" of over 50 instruments, including scanning radars (the first to be deployed in the Arctic Ocean) and precipitation sensors, atmospheric radiation measurement instruments, an aerosol observing system, and wind and atmospheric profilers. The DOE Atmospheric System Research Program is funding research that will use data obtained by the ARM cloud observatory. NASA is supporting several researchers focused on validating ICESat-2 data with ground truth observations of sea ice thickness, snow depth, and freeboard. NOAA is contributing a flux tower and autonomous surface flux stations to measure surface energy budgets throughout the year, and a suite of snow and atmospheric radiation sensors. The U.S. National Ice Center is also providing weekly summaries of ice conditions to support MOSAiC. The NSF Arctic Sciences Section has made 23 awards to 17 different institutions to support research projects on diverse topics concerning the atmosphere; sea ice and snow; sea ice modeling; ocean physics and ecosystems; biogeochemical cycles; and remote sensing. NSF also funded an office to sustain U.S. scientific leadership of this flagship program to advance Arctic weather and climate forecasting skill and to coordinate related U.S. education and outreach efforts.

Policy Driver 3: Strengthen National and Regional Security

As an Arctic Nation, the United States of America desires a stable and secure Arctic region where national security interests are safeguarded, as described in the DoD Arctic Strategy[19]. The Strategy notes that "DoD will continue to coordinate and collaborate with interagency partners on research and development activities to build Arctic capabilities through the Interagency Arctic Research and [sic] Policy Committee." A three-way approach informs the implementation of the Strategy:

1. Building Arctic awareness
2. Enhancing Arctic operations
3. Strengthening the rules-based order in the Arctic

Building Arctic awareness and enhancing Arctic operations through observations and observing systems are exemplified by two particular IARPC efforts: the Stratified Ocean Dynamics in the Arctic (SODA) project and the work of the Arctic Observing Systems Sub-team (AOSST).

Initiated by the Office of Naval Research, the 5-year SODA project was transformed, with the encouragement of OSTP, into SODA+ by the addition of contributions from BOEM, NASA, and NOAA. BOEM contributed sensors to place on deep-ocean moorings; NASA tested and evaluated sea surface salinity sensors; and NOAA contributed sail-powered drones, airborne drones, and the airborne Arctic Heat project. With a focus on measurements of three fundamental ocean properties—buoyancy, momentum, and heat—SODA+ aims to understand the changing and interactive system of sea ice, water stratification and circulation, and acoustics of the Beaufort Sea north of Alaska. After two years of planning and preparation, the SODA+ field program began in August and September 2018 with process studies from the RV *Sikuliak*, supplemented by sail-powered drones, airborne drones, and Arctic Heat, and the deployment, for a year, of moorings, on-ice drifting platforms, and under-ice gliders from the Coast Guard cutter *Healy* (WAGB 20) a medium icebreaker. Further process studies were completed in August and September 2019 in conjunction with the recovery and redeployment of the moorings and gliders by the *Healy*. The coordinated basic research exemplified by SODA+ is essential to the improvement of numerical models for Arctic environmental forecasting (for which NOAA and the

[19] https://www.iarpccollaborations.org/members/documents/13868

U.S. Navy have core responsibilities) and for the development of observing systems for research and Arctic domain awareness.[20]

Multiple individual observing systems that collectively comprise an Arctic-wide observing system provide fundamental data and information that serve numerous and interlinked purposes: (1) research to improve understanding of the Arctic changing environmental system; (2) environmental change detection and short-term prediction capability; (3) longer-term projections of the future state of the Arctic region; (4) skillful forecasts of the operational environment in support of emergency response and security; and (5) domain awareness. The AOSST has addressed national and regional security through its work on observational needs in support of security in the Arctic, and the application of multi-use observing networks for research and domain awareness. The AOSST also coordinated U.S. contributions to an Arctic-wide observing strategy and implementation plan[21] of the Sustaining Arctic Observing Networks (SAON, which is a joint effort of the Arctic Council and the International Arctic Science Committee). The U.S. input emphasized the implementation of the International Arctic Observations Assessment Framework, which uses a value tree methodology to map Arctic Societal Benefit Areas to the set of Arctic observations that contribute to delivering societal benefits. The AOSST applied the assessment framework to four topics: (1) wildfire forecasting; (2) sea ice forecasting; (3) advancing the blue economy; and (4) supporting Arctic marine domain awareness. This framework-based activity is promoting collaboration that enables the research community to identify observational priorities to meet research goals and to identify gaps in current observing networks and data sets.

Arctic operations are also enhanced by resilient infrastructure, which includes critical infrastructure (assets, systems and networks that underpin society)[22] as well as military installations and training ranges. Understanding the causes and consequences of warming and thawing permafrost, a topic central to the work of three IARPC collaborations teams—Coastal Resilience, Permafrost, Terrestrial Ecosystems—is contributing to the enhancement of Arctic operations. For example, novel methods for detecting and mapping the size and distribution of ground ice and impacts on infrastructure are informing the operation and sustainment of Thule Air Base, Greenland, and Army mobility and mitigation of training impacts in central Alaska.

IARPC contributes to strengthening the rules-based order in the Arctic by facilitating communication and collaborative research among U.S. and overseas researchers (e.g., MOSAiC described in the previous section, and SAON described above). A rules-based order is also facilitated by international scientific meetings such as the Second Arctic Science Ministerial (ASM-2) that was held in Berlin, Germany, in October 2018. Under NSF leadership, IARPC played a significant role in ASM-2: three IARPC Collaborations team leaders were members of the U.S. science delegation to the Arctic Science Forum on Day 1 of ASM-2, and Dr. France Cordova (Director of NSF and Chair of IARPC) led the U.S. Government delegation to the Ministerial itself on Day 2. The other members of the U.S. Government delegation

[20] Domain awareness is the effective understanding of anything associated with a particular domain (e.g., the Arctic domain), which could affect the security, safety, economy, or environment of the United States. Adapted from *Navy Maritime Domain Awareness Concept*, https://www.navy.mil/navydata/cno/Navy_Maritime_Domain_Awareness_Concept_FINAL_2007.pdf

[21] https://www.arcticobserving.org/strategy

[22] National Infrastructure Protection Plan, DHS 2013, https://www.dhs.gov/sites/default/files/publications/NIPP%202013_Partnering%20for%20Critical%20Infrastructure%20Security%20and%20Resilience_508_0.pdf

were the Honorable Fran Ulmer (Chair, U.S. Arctic Research Commission) and Rear Admiral Tim Gallaudet (U.S. Navy, retired, and then-Acting Director of NOAA).

Policy Driver 4: Improve Understanding of the Arctic as a Component of Planet Earth

In May 2018, the GRACE FO (Gravity Recovery and Climate Experiment Follow On) satellites, a joint U.S. (NASA) and Germany mission, were launched. GRACE FO is successor to the GRACE mission, which surveyed the Earth from 2002 to 2017. Among the products of both missions are estimates of the diminishing mass of the Greenland ice sheet, and other large land ice bodies in the Arctic.

In September 2018, NASA launched the ICESat-2 (Ice, Cloud and Land Elevation Satellite-2) satellite, the successor to the ICESat mission, which surveyed the Earth from 2003-2009. The elevation of the surface of the Greenland Ice Sheet is a key product of both missions. ICESat-2 also measures the surface elevation, or freeboard, of sea ice, from which its thickness can be inferred.

GRACE-FO and ICESat-2 data are available to all researchers regardless of their affiliation and country of origin. This open-data policy encourages the collaborative research that is essential to understand and respond to two critical issues concerning the role of the Arctic as a component of Planet Earth.

One critical issue is the role of Arctic glaciers, ice caps, and the Greenland Ice Sheet in sea-level change, a topic central to the work of the IARPC Glaciers and Sea Level Collaboration Team. The team has been a forum for bringing together Federal and non-Federal researchers engaged in observing and modeling land ice to address topics such as the challenges of projecting the future state of the Greenland Ice Sheet, and the complexity and variability of radiative forcing and sediment discharge that pose a challenge to modelers. Discussions have also highlighted the absence of dynamic mountain glaciers in Earth System models and the need for further development of glacier processes in models.

A second critical issue is the impact of diminishing Arctic sea ice and impacts on weather in the mid-latitude regions of the Earth. This was a particular focus of the Atmosphere Collaboration Team, which addressed emerging findings related to the Polar Vortex.[23] Discussions explored differences between stratospheric and tropospheric polar vortices, their increasing influence on mid-latitude weather and extreme events, and connections between those events and climate. The Atmosphere Collaboration Team and the Modeling Sub-team, with staff group approval, added language to the Plan to address mid-latitude weather connections jointly. Related to the Polar Vortex discussions was a joint effort of the Atmosphere and Modeling collaboration teams to raise awareness of the Polar Amplification Model Intercomparison Project (PAMIP). Aimed at understanding why Arctic air temperatures are rising at twice the rate of the global average and the global impacts of this phenomenon, PAMIP also contributes to continuing efforts to enhance interagency coordination for numerical model development, evaluations, synthesis, and verification that enhances predictability and the understanding of important processes in the context of the broader Arctic system and its impacts on the rest of the world.

In addition to the impacts of diminishing Arctic sea ice and land ice on the rest of the world, and the impacts of warming and thawing permafrost on Arctic infrastructure (see previous section), IARPC is addressing a third critical issue: warming and thawing permafrost, soil carbon content, and the prospect of radiatively potent gases such as carbon dioxide and methane being released to the Arctic and sub-Arctic atmosphere. Of mutual interest to the Permafrost, Terrestrial Ecosystem, and Modeling teams, those topics fostered discussions of the representation of permafrost processes in Arctic System

[23] https://www.weather.gov/safety/cold-polar-vortex

models in order to enhance permafrost projection capabilities and identified the need for better maps of ground ice and assessment of regional responses to abrupt thaw of ice-rich permafrost.

The Arctic Research Plan 2017-2021 and 'America Leading the World in Science and Technology'

In April 2019, the Office of Science and Technology Policy released a statement—'America Leading the World in Science and Technology'[24]—describing the Administration's commitment "to a robust agenda that unleashes American discovery and innovation, builds our workforce of the future, and advances American values at home and abroad." Through its continued successful implementation of Arctic Research Plan 2017-2021, as highlighted in the previous section, IARPC is making a significant contribution to this agenda. This section describes three additional IARPC initiatives that address the 'America Leading the World in Science and Technology' agenda.

Unleash American Discovery and Innovation

Active since December 2018, the IARPC *Diversity and Inclusion Working Group* pursues three goals:

1. Share resources and best practices for improving diversity and inclusion in Arctic research wherever it takes place—the office, the laboratory, workshops and conferences, and in fieldwork.
2. Provide a virtual meeting space for members to discuss and identify opportunities to network, find mentors, and make progress on creating diverse and inclusive research environments.
3. Promote discussion on equity in Arctic research that addresses Indigenous peoples, women, and minorities in particular.

The Diversity and Inclusion Working Group recognizes that increasing diversity and inclusion in Arctic research provides a wealth of different viewpoints and approaches that enrich research in all disciplines and strengthen the research community. Acknowledging the great value of diversity and inclusion, the working group promotes open conversations on how to increase inclusion and equity in ways that will enhance research and problem solving, and support *discovery and innovation* in the search for solutions to the many pressing challenges facing the Arctic.

Build the Workforce of the Future

In December 2018, the National Science and Technology Council Committee on STEM Education (NSTC CoSTEM) released the report *Charting a Course for Success: America's Strategy for STEM Education.*[25] Throughout the circum-Arctic region, STEM education is recognized as essential for preparing people to meet the challenges faced due to Arctic change, and for empowering them to participate in the development of policies and make decisions that will affect future social and environmental conditions in the Arctic. Additionally, since conditions in the Arctic are changing so rapidly, using examples of Arctic science in STEM education can increase student engagement in Arctic classrooms, and elsewhere in the world, and enhance understanding of climate science.

In response to the NSTC CoSTEM report, in August 2018 IARPC created an Arctic STEM Education Working Group. The goals of the working group are:

[24] https://www.whitehouse.gov/articles/america-leading-world-science-technology/
[25] https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf

1. Identify current STEM education efforts that leverage Arctic science and opportunities for STEM education synergies among Federal agencies.
2. Engage with national, State, and local education organizations and agencies, and then international education organizations and agencies.
3. Develop an engaged community from a diverse variety of Federal and non-Federal organizations, e.g., practitioners/educators, local colleges, museums and libraries, northern communities, to share resources, new findings and best practices.

The Arctic STEM Education Working Group is working with the NSTC CoSTEM to coordinate Federally funded efforts both in the Arctic and about the Arctic. This partnership will help build the workforce of the future through the development of a diverse and highly skilled pool of Arctic STEM-literate citizens equipped to advance discovery and innovation in Arctic research.

Advance American Values

In 1990, recognizing that researchers working in the Arctic have a responsibility to respect local culture and knowledge, and advance stewardship of the Arctic environment, IARPC released the original *Principles for the Conduct of Research in the Arctic*. To better align with U.S. Arctic policy, to incorporate the latest advances in research methods, and to reflect expanded research efforts and disciplinary breadth in a rapidly changing Arctic, in December 2018 IARPC released the updated *Principles for Conducting Research in the Arctic.*[26]

Informed by diverse input from Federal, State, and local government representatives, Alaska Native people and organizations, academic institutions and individual researchers through outreach efforts, listening sessions, and two Federal Register open comment periods, the core Principles are:

- Be Accountable
- Establish Effective Communication
- Respect Indigenous Knowledge and Cultures
- Build and Sustain Relationships
- Pursue Responsible Environmental Stewardship

These updated *Principles for Conducting Research in the Arctic* reflect the core principles of freedom of inquiry, scientific integrity, collaboration, and openness called for in 'America Leading the World in Science and Technology.'

The Arctic Research Plan 2017-2021 and Administration Research and Development Priorities

In August 2019, the Office of Management and Budget (OMB) and the Office of Science and Technology Policy in the Executive Office of the President issued a memorandum describing the Administration's FY2021 research and development (R&D) priorities.[27] This section provides some examples of how the continued implementation of the Plan will contribute to the *Oceans* and *Earth System Predictability* topics in the *American Energy and Environmental Leadership* budgetary priority, and the *Priority Crosscutting Actions to Build and Leverage a Diverse, Highly-skilled American Workforce*, *Create and*

[26] https://www.iarpccollaborations.org/uploads/cms/documents/principles_for_conducting_research_in_the_arctic_final_2018.pdf

[27] https://www.whitehouse.gov/wp-content/uploads/2019/08/FY-21-RD-Budget-Priorities.pdf

Support Research Environments that Reflect American Values, and *Build, Strengthen, and Expand Strategic Multisector Partnerships*.

The Plan addresses *Oceans* issues through five collaboration teams in particular: Health and Well-being; Sea Ice; Marine Ecosystems; Coastal Resilience; and Environmental Intelligence. Many Arctic communities are located by the ocean, where coastal residents continue to pursue a traditional way of life that depends on the marine (and terrestrial) ecosystems for food security. Sea ice, a habitat for numerous organisms, large and small, plays a key role in shaping the structure and function of marine ecosystems that are integral to coastal community cultures, and peoples' health and well-being. Environmental Intelligence—Observations; Models; Data Management—is essential to understanding processes, interactions and variability of Arctic peoples' health and well-being, marine ecosystems and sea ice, and science-informed management policy and decisions.

The Plan addresses *Earth System Predictability* issues through its focus on basic research to understand physical and biological processes, interactions and systems, which informs their representation in weather, water, and ice forecast models, Arctic System models, and Arctic climate models. For example, the predictability of sea ice, a critical component of the Arctic and Earth systems, is the focus of the Sea Ice Prediction Network,[28] which is supported by multiple IARPC agencies. Now in its second phase, the Sea Ice Prediction Network continues the annual Sea Ice Outlook to advance understanding of the impact on predictability of variables such as initial ice thickness, melt pond fraction, melt onset and ice retreat, and weather. The network now also conducts quantitative analysis of model forecast outputs, investigates the role of ocean heat flux on the limits of sub-seasonal to seasonal ice predictability, and studies the economic value of 2-week to seasonal scale predictions.

The IARPC contributions—STEM Education Working Group; Diversity and Inclusion Working Group; Principles for Conducting Research in the Arctic—to *Build and Leverage a Diverse, Highly-skilled American Workforce* and *Create and Support Research Environments that Reflect American Values* were described in the previous section. By its very nature, IARPC makes a significant contribution to *Build, Strengthen, and Expand Strategic Multisector Partnerships*. For example, through the innovative IARPC Collaborations platform and practice, multiple stakeholders are coming together to address the need for research and an early warning system for harmful algal blooms, which are growing in number and intensity in the Bering Sea region, where Indigenous people and communities are concerned about the implications for marine wildlife and subsistence hunting.

Alignment with the Recommendations of the U.S. Arctic Research Commission

Through the Arctic Research Policy Act (ARPA), IARPC is tasked to align its activities with the recommendations put forth by the United States Arctic Research Commission (USARC), which publishes a biennial Goals and Objectives Report (the Report). The most recent Report—Goals and Objectives for Arctic Research 2019-2021[29]—was published in 2019, in the midst of the implementation of the Arctic Research Plan 2017-2021 (the Plan). While the current Plan cannot directly respond to the Report, the connections developed during frequent discussions between these two bodies is evident through the many shared goals and objectives in the two documents. The implementation arm of IARPC, the nine Collaboration Teams, and three sub-teams, are advancing research in line with the Report.

[28] https://www.arcus.org/sipn

[29] https://www.arctic.gov/reports_goals.html

The USARC Report on Goals and Objectives for Arctic Research 2019-2020 has five goals:

1. Advance Arctic Infrastructure
2. Assess Arctic Natural Resources
3. Observe, Understand, and Forecast Arctic Environmental Change
4. Improve Community Health and Well-being
5. Enhance International Science Cooperation in the Arctic

Several teams have Performance Elements that contribute to USARC Goal 1 (Advance Arctic Infrastructure). They include the Health and Well-being Collaboration Team, the Terrestrial Ecosystems Collaboration Team, the Permafrost Collaboration Team, the Coastal Resilience Collaboration Team, and the Environmental Intelligence Collaboration Team. Permafrost Collaboration Team activities include a collaboration with the Denali Commission to determine how warming and thawing of permafrost impact infrastructure; the Denali Commission will deliver a report on this topic in 2020. The Coastal Resilience Team supports efforts, like those by the Alaska Department of Geological and Geophysical Surveys, to understand storm surge and saline inundation impacts on coastal infrastructure and human health and safety.

Under USARC Goal 2 (Assess Arctic Natural Resources), the Marine Ecosystems and Terrestrial Ecosystems teams support interagency efforts to better assess animal abundance and distribution. The Coastal Resilience and Environmental Intelligence teams support interagency efforts to develop new sensor technologies and data collection techniques to improve understanding of relationships across coastal systems as well as updating of baseline maps and charts across the Arctic.

USARC Goal 3 (Observe, Understand, and Forecast Environmental Change) is central to much of the interagency research described in the Plan and all collaboration teams contribute to this goal. The work of several collaboration teams is directly relevant to the USARC Goals and Objectives Report 2019-2020. Efforts by the Permafrost Collaboration Team in coordination with the Permafrost Carbon Network advance the understanding of carbon dioxide and methane fluxes to improve climate projections. The Arctic Observing Systems Sub-team is working at both a domestic and international level to develop a sustained Arctic observing network based on a societal benefits framework. The Modeling Sub-team has held many discussions regarding model-intercomparison projects that inform how well Earth System models capture Arctic processes and enhance projections of the future.

The Health and Well-being Collaboration Team directly addresses USARC Goal 4 (Improve Community Health and Well-being) through a wide range of activities, including participation in One Health activities related to pathogens emerging in response to the changing climate, and support of increased efforts by the Department of Justice to address the crisis of violence against women in rural Alaska. Other collaboration teams are also invested in supporting Goal 4 through consideration of community health needs and connecting Arctic science to the well-being of those living there.

Finally, IARPC and many collaboration teams support USARC Goal 5 (Enhance International Science Cooperation in the Arctic) through continued inclusion of internationally relevant research and researchers in team meetings and reports, and significant participation in international research activities (e.g., MOSAiC).

IARPC and USARC will continue to work together to address research needs in the Arctic. The USARC Goals and Objectives Report will inform the development of the Arctic Research Plan 2022-2027, for which preparations are getting underway in early 2020.