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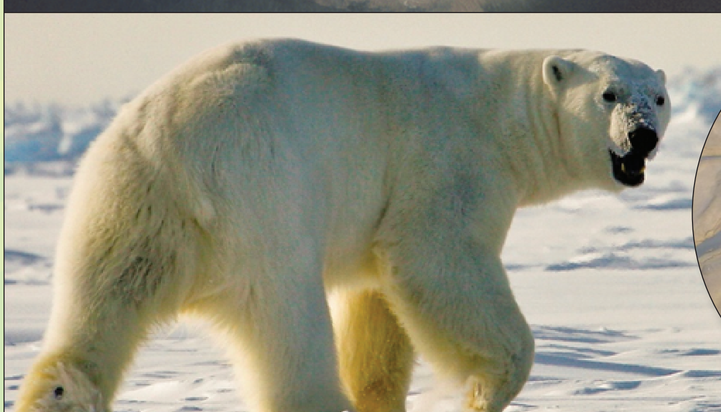
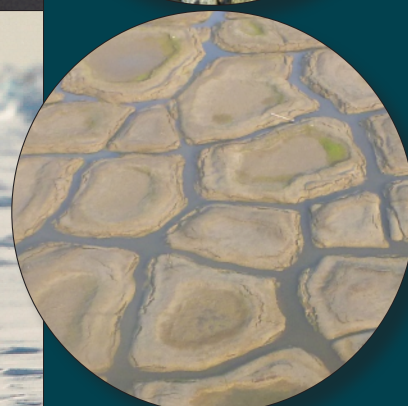
U.S. Geological Survey—Department of the Interior Region 11, Alaska—2019 Annual Science Report



Open-File Report 2019–1141

U.S. Department of the Interior
U.S. Geological Survey

Cover.
Top Left: Photograph of Kasatochi Volcano after eruption, Aleutian Islands, Alaska, taken by Gary Drew, U.S. Geological Survey (USGS), July 30, 2018.
Top right: Photograph of salmon swimming taken by Jonny Armstrong, Oregon State University, July 24, 2012.
Middle left: Photograph of large polar bear taken by Mike Lockhart, USGS, April 2, 2009.
Middle right: Photograph of degrading ice wedges in permafrost, Ikpikpuk River Delta, Alaska North Slope, taken by Benjamin Jones, USGS, August 7, 2013.
Bottom left: Photograph of researchers measuring water-quality on the Pilgrim River, northwestern Alaska, taken by Chris Zimmerman, USGS, June 2014.
Bottom right: Photograph of female walrus resting beside a yearling walrus during a period of sea ice scarcity in the Chucki Sea, northern Alaska, taken by Ryan Kingsbery, USGS, September 19, 2013.

U.S. Geological Survey—Department of the Interior Region 11, Alaska—2019 Annual Science Report

Edited by Dee Williams and Elizabeth Powers

Open-File Report 2019–1141

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
DAVID BERNHARDT, Secretary

U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia: 2019

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Director's Message

Aimee Devaris

Dear Stakeholders and Partners:

Thank you for your interest in the ongoing scientific work of the U.S. Geological Survey (USGS) in Alaska. It is a pleasure to release this first edition of our Annual Science Report and share the impressive breadth of this work and range of meaningful outcomes with you!

Alaska is one-sixth of the landmass of the United States, and because of its geographic separation and unique geologic history, contains mineral occurrences and geologic settings not found elsewhere in the Nation that are critical to national economic and defense security. It is home to 229 Native Tribes and a vast diversity of wildlife and plant communities, many of which are valued as subsistence foods. Alaska also has 52 historically active volcanoes and experiences thousands of earthquakes every year. With Alaska's unique geology and geography, its terrestrial and marine environments provide the Nation with an amazing and active physical laboratory within which many Federal, State, and academic entities conduct research, documenting resource availability and substantive ecosystem changes potentially related to land use, climate, and natural hazards.

A diverse team of USGS scientists work hard throughout the remote spaces of Alaska to collect, monitor, analyze, and provide scientific understanding about issues of interest across the State. From delivering assessments of oil and gas resources on the North Slope to conducting bio-surveillance for avian flu, we address various scientific questions to inform decision makers at all levels of government. Much of our work is conducted through multi-year projects, and this report provides a comprehensive snapshot of activities and milestones undertaken in fiscal year 2019, recognizing that some projects are midway to completion. The launch of our Annual Report is intended to help meet the need to communicate our science effectively by co-locating many of our programmatic and project highlights in one single "living" document to facilitate greater ease of discovery.

The Federal government has considerable interest in Alaska, and in fact, nearly 70 percent of all U.S. Department of Interior land holdings are in Alaska. As a result, our science portfolio is driven by the Department's strategic priorities, and we have key support in many USGS programs with specific investments in Alaska:

- Under the new Earth Mapping Resources Initiative (Earth MRI), projects are under development for the exploration of critical minerals in Alaska.
- National Geospatial Program funding has been sustained for the completion of new high-resolution elevation data and updated topographic mapping for the entire State.

- There have been substantial increases in the Natural Hazards mission, including sustained funding for modernizing our volcano monitoring systems, expanding networks in support of the National Volcano Early Warning System, and adopting 43 earthquake seismic stations from the "transportable array."
- We also received supplemental disaster recovery funding to replace and repair equipment and facilities and reinforce disaster preparedness after the 2018 Kilauea eruption in Hawaii and the Anchorage Magnitude 7.1 earthquake.
- In the Water mission area, we received funding to support trans-boundary river water quality work near the Canadian border in Southeast Alaska, and we have initiated planning for a water resources assessment on the North Slope.
- We applied additional funding to support polar bear research efforts in support of the U.S. Fish and Wildlife Service and Bureau of Land Management decision plans and processes.

These are but a handful of the many projects underway in our great State, as you will note in the following report.

We here at USGS remain focused on ensuring the long-term health and vitality of our operations and research activities to meet the ever-growing demands for the scientific information needed for resource and emergency management decisions in Alaska. We hope this Annual Report provides yet another useful tool in service of those goals.

Aimee Devaris
USGS Alaska Regional Director

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Figures

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U.S. Geological Survey—Department of the Interior Region 11, Alaska—2019 Annual Science Report

Edited by Dee Williams and Elizabeth Powers

Alaska Organizational Overview

In keeping with our national mission, the USGS in Alaska provides timely and objective scientific information to help the Nation address issues and solve problems in five major topical areas (listed alphabetically):

- Energy and Minerals;
- Geospatial Mapping;
- Natural Hazards;
- Water Quality, Streamflow, and Ice Dynamics; and
- Wildlife, Fish, and Habitat.

The USGS in Alaska engages about 400 scientists and support staff working in three major science centers, Cooperative Research Units, and USGS centers outside Alaska, with a combined annual science budget of about $60 million. In just the last 5 years, the USGS in Alaska has produced scientific benefits resulting from more than 1,000 publications and about 250 technical reports. Publications relevant to Alaska can be conveniently searched by keyword through the USGS Publications Warehouse at https://pubs.er.usgs.gov/search?q=Alaska.

U.S. Geological Survey (USGS) Mission:

The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Regional Office

The Office of the Alaska Regional Director provides strategic leadership for the region's science programs while facilitating growth of USGS science capacity centering on Arctic and Subarctic systems. The office maintains relations with other Federal and State agencies, Tribes, the international community, and the academic community, advancing the goals and objectives of the U.S. Department of the Interior (DOI) and the Administration and representing a single interface point for the entire breadth of USGS science and its capabilities. The regional office is responsible for gathering, synthesizing, and delivering scientific information that is timely, relevant, and impartial concerning Alaska's geology, geography, hydrology, diverse physical and biological resources, and natural hazards.

The Alaska Regional Office maintains a distinctive organizational status within USGS by virtue of several key factors:

1. Alaska's size, extensive coastline, geographic separation, Arctic and circumpolar nexus, and complex tectonic history afford it a unique geology and geography compared to the rest of the Nation;
2. The Federal government owns and manages about 65 percent of Alaska as public lands, including numerous national forests, national parks, and national wildlife refuges;
3. Alaska Native subsistence activities and complex legal protections create unique circumstances that necessarily shape the planning and conduct of scientific research throughout the State;
4. The USGS Alaska Science Center (ASC) currently operates as the largest and most horizontally integrated single center within USGS, and a large volume of Alaskan and Arctic research activities also are conducted by staff from centers outside the State, thus making the Alaska Region a highly dynamic and resourceful area for USGS engagement.

The Alaska Regional Office provides management and strategic coordination with the ASC, the Volcano Science Center (VSC), the Climate Adaptation Science Center, USGS scientists from other regions, and external partners operating in Alaska. Current Alaska Regional personnel include the Regional Director (Aimee Devaris), the Deputy Regional Director (Dr. Dee Williams), Chief of Staff/ Regional Management Officer (Durelle Smith), Science Coordinator (Dr. Elizabeth Powers), Safety Manager (Melvin Flynn), and Budget Analyst (Marnelli Cordero). More information about the Alaska Region is available at https://www.usgs.gov/states/alaska.

Alaska Science Center

The ASC, led by Dr. Christian Zimmerman, is composed of about 150 science personnel representing the full suite of disciplines at USGS. All the USGS Mission Area Programs are managed collectively with a vision to achieve an integrated landscape-level understanding of the highly diverse and complex ecosystems of Alaska. Its current science priorities are mineral and energy resources, public safety, and addressing priority information needs for land and water stewardship. More information about specific research conducted in Alaska is available in this volume and on the ASC web portal at https://www.usgs.gov/centers/asc.

Volcano Science Center

The VSC, led by Thomas Murray, is based in the Alaska Region, and manages the five U.S. volcano observatories and about 200 employees on the West Coast and in Hawaii, including the (1) Alaska Volcano Observatory (AVO) in Anchorage; (2) Cascades Volcano Observatory and (3) Yellowstone Volcano Observatory in Vancouver, Washington; (4) Hawaiian Volcano Observatory in Hilo, Hawaii; (5) and California Volcano Observatory in Moffett, California ; as well as the internationally-scoped Volcano Disaster Assistance Program. Their common mission is to enhance public safety and minimize social and economic disruption from eruptions through delivery of effective forecasts, warnings, and information of volcano hazards based on scientific understanding of volcanic processes. Follow news from the AVO at https://www.avo.alaska.edu/.

Alaska Climate Adaptation Science Center

The Alaska Climate Adaptation Science Center, led by Dr. Stephen Gray, is one of eight regional centers that provide managers with the tools and information they need to develop and execute management strategies that address the impacts of the climate on natural and cultural resources. The Center is hosted by the University of Alaska Fairbanks but is physically housed within the USGS campus at Alaska Pacific University. Various program partners provide expertise in climate science, ecology, environmental impact assessments, modeling, and advanced information technology. More information is available at https://casc.alaska.edu/.

External Partners

To meet the Nation's most pressing science needs and deliver timely and relevant information, USGS scientists routinely work with other Federal, State, and local government agencies; Tribal nations; academic institutions; and nongovernmental and private organizations. For the purposes of this report, we define a partner as any entity that actively works with USGS to co-fund or co-produce scientific research activities. External partners include more than 20 Federal agencies, 25 State agencies, five Alaska Native Organizations, 20 non- governmental organizations, ten industry partners, and more than 50 academic institutions. USGS Regional Managers collaborate actively with DOI Alaska Bureaus and State and regional groups, especially through the Alaska Cooperative Planning Group, the Interagency Arctic Research Policy Committee, the North Slope Science Initiative, Arctic Council Working Groups, and numerous bilateral interagency agreements with the DOI bureaus of the U.S. Fish and Wildlife Service (FWS), National Park Service (NPS), Bureau of Ocean Energy Management, and Bureau of Land Management.

One formal partnership worth an explicit mention here is the Alaska Cooperative Fish and Wildlife Research Unit hosted at the University of Alaska Fairbanks campus. This unit is part of a nationwide program dating back to 1935 when the first units were formed under cooperative agreements to foster college-level research and graduate student training in support of science-based management of fish and wildlife and their habitats. Today there are 40 units located in 38 States. The Alaska Unit exists by cooperative agreement between the USGS, Alaska Department of Fish and Game (ADF&G), University of Alaska Fairbanks, FWS, and the Wildlife Management Institute. The unit mission is aimed at understanding the ecology of Alaska fish and wildlife; evaluating impacts of land use and development on these resources; and relating effects of social and economic needs to production and harvest of natural populations. The Alaska Cooperative Fish and Wildlife Research Unit Leader is Dr. Jeffrey Falke, Assistant Professor of Fisheries, and the most recent annual report is available at https://www.akcfwru.uaf.edu/documents/2018_AKCFWRU_Ann_Rep.pdf.

Structure of Report

The research highlighted in this annual report is organized primarily by the five major topical areas (energy and minerals; geospatial mapping; natural hazards; water quality, streamflow, and ice dynamics; and wildlife, fish, and habitat). The topical areas are then subdivided into relevant subsections. However, each project description also could be sorted into other categories of reader interest, such as geographic location, or association with established DOI research priorities. To facilitate this type of search and discovery, this report uses various icons, which are embedded immediately below the title of each project description. Different icons are used to represent the five different categories of topics, four different geographic locations, and five different established DOI priorities. All 14 icons are illustrated in a legend at the conclusion of this section.

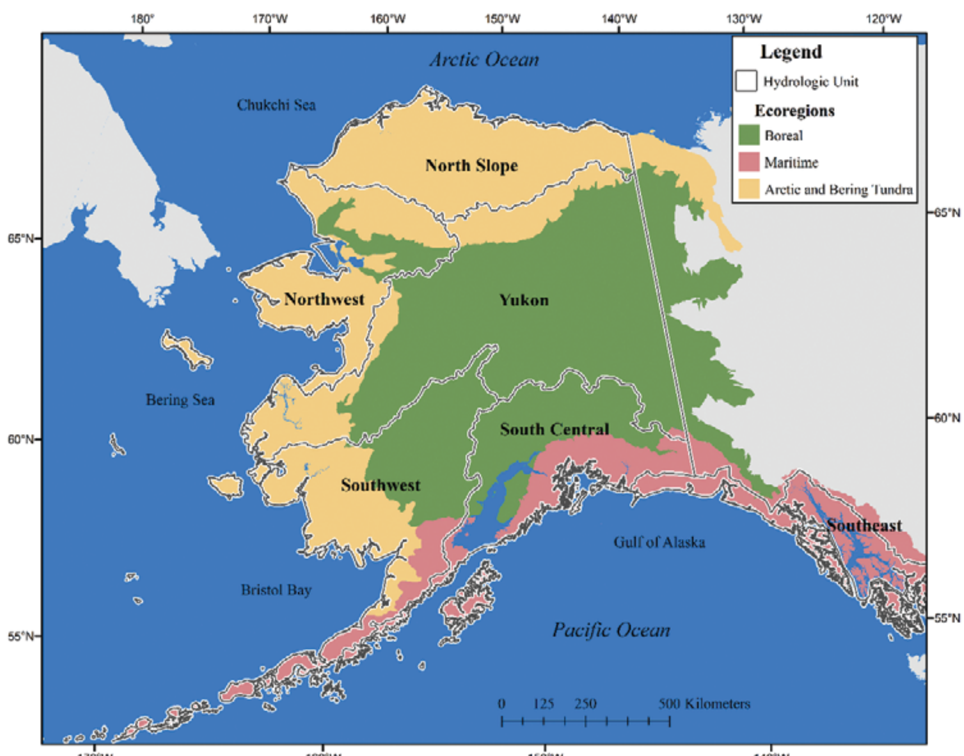
This report uses broad ecoregions as a convenient means to establish categories of geographic location. An ecoregion is an ecologically and geographically defined area that covers relatively large areas of land or water and contains distinct assemblages of natural communities and species. Within each ecoregion, there exists substantial, but not absolute spatial correlation among the characteristic assemblages. The three broad Alaska ecoregions include (1) Arctic, (2) Boreal Forest, and (3) Subarctic Coastal (Maritime). A fourth icon is used to represent work that generally spans across the entire State of Alaska. For quick orientation, we briefly discuss the broad parameters of each ecoregion.

Arctic Ecoregion

The Arctic ecoregion of Alaska encompasses the area north of the Arctic Circle and consists of the flat and treeless coastal plains (tundra) and the rolling foothills and rugged peaks of the Brooks Range. In the United States, the Arctic is geographically defined to include the territory north and west of the boundary formed by the Porcupine, Yukon, and Kuskokwim Rivers (including North Slope and Northwest hydrologic zones), and all contiguous seas (including the Bering, Beaufort, Chukchi, and Arctic Seas). The climate of the ecoregion is primarily cold and dry, where freezing temperatures dominate most of the year. Permafrost is prevalent across the most northerly areas, and the landscape is covered in poorly-drained lakes and wetland areas that become more stream-dominant closer to the Brooks Range. Vegetation across this region is mostly wet sedge tundra in the floodplains and mixed-shrub sedge tussock tundra on the gentle ridges; willows are prevalent along streams and rivers closer to the Brooks Range. Many species of waterfowl and shorebirds nest in this ecoregion, and it is home to many mammals, including polar bears, ice seals, whales, walrus, caribou, wolves, and Dall sheep. The region is home to Native Inupiaq, Yupik, and Athabascan residents. The area is well-known for its oil and gas industry and the Trans-Alaska pipeline that begins in Prudhoe Bay on the Beaufort Sea coast.

Boreal Forest Ecoregion

The Boreal Forest ecoregion encompasses interior Alaska, stretching from the southern side of the Brooks Range in the north and to the Alaska Range in the south. This region covers a wide geographic area and thus has considerable



U.S. Geological Survey map showing the three major ecoregions (arctic, boreal, maritime) and six major hydrologic zones of Alaska (Southeast, South Central, Southwest, Yukon, Northwest, and North Slope). Source: Figure 1, Stackpole, S.M., and others, Inland waters and their role in the carbon cycle of Alaska: Ecological Applications, v. 27, no. 5, p. 1403–1420, https://doi.org/10.1002/eap.1552.

variation in temperature and precipitation, yet the climate is considered continental with short, warm summers, and long, very cold winters. In general, the landscape is predominantly spruce and deciduous forests with numerous lakes and rivers. The vast forests are composed mainly of black and white spruce, and balsam poplar, paper birch, and aspen. Wildfires occur frequently in this ecoregion from June through early August due to relatively warm and dry summers and the prevalence of trees and low-lying shrubs that aid in the ignition and spread of wildfire. This ecoregion is home to thousands of people, including many Athabascan tribes. Human communities range from small villages to the larger urban center of Fairbanks. This area attracts millions of migratory birds, including sandhill cranes, trumpeter swans, thrushes, and ospreys, and is home to many species of small mammals and top-level predators (brown bears, wolverines, and gray wolves). Caribou herds use the forests for cover in the winter, and salmon and other freshwater fish return in the summer and are important sources for local subsistence.

Subarctic Coastal Ecoregion (Maritime)

This is the most diverse ecoregion in Alaska, consisting of all subarctic coastal regions stretching from Southeast Alaska to the tip of the Aleutian Island chain, including Kodiak Island, the Bristol Bay region, and most of western Alaska up to the Seward Peninsula. Variable landscapes include fjords, beaches, rocky intertidal zones, kelp forests, underwater seamounts, and a sedimentary seafloor.

Southeast Alaska

Southeast Alaska is characterized by its maritime climate, temperate rainforests, abundant islands, and long fjords. In this region, there is relatively small seasonal temperature variation, large amounts of precipitation (mostly rain), and extended periods of cloudiness and fog. The temperate rainforest consists primarily of Sitka spruce, mountain hemlock, and western hemlock, and drier areas are mixed with black cottonwood and lodgepole pine. Areas that drain poorly support open muskeg and forested wetlands. The fragmented nature of the island archipelago leads to natural fragmentation of plants and wildlife, with some species found on the mainland and only some or none of the islands. Unlike most of Alaska, this region is rich in amphibians. Brown bears, black bears, gray wolves, and Sitka black-tailed deer roam the mainland and some of the islands, and the forests, estuaries, wetlands, and rivers provide rich habitat for birds and fish. All five species of Pacific salmon return to the streams every year, accompanied as well by humpback, gray, and orca whales. This region also supports the largest Steller sea lion rookery in Alaska. This region is home to the capital of Alaska and supports a robust economy composed mainly of timber harvest, tourism and recreation, commercial fishing, and mining.

Aleutian Islands

The Aleutian Islands are a chain of volcanic islands covered in rugged mountain peaks with carved fjords, high cliffs, rocky and wave-battered beaches, and small dune fields. This part of the region has a cool maritime climate but varies greatly in terms of precipitation amounts, although high winds and intense ocean storms are common across the region. The islands are treeless, dominated by flora unique to the area and other common low shrubs and grasses. These islands are important breeding grounds for birds and marine mammals including cormorants, storm petrels, kittiwakes, and the Aleutian Canada goose. Most western populations of the endangered Stellar sea lion give birth at rookeries on the islands, and multiple whale species feed in the nearshore and offshore waters in the summer. Deep-sea cold-water coral gardens also flourish in the Aleutians, providing habitat for diverse marine life. The region is home to Native Unangan residents, and commercial fishing for shellfish and groundfish brings a lot of traffic to the ports.

Western Alaska

This area of Alaska is diverse in climate, landscape, and resources, and is composed of the Bristol Bay region, Bering Sea islands, Yukon-Kuskokwim Delta, and parts of the Seward Peninsula. The climate is transitional between maritime and continental in the Bristol Bay area and shifts to a colder moist polar climate to the north, regulated in temperature by the Bering Sea but cooled off in the winter months by sea ice that extends into this area. The Kvichak River feeds Bristol Bay and is one of the most productive sockeye salmon fisheries in the world, and the Nushagak River supports the third largest king salmon run in the world. The Pribilof Islands in the Bering Sea provide habitat for more than 3 million seabirds and critical breeding habitat for Stellar sea lions and about 80 percent of the world's northern fur seals. These rich waters support world-renowned Tanner and King crab fisheries and abundant marine life. The Yukon-Kuskokwim Delta is a result of sediment deposition from past glacial rivers and provides rich coastal marsh habitat for birds and fish. The Delta is the primary breeding grounds for the Emperor Goose and all of North America's Cackling geese. The population is in large part Alaska Native, with over 120 towns and villages located throughout the region.

U.S. Department of the Interior Priorities

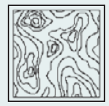
This report links each USGS program/project description with established DOI priorities and goals. There are five DOI priorities and goals that apply most directly to the conduct of science in Alaska, as illustrated by the distinct icons that appear in the legend at the end of the following section.

Icon Legend

Topical Areas:


Energy and Minerals

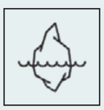

Water Quality, Streamflow, and Ice Dynamics

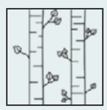

Alaska Mapping


Natural Hazards


Wildlife, Fish, and Habitat

Ecoregions:


Arctic


Boreal Forest


Subarctic Coastal


Statewide

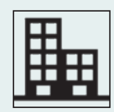
Alaska U.S. Department of the Interior Priorities:


Create a conservation stewardship legacy


Sustainably develop our energy and natural resources


Restore trust with local communities


Protect our people and the border


Modernize our infrastructure

Note: All maps, illustrations, and photographs in the report have a USGS source that is in the public domain, unless otherwise noted.

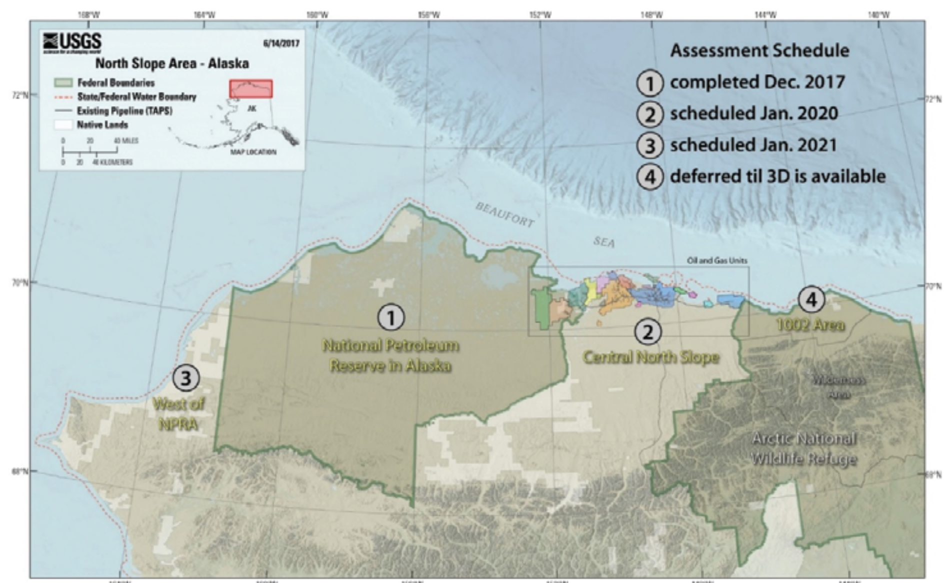
Project Descriptions

Energy and Minerals

Energy Resources

Alaska Petroleum Systems

Since 2017, the USGS Alaska Petroleum Systems project has concentrated on complying with DOI Secretarial Order 3352, which directs the USGS to update a series of assessments across the entire Alaska North Slope. Recent exploration drilling has resulted in significant oil discoveries in the Cretaceous Nanushuk and Torok Formations in and near the National Petroleum Reserve in Alaska (NPR-A). These new discoveries have spurred exploration activity in the region and have increased demand for enhanced information regarding the oil-resource potential of these formations. The project has three main objectives: (1) conduct research that increases our understanding of Alaska petroleum systems, (2) conduct assessments of undiscovered oil and gas resources, and (3) deliver energy-resource information to land and resource managers, policy makers, and the public. Fundamental research methods—such as regional sequence stratigraphic and structural frameworks, distribution and quality of source rocks, and geo-chronologic and thermo-chronologic history of critical regions—are essential because Alaska remains an underexplored energy frontier. A robust petroleum-systems framework is the key to understanding regional petroleum potential, completing our mission-critical work (assessments of undiscovered petroleum resources), and responding quickly to information requests regarding new and emerging oil and gas activities. Research results will be released either in USGS publications or in peer-reviewed journals. USGS completed an updated assessment of NPR-A in December 2017 and has planned completion of an updated Central North Slope (aka "State Lands") assessment by January 2020. The estimated undiscovered oil resources in the Nanushuk and Torok Formations are significantly higher than previous estimates, owing primarily to recent, larger than anticipated oil discoveries.



Boundaries of the National Petroleum Reserve in Alaska (NPR-A), the Central North Slope, the Arctic National Wildlife Refuge (including "1002 Area"), and Native lands (transparent white polygons, existing and proposed).

Time frame	Budget
Ongoing	$3.8 million

Contact

David Houseknecht, USGS Eastern Energy Resources Science Center, Reston, Virginia, dhouse@usgs.gov, (703) 648–6466

Project Link

https://www.usgs.gov/energy-and-minerals/energy-resources-program/science/alaska-petroleum-systems

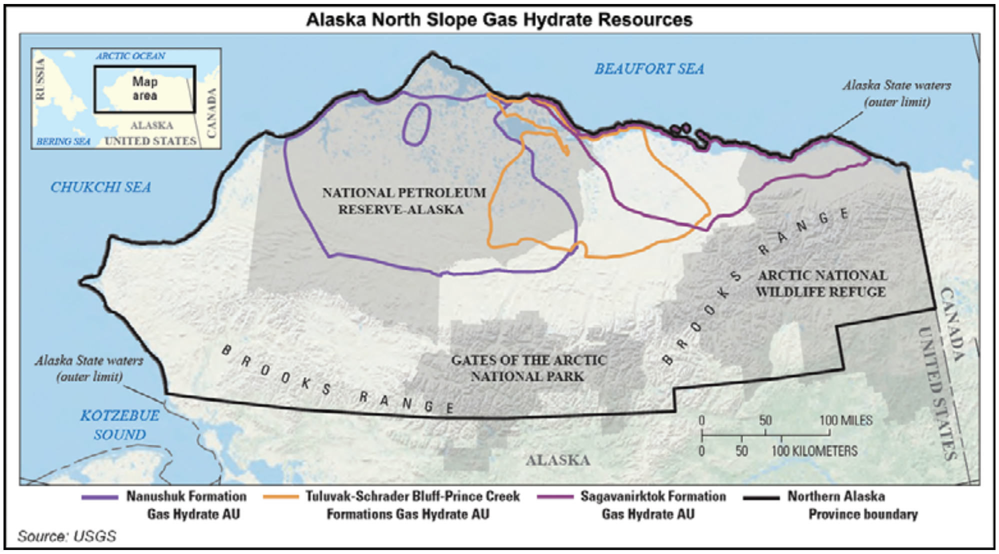
Recent Publications

Houseknecht, D.W., 2019, Evolution of the Arctic Alaska sedimentary basin, in The sedimentary basins of the United States and Canada (2d ed.): New York, Elsevier, p. 719–745, ISBN 9780444638953, doi:10.1016/B978-0-444-63895-3.00018-8.

Houseknecht, D.W., 2019, Petroleum systems framework of significant new oil discoveries in a giant Cretaceous (Aptian–Cenomanian) clinothem in Arctic Alaska: American Association of Petroleum Geologists Bulletin, v. 103, no. 3, p. 619–652, doi:10.1306/08151817281.

Houseknecht, D.W., and others, 2017. Assessment of undiscovered oil and gas resources in the Cretaceous Nanushuk and Torok Formations, Alaska North Slope, and summary of resource potential of the National Petroleum Reserve in Alaska, 2017: U.S. Geological Survey Fact Sheet 2017–3088, 4 p., https://doi.org/10.3133/fs20173088.

Gas Hydrate Resource Assessment on the North Slope of Alaska



North Slope gas hydrate resources in northern Alaska. From Collett, T.S., and others, (2019) (see “Recent Publication” at the end of this section).

Gas hydrates are naturally occurring, ice-like solids in which water molecules trap gas molecules in a cage-like structure known as a clathrate. USGS recently completed its second assessment of the undiscovered technically recoverable gas hydrate resources on the North Slope of Alaska. Using a geology-based assessment methodology, the USGS estimates that there are about 53,796 billion cubic feet (BCFG) of undiscovered, technically recoverable gas resources within gas hydrates in northern Alaska. This new estimate is less than the 85,427 BCFG reported in the 2008 USGS assessment. Because of access to additional three-dimensional (3D) seismic data volumes and well-log datasets, this 2018 assessment features improved mapping of all three assessment units (AU). The latest assessment is based on the geologic elements used to define a Total Petroleum System (TPS), including hydrocarbon source rocks (source-rock type and maturation and hydrocarbon generation and migration), reservoir rocks (sequence stratigraphy, petrophysical properties, seismic attribute development, and prospecting), and hydrocarbon traps (trap formation and timing). The area assessed in northern Alaska extends from the NPR-A on the west through the Arctic National Wildlife Refuge (ANWR) on the east, and from the Brooks Range northward to the State-Federal offshore boundary (located 3 miles north of the coastline). This area consists mostly of Federal, State, and Native lands covering about 55,894 square miles. Although many gases form hydrates in nature, methane hydrate is by far the most common. Of the Northern Alaska Gas Hydrate TPS mean estimate of 53,796 BCFG, about 27 percent is within the Sagavanirktok Formation Gas Hydrate AU, 33 percent is within the Tuluvak-Schrader Bluff-Prince Creek Formations Gas Hydrate AU, and 40 percent is within the Nanushuk Formation Gas Hydrate AU.

Project Partners

The research project in support of this assessment was a cooperative effort with the Bureau of Land Management.

Contact

David Ferderer, Central Energy Resources Science Center, Denver, Colorado, dferdere@usgs.gov, (303) 236–7775

Recent Publication

Collett, T.S., Lewis, K.A., Zyrianova, M.V., Haines, S.S., Schenk, C.J., Mercier, T.J., Brownfield, M.E., Gaswirth, S.B., Marra, K.R., Leathers-Miller, H.M., Pitman, J.K., Tennyson, M.E., Woodall, C.A., and Houseknecht, D.W., 2019, Assessment of undiscovered gas hydrate resources in the North Slope of Alaska, 2018: U.S. Geological Survey Fact Sheet 2019–3037, 4 p., https://doi.org/10.3133/fs20193037.

Program Website

https://energy.usgs.gov

Mineral Resources

Earth Mapping Resources Initiative Scoping Project in Alaska

The USGS Earth Mapping Resources Initiative (EarthMRI) will provide unprecedented opportunities for mapping and interpreting the geologic framework and critical mineral resources of the United States through funding directed to State geological surveys. The USGS Alaska scoping project will help identify priority areas in Alaska for study under EarthMRI. Alaska has significant known or suspected critical mineral potential and is a priority focus area of the USGS Mineral Resources Program. Thus, we anticipate significant levels of EarthMRI funding being devoted to addressing a multitude of fundamental gaps in the geologic and geophysical understanding of many of the State's metallogenic regions. This scoping project team will entail the examination of existing Alaska geologic datasets and data gaps, coordination with the national EarthMRI program and external partners and collaborators, consultation with external data users to solicit input on science priorities and desired outcomes, and development of strategic plans for new airborne geophysical surveys and focused geologic research. The overall project objective is to provide an essential, strategic framework for planning, coordination, and execution of an important new national initiative focused on Earth resources.

Geologists studying and sampling uranium-rich rocks at the Roy Creek prospect in the White Mountains, northern Alaska. Area also contains significant rare earth element mineralization. Photograph by Jamey Jones, U.S. Geological Survey.

Time frame	Budget	Project partner
Fiscal year (FY) 2018–19	$540,000	Alaska Division of Geological and Geophysical Surveys.

Contact

Jamey Jones, USGS ASC, jvjones@usgs.gov, (907) 786–7442

Maintenance of Alaska Geologic Map and Mineral Deposit Databases

The USGS is responsible for tracking and updating both the geologic map of Alaska and the Alaska Resource Data File (ARDF). The Alaska geologic mapping project entails the maintenance and updating of the Alaska geologic map database created in 2015, including newly available data and releasing it in episodic updates. The 2015 compilation involved creating text and spatial databases of available information and data. The dataset was then integrated statewide to produce, in addition to the new State map, several other derivative maps. As a digital database, it is a valuable analytical tool that can continually be updated. The project also entails the integration of the Alaska data with datasets covering parts of Canada, Russia, and the conterminous United States. Mineral and energy resource assessments drive demand for the geologic map, but the map and associated spatial and attribute datasets supporting it have tremendous potential for use in addressing regional environmental issues.

Geologic map of Alaska showing the generalized geology of the State, with each color representing a different type or age of rock. From Wilson, F.H., and others, compilers (2015) (see "Recent Publication" at the end of this section).

The ARDF is a mission-critical database of mines, prospects, and mineral occurrences in the State of Alaska that is continually updated as new information becomes available. The project (1) provides complete, up-to-date and user-accessible information on metallic and selected non-metallic mineral occurrences in Alaska; (2) tracks mineral industry activity in the State; and (3) systematically releases updated records on the Internet. The information collected and maintained by the project is valuable for mineral resource assessments, mineral deposit modeling, and mineral environmental studies, as well as land-use decisions.

Time frame	Budget
FY2017–20	$166,000 (FY2019).

Contact

Frederic H. Wilson, ASC, fwilson@usgs.gov, (907) 786–7448

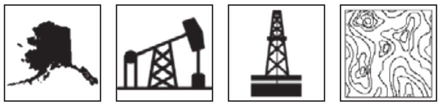
Recent Publication

Wilson, F.H., Hults, C.P., Mull, C.G, and Karl, S.M, compilers, 2015, Geologic map of Alaska: U.S. Geological Survey Scientific Investigations Map 3340, pamphlet 196 p., 2 sheets, scale 1:1,584,000, http://dx.doi.org/10.3133/sim3340.

Project Link

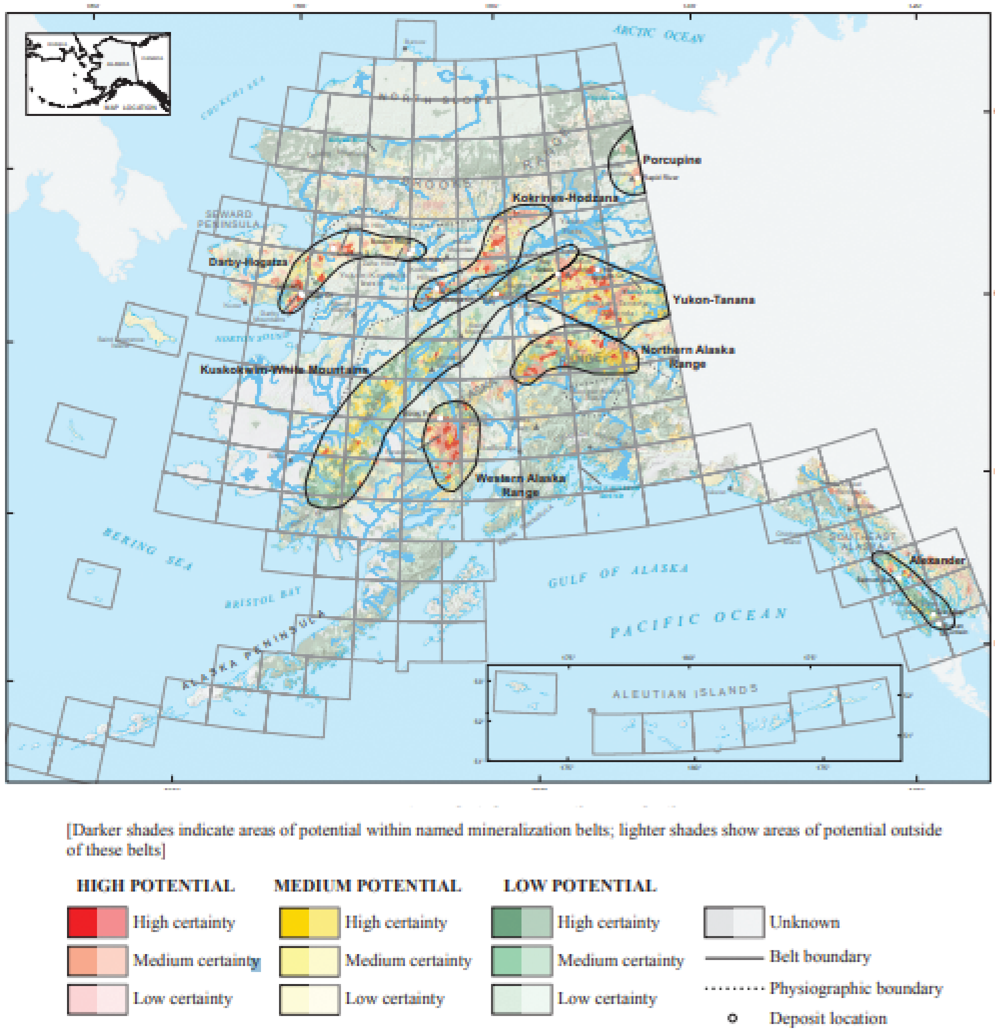
https://ardf.wr.usgs.gov/

Mineral Resources Databases and Information Analysis



The mineral resources databases and information analysis project provides geographic information system (GIS) support to Alaska-based geology research projects. Support includes building geoscience datasets, geospatial analyses, map production, and preparing digital datasets and metadata for publication. The ASC finds it beneficial to consolidate most of its GIS proficiency and make it accessible to all projects. With the advent of the era of digital data, the ASC and the Mineral Resources Program have been building very large statewide (and nationwide) datasets, including geochemistry, geology, mineral resource deposits, and geophysics. Recently, the ASC has developed a method for analyzing these types of data spatially to identify areas with potential for various categories of mineral deposits. As a part of this project, the USGS recently published a Data Series that is the most complete Alaska geochemical dataset available to the public. It is being used to assess Alaska critical mineral resources and is a Mineral Resources Program guide for the use of geochemical data in the conterminous United States. The Alaska Geochemical Database Version 3.0 (AGDB3) is a key component in the assessment of Alaska critical mineral resources.

Time frame	Budget
FY1996–continuing	$218,000 (FY2019)



Mineral resource potential for rare earth element-Th-Y-Nb(-U-Zr) deposits associated with peralkaline to carbonatitic intrusive rocks, in Alaska. From Karl, S.M., Jones, J.V., III, and Hayes, T.S. (2016) (see "Recent Publication" at the end of this section).

Contact

Nora B. Shew, ASC, nshew@usgs.gov, (907) 786–7445

Recent Publication

Karl, S.M., Jones, J.V., III, and Hayes, T.S., 2016, GIS-based identification of areas that have resource potential for critical minerals in six selected groups of deposit types in Alaska: U.S. Geological Survey Open-File Report 2016-1191, 99 p., https://doi.org/10.3133/ofr20161191.

Critical Minerals Mapping in Ore-Forming Systems in Alaska

The primary objective of the project is to quantify and understand the distribution of critical elements in ore-forming systems in Alaska. This is accomplished by using a data-driven, GIS-based method that systematically and simultaneously analyzes geospatially-referenced datasets. This data-driven GIS approach provides an unbiased, quantitative method of assessing large areas. Goals of this project are to (1) provide statewide mineral prospectivity maps and data in GIS format for targeted critical minerals that are needed for technological, economic, and military applications; (2) identify new areas in Alaska with resource potential for specified commodities; (3) identify understudied areas with mineral potential that warrant further investigation; (4) identify areas where data coverage is insufficient and requires future sampling; (5) improve spatial accuracy of datasets; (6) incorporate newly acquired data or newly published data in the datasets; and (7) acquire additional datasets such as airborne surveys and remote-sensing compilations.

Bokan Mountain with Dotson Ridge in the foreground to the right, Prince of Wales Island, Southeast Alaska. Dikes that intrude Dotson Ridge are rich in rare-earth element-bearing minerals. Photograph by Susan Karl, U.S. Geological Survey.

A product of this work includes the Alaska Geochemical Database Version 3.0, which was designed to compile and integrate geochemical data from Alaska to facilitate geologic mapping, petrologic studies, mineral resource assessments, definition of geochemical baseline values and statistics, element concentrations and associations, environmental impact assessments, and studies in public health associated with geology. This relational database, created from databases and published datasets of the USGS, Atomic Energy Commission National Uranium Resource Evaluation, Alaska Division of Geological and Geophysical Surveys (DGGS), U.S. Bureau of Mines, and Bureau of Land Management, serves as a data archive in support of geologic and geochemical projects in Alaska, and contains data tables in several different formats describing historical and new quantitative and qualitative geochemical analyses.

Contact

Susan Karl, ASC, skarl@usgs.gov, (907) 786–7428

Time frame	Budget	Project partner
FY2018–21	$293,000 (FY2019)	Bureau of Land Management, and Alaska Division of Geological and Geophysical Surveys.

Recent Publications

Jones, J.V., III, Karl, S.M., Labay, K.A., Shew, N.S., Granitto, M., Hayes, T.S., Mauk, J.L., Schmidt, J.M., Todd, E., Wang, B., Werdon, M.B., and Yager, D.B., 2015, GIS-based identification of areas with mineral resource potential for six selected deposit groups, Bureau of Land Management Central Yukon Planning Area, Alaska: U.S. Geological Survey Open-File Report 2015-1021, 78 p., 2 appendixes, 12 plates.

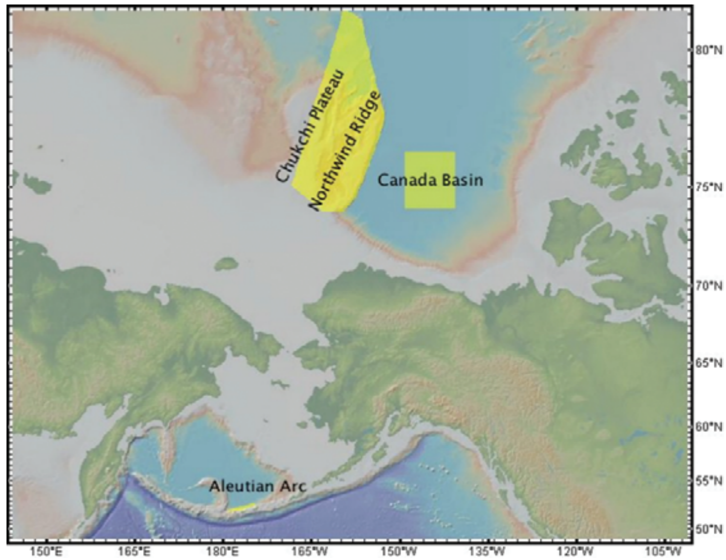
Karl, S.M., Jones, J.V., III, and Hayes, T.S., eds., 2016, GIS-based identification of areas that have resource potential for critical minerals in six selected groups of deposit types in Alaska: U.S. Geological Survey Open-File Report OF-2016–1191, 99 p., 5 appendixes, 12 plates, scale 1:10,500,000.

Karl, S.M., and Labay, K.A., 2017, Geospatial analysis identifies critical mineral-resource potential in Alaska: U.S. Geological Survey Fact Sheet 2017–3012, 4 p.

Karl, S.M., Labay, K.A., Shew, N.S., Wang, B., Granitto, M., Kreiner, D., and Case, G., 2017, GIS-based identification of areas that have potential for lode gold deposits in Alaska: Association for Mineral Exploration Roundup Annual Convention, poster, 5 maps, scale 1:5,000,000.

Improving Understanding of Domestic Critical Mineral Potential in the Pacific Outer Continental Shelf

This project continues the long-standing Bureau of Ocean and Energy Management (BOEM)-USGS partnership for evaluating the energy and mineral resources located on the Federal Outer Continental Shelf (OCS). In response to Executive Order 13817, the purpose of this study is to enhance the ability of the United States to identify and use domestic critical marine mineral resources through advanced ocean observation data products, robust marine mineral information collection and analysis, and estimates of critical mineral resources. In consultation with BOEM, USGS will synthesize oceanographic and geologic data to create actionable permissive-region mineral maps to ensure marine mineral exploration efforts can be designed using the best-available data pertaining to critical marine minerals. This geospatial information will aid in the identification of priority regions with significant critical mineral resource potential on the OCS and contribute to the development of future regional scoping studies to identify and prioritize critical mineral mapping. Final deliverable products will include permissive regional maps for the U.S. Exclusive Economic Zone with integrated bathymetric, oceanographic, and geologic data that can be updated as new datasets become available. The study will yield a cost-tiered program proposal for potential future field work in the Alaska OCS.



Map of the Alaska OCS region and Extended Continental Shelf showing that the Chukchi Plateau is permissive for ferromanganese crusts, the Canada Basin is permissive for manganese nodules, and the Aleutian Arc is permissive for seafloor massive sulfides and hydrothermal oxides.

Time frame	Budget	Project partner
FY2019–24	$1,000,000 (Bureau of Ocean Energy Management [BOEM] funding with U.S. Geological Survey in-kind support).	BOEM.

Contact

Amy Gartman, Pacific Coastal and Marine Science Center, Santa Cruz, California, agartman@usgs.gov, (831) 460–7562

Petrogenesis and Mineralization of the Darby and Kachauik Plutons, Seward Peninsula

In the southeastern Seward Peninsula, a body of intrusive igneous rock, known as the Darby and Kachauik plutons, was formed from the cooling and solidification of magma. These plutons are part of the Hogatza igneous belt, which extends for 500 kilometers from Saint Lawrence Island to the southern Brooks Range in northwestern Alaska. They have unusually high-potassium alkaline compositions, unevaluated high concentrations of rare earth elements and high field strength elements. The objective of this project is to determine the origin and formation, source of mineralization, and tectonic setting of these unusual plutons. Resolution of the parameters that controlled the magmatic sources, evolution, and emplacement of the Darby and Kachauik plutons and mineralization associated with them will contribute significantly to understanding the Hogatza igneous belt and the regional tectonics of northwestern Alaska during the middle Cretaceous, a time of widespread magmatic activity and mineralization throughout the State of Alaska.

Fine-grained, greenish-gray, rare-earth-elements-rich dike that has a sheared and altered contact with the Kachauik pluton. Photograph by Sue Karl, U.S. Geological Survey.

Time frame	Budget
FY2016–19	$195,000 (FY2019)

Contact

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Tectonic and Metallogenic Evolution of the Eastern Yukon-Tanana Upland

The Yukon-Tanana upland in eastern Alaska contains multiple mining districts and significant placer gold resources. It also has known or suspected potential for multiple critical mineral commodities. The known deposits in the region remain poorly characterized, inventoried, and incompletely understood. Furthermore, published geologic mapping and data are insufficient for developing a comprehensive geologic and metallogenic framework that is essential for assessing Alaska's mineral resource endowment and identifying fundamental geologic controls on mineral deposit formation and preservation. Study methods include (1) new geologic mapping and bedrock sampling, (2) geophysical interpretation and modeling, (3) focused ore deposit and placer studies and regional characterization of mineralized systems, and (4) topical studies of major fault networks and Cenozoic landscape evolution. The core objectives of the project are to develop a modern and integrated geologic, metallogenic, and geophysical framework for the Yukon-Tanana upland.

Meter-thick quartz vein cutting across Late Devonian (about 360-million-year-old) metamorphic rocks on Divide Mountain, eastern Yukon-Tanana upland, eastern Alaska. Photograph by Jamey Jones, U.S. Geological Survey.

Time frame	Budget	Project partners
FY2015–19	$650,000 (FY2019)	Alaska Division of Geological and Geophysical Surveys, Yukon Geological Survey, and Geological Survey of Canada.

Contact

Jamey Jones, USGS AS, jvjones@usgs.gov, (907) 786–7442

Recent Publications

Bender, A.M., Lease, R.O., Corbett, L.B., Bierman, P. and Caffee, M.W., 2018, Ongoing bedrock incision of the Fortymile River driven by Pliocene-Pleistocene Yukon River capture, eastern Alaska, USA, and Yukon, Canada: Geology, v. 46, no. 7, p. 635–638.

Dusel-Bacon, C., Holm-Denoma, C.S., Jones III, J.V., Aleinikoff, J.N., and Mortensen, J.K., 2017, Detrital zircon geochronology of quartzose metasedimentary rocks from parautochthonous North America, east-central Alaska: Lithosphere, v. 9, no. 6, p. 927–952.

Dusel-Bacon, C., Bacon, C.R., O'Sullivan, P.B., and Day, W.C., 2016, Apatite fission-track evidence for regional exhumation in the subtropical Eocene, block faulting, and localized fluid flow in east-central Alaska: Canadian Journal of Earth Sciences, v. 53, no. 3, p. 260–280.

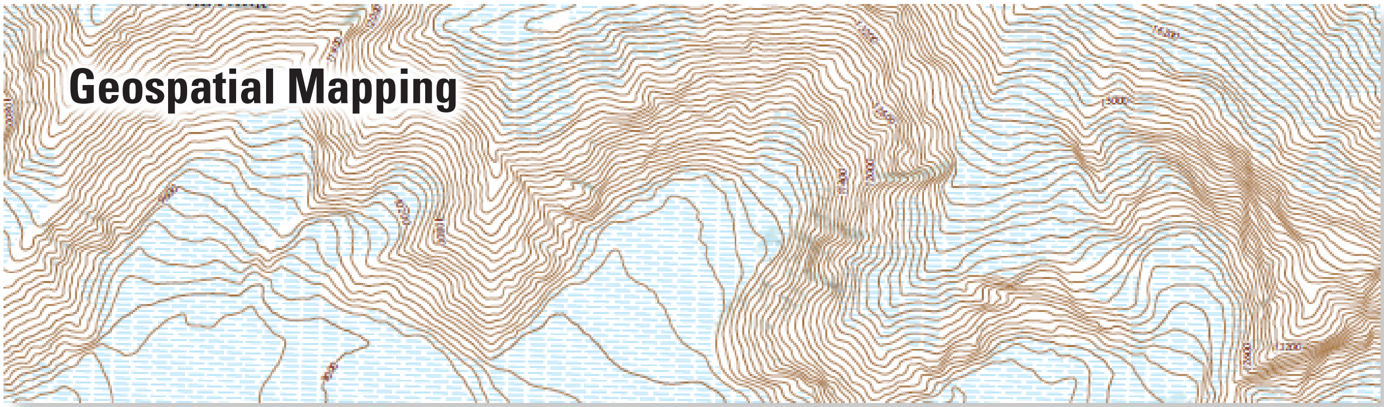
Dusel-Bacon, C., Aleinikoff, J.N., Day, W.C., and Mortensen, J.K., 2015, Mesozoic magmatism and timing of epigenetic Pb-Zn-Ag mineralization in the western Fortymile mining district, east-central Alaska—Zircon U-Pb geochronology, whole-rock geochemistry, and Pb isotopes: Geosphere, v. 11, no. 3, p. 786–822.

Miles, W., Saltus, R., Hayward, N., and Oneshuk, D., 2015, Alaska and Yukon magnetic compilation, residual total magnetic field: Geological Survey of Canada Open File 7862, 1 sheet.

Emond, A.M., Saltus, R.W., Graham, G., and Goldak Airborne Surveys, 2015, Airborne magnetic geophysical survey of the Tanacross region, Alaska: Alaska Division of Geological and Geophysical Surveys Geophysical Report 2015-6, doi:10.14509/29514.

Project Link

https://www.usgs.gov/centers/asc/science/tectonic-and-metallogenic-evolution-eastern-yukon-tanana-upland-alaska



Geospatial Mapping

Light Detection and Ranging (Lidar)

USGS partners with Federal, State, local, and private entities to collect high-quality, 3D mapping data of the United States. The 3D Elevation Program (3DEP) presents a unique opportunity for collaboration between all levels of government and private organizations to leverage the services and expertise of private-sector mapping firms that acquire 3D elevation data. Federal funds to support this opportunity are provided by the USGS, the Federal Emergency Management Agency, and the Natural Resources Conservation Service. The USGS is acting in a management role to facilitate planning and acquisition for the broader community through the use of government contracts and partnership agreements. All data (digital elevation models) will be made publicly available on the USGS The National Map. Current lidar projects include data collection at Glacier Bay National Park and Preserve, on Alaska Native Tribal Lands, and in the Matanuska-Susitna Borough.

Glacier Bay National Park and Preserve. Acquiring lidar in the most visited National Park areas will improve the NPS's ability to manage National Park land, maintain infrastructure, plan for visitor use, and conduct science-related activities.

Alaskan Native Tribal Lands. Ahtna Native Regional Corporation shareholders principally are the Athabascan people occupying the Copper River and Cantwell regions of south-central Alaska. The purpose of lidar data acquisition is to support Ahtna Native Lands and Resource management, including (1) baseline and growth assessments of Ahtna Lands' forest carbon capture; (2) watershed and rivers management for flood control; and (3) forest-based fuels assessments for wildfire prediction, prevention, and control.

Matanuska-Susitna Borough. The Matanuska-Susitna Borough (MSB) project covers more than 1,080 square-miles in the south-central part of the MSB. It includes the populated areas of Point MacKenzie, Knik, Big Lake, Houston, Wasilla, Palmer, Butte, Sutton, Chickaloon, Glacier View, and Eureka—areas that have had significant population and landscape changes since 2011 (previous lidar collection). The lidar data will support upcoming projects, such as the Port MacKenzie railway corridor, all projects in the MSB 2018 road bond package, and 19 projects in the Alaska 2018–2121 Statewide Transportation Improvement Program.

Time frame	Project partners
FY2018–21	Federal Emergency Management Agency, Natural Resources Conservation Service, National Park Service, and Ahtna Native Regional Corporation.

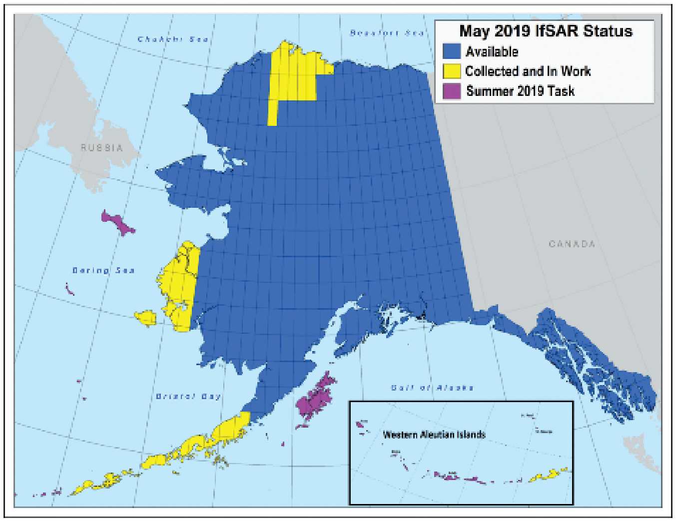
Contact

Brian Wright, National Geospatial Program,
bwright@usgs.gov, (907) 201–0113

Alaska IfSAR Radar Elevation Data Acquisition Program

The USGS Alaska Mapping Initiative supports acquisition of new topographic map data and maps for Alaska. The new data and maps raise the accuracy of Alaska topographic mapping to levels common in the conterminous United States. Topographic maps are generated from radar technology referred to as IfSAR (interferometric synthetic aperture radar) elevation data. IfSAR is used to collect the data because it can penetrate the clouds, smoke, and haze that are often present in Alaska. Alaska IfSAR acquisition also supports the broader national 3DEP. Collection of a 5-meter resolution elevation grid for Alaska began in 2012 and will be completed in 2019, replacing the former 60-meter statewide elevation grid. Data for the final far outlying islands are being collected in 2019 and are expected to be processed and delivered in 2020. The data are free to the public for any use. New technologies also are being investigated to collect high-resolution elevation data for Alaska in the future.



Status of ifSAR (interferometric synthetic aperture radar) use in the Alaska, ifSAR Radar Elevation Data Acquisition Program, 2019.

Time frame
FY2012–20

Contact

Brian Wright, National Geospatial Program, bwright@usgs.gov, (907) 201–0113

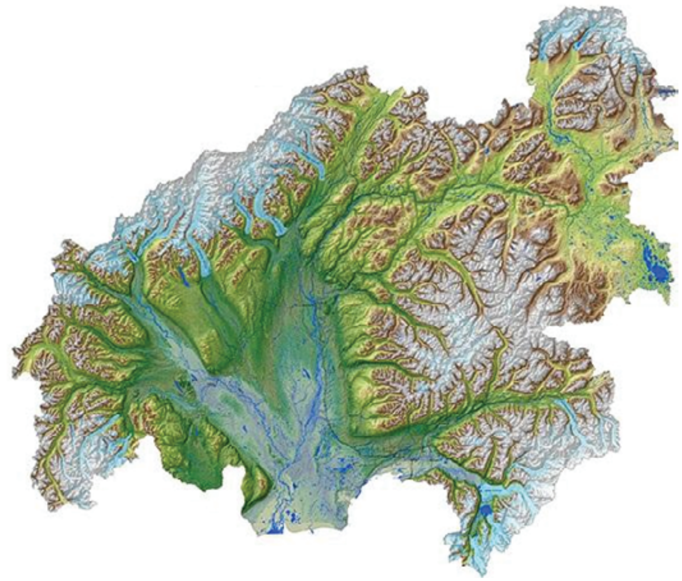
Project Link

https://www.usgs.gov/core-science-systems/ngp/user-engagement-office/alaska-mapping-initiative

Alaska Hydrography Map

The National Hydrography Dataset (NHD), Watershed Boundary Dataset (WBD), and NHDPlus High Resolution (NHDPlus HR) are geospatial datasets that map and model the surface water of the United States. Together, the NHD and WBD form a rich data suite that map the Nation's surface water network and hydrologic unit areas. The NHD at 1:24,000 scale or better represents the Nation's hydrologic drainage networks and related features, including rivers, streams, canals, lakes, ponds, glaciers, coastlines, dams, and stream gauges. The WBD represents drainage areas of the country at eight nested levels. The NHD and WBD are the most up-to-date and geographically inclusive hydrography datasets for the Nation.

In Alaska, most of the mapping of this water is based on 1950s-era USGS historical topographic maps and is mapped at a broad 1:63,360-scale. Numerous partners are engaged in an effort to remap Alaska waters to meet national high-resolution, 1:24,000-scale standards. This work is overseen by the Alaska Geospatial Council Alaska Hydrography Technical Working Group, which has two goals: (1) update the NHD to national standards, and (2) meet the hydrography mapping needs of agencies in Alaska. As a result of this collaborative effort, nearly 30 percent of the NHD in Alaska has been updated to the 1:24,000 scale national standard and the data are available to the public. Hydrography updates also include updates to the WBD. The WBD, NHD USGS digital elevation data will be used to generate NHDPlus HR for Alaska in the future.



Terrain and hydrography of the Matanuska-Susitna, watershed south-central Alaska. Image provided by Kacy Krieger, University of Alaska Anchorage (public domain).

Time frame	Project partners
Ongoing	State, Federal, and private partners engaged in the Alaska Geospatial Council.

Contact

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Project Link

http://agc.dnr.alaska.gov/hydrography.html

Landsat 9 Analysis Ready Data

Landsat 9 represents a longstanding partnership between the National Aeronautics and Space Administration (NASA) and the USGS that will continue the Landsat program's critical role of repeat global observations for monitoring, understanding, and managing Earth's natural resources. Since 1972, Landsat data have provided a unique resource for those who work in agriculture, geology, forestry, regional planning, education, mapping, and global-change research. NASA is responsible for the space segment (instruments and spacecraft/observatory), mission integration, launch, and on-orbit checkout. The USGS Earth Resources Observation and Science (EROS) Center is responsible for the ground system, flight operations, data processing, and data product distribution after NASA completes on-orbit checkout. The Landsat 9 spacecraft and instruments are being developed towards a launch-readiness date of December 2020. Landsat 9 will image the Earth every 16 days in an 8-day offset with Landsat 8. Landsat 9 will collect as many as 750 scenes per day, and with Landsat 8, the two satellites will add nearly 1,500 new scenes per day to the USGS Landsat archive. All Landsat 9 data products will continue to be made available for download through the USGS EROS Center at no charge. U.S. Landsat Analysis Ready Data (ARD) products are consistently processed to the highest scientific standards and level of conversion required for direct use in monitoring and assessing landscape change. U.S. Landsat ARD is available for the conterminous United States, Alaska, and Hawaii. In Alaska, USGS scientists and others use Landsat imagery to help land and resource managers make informed decisions about the State's energy and mineral resources and wildlife habitats, as well as to contribute to a greater understanding of geologic processes, coastal erosion, and anticipated future landscape changes. Landsat ARD products include Landsat 4-8 collections and are available for Alaska from 1984 to present, with significant expansion in the number of scenes available for download occurring in 1999 and 2013, and forthcoming in 2020.

Time frame	Project partners
FY2015–21	National Aeronautic and Space Administration Kennedy Space Center and Goddard Space Flight Center.

Contact

Chris Crawford, EROS Center, cjcrawford@usgs.gov, (605) 594–2874

Recent Publications

U.S. Geological Survey, 2019, Landsat 9 (ver. 1.1, May 2019): U.S. Geological Survey Fact Sheet 2019–3008, 2 p., https://doi.org/10.3133/fs20193008.

Natural Hazards

Earthquakes and Tsunamis

Alaska Earthquake Hazards

The earthquake hazards research team examines major fault systems in Alaska capable of generating large earthquakes, including the Alaska-Aleutian subduction zone, the Denali Fault system, and the Queen Charlotte-Fairweather Fault system. Many active faults in Alaska are capable of generating large tsunamis that threaten coastal communities in Alaska and beyond. Using methods in paleoseismology, geochronology, and quantitative geomorphology, the team conducts field-based research to understand how, where, and why earthquakes and tsunamis occur in Alaska. The main objective of this research is to more accurately define the location, magnitude, and frequency of prehistoric earthquakes and tsunamis, which inform probabilistic assessments that forecast future hazards. The expected outcomes include seismic and tsunami source parameters used to update the National Seismic Hazard Map for Alaska and tsunami hazard assessments conducted by States and U.S. territories with support from the National Oceanic and Atmospheric Administration (NOAA) National Tsunami Hazard Mitigation Program.

U.S. Geological Survey geologist surveying a trace of the 1958 Fairweather Fault earthquake surface rupture, at Crillon Lake, Glacier Bay National Park, Southeast Alaska. Trace forms a linear, uphill-facing, 1–2-meter tall escarpment flanked by trees that likely were tilted during the 1958 earthquake. Photograph by Rob Witter, U.S. Geological Survey.

Time frame	Budget
Ongoing	$406,000

Contact

Robert Witter, ASC, rwitter@usgs.gov, (907) 786–7404

Recent Publications

Bender, A.M., Lease, R.O., Haeussler, P.J., Rittenour, T., Corbett, L.B., Bierman, P.R., and Caffee, M.W., 2019, Pace and process of active folding and fluvial incision across the Kantishna Hills anticline, central Alaska: Geophysical Research Letters, v. 46, p. 3235–3244, doi:10.1029/2018GL081509.

Haeussler, P.J., Gulick, S.P.S., McCall, N., Walton, M., Reece, R., Larsen, C., Shugar, D.H., Geertsema, M., Venditti, J.G., and Labay, K., 2018, Submarine deposition of a subaerial landslide in Taan Fiord, Alaska: Journal of Geophysical Research—Earth Surface, v. 88, p. 1–21, doi:10.1029/2018JF004608.

Haeussler, P.J., Matmon, A., Schwartz, D.P., and Seitz, G.G., 2017, Neotectonics of interior Alaska and the late Quaternary slip rate along the Denali fault system: Geosphere, v. 13, no. 5, 19 p., doi:10.1130/GES01447.1.

Haeussler, P.J., Saltus, R.W., Stanley, R.G., Ruppert, N., Lewis, K., Karl, S.M., and Bender, A., 2017, The Peters Hills Basin, a Neogene wedge-top basin on the Broad Pass thrust fault, south-central Alaska: Geosphere, v. 13. no. 5, p. 1464–1488, doi 10.1130/GES01487.1.

Witter, R., Briggs, R., Engelhart, S.E., Gelfenbaum, G., Koehler, R.D., Nelson, A., La Selle, S., Corbett, R., and Wallace, K., 2018, Evidence for frequent, large tsunamis spanning locked and creeping parts of the Aleutian megathrust: Geological Society of America Bulletin, p. 1–23, doi:10.1130/B32031.1.

Witter, R.C., Carver, G.A., Briggs, R.W., Gelfenbaum, G., Koehler, R.D., La Selle, S., Bender, A.M., Engelhart, S.E., Hemphill-Haley, E., and Hill, T.D., 2016, Unusually large tsunamis frequent a currently creeping part of the Aleutian megathrust: Geophysical Research Letters, v. 43, p. 76–84, doi:10.1002/(ISSN)1944-8007.

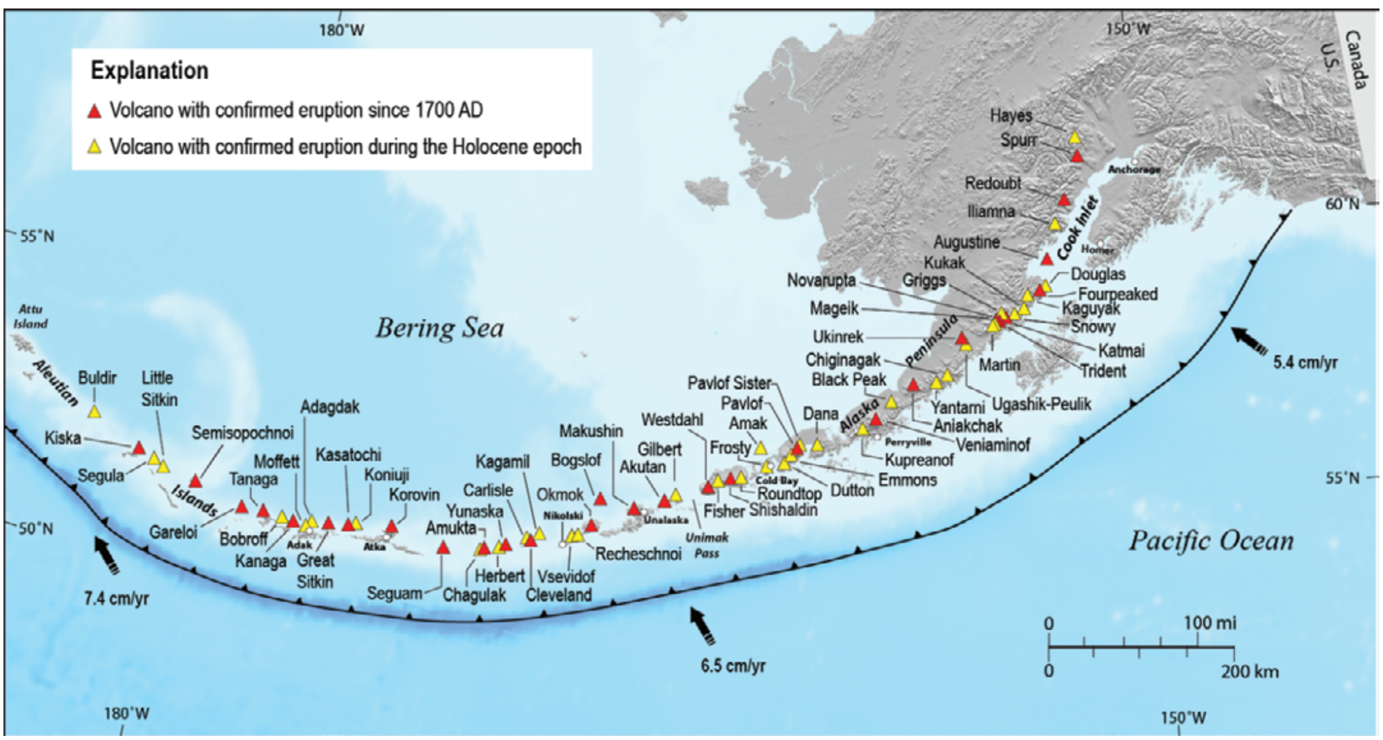
Witter, R.C., LeWinter, A., Bender, A.M., Glennie, C., and Finnegan, D., 2017, Sculpted by Water, elevated by earthquakes—The coastal landscape of Glacier Bay National Park, Alaska: U.S. Geological Survey General Information Product 177, p. 1–1, doi:10.3133/gip177.

Project Link

https://www.usgs.gov/centers/asc/science/alaska-earthquake-and-tsunami-hazards

Volcanoes

Alaska Volcano Observatory



Volcanoes in Alaska. Alaska Volcano Observatory uses various methods including real-time geophysical networks and data collected by satellite to monitor activity at Alaskan volcanoes stretching from Mount Hayes, 141 kilometers (km) from Anchorage, to Kiska, 2,198 km from Anchorage.

The AVO is a joint program of the USGS, the Geophysical Institute of the University of Alaska Fairbanks, and DGGS. The AVO was formed in 1988, and uses Federal, State, and university resources to monitor and study Alaska's hazardous volcanoes, to predict and record eruptive activity, and to mitigate volcanic hazards to life and property.
AVO has three primary objectives:

- To conduct monitoring and other scientific investigations to assess the nature, timing, and likelihood of volcanic activity;
- To assess volcanic hazards associated with anticipated activity, including kinds of events, their effects, and areas at risk; and
- To provide timely and accurate information on volcanic hazards, and warnings of impending dangerous activity, to local, State, and Federal officials and the public.

Time frame	Budget	Project partners
FY1988–ongoing	$4.2 million for FY2019	State of Alaska Division of Geological and Geophysical Surveys, University of Alaska Fairbanks Geophysical Institute, and National Oceanic and Atmospheric Administration.

Contact

Tom Murray, Volcano Science Center, tlmurray@usgs.gov, (907) 786–7443

Project Link

https://avo.alaska.edu/

Recent Publications

Bigelow, N.H., Reuther, J.D., Wallace, K.L., Saulnier-Talbot, É., Mulliken K., and Wooller, M.J., 2019, Late-glacial paleoecology of the middle Susitna Valley, Alaska—Environmental context for human dispersal, Frontiers in Earth Science, https://doi.org/10.3389/feart.2019.00043.

Burgess, S.D., Coble, M.A., Vazquez, J.A., Coombs, M.L., and Wallace, K.L., 2019, On the eruption age and provenance of the Old Crow tephra: Quaternary Science Reviews, v. 207, p. 64–79, https://doi.org/10.1016/j.quascirev.2018.12.026.

Cameron, C.E., Mulliken, K.M., Crass, S.W., Schaefer, J.R., and Wallace, K.L., 2019, Alaska Volcano Observatory geochemical database, version 2: Alaska Division of Geological and Geophysical Surveys Digital Data Series 8, v. 2, 22 p., https://doi.org/10.14509/30058.

Iezzi, A.M., Schwaiger, H.F., Fee, D., and Haney, M.M., 2019, Application of an updated atmospheric model to explore volcano infrasound propagation and detection in Alaska: Journal of Volcanology and Geothermal Research, v. 371, p. 192–205, https://doi.org/10.1016/j.jvolgeores.2018.03.009.

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Schwaiger, H.F., Iezzi, A.M., and Fee, D., 2019, AVO-G2S—A modified, open-source Ground-to-Space atmospheric specification for infrasound modeling: Computers and Geosciences, v. 125, p. 90–97, https://doi.org/10.1016/j.cageo.2018.12.013.

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Tepp, G., Chadwick, W.W., Jr., Haney, M.M., Lyons, J.J., Dziak, R.P., Merle, S.G., Butterfield, D.A., and Young, C.W., III, 2019, Hydroacoustic, seismic, and bathymetric observations of the 2014 submarine eruption at Ahyi Seamount, Mariana Arc: Geochemistry, Geophysics, Geosystems, v. 20, no. 7, p. 3608–3627.

Analog-to-Digital Conversion of Monitoring Sites in Alaska

In mid-August, the USGS AVO completed the field season for the first phase (Year-1) of a 3-year analog-to-digital conversion project in the Aleutians and elsewhere. The project converts and upgrades all remaining legacy analog equipment in the AVO geophysical network to enhance monitoring capabilities and regulatory requirements. Upgrades have been performed at the following 13 volcanoes: Akutan, Augustine, Dutton, Gareloi, Great Sitkin, Iliamna, Kanaga, Katmai, Korovin, Makushin, Okmok, Tanaga, and Westdahl. The new ground-based instrumentation includes seismometers, infrasound sensors, and web cameras, and significantly improves AVO's ability to detect unrest, forecast eruptive activity, and issue timely alerts of volcano hazards. The upgrades have addressed needed replacement of aging analog equipment with modern digital instruments and radios, as well as refurbishment of existing digital equipment at some sites with more robust digital installations. In particular, five entire seismic networks located at volcanoes in the Aleutian Islands—Korovin, Great Sitkin, Kanaga, Tanaga, and Gareloi—have been completely transitioned from analog to digital systems. Mount Dutton on the Alaska Peninsula also underwent a complete upgrade. This work, which was mandated by requirements set forth by the National Telecommunications and Information Administration to vacate radio frequencies used by older analog equipment, has substantially improved the data quality at new digital stations installed this past summer at the 13 volcanoes. The new data also will be of value for other monitoring programs, such as those focused on earthquakes and tsunamis. Owing in part to these upgrades, the AVO has reestablished seismic monitoring at Dutton and Wrangell volcanoes and recently has changed the status of these volcanoes from "UNASSIGNED" to Volcano Alert Level NORMAL and Aviation Color Code GREEN. Dutton and Wrangell had been removed from the AVO list of officially monitored volcanoes in past years owing to their original analog seismic networks being inoperable. Phase 2 field plans (Year-2) will focus on networks in the far western Aleutians and the Alaska Peninsula, and are expected to be completed during the 2020 field season.

Field engineer with Alaska Volcano Observatory/University of Alaska Fairbanks working on analog to digital station upgrades at Tanaga site in the Aleutian Islands, Alaska. Photograph by Taryn Lopez, U.S. Geological Survey Alaska Volcano Observatory/University of Alaska Fairbanks, Geophysical Institute.

Time frame	Budget
Ongoing	$406,000

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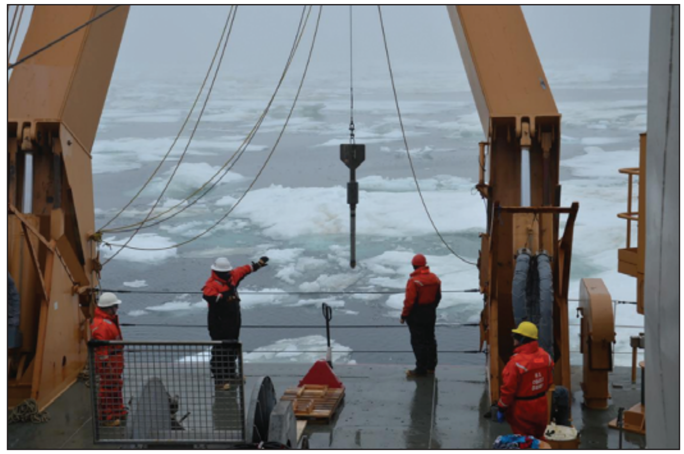
Sea Ice Loss, Coastal Flooding, and Erosion

Land-Sea Linkages in the Arctic

Paleoclimate records in Arctic Ocean sediments improve understanding of patterns and causes of Arctic climate change, shed light on possible future climate change and impacts of Arctic sea ice on mid-latitude weather, and help decision makers address issues of ecosystems, endangered species, energy policy, national security, and transportation. The USGS is studying sea ice history over the past 500,000 years using sediment cores and surface sediment samples. The objectives of this research are to understand past Arctic sea ice history during past periods of climate warming and to determine impacts on ecosystems and species. Various proxy methods are used to address the history of Arctic sea ice, bottom and surface ocean circulation, and ocean temperature variability. Results from this and prior projects indicate that summer sea-ice free conditions are common in the sediment record of the pre-industrial Arctic Ocean and that ecosystems are resilient in the face of changing environments. Some evidence also indicates recent sea-ice loss in the western Arctic Ocean is unprecedented in the last 4,000 years.



Deployment of a gravity corer aboard *U.S. Coast Guard Cutter Healy* during an expedition to the Chukchi Sea, northern Alaska. Photograph by Laura Gemery, U.S. Geological Survey.

Time frame	Budget	Project partners
FY2019–23	$424,000	Stockholm University, Princeton University, Columbia University, Aarhus University [Denmark], GEOMAR, Kiel [Germany], University of Maryland, and National Oceanic and Atmospheric Administration.

Contact

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Recent Publications

Cronin, T.M., Dwyer, G.S., Caverly, E.K., Farmer, J., DeNinno, L.H., Rodriguez-Lazaro, J., and Gemery. L., 2017, Enhanced Arctic amplification began at the Mid-Brunhes Event ~400,000 years ago: Nature Scientific Reports, v. 7, no. 14475, doi:10.1038/s41598-017-13821-2.

Osborne, E., Cronin T.M., and Farmer, J., 2018, SIDEBAR 5.1—Paleoclimate records—Providing context and understanding of current Arctic change, *in* Blunden, J., Arndt, D.S., and Hartfield, G., eds., State of the climate in 2017, Special supplement to the Bulletin of the American Meteorology Society, v. 99, no. 8, p. S150–S151

Project Link

https://www.usgs.gov/centers/gecsc/science/terrestrial-records-holocene-climate-change-fire-climate-and-humans?qt-science_center_objects=0#qt-science_center_objects

Heat Flow in the Western Arctic Ocean Seafloor

During the Cold War era, scientists from Federal agencies, university research groups, and indigenous residents set up camp on ice that stretched more than 77 square kilometers in the western Arctic Ocean to conduct meteorological, oceanographic, and geophysical surveys. The western Arctic Ocean is the largest area of seafloor in the world and it is unclear exactly how and when it formed. USGS researchers began to unravel this mystery in 1963 by collecting temperature measurements from the western Arctic seafloor, known as marine heat flow measurements. This legacy dataset was recently resurrected and analyzed with modern seismic data to complete the first thorough analysis of Arctic marine heat flow data. The data provide clues to the geologic history of the region. This information also serves as an important foundation to test plate tectonic theories and provide information about offshore oil and gas reservoirs.

Time frame	Project partner
FY1963–2019	Naval Arctic Research Laboratory.

Hydrohut, a building in which U.S. Geological Survey technicians took marine heat flow measurements, in the western Arctic Ocean off the north coast of Alaska. The hut surrounded a hole in the ice through which the heat flow probe descended to reach the ocean and seafloor below. Photograph by D. Scoboria, U.S, Geological Survey.

Contact

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Recent Publication

Ruppel, C., Lachenbruch, A., Hutchinson, D., Munroe, R., and Mosher, D., 2019, Heat flow in the western Arctic Ocean (Amerasian Basin): Journal of Geophysical Research—Solid Earth, v. 124, no. 8, p. 7562–7587, https://doi.org/10.1029/2019JB017587.

Building an Operational System to Forecast Potential Flood Hazards in Unalakleet, Alaska

Like many coastal communities of Alaska, the village of Unalakleet is vulnerable to marine flooding during large storms. Storm surge in Norton Sound typically occurs in the fall and winter months when the coastline is protected by shorefast ice. However, warming trends in the Arctic have resulted in reduced ice coverage and increased occurrence of wave events affecting coasts. Two video cameras were installed by USGS in collaboration with DGGS and village authorities to better understand wave and water-level dynamics in Norton Sound. Every 30 minutes during daylight hours, the cameras collect snapshots and videos for 10 minutes, which are posted online. These and other images are then used to observe and quantify coastal processes such as wave run-up, development of rip channels, bluff erosion, and movement of sandbars and ice floes. The USGS plans to install similar systems in

Looking westward over Norton Sound from two video cameras atop a windmill tower in Unalakleet, western Alaska.

other U.S. locations (two video cameras temporarily overlooked the Beaufort Sea coast from atop the coastal bluff of Barter Island near Kaktovik in 2018). The knowledge gained from these camera systems will improve computer-derived simulations of shoreline change that communities can use to plan for sea-level rise, changing storm patterns, and other threats to coasts. In collaboration with NOAA, the overriding USGS goal is to develop a real-time system to provide approximately 6-day forecasts of total water level and flood potentials from the analysis of astronomic tides, storm surge, and wave runup. Toward that end, about 90 kilometers of bathymetry track-line data were collected in the inlet and estuary and along the open coast extending about1.2 kilometers north and south of the inlet and about 1.5 kilometers offshore.

Time frame	Budget	Project partners
FY2019–ongoing	$50,000	Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys; Native Village of Unalakleet; City of Unalakleet; and National Oceanic and Atmospheric Administration.

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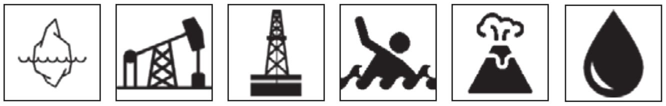
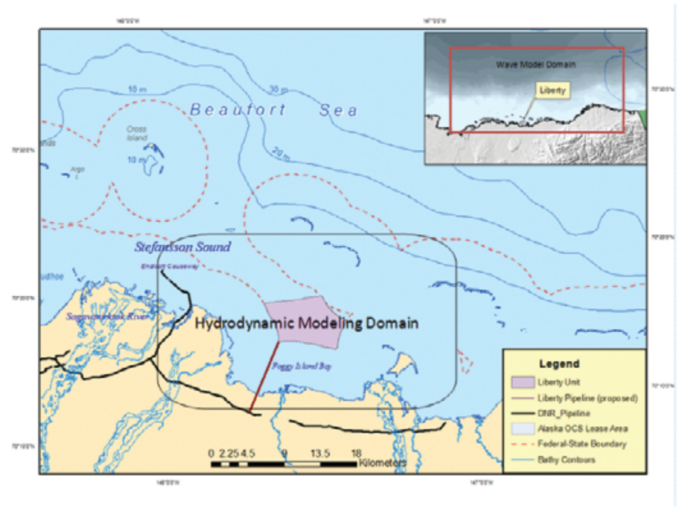
Project Link

https://www.usgs.gov/centers/pcmsc/science/using-video-imagery-study-wave-dynamics-unalakleet?qt-science_center_objects=0#qt-science_center_objects

Wave and Hydrodynamic Observations and Modeling in the Nearshore Beaufort Sea



Renewed interest in nearshore oil exploration and production in the central Beaufort Sea has created a general need to advance understanding of the dynamic physical conditions in this Beaufort Sea coastal region. Specifically, BOEM requires information on the impacts that climate change may have on sea ice, wind and wave conditions, changes in sedimentation rates, and ice pile-up events during the expected timeframe of the offshore Liberty Development Project (about 2020–50). Coordinated field observations are needed for model validation because wave observations are limited in the central Beaufort Sea. For this project, USGS will develop a coupled wave-hydrodynamic-sediment transport model to produce a 40-year hindcast (1979–2019) and projection (2020–49) of waves, storm surge, and sediment transport potentials within Stefansson Sound to assess the impacts of waves on sea ice and offshore structures. A coordinated field effort will collect offshore observations using fixed moorings and buoys for validation of the proposed wave model. Additional field efforts will be conducted to map ice pile-up events within Stefansson Sound. The goal is to be able to adequately document wave and sediment transport conditions within Stefansson Sound, and provide input data assimilation and validation support for project modeling activities.



Proposed general location of Liberty Development Project with the study model domain, in Foggy Island Bay and Stefansson Sound area of the Beaufort Sea, on the north coast of Alaska.

Time frame	Budget	Project partners
FY2017–22	More than $2 million	Bureau of Ocean Energy Management, University of Alaska Fairbanks, and University of Alaska Anchorage.

Contact

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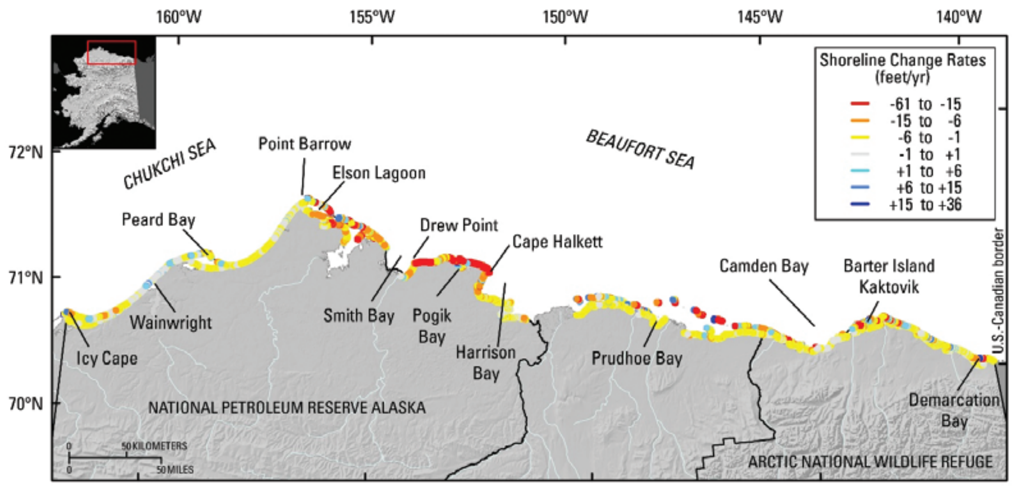
Rates of Shoreline Change on the Arctic Coast of Alaska

Although Alaska's north coast has both erosion and accretion, it is predominantly erosional, receding on average about 4.6 feet per year. Along a much smaller stretch (37 miles) of this coastline, the USGS noted that average annual erosion rates doubled from historical levels of about 20 feet per year to 45 feet per year from 2002 to 2007. The goals of this project include developing and improving coastal-change assessments and supporting long-term planning and decision making to ensure sustainable coastal economies, infrastructure, and ecosystems. The study also verified the disappearance of cultural and historical sites. The change in erosion rates likely is the result of several changing Arctic conditions, including declining sea-ice extent, increasing summertime sea-surface temperature, rising sea level, and possible increases in storm power and corresponding wave action. The numerous low-lying barrier islands that provide habitat for nesting birds, buffer wave energy reaching the mainland coast, and regulate saltwater and freshwater exchange in the lagoons are extremely mobile and have high rates of both erosion and accretion. The next phase of analysis, currently under peer review, covers the shoreline from Icy Cape to Wales. More long-term work is needed to understand the interplay of changing conditions and how they drive changes in coastal erosion. By understanding the effects of extreme storms, including coastal flooding, changes in the shoreline, and movement of sediment, USGS can develop better models for understanding long-term vulnerability from coastal hazards, and help coastal managers and communities plan for a changing climate.



Color-coded shoreline change rates and key geographic locations on the north coast of Alaska. From Gibbs and Richmond (2015) (see "Recent Publications" at the end of this section).

Time frame	Budget	Project partner
FY2006–ongoing	$200,000/year	Alaska Division of Geological and Geophysical Surveys.

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Recent Publications

Gibbs, A.E., and Richmond, B.M., 2015, National assessment of shoreline change—Historical shoreline change along the north coast of Alaska, U.S.–Canadian border to Icy Cape: U.S. Geological Survey Open-File Report 2015–1048, 96 p., https://dx.doi.org/10.3133/ofr20151048.

Gibbs, A.E., and Richmond, B.M., 2017, National assessment of shoreline change—Summary statistics for updated vector shorelines and associated shoreline change data for the north coast of Alaska, U.S.-Canadian border to Icy Cape: U.S. Geological Survey Open-File Report 2017–1107, 21 p., https://doi.org/10.3133/ofr20171107.

Project Links

https://www.usgs.gov/natural-hazards/coastal-marine-hazards-and-resources/science/climate-change-us-arctic-ocean-margins?qt-science_center_objects=0#qt-science_center_objects
https://www.usgs.gov/centers/pcmsc/science/climate-impacts-arctic-coasts?qt-science_center_objects=0#qt-science_center_objects

Wildfire

Ecosystems on the Edge—Changing Fire Regimes and Fire Behavior Impact on the Ecology and Management of Boreal and Tundra Systems

Wildfires that are uncharacteristically large, severe, or frequent can abruptly reorganize ecosystems, posing serious threats to ecosystem resilience and challenging management and conservation. High northern latitudes, including Alaska's boreal and subboreal forests and tundra, are warming approximately twice as fast the global average, driving broad-scale shifts in vegetation communities, fuel availability, and wildfire characteristics. The objectives of this fire study are to provide partners and stakeholders with critical information on observed and potential future impacts of changing fire regimes and fire behavior on Alaska's ecosystems. The methods integrate field studies, in-place instrumentation and monitoring, ecosystem and fire models, geospatial and statistical modeling and analysis, and ecological theory to understand how, when, and where ecosystems on the edge will be affected by the synergistic interactions of climate and wildfires, and what may be done to buffer or mitigate negative impacts. Products include datasets that quantify fire characteristics and spatial patterns of fire across broad regions and ecosystems, manager-focused reports and other media that inform forward-looking management strategies, and peer-reviewed publications.

Fire ecologists recording post-fire information on tree mortality, fuel consumption, and vegetation communities to better understand and predict fire impacts, Kenai National Wildlife Refuge, Alaska. Photograph by Rachel Loehman, U.S. Geological Survey.

Time frame	Budget	Project partners
FY2016–20	$145,000	Northwest Boreal Landscape Conservation Cooperative, $40,000; U.S. Geological Survey Ecosystems Program, $55,000; and Joint Fire Science Program, $50,000 (with nonmonetary contributions from the National Park Service and U.S. Fish and Wildlife Service).

Contact

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Recent Publications

Keane, R.E., Loehman, R.A., and Holsinger, L.M., 2019, Selecting a landscape model for natural resource management applications: Current Landscape Ecology Reports, p.1–10.

Keane, R. E., Loehman, R.A., Holsinger, L.M., Falk, D. A., Higuera, P., Hood, S.M., and Hessburg, P.F., 2018, Use of landscape simulation modeling to quantify resilience for ecological applications: Ecosphere, v. 9, no. 9, p. e02414, https://doi.org/10.1002/ecs2.2414.

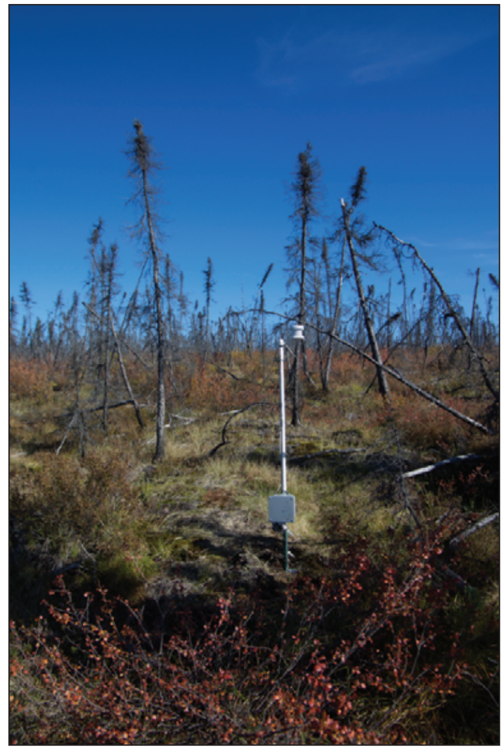
Parks, S.A., Holsinger, L.M., Voss, M.A., Loehman, R.A., and Robinson, N.P., 2018, Mean composite fire severity metrics computed with Google Earth engine offer improved accuracy and expanded mapping potential: Remote Sensing, v. 10, no. 6, p. 879, doi:10.3390/rs10060879.

Project Link

https://www.usgs.gov/centers/asc/science/ecosystems-edge-landscape-and-fire-ecology-forests-deserts-and-tundra?qt-science_center_objects=0#qt-science_center_objects

Observing and Understanding the Impacts of Climate on Alaskan Forests

Changing climate conditions, including changes to air temperature, surface temperature, soil temperature, and snowpack duration affect where trees are able to grow and are bringing changes to the structure of forests throughout many parts of Alaska. To understand and project future vegetation change, USGS scientists use field-based data and computer models to establish relations between climate variables and ecological responses, including the presence or absence of tree and shrub species, tree and shrub growth and establishment, changes in sap flow, and other demographic and physiological responses. These computer models, however, frequently do not account for Alaska's extreme topography and climatic gradients and often have not been verified along those same observations because of availability of only a sparse observational network. Direct observations of tree and shrub responses to climate change are currently limited in Alaska. This project aims to provide observations of climate and tree/shrub responses to better establish the direct effects of climate on ecological processes. The project team has established a network of forest and tree line observation sites in wet, comparatively warm Southeast Alaska forests, transitional boreal forests in south-central Alaska, and at the limits of tree distribution in the boreal forest. The project also will contribute to the use of temperature sensors in high-latitude environments and to synthesis assessments for the modeling of species distribution.



Burned spruce forest in interior Alaska. Photograph by Jeremy Littell, U.S. Geological Survey.

Time frame	Budget
FY2013–ongoing	$15,000

Contact

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Project Link

https://cascprojects.org/#/project/4f831626e4b0e84f6086809b/586d3493e4b0f5ce109faa69

Hazard Response

U.S. Geological Survey 2018 Kīlauea Volcano Eruption Response After-Action Review

The 2018 Kīlauea Volcano eruption in Hawai'i lasted 107 days, and now ranks as Kīlauea's most destructive event since 1790. It also was one of the most costly volcanic disasters in U.S. history. Over time, the USGS response team grew to include 29 staff from Hawai'i and 83 from elsewhere across 17 different program offices, plus 31 volunteers and 52 staff from other DOI operations. The response team handled nearly 700 media inquiries from outlets all over the world, and more than 1.5 million people viewed daily video updates. The eruption response offered a prime opportunity for the USGS VSC and the Alaska Regional Office to review, assess, and improve on their disaster preparedness, and to ensure that institutional capacities are in place to optimize effective planning, response, and mitigation. An After-Action review team was

U.S. Geological Survey scientist documenting an approximately 50-meter-tall lava fountain at fissure 7, in the Kīlauea Volcano, Hawai'i. Photograph by Brett Walker, U.S. Geological Survey.

established in 2019 to produce an After-Action Report that identified priorities for programmatic or policy improvements that the USGS could feasibly implement to advance strategic preparation for future disasters, and thereby reduce public vulnerabilities. The report will help USGS respond even better to the next eruption in Hawai'i or elsewhere by advancing the following goals:

- Design better planning scenarios;
- Enhance response team effectiveness;
- Assist local decision makers;
- Promote new areas of strategic research; and
- Streamline administrative, finance, and Incident Management Team support functions during a crisis to secure continuity of operations and essential records management.

Time frame
FY2019

Contact

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Recent Publication

Williams, D., Avery, V., Coombs, M., Cox, D., Horwitz, L., McBride, S., McClymont, R., and Moran, S., 2019, USGS 2018 Kilauea volcano eruption response in Hawaii—After Action Review: Internal U.S. Geological Survey Report.

U.S. Geological Survey Magnitude 7.1 Anchorage Earthquake Response After-Action Review

One of the core charges of the USGS mission is to minimize loss of life and property from natural disasters. Supplying accurate and timely information to the public, emergency managers, and decision makers is one way the USGS achieves this goal. USGS collects scientific information and documents impacts of the event directly following a large earthquake to better understand these natural phenomena and to help communities and emergency responders be more prepared for the next event. The 2018 Anchorage Earthquake offers a prime opportunity to review, assess, and improve on those capacities.

Following the November 30, 2018 Magnitude 7.1 Anchorage Earthquake, the USGS Alaska Regional Office initiated an After Action Review (AAR), which focused on the following questions:

- What went well and why?
- What can be improved and how?

The AAR report synthesized the most notable themes of successful accomplishments and suggested improvements in five main areas: (1) preparedness and planning, (2) training, (3) internal communication, (4) external communication, and (5) technical response. Suggestions for improvement were offered in the context of strengthening technical response activities and ensuring that the USGS is well prepared for future natural hazards.

Time frame
FY2018–19

Lateral spreading ruptured Vine Road near Wasilla, Alaska. Many failures of engineered materials occurred on or adjacent to saturated lowlands filled with organic sediment, silt, or sand. Photograph provided by Rob Witter, U.S. Geological Survey.

Contact

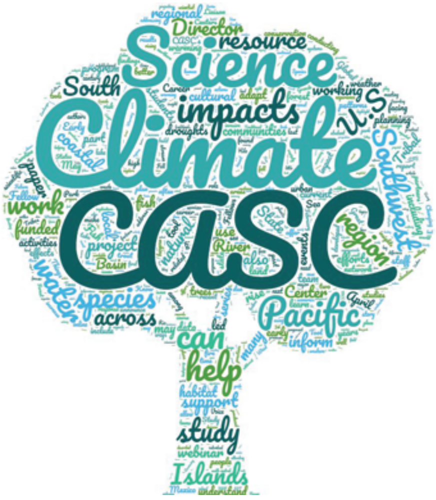
Elizabeth Powers, USGS Alaska Regional Office, epowers@usgs.gov, (907) 786–7085

Recent Publication

Powers, E., Schmitt, S., Cox, D., Knudson, D., Power, J., Brady, G., Gillespie, J., Koontz, H., Pennaz, A., and Peppler, M., 2019, USGS M7.1 Anchorage earthquake after action review: Internal U.S. Geological Survey Report.

Translating Scientific Information for Use by Decision Makers in Alaska

As temperature and precipitation patterns change in Alaska, and the physical and ecological changes necessitate adaptation, the need for scientific information to inform decision making related to the management of Alaska natural resources becomes increasingly important. However, the research being conducted to understand potential future impacts of climate change in Alaska frequently results in output and products that, in their raw forms, are not easily used by stakeholders and partners or are somewhat removed from the direct information needs of natural resource decision makers. This project broadly aims to (1) evaluate the information needs of regional stakeholders and partners; (2) conduct “translational” activities to make archived historical data, modeled output, and future projections more understandable and usable to stakeholders; and (3) synthesize research information and develop products that advance the climate research community in Alaska. This work has resulted in several collaborations with the U.S. Forest Service, U.S. Fish and Wildlife Service, and currently forms the core of climate information for several adaptation planning efforts with Alaska Native communities.



Web image of the U.S. Geological Survey Climate Adaptation Science Center (CASC).

Time frame	Budget
FY2016–ongoing	$45,000/year

Contact

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Recent Publications

Hayward, G., Johnson, E. Walker, N. Littell, J., and Thompson, J., 2017, Changing water dynamics—The consequences of shifting snow, ice, and running water for ecosystems, people, and national forests in Alaska: U.S. Forest Service fact sheet, 20 p, https://www.fs.fed.us/sites/default/files/r10-droughtfactsheet.pdf.

Littell, J.S., McAfee, S., and Hayward, G., 2018, Alaska snowpack response to climate change—Statewide snowfall equivalent and snowpack water scenarios: Water, v. 10, no. 5, 16 p., https://doi.org/10.3390/w10050668.

Littell, J.S., O’Neel, S , McAfee, S., Burgess, E., Sass, L., Clark, P., and Colt, S., 2017, Snow and ice, chap. 3 *of* Hayward, G.D., Colt, S., McTeague, M., and Hollingsworth, T. eds., Climate change vulnerability assessment for the Chugach National Forest and the Kenai Peninsula: U.S. Forest Service General Technical Report PNW-GTR-950, 340 p., https://www.srs.fs.usda.gov/pubs/54139.

Littell, J.S., Poe, A., and Bond, N., 2017, Climate projections for the Aleutians and Bering Sea, chap. 2 *of* Poe, A., Van Pelt, T.I., and Littell, J., 2018, The Aleutian-Bering climate vulnerability assessment—Final report: Anchorage, Alaska, Aleutian and Bering Sea Islands Landscape Conservation Cooperative, 151 p. [Also available at http://www.absipartnership.org/.]

Lujan, E., Brubaker, M., Warren, J., Christensen, J., Anderson, S., O’Domin, M., Littell, J., Buzard, R., Overbeck, J., Holen, D., Flensburg, S., and Powers, E., 2018, Climate change in Port Heiden, Alaska—Strategies for community health: Anchorage, Alaska Native Tribal Health Consortium, 61 p., https://anthc.org/wp-content/uploads/2018/10/ANTHC-Port-Heiden_Final.pdf.

Markon, C., Gray, S., Berman, M., Eerkes-Medrano, L., Hennessy, T., Huntington, H. Littell, J., McCammon, M., Thoman, R., and Trainor, S., 2018, Alaska, chap. 26 *of* Reidmiller, D.R., Avery, C.W., Easterling, D.R., Kunkel, K.E., Lewis, K.L.M., Maycock, T.K., and Stewart, B.C., eds.: Washington, D.C., U.S. Global Change Research Program, p. 1185–1241, doi:10.7930/NCA4.2018.

Project Link

https://cascprojects.org/#/project/4f831626e4b0e84f6086809b/586d3410e4b0f5ce109faa63

Looking Forward, Looking Backward—Building Resilience Today

This project aims to build resilience to extreme events and changing environmental conditions by engaging multiple Tribal leaderships and environmental staff through a series of two trainings and two workshops. The objective of the first training is to create a common understanding, where Western scientists and Tribal participants will explore historical, current, and future environmental trends and key adaptation concepts. Following the training, two on-site tribal workshops will document Indigenous Knowledge of (1) a traditional use area, (2) a list of priority subsistence species, and (3) and Indigenous Knowledge of environmental changes and impacts. Tribal members also will hear about projected future environmental trends at these on-site workshops. A document that includes the Indigenous Knowledge around critical species and lands of concern will be produced for future use by the Tribes in adaptive management and planning. A final training will be held to orient and provide participants with the opportunity to practice using various online tools developed for resilience and adaptation planning in Alaska. A report of the overall process and findings from this project approach will be produced with project staff and Tribal involvement.

Time frame	Budget	Project partner
FY2018–20	$145,000	Bureau of Indian Affairs.

Tribal liaison working with community members on a climate change visualization. Photograph by Molly Tankersly.

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Project Link

https://casc.alaska.edu/news/coastal-communities-plan-climate-change-ak-casc-workshop

Developing Strategies to Adapt to Environmental Change in the Yukon-Kuskokwim Delta Region

The Yukon-Kuskokwim Delta (Y-K Delta) region has rich biological and cultural resources that have sustained people, fish, and wildlife for more than 10,000 years. The region, however, is changing fast, threatening these resources and the cultural values and livelihoods of the region's communities. A multi-organizational effort was initiated by the Western Alaska Landscape Conservation Cooperative to develop regional climate adaptation strategies to help the region's 56 Tribes adapt to a new climate, new landscapes, and new conservation and development challenges and opportunities. The Adapt Y-K Delta Climate Adaptation

Participants in the first of three Adapt Yukon-Kuskokwim Delta workshops in Bethel, Alaska. Photograph courtesy of Nautilus Impact Investing and Agnew Beck Consulting.

Strategies are the first stage of an adaptive management process that is designed to help build the resilience of Y-K Delta resources and the people who depend on them. The Adapt Y-K Delta Climate Adaptation Strategies were developed by a steering committee made up of a regionally representative group of Tribal and community leaders, non-profit organizations, individuals, researchers, and public resource managers, with advice from regionally based State and government agencies. USGS staff collaborated with the Adapt YK Delta Steering Committee to provide baseline climate data for the region and to help organize and participate in three Adapt Y-K Delta workshops in Bethel, Alaska.

Time frame	Project partners
FY2017–ongoing	Western Alaska Landscape Conservation Cooperative; U.S. Fish and Wildlife Service; Alaska Native Tribal Health Consortium; Association of Village Council Presidents; Alaska Department of Commerce, Community and Economic Development; Division of Community and Regional Affairs, RiskMAP Program; Alaska Department of Military and Veterans Affairs; U.S. Department of Agriculture Natural Resources Conservation Service; Alaska Division of Homeland Security and Emergency Management; Denali Commission; National Oceanic and Atmospheric Administration; Alaska Department of Fish and Game; University of Alaska Fairbanks; Bethel Search and Rescue; U.S. Army Corps of Engineers; Native Village of Mekoryuk; Orutsaramiut Native Council; Bering Sea Elders Group; Kuskokwim Corporation; Sea Lion Corporation; and multiple community members in the Yukon Kuskokwim region.

Contact

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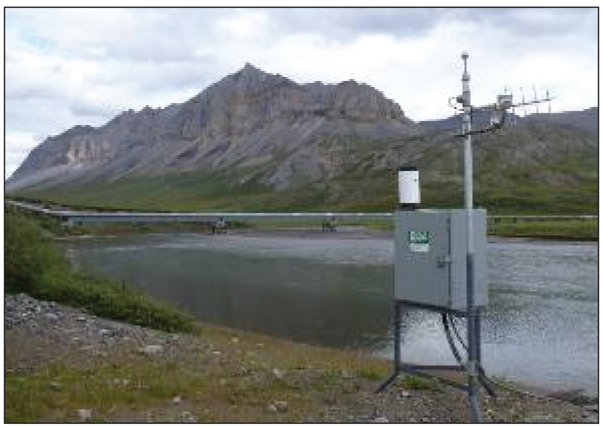
Project Link

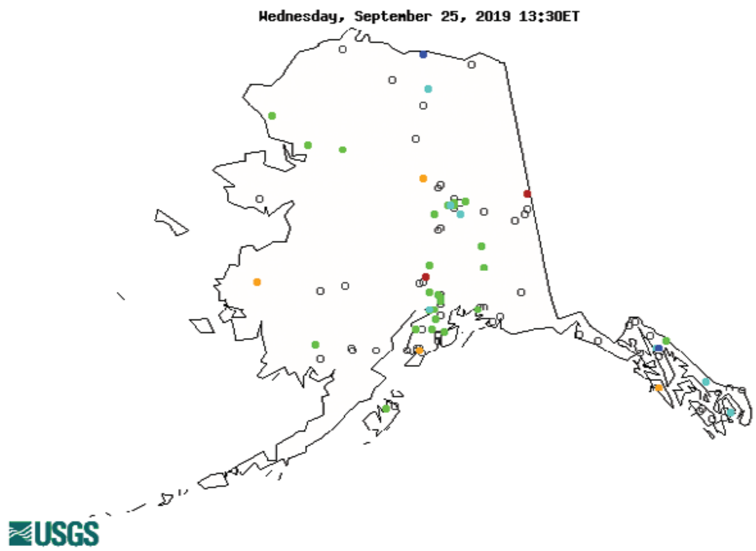
https://adaptalaska.org/projects/adapt-yk-delta/

Water Quality, Streamflow, and Ice Dynamics

Hydrologic Monitoring

Groundwater and Streamflow Monitoring





Example of U.S. Geological Survey streamgage (left) and map of current (2019) 109 streamgage network sites (right) in Alaska.

Nationwide, the USGS Groundwater and Streamflow Information Program supports the collection and delivery of streamflow and water-level information for more than 8,500 sites. The data are served online—most in near real time—to meet many diverse needs. The streamgages are operated and maintained by the USGS, but most are funded in partnership with one or more of about 1,400 Federal, State, local, and Tribal agencies or organizations. This unique cooperation results in nationally consistent and impartial data that also aids in local decision making. Alaska has the lowest density of streamflow information stations in the Nation (currently 109 streamflow sites in 2019, 57 of which also measure water temperature). The distribution of these streamgages is concentrated along the road system and near population centers, leaving many areas of the State devoid of any hydrologic information. Operation of a streamgage in Alaska is expensive; complex logistics, high personnel costs, and accessibility all contribute to the costs. The average cost of a USGS streamgage in Alaska is $30,000 plus logistics, which vary considerably. Streamflow data are recorded at 15-minute intervals, stored on-site, and then transmitted to USGS offices every 1–4 hours, depending on the data relay technique used. Provisional data are relayed to USGS offices by satellite, telephone, and (or) radio telemetry; receive an automated quality-assurance check; and are available for viewing within minutes of arrival. All real-time data are provisional and subject to revision after a formal review process that includes computation of annual statistics.

Time frame	Project partners
Ongoing	Alaska Department of Transportation; Alaska Department of Fish and Game; Alaska Energy Authority; U.S. Forest Service; U.S. Fish and Wildlife Service; U.S. Army Corps of Engineers; and several municipalities and boroughs, hydropower operators, and operating mines.

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Project Link

https://waterdata.usgs.gov/ak/nwis/rt

Continuous Monitoring and Baseline Assessment of Water Quality of Transboundary Alaskan Rivers

Multiple rivers, including the Unuk, Stikine, Taku, and Alsek Rivers, originate in Canada and flow into Southeast Alaska. All four rivers support traditional, recreational, and commercial salmon fisheries. Active and proposed large-scale mining activity in the Canadian parts of these watersheds poses a potential threat to the fisheries and traditional lifestyles in Alaska. The objectives of this study are to (1) assess the geology and mineralization potential of study area watersheds; (2) analyze retrospectively and collect new data to characterize the water, sediment, and biological quality of the rivers; and (3) establish partnerships with Tribes and government agencies to ensure that assessments meet the needs of Tribes and local stakeholders. Information on streamflow and water-quality conditions collected hourly at downstream monitoring sites will be paired with periodically collected samples that are analyzed for concentrations of metals, nutrients, and major ions. In combination, these datasets will allow analysts to quantify loads of important water-quality constituents at daily, monthly, and annual time-steps. These data will serve as the basis for identifying potential changes in water-quality conditions resulting from future upstream mining activities.

Time frame	Budget	Project partner
FY2019–23	$1,005,000	U.S. Geological Survey Water Mission Area.

U.S. Geological Survey (USGS) staff servicing a water-quality gage in the Unuk River, Alaska. Photograph by Randy Host, USGS.

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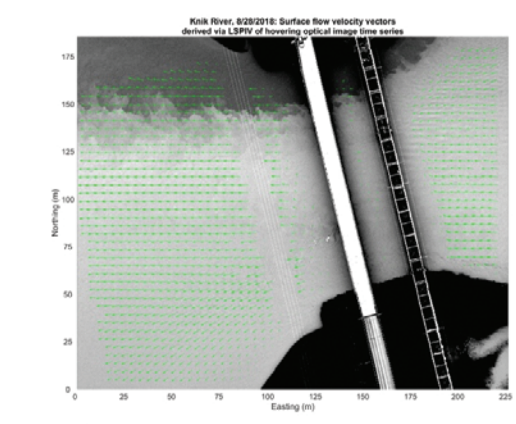
Project Link

https://www.usgs.gov/centers/asc/science/usgs-transboundary-river-monitoring-southeast-alaska?qt-science_center_objects=0#qt-science_center_objects

Developing Remote Sensing Methods to Measure Streamflow in Alaskan Rivers

Obtaining timely, accurate information on streamflow in Alaskan rivers is difficult because streamgages are few and far between. Even for established streamgages, the maintenance and periodic measurements involved in operating a streamgage are logistically challenging and can place personnel at risk, particularly during high water flows. The core objective of this study is to develop and test remotely sensed methods of measuring river discharge flow. Our work focuses on estimating surface-flow velocities from optical and thermal image time series acquired from helicopters. We also collect direct field measurements of velocity from bridges and boats to assess the accuracy of image-derived estimates. Study sites are located on the Knik, Matanuska, Susitna, Tanana, Chena, and Salcha Rivers. Each site consists of a study reach that is 2–10 kilometers in length. This research is significant because most Alaskan rivers do not have streamgages and efficient remote-sensing methods of measuring discharge could provide valuable streamflow information for water-resource management and flood-hazard mitigation. Ultimately, our



Surface-flow velocity vectors derived from large-scale particle image velocimetry of an optical image time series on the Knik River near Palmer, Alaska, August 28, 2018. Image provided by Car Legleiter, U.S. Geological Survey.

objective is to operationalize these methods so that remote sensing can become a viable tool for the USGS and other stakeholders.

Contact

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Time frame	Budget	Project partner
FY2016–ongoing	$100,000	U.S. Army Corps of Engineers.

Recent Publication

Legleiter, C.J., and others, 2017, Remote measurement of river discharge using thermal particle image velocimetry (PIV) and various sources of bathymetric information: Journal of Hydrology, v. 554, p. 490–506., doi:10.1016/j.jhydrol.2017.09.004.

Alaska Streambed Scour Monitoring and Modeling

More than 60 percent of all bridge failures in the United States are caused by streambed scour, which is a result of complex hydraulic forces acting on streambeds during major flooding events. The costs associated with restoring damaged structures are substantial, but the indirect costs associated with the disruption of traffic are often even greater, especially in Alaska, where alternate travel routes between many cities do not exist. In cooperation with the Alaska Department of Transportation and Public Facilities (AKDOT&PF), USGS has been researching streambed scour through scour monitoring, hydrodynamic modeling, and data collection during high flows for several decades. The current objectives of the streambed scour project are twofold. The first objective is to monitor streambed elevations in real time at bridges coded as scour-critical and provide warnings to AKDOT&PF during scour events. These methods include instrumenting bridges with sonars and stage sensors and collecting data during floods. The second objective is to predict hydraulic conditions that could lead to scour at bridges during floods using hydrodynamic models. This work allows State and Federal agencies to identify infrastructure that requires stream scour mitigation or annual monitoring for potential damage to infrastructure.

Time frame	Budget	Project partner
FY2017–21	$380,000/year	Alaska Department of Transportation and Public Facilities, $220,000/year.

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Project Link

https://www.usgs.gov/centers/asc/science/streambed-scour-bridges-alaska?qt-science_center_objects=0#qt-science_center_objects

Pier hydraulics at Red Cloud River near Kodiak, Alaska, November 2018. Photograph by Paul Schauer, U.S. Geological Survey.

Recent Publications

Dworsky, K.L., and Conaway, J.S., 2019, Measurement of long-term channel change through repeated cross-section surveys at bridge crossings in Alaska: U.S. Geological Survey Open-File Report 2019–1028, 118 p., https://doi.org/10.3133/ofr20191028.

Beebee, R.A., Dworsky, K.L., and Knopp, S.J., 2017, Streambed scour evaluations and conditions at selected bridge sites in Alaska, 2013–15: U.S. Geological Survey Scientific Investigations Report 2017–5149, 67 p., https://doi.org/10.3133/sir20175149.

Beebee, R.A., and Schauer, P.V., 2015, Streambed scour evaluations and conditions at selected bridge sites in Alaska, 2012: U.S. Geological Survey Scientific Investigations Report 2015–5154, 45 p., https://doi.org/10.3133/sir20155154.

Yukon River Basin Indigenous Observation Network

The Indigenous Observation Network (ION) is a community-based project that was initiated by the Yukon River Inter-Tribal Watershed Council and USGS. The objectives of ION are to document important regional differences in geochemistry and active layer parameters linked to permafrost continuity and major tributaries of the Yukon River. Additionally, annual trends and seasonal dynamics describing the spatial and temporal heterogeneity of the watershed will be presented in the context of observed hydrological changes. Capitalizing on existing USGS monitoring and research infrastructure and supplementing USGS collected data, ION uses USGS and Circumpolar Active Layer Network methods to investigate changes in surface-water geochemistry and active-layer dynamics throughout the Yukon River Basin. More than 1,600 samples of surface water geochemistry (that is, major ions, dissolved organic carbon, and the isotopic composition of oxygen and hydrogen elements) have been collected at 35 sites throughout the Yukon River and its major tributaries over the past 15 years. Active layer dynamics (maximum thaw depth, soil temperature, and moisture) have been collected at 20 sites throughout the Yukon River Basin for the past 8 years. These data assist the global effort to characterize Arctic river fluxes and their relation to the carbon cycle, weathering, and permafrost degradation. They also allow local and Native communities to monitor the quantity and quality of vital freshwater resources.

U.S. Geological Survey Student Intern in Support of Native American Relations (SISNAR) at the Hess Creek Active Layer Network site, interior Alaska. Photograph by Ryan Toohey, U.S. Geological Survey.

Time frame	Budget	Project partner
FY2006–22	$1,300,000	Yukon River Inter-Tribal Watershed Council.

Contact

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Recent Publications

Herman-Mercer, N.M., Antweiler, R.C., Wilson, N.J., Mutter, E.A., Toohey, R.C., and Schuster P.F., 2018, Data quality from a community-based, water-quality monitoring project in the Yukon River Basin: Citizen Science—Theory and Practice, v. 3, no. 2, 13 p., http://doi.org/10.5334/cstp.123.

Toohey, R., Herman-Mercer, N., Mutter, E., Schuster, P., Koch, J., 2016, Multi-decadal increases in Yukon River Basin chemical fluxes as indicators of changing flowpaths, groundwater, and permafrost: Geophysical Research Letters, v. 43, no. 23, p., 12120–12130, https://doi.org/10.1002/2016GL070817.

Project Link

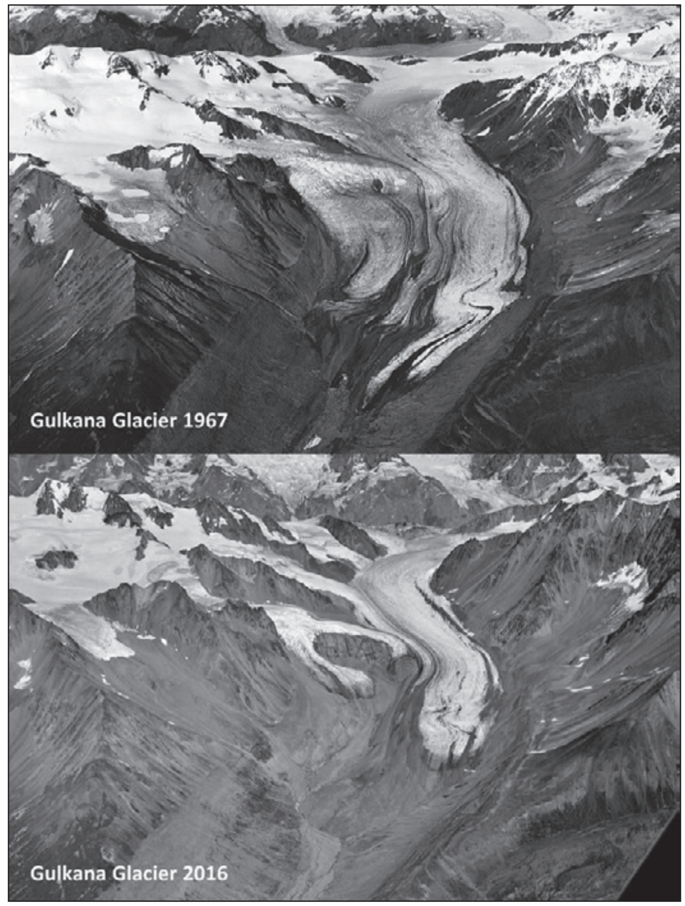
https://cascprojects.org/#/project/4f831626e4b0e84f6086809b/59efa6d0e4b0220bbd99b1b5

Glaciers

Glaciers and Climate Project

When paired with weather, streamflow, and geochemical data, information about glacier mass balance helps managers prepare for impacts of glacier change at local, regional, and global scales. With a firm foundation of long-term records of glacier mass balance, the USGS Glaciology Project aims to advance the quantitative understanding of glacier-climate interactions from local to regional scales. The current focus is on merging long-term field records at five glaciers (Gulkana, Lemon Creek, South Cascade, Sperry, Wolverine) in North America with new, rich remote-sensing data. The team also is working to ensure consistency and comparability between records and evaluating methodological sensitivities of field and remote-sensing techniques. Field techniques include measuring snow accumulation, snowmelt, and ice melt at specific locations on the glaciers, then extrapolating the point observations across the entire glacier surface. Air temperature and precipitation also are measured at each site to connect glacier and climate change. The remote-sensing data are being used to study and monitor the changes that the glaciers have undergone over the past 60 years.

Time frame	Budget	Project partners
FY2019–20	$500,000/year	Army Corps of Engineers, Cold Regions Lab ($100,000/year), National Streamflow Information Program ($70,000/year), Water Mission, ext-Conus water balance model ($27,000/year), and U.S. Geological Survey Climate Adaptation Science Center ($55,000 for FY19).



Repeat oblique photographs of Gulkana glaciers in Alaska, 1967 (top) and 2016 (bottom).

Contact

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Recent Publications

Box, J.E., Colgan, W.T., Wouters, B., Burgess, D., O’Neel S., Thomson, L., and Mernild, S.H., 2018, Global sea-level contribution from Arctic land ice—1971–2017: Environmental Research Letters, v. 13, no. 12, 11 p., https://doi.org/10.1088/1748-9326/aaf2ed.

Enderlin, E.M., O’Neel, S., Bartholomaus, T.C., and Joughin, I., 2018, Evolving environmental and geometric controls on Columbia Glacier’s continued retreat: Journal of Geophysical Research—Earth Surface, v. 123, no. 7, p. 1528–1545.

Liljedahl, A.K., Gädeke, A., O’Neel, S., Gatesman, T.A., and Douglas, T.A., 2017, Glacierized headwater streams as aquifer recharge corridors, subarctic Alaska: Geophysical Research Letters, v. 44, no. 13, p. 6876–6885, doi:10.1002/2017GL073834.

Littell, J.S., O’Neel, S., McAfee, S., Burgess, E., Sass, L., Clark, P., and Colt, S., 2017, Snow and ice, chap. 3 *of* Hayward, G.D., Colt, S., McTeague, M., and Hollingsworth, T., eds., Climate change vulnerability assessment for the Chugach National Forest and the Kenai Peninsula: U.S. Forest Service General Technical Report PNW-GTR-950, 340 p., https://www.srs.fs.usda.gov/pubs/54139.

McGrath, D., Sass, L.C., O'Neel, S., Arendt, A., and Kienholz, C., 2017. Hypsometric control on glacier mass balance sensitivity in Alaska and northwest Canada: Earth's Future, v. 5, no. 3, p. 324-336, doi:10.1002/2016EF000479.

McGrath, D., Sass, L.C., O'Neel, S., McNeil, C., Candela, S.G., Baker, E.H., and Marshall, H.P., 2018, Interannual snow accumulation variability on glaciers derived from repeat, spatially extensive ground-penetrating radar surveys: The Cryosphere, v. 12, no. 11, p. 3617–3633, https://doi.org/10.5194/tc-12-3617-2018.

Sass, L.C., Loso, M.G., Geck, J., Thoms, E.E., and Mcgrath, D., 2017. Geometry, mass balance and thinning at Eklutna Glacier, Alaska—An altitude-mass-balance feedback with implications for water resources Journal of Glaciology, v. 63, no. 238, p. 343–354, doi:10.1017/jog.2016.146.

Project Link

https://www.usgs.gov/land-resources/land-change-science-program/science/usgs-glaciers-and-climate?qt-science_center_objects=0#qt-science_center_objects

Terrestrial Records of Holocene Climate Change—Fire, Climate, and Humans

Over the past decade, increased fire activity has occurred in Alaska. Fires produce aerosols that can alter atmospheric and surface chemistry extending thousands of kilometers. Dark aerosols such as soot and black carbon can accelerate glacier melt when they are deposited on surface snow. The objectives of this study are to determine if aerosols from recent fires are deposited on the Juneau Icefield, and if so, if there is any indication that aerosols affect glacier mass balance. The methods include drilling a series of approximately 10-meter ice cores throughout the Juneau Icefield and developing a new analytical method to detect specific biomarkers (levoglucosan, mannosan, and galactosan) in ice cores. These biomarkers are only produced by fire and, therefore, are precise indicators that fire aerosols were deposited on the glaciers. The links between aerosol deposition and effects on glacier chemistry also are being investigated.

Interactions between glaciers and sediments, as shown in the Gilkey Trench near the Juneau Icefield Research Program Camp 18, Southeast Alaska.

Time frame	Budget	Project partners
FY2017–22	$147,000	U.S. Geological Survey (USGS) Earth System Processes Division, Juneau Icefield Research Program (http://juneauicefield.org/mission), and USGS Alaska Science Center. Partner contributions, $22,000.

Contact

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Project Link

https://www.usgs.gov/centers/gecsc/science/terrestrial-records-holocene-climate-change-fire-climate-and-humans?qt-science_center_objects=0#qt-science_center_objects

Permafrost

Biogeochemistry and Molecular Biology of Permafrost Environments

Permafrost contains large quantities of carbon and nitrogen that likely will be made available to ecosystems, waterways, and the atmosphere as they thaw in response to a warmer climate. This project examines the vulnerability of permafrost carbon and nitrogen to thaw using long-term and short-term perspectives. On annual scales, the USGS examines whether ecosystems release or sequester carbon, focusing particularly on winter processes and the microbiology of frozen soils. At the decadal-to-century scale, the USGS examines the timing of thaw and the history of peatland landscapes. At the millennial scale, the USGS focuses on the microbiology of the cryosphere, including an understanding of how microbes active in permafrost may affect its unique chemistry. The methods span a range from molecular biology to isotopes to autochambers, in-place sensors and drones. The objective is to establish a conceptual and quantitative understanding of how terrestrial biogeochemistry is altered in response to disturbance over multiple temporal and spatial scales.

Permafrost thaw causing saturated soils, soil slumping, and the phenomenon of "drunken trees" in Interior Alaska. Photograph by Jack McFarland, U.S. Geological Survey.

Time frame	Budget	Project Partners
FY2016–20	$800,000/year	University of Alaska Fairbanks, California State University Northridge, and University of Washington. Partner contributions, about $30,000.

Contact

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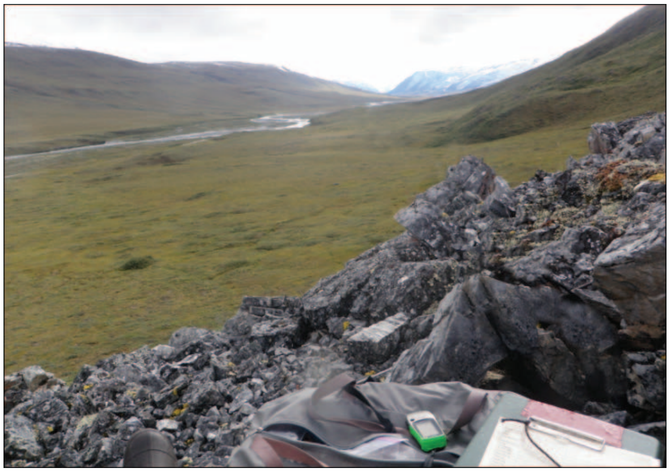
Recent Publication

Mackelprang, R., and others, 2017, Microbial survival strategies in ancient permafrost—Insights from metagenomics: The ISME Journal, v. 11, p. 2305–2318, https://doi.org/10.1038/ismej.2017.93.

Permafrost Mapping and Land-Cover Change

Given substantial changes in high-latitude systems, we seek to quantify and better understand the distribution and drivers of near-surface permafrost and associated land cover change. The objectives of this study are to (1) improve baseline spatial information on near-surface permafrost and various types of historical land-cover change to improve modeling and understanding, and (2) quantify land-cover change probability of various kinds of change and their relation to environmental drivers. Regression and decision-tree methods have statistically captured complex interactions to spatially extend field observations and image interpretations to map near-surface permafrost and land-cover change at a 30-meter resolution. An overall mapping of near-surface permafrost (85 percent) and accuracies of land-cover change (98 percent) in the overall mapwere strong. Results indicated that near-surface permafrost underlies 38 percent of mainland Alaska, with 16–24-percent potential reductions in area by the end of the 21st century. Thirteen percent of Alaska has had a change in land cover in the last 32 years. Current work is focusing on surface-water dynamics and association of land cover change with permafrost and methane emissions.



Permafrost sampling from talus slopes to riverbanks in Alaska's North Slope. Photograph by Bruce Wylie, U.S. Geological Survey.

Contacts

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Neal Pastick, EROS Center, njpastick@contractor.usgs.gov; (605) 594–2652

Time frame	Budget	Project partners
FY2008–20	$100,000	National Aeronautics and Space Administration Arctic-Boreal Vulnerability Experiment, Bureau of Land Management, and U.S. Fish and Wildlife Service.

Recent Publications

Minsley, B.J., Pastick, N.J., Wylie, B.K., Brown, D.R.N., and Kass, M.A., 2017, Evidence for nonuniform permafrost degradation after fire in boreal landscapes: Journal of Geophysical Research—Earth Surface, v. 121, no. 2, p. 320–335, https://doi.org/10.1002/2015JF003781.

Pastick, N.J., Duffy, P., Genet, H., Rupp, S.T., Wylie, B.K., Johnson, K.D., Jorgenson, M.T., Bliss, N., McGuire, A.D., Jafarov, E.E., and Knight, J.F., 2017, Historical and projected trends in landscape drivers affecting carbon dynamics in Alaska: Ecological Applications, v, 77, p. 1383–1402, no. 5, https://doi.org/10.1002/eap.1538.

Pastick, N.J., Jorgenson, M.T., Goetz, S.J., Jones, B.M., Wylie, B.K., Minsley, B.J, Genet, H., Knight, J.F., Swanson, D.K., and Jorgenson, J.C., 2019, Spatiotemporal remote sensing of ecosystem change and causation across Alaska: Global Change Biology, v. 25, no. 3, p. 1171–1189, https://doi.org/10.1111/gcb.14279.

Pastick, N.J., Jorgenson, M.T., Wylie, B.K., Nield, S.J., Johnson, K.D., and Finley, A.O., 2015, Distribution of near-surface permafrost in Alaska—Estimates of present and future conditions: Remote Sensing of Environment, v. 168, p. 301–315, https://doi.org/10.1016/j.rse.2015.07.019.

Wylie, B.K., Pastick, N.J., Johnson, K.D., Bliss, N., and Genet, H., 2016, Soil carbon and permafrost estimates and susceptibility to climate change in Alaska, chap. 3 *of* Zhu, Z., and McGuire, A.D., Baseline and projected future carbon storage and greenhouse-gas fluxes in ecosystems of Alaska: U.S. Geological Survey Professional Paper 1826, p. 53–76, https://doi.org/10.3133/pp1826.

Project Link

https://www.usgs.gov/centers/eros/science/ecosystem-performance-productivity-and-sustainability?qt-science_center_objects=0#qt-science_center_objects

Hydrologic Modeling of Permafrost-Affected Systems in Transition

Permafrost exerts a major control on water movement and distribution across the landscapes of interior Alaska. As permafrost thaws, the subsurface becomes more permeable, allowing water to flow more freely and deeply below the surface. To better understand and quantify these complex dynamics, USGS is using a hydrologic modeling approach to study historical changes in lakes and rivers that can be attributed to permafrost thaw and consequent effects on water fluxes. Site-based model simulations integrate field data from streamflow, water chemistry, soils, and geophysical methods to represent diverse permafrost-affected landscapes. Understanding past changes provides the basis for model predictions of future streamflow, groundwater availability, and surface-water distribution in response to anticipated changes in air temperature, precipitation, wildfire, and vegetation. Projecting water assessments into the future for interior Alaska is a primary objective of this modeling work.

Dynamic physical and hydrologic conditions responding to permafrost thaw and ground collapse in the Erickson Creek watershed of interior Alaska. Photograph by Michelle Walvoord, U.S. Geological Survey.

Time frame	Project partners
FY2016–20	National Aeronautics and Space Administration.

Contact

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Recent Publications

Briggs, M.A., Campbell, S., Nolan, J., Walvoord, M.A., Ntarlagiannis, D., Day-Lewis, F.D., and Lane, J.W, 2017, Surface geophysical methods for characterising frozen ground in transitional permafrost landscapes: Permafrost and Periglacial Processes, v. 28, p. 52–65, https://doi.org/10.1002/ppp.1893.

Ebel, B., Koch, J., and Walvoord, M., 2019, Soil physical, hydraulic, and thermal properties in interior Alaska, USA—Implications for hydrologic response to thawing permafrost conditions: Water Resources Research, v. 55, p. 4427–4447, https://doi.org/10.1029/2018WR023673.

Walvoord, M.A., and Kurylyk, B.L., 2016, Hydrologic impacts of thawing permafrost—A review: Vadose Zone Journal, v. 15, no. 6, 20 p., https://doi.org/10.2136/vzj2016.01.0010.

Walvoord, M.A., Voss, C.I., Ebel, B.A., and Minsley, B.J., 2019, Development of perennial thaw zones in boreal hillslopes enhances potential mobilization of permafrost carbon: Environmental Research Letters, v. 14, no. 1, 11 p., https://doi.org/10.1088/1748-9326/aaf0cc.

Project Link

https://above.nasa.gov/cgi-bin/inv_pgp.pl?pgid=3376

Mercury and Carbon Dynamics in the Environment

Changing climate in northern regions is causing permafrost to thaw with major implications for the global mercury (Hg) cycle. Before the publication of this research, the storage of Hg in permafrost was not quantified. Thus, the research objective was to determine how much Hg is frozen in Northern Hemisphere permafrost soils. Standard soil analysis methods were used to measure sediment total mercury, bulk density, soil moisture and carbon-14 dating. Elevated precautions were taken to minimize Hg contamination of the soil samples. Our results estimate that these regions contain 1,656 ±962 gigagrams (Gg) Hg, of which 793 ±461 Gg Hg is frozen in permafrost. Permafrost soils store nearly twice as much Hg as all other soils, the ocean, and the atmosphere combined, and this Hg is vulnerable to release as permafrost thaws over the next century. Existing estimates greatly underestimate Hg in permafrost soils, indicating a need to reevaluate the role of the Arctic regions in the global Hg cycle.

Permafrost core broken into segments, photographed, labeled, wrapped in plastic, encased in polyvinyl-chloride tubes, and then stored in a freezer until laboratory analysis. Photograph by Kim Wickland, U.S. Geological Survey.

Time frame	Project partner
FY2004–18	National Snow and Ice Data Center.

Contact

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Recent Publication

Schuster, P.F., Schaefer, K.M., Aiken, G.R., Antweiler, R.C., Dewild, J.F., Gryziec, J.D., and Zhang, T., 2018, Permafrost stores a globally significant amount of mercury: Geophysical Research Letters, v. 45, p. 1463–1471, https://doi.org/10.1002/2017GL075571.

Strategic Needs of Water in the Yukon (SNOWY)

The Yukon-Kuskokwim Delta of western Alaska is undergoing significant environmental and societal change. Strategic Needs of Water on the Yukon (SNOWY) is a multi-disciplinary project with the objective to increase our understanding of the impacts of climate change on communities in this region. This increased understanding was accomplished using social science methods—semi-structured interviews and participatory mapping, in combination with traditional natural science techniques. Semi-structured interviews focused on shifts in seasonal weather patterns and impacts on subsistence activities, and participatory mapping focused on the locations of seasonal subsistence resources. Results from the interviews highlighted differences in perception of climate change among younger and older generational cohorts. Participatory mapping results underscored the potential vulnerability of subsistence systems in this region, particularly in light of recent socio-cultural change in these communities. Current research applying Indigenous Knowledge and observations to environmental change problems includes recent surveys to fill gaps in our understanding of wild berry productivity, abundance, and distribution, and community workshops to facilitate the documentation of locations and severity of impacts of landscape change in the region.

Winter view of village of Kotlik, western Alaska. Photograph by Kelly Elder, U.S. Forest Service. Used with permission.

Time frame	Budget	Project partners
FY2012–ongoing	$400,000	The Yukon River Inter-Tribal Watershed Council, Colorado State University, U.S. Forest Service, Kotlik Tribal Council, and Chevak Traditional Council.

Contact

Nicole Herman Mercer, Integrated Information Dissemination Division, Water Mission Area, nhmercer@usgs.gov, (303) 236–5031

Recent Publications

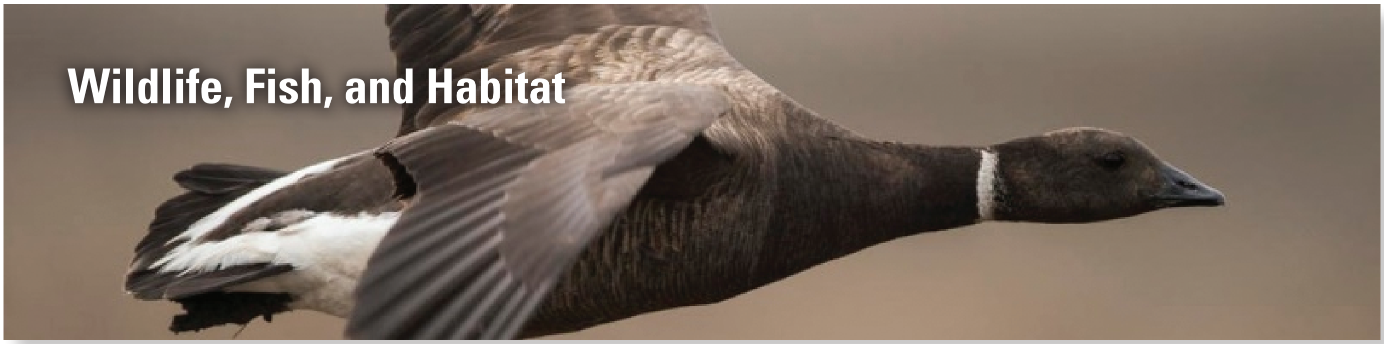
Herman-Mercer, N.M., and Schuster, P.F., 2014, Strategic needs of water on the Yukon—An interdisciplinary approach to studying hydrology and climate change in the Lower Yukon River Basin: U.S. Geological Survey Fact Sheet 2014-3060, 4 p, https://doi.org/10.3133/fs20143060.

Herman-Mercer, N.M., and others, 2016, Changing times, changing stories—Generational differences in climate change perspectives from four remote indigenous communities in Subarctic Alaska: Ecology and Society, v. 21, no. 3, 19 p.

Herman-Mercer, N.M., and others, 2019, Vulnerability of subsistence systems due to social and environmental change—A case study in the Yukon-Kuskokwim Delta, Alaska: ARCTIC, v. 72, no. 3, p. 215–335, https://doi.org/10.14430/arctic68867.

Project Link

https://toolkit.climate.gov/case-studies/yukon-delta-villages-document-baseline-environmental-data



Wildlife, Fish, and Habitat

Mammals

Polar Bear Distribution, Population Dynamics, Health, and Energetics Research

The polar bear is recognized worldwide as a vulnerable species because of the loss of its required sea ice habitats. USGS science played a central role in informing the decision to list the polar bear as threatened under the Endangered Species Act in 2008. This science was founded in understanding gained from long-term studies of the southern Beaufort Sea population, 1 of 19 worldwide, and 1 of only 2 populations with long-term data. In these studies, the USGS documented a negative relation between length of the open water season over the continental shelf and population growth rate. Applying future sea ice conditions to the relation between sea ice availability and population growth rate allowed us to project a future trajectory of the population. We are monitoring the survival and habitat use of the southern Beaufort Sea population to determine whether the habitat base for this population changes as projected and whether the population responds to those habitat changes as we projected in 2007. Information about how polar bears in this population respond to sea ice loss will inform management of the subsistence harvest, permitting of oil and gas activities in Alaska's coastal plain, and projections for the worldwide population.

Polar bear on ice in the southern Beaufort Sea, off northern Alaska. Photograph by Mike Lockhart, U.S. Geological Survey.

Time frame	Project partners
FY1980s–ongoing	U.S. Fish and Wildlife Service, Bureau of Land Management, North Slope Borough, State of Alaska, North Slope communities and industry, National Ocean and Atmospheric Administration, and Canadian Wildlife Service.

Contact

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Recent Publications

Atwood, T.C., Duncan, C., Patyk, K.A., Nol, P., Rhyan, J., McCollum, M., McKinney, M.A., Ramey, A.M., Cerqueira-Cézar, C.K., Kwok, O.C.H., Dubey, J.P., and Hennager, S., 2017, Environmental and behavioral changes may influence the exposure of an Arctic apex predator to pathogens and contaminants: Scientific Reports, v. 7, article no. 13193, 12 p., doi:10.1038/s41598-017-13496-9.

Atwood, T.C., Simac, K., Breck, S.W., York, G., and Wilder, J., 2017, Human–polar bear interactions in a changing Arctic—Existing and emerging concerns, *in* Butterworth, A., ed., Marine mammal welfare—Human induced change in the marine environment and its impacts on marine mammal welfare, volume 17: Cham, Switzerland, Springer, p. 397–418, doi:10.1007/978-3-319-46994-2.

Durner, G.M., and Atwood, T.C., 2018, A comparison of photograph-interpreted and IfSAR-derived maps of polar bear denning habitat for the 1002 Area of the Arctic National Wildlife Refuge, Alaska: U.S. Geological Survey Open-File Report 2018–1083, 12 p., https://doi.org/10.3133/ofr20181083.

Rode, K.D., Fortin-Noreus, J.K., Garshelis, D.L., Dyck, M., Sahanatien, V., Atwood, T.C., Belikov, S.E., Laidre, K.L., Miller, S., Obbard, M.E., Vongraven, D., Ware, J.V., and Wilder, J., 2018, Survey-based assessment of the frequency and potential impacts of recreation on polar bears: Biological Conservation, v. 227, p. 121–132, doi:10.1016/j.biocon.2018.09.008.

Rode, K.D., Wilson, R.R., Douglas, D.C., and others, 2017, Spring fasting behavior in a marine apex predator provides an index of ecosystem productivity: Global Change Biology, v. 14, no., 1, p. 410–423, https://doi.org/10.1111/gcb.13933.

Project Links

https://www.usgs.gov/centers/asc/science/polar-bear-research
https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems

Pacific Walrus Research

The Pacific walrus (*Odobenus rosmarus divergens*) is one of four marine mammal species managed by the DOI. The USGS ASC conducts long–term research on Pacific walruses to inform local, State, national and international policy makers regarding conservation of the species and its habitat. The goal of current research is to refine and enhance models to forecast future walrus abundance and distribution resulting from changing Arctic conditions and human activities. The initial phase of current work began with the collection of population age structure data in three consecutive years (2013–15) from the Chukchi Sea during ship-based research cruises in collaboration with FWS and ADF&G. These field efforts provided updated estimates of walrus population age structure, and these data, together with data from surveys repeated over the past four decades, provided current information on population status and trends. Current collaborations between USGS and FWS also will use these data to develop new statistical techniques to combine traditional mark-recapture with kinship data to provide more robust estimates of walrus population size. Ongoing and future work include Unmanned Aircraft System (drone) population surveys of hauled-out walruses in northwestern Alaska, assessments of walrus behavioral response to vessel interactions, and modeled linkages between future sea ice availability and walrus energetic requirements to population vital rates.

Time frame	Project Partners
FY2013–ongoing	Alaska Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Offshore Energy Management, Eskimo Walrus Commission, and North Slope Borough.

Scientists preparing to radio-tag walruses in the Chukchi Sea, northern Alaska, to track movements as sea ice is reduced in the region.

Contact

Chadwick Jay, ASC, cjay@usgs.gov, (907) 786–7414

Recent Publications

Fischbach, A.S., Kochnev, A.A., Garlich-Miller, J.L., and Jay, C., 2016, Pacific walrus coastal haulout database, 1852–2016—Background report: U.S. Geological Survey Open-File Report 2016–1108, 27 p., https://doi.org/10.3133/ofr20161108.

Battaile, B.C., Jay, C.V., Udevitz, M.S., and Fischbach, A., 2017, Evaluation of a method using survey counts and tag data to estimate the number of Pacific walruses (*Odobenus rosmarus divergens*) using a coastal haulout in northwestern Alaska: Polar Biology, v. 40, p. 1359–1369.

Jay, C.V., Taylor, R.L., Fischbach, A.S., Udevitz, M.S., and Beatty, W.S., 2017, Walrus haul-out and in water activity levels relative to sea ice availability in the Chukchi Sea: Journal of Mammalogy, v. 98, p. 386–396.

Taylor, R.L., Udevitz, M.S., Jay, C.V., Citta, J.J., Quakenbush, L.T., Lemons, P.R., and Snyder, J.A., 2017, Demography of the Pacific walrus (*Odobenus rosmarus divergens*) in a changing Arctic: Marine Mammal Science, v. 34, p. 54–86.

Udevitz, M.S., Jay, C.V., Taylor, R.L., Fischbach, A.S., Beatty, W.S., and Noren, S.R., 2017, Forecasting consequences of changing sea ice availability for Pacific walruses: Ecosphere, v. 8, no. 11, 30 p., article e02014, https://doi.org/10.1002/ecs2.2014.

Citta, J.J., Lowry, L.F., Quakenbush, L.T., Kelly, B.P., Fischbach, A.S., London, J.M., Jay, C.V., Frost, K.J., Crowe, G.O.C., Crawford, J.A., Boveng, P.L., Cameron, M., Von Duyke, A.L., Nelson, M., Harwood, L.A., Richard, P., Suydam, R., Heide-Jørgensen, M.P., Hobbs, R.C., Litovka, D.I., Marcoux, M., Whiting, A., Kennedy, A.S., George, J.C., Orr, J., and Gray, T., 2018, A multi-species synthesis of satellite telemetry data in the Pacific Arctic (1987–2015)—Overlap of marine mammal distributions and core use areas: Deep Sea Research Part II—Topical Studies in Oceanography, v. 152, p. 132–153.

Project Links

https://www.usgs.gov/centers/asc/science/walrus-research
https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems

Nearshore Marine Ecosystem Research Program

Sea otter in kelp. Photograph by Benjamin Weitzman, U.S. Geological Survey.

Nearshore ecosystems include many resources that are of high ecological, recreational, subsistence, and economic value. They also are subject to influences from a wide variety of natural and human-caused perturbations, which can originate in terrestrial or oceanic environments. Our research is designed to evaluate sources of variation in the nearshore and how they influence resources of high conservation interest. Our studies address community members at every trophic level, ranging from intertidal macroalgae and kelps to benthic invertebrates to top-level predators such as sea otters, black oystercatchers, and sea ducks. Key issues addressed by our program include ecosystem recovery from the Exxon Valdez oil spill; in particular, studies of sea otters and harlequin ducks have provided unprecedented insights into the processes and timelines of recovery of vulnerable species. We also have a long history, and ongoing efforts, to evaluate population dynamics of sea otters and their effects on other components of nearshore ecosystems. We also study sea ducks, a group of waterfowl of high conservation concern, evaluating factors on marine habitats that influence their distribution, abundance, and demography. A large component of our program is participation in Gulf Watch Alaska, which is designed to monitor marine ecosystem structure and function in the northern Gulf of Alaska.

Time frame	Project partners
FY2005–ongoing	U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, National Park Service, and Exxon Valdez Oil Spill Trustee Council.

Contact

Daniel Esler, ASC, desler@usgs.gov, (907) 786–7068

Recent Publications

Bodkin, J.L., Coletti, H.A., Ballachey, B.E., Monson, D.H., Esler, D., and Dean, T.A., 2017, Variation in abundance of Pacific Blue Mussel (*Mytilus trossulus*) in the Northern Gulf of Alaska, 2006–2015: Deep Sea Research Part II—Topical Studies in Oceanography, v. 147, p. 87–97. https://doi.org/10.1016/j.dsr2.2017.04.008.

Esler, D., Ballachey, B.E., Bowen, L., Miles, A.K., Dickson, R.D., and Henderson, J.D., 2016, Cessation of oil exposure in harlequin ducks after the Exxon Valdez oil spill—Cytochrome P4501A biomarker evidence: Environmental Toxicology and Chemistry, v. 36, no. 5, p. 1294–1300, https://doi.org/10.1002/etc.3659.

Esslinger, G.G., Esler, D., Howlin, S., and Starcevich, L.A., 2015, Monitoring population status of sea otters (*Enhydra lutris*) in Glacier Bay National Park and Preserve, Alaska—Options and considerations: U.S. Geological Survey Open-File Report 2015-1119, 42 p, http://dx.doi.org/10.3133/ofr20151119.

Konar, B., Iken, K., Coletti, H., Monson, D.H., and Weitzman., B.P., 2017, Influence of static attributes on local and regional rocky intertidal community structure: Estuaries and Coasts, v. 39, no. 6, p. 1735–1745, https://doi.org/10.1007/s12237-016-0114-0.

Project Link

https://www.usgs.gov/centers/asc/science/nearshore-marine-ecosystem-research

Ecological Studies of Alaskan Brown Bears

The USGS seeks to identify causal relations between marine intertidal invertebrate (MII) health, visitor use, and brown bear physiology. This work will increase understanding of how anthropogenic stressors may affect MII and bear population persistence at multiple spatial and temporal scales. The objectives of our studies include (1) mapping the distribution of bivalves along the coasts of the Katmai and Lake Clark National Parks and Preserves ; (2) assessing a select number of bivalve species' responses to potential environmental perturbations within coastal parks; (3) determining brown bear reliance on MIIs as forage resources; (4) evaluating potential decision alternatives and management actions involving coastal bear viewing and clam harvest on bear access to critical resources; (5) developing a monitoring tool that uses genetic transcription diagnostics (gene expression) that links changing ocean conditions directly to food web dynamics; and (6) developing outreach content that will connect visitors and the broader public to the research, results, resources of concern, and anthropogenic drivers. This work will make a significant contribution to scientific understanding, management decision making, and public experiences within coastal national parks. Findings from this project will be integrated into broader brown bear studies conducted in Gates of the Arctic National Park, Lake Clark National Park, and Kodiak National Wildlife Refuge.

Weighing an adult female brown bear in Katmai National Park, Alaska. Photograph by National Park Service.

Time frame	Project partners
FY2014–ongoing	National Park Service and U.S. Fish and Wildlife Service.

Contact

Grant V. Hilderbrand, ASC,
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Recent Publications

Bled, F., Belant, J.L., Van Daele, L.J., Svoboda, N., Gustine, D., Hilderbrand, G., and Barnes, V.G., 2017, Using multiple data types and integrated population models to improve our knowledge of apex predator population dynamics: Ecology and Evolution, v. 7, no. 22, p. 9531–9543, https://doi.org/10.1002/ece3.3469.

Hilderbrand, G.V., Gustine, D.D., Mangipane, B., Joly, K., Leacock, W., Manipane, L., Erlenbach, J., Sorum, M.S., Cameron, M.D., Belant, J. L., and Cambier, T., 2018, Body size and lean mass of brown bears across and within four diverse ecosystems: Journal of Zoology, v. 305, p. 53–62, https://doi.org/10.1111/jzo.12536.

Hilderbrand, G.V., Gustine, D.D., Mangipane, B., Joly, K., Leacock, W., Manipane, L., Erlenbach, J., Sorum, M.S., Cameron, M.D., Belant, J.L., and Cambier, T., 2018, Plasticity in physiological condition of female brown bears across diverse ecosystems: Polar Biology, v. 41, no. 4, p .773–780, https://doi.org/10.1007/s00300-017-2238-5.

Hilderbrand, G.V., Joly, K., Sorum, M.S., Cameron, M.D., and Gustine, D.D., 2019, Brown bear (*Ursus arctos*) body size, condition, and productivity across time in the Alaskan Arctic, 1977–2016, Polar Biology, v. 42, no. 6, p. 1125–1130, https://doi.org/10.1007/s00300-019-02501-8.

Ecology of Terrestrial Vertebrates (Caribou, Moose, Sheep, Wolves, Bears) in Alaska

Understanding the population dynamics, predator/prey relations and habitat ecology of large, terrestrial mammals is critical for the management of these wildlife species in Alaska and elsewhere around the world. Denali National Park has been the site of continuous research on the population dynamics of the Denali Caribou Herd since 1984. The park provides a unique opportunity to investigate caribou population dynamics where ungulate populations (caribou, moose, and Dall's sheep) and the large carnivores that prey on them (wolves, grizzly bears, and American black bears) are largely unaffected by human harvest. Management of large carnivores and ungulates in Alaska, as well as throughout North America, engenders contentious debate about the influences of predation on the dynamics of ungulate populations. This project is conducted by one staff member of the ASC who conducts monitoring and research in support of DOI and State of Alaska partners. Recent research objectives included (1) continued monitoring of the Denali National Park caribou herd, (2) data summary and writing of a report on the population dynamics of wolves in Denali National Park, and (3) finalization of a report on the evaluation of maternal penning of the Chisana caribou herd to improve calf survival.

U.S. Geological Survey scientist placing radio collar on a sedated bull caribou in Alaska. Photograph by U.S. Geological Survey.

Time frame	Budget	Project partners
FY2016–19	$200,000	Alaska Department of Fish and Game, National Park Service, and Yukon Department of Environment.

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Project Link

https://www.usgs.gov/centers/asc/science/terrestrial-mammal-ecology-research?qt-science_center_objects=0#qt-science_center_objects

Birds

Role of Gulls in Alaska in the Dissemination of Antimicrobial-Resistant *E. coli*

Two ASC staff members have been conducting research into the role of gulls in Alaska in the dissemination of anti-microbial-resistant *E. coli* bacteria—research that was initiated after the State of Alaska found high bacterial levels in the Kenai River starting in 2014. In 2018, ASC research objectives included (1) assessing maintenance, transmission and dispersal of antibiotic resistant *E. coli* in gulls of Alaska; (2) quantifying prevalence of antibiotic-resistant bacteria in wildlife and environmental sources across Alaska; and (3) determining migratory routes of large gull species that are breeding in Alaska and that are a potential reservoir and dispersal agents of antibiotic-resistant bacteria.

Time frame	Budget	Project partners
FY2016–20	$200,000	U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, Alaska Department of Health and Social Service, Alaska Department of Environmental Quality, and U.S. Department of Agriculture.

U.S. Geological Survey scientist holding gull with satellite transmitter.

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094

Recent Publications

Ahlstrom, C.A., Bonnedahl, J., Woksepp, H., Hernandez, J., Olsen, B., and Ramey, A.M., 2018, Acquisition and dissemination of cephalosporin-resistant *E. coli* in migratory birds sampled at an Alaska landfill as inferred through genomic analysis: Scientific Reports, v. 8, no. 1, 11 p., https://doi.org/10.1038/s41598-018-25474-w.

Muellner, U., Fournie, G., Muellner, P., Ahlstrom, C.A., and Pfeiffer, D.U., 2018, *epidemix*—An interactive multi-model application for teaching and visualizing infectious disease transmission: Epidemics, v. 23, p. 49–54, https://doi.org/10.1016/j.epidem.2017.12.003.

Ramey, A.M., Hernandez, J., Tyrlöv, V., Uher-Koch, B.D., Schmutz, J.A., Atterby, C., Järhult, J., Olsen, B., and Bonnedahl, J., 2018, Antibiotic-resistant *Escherichia coli* in migratory birds inhabiting remote Alaska: EcoHealth, v. 5, no. 1, p. 72–81, https://doi.org/10.1007/s10393-017-1302-5.

Project Link

https://www.usgs.gov/centers/asc/science/antibiotic-resistant-bacteria-migratory-birds?qt-science_center_objects=0#qt-science_center_objects

Epidemic of Beak Deformities (Avian Keratin Disorder) Among Wild Bird Populations

Thousands of land birds from 30 different species in Alaska have been reported with grossly deformed beaks since January 1998. Most sightings have been concentrated in south-central Alaska, primarily in black-capped chickadees. Outside Alaska, there have been about 300 reports of individuals of more than 80 species of wild birds with similarly deformed beaks scattered across North America. The geographic distribution of deformities and high prevalence among resident birds suggest an acute, ecosystem-wide problem, but the cause and geographic origin of deformities are still unknown. Research objectives are to determine (1) the causative factors and geographic distribution of the disease, and (2) possible management actions to limit continuation of the deformities in birds. Methods thus far to understand the disease have involved contaminant screening, genetic defect evaluation, changes in forage quality, bone and keratin evaluation, and viral and bacterial factors.

Black-capped chickadee with a beak that has grown long and crossed. Photograph by Rachel Richardson, U.S. Geological Survey.

Time frame	Project partners
FY2005–ongoing	U.S. Fish and Wildlife Service, Alaska Regional Office; Alaska Migratory Bird Management Office; Bureau of Land Management, Alaska State Office; and citizen science observers and university partners.

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Caroline Van Hemert, ASC, cvanhemert@usgs.gov, (907) 786–7167;
Rachel Richardson, ASC, rrichardson@usgs.gov, (907) 786–7194; and
Lisa Pajot, ASC, lpajot@usgs.gov, (907) 786–7191

Recent Publications

Hofmeister, E., and Van Hemert, C.R., 2018, The effects of climate change on disease spread in wildlife, *in* Miller, E.R., Lamberski, N., and Calle, P., eds., Fowler's zoo and wild animal medicine current therapy, volume 9: Elsevier Health Sciences, p. 247–254.

Zylberberg, M., Van Hemert, C.R., Handel, C.M., and DeRisi, J.L., 2018, Avian keratin disorder of Alaska black-capped chickadees is associated with Poecivirus infection: Virology, v. 15, no. 100, https://doi.org/10.1186/s12985-018-1008-5.

Project Link

https://www.usgs.gov/centers/asc/science/beak-deformities-landbirds

Population Ecology and Habitats of Alaska Landbirds

Alaska supports more than 130 species of breeding landbirds, including many that migrate to neotropical wintering areas. Population declines have been documented for several species over the past few decades and land managers in Alaska are requesting information on possible drivers of population change, such as spruce beetle epidemics, fire, and disease. Little information exists on the status of Alaskan landbird populations in relation to those of temperate regions. Objectives of this project are to coordinate a cooperative, regional program to monitor population trends of landbirds breeding in northern ecoregions, to investigate relations between the distribution of breeding landbirds and terrestrial habitats at the landscape level, and to examine population dynamics governing population trends. Methods used include annual ground surveys and banding to understand changes in population size and demography over time.

U.S. Geological Survey biologist conducting a bird survey on Alaska's Seward Peninsula. Photograph by Lance McNew, U.S. Geological Survey.

Time frame	Project partners
FY2001–ongoing	Canadian Wildlife Service, U.S. Fish and Wildlife Service—Alaska Region, U.S. Fish and Wildlife Service—Alaska Migratory Bird Management, National Park Service—Alaska Region, Bureau of Land Management—Alaska State Office and Arctic Office, University of Alaska Fairbanks, and Alaska Department of Fish and Game.

Contacts

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Recent Publications

Amundson, C.L., Handel, C.M, Ruthrauff, D.R. Tibbitts, T.L., and Gill, R.E., Jr., 2018, Montane-breeding bird distribution and abundance across national parks of southwestern Alaska: Journal of Fish and Wildlife Management, v. , no. 1, p. 180–207, https://doi.org/10.3996/062017-JFWM-050.

Sólymos, P., Matsuoka, S.M., Cumming, S.G., Stralberg, D., Fontaine, P., Schmiegelow, F.K., A., Song, S.J., and Bayne, E.M., 2018, Evaluating time-removal models for estimating availability of boreal birds during point count surveys—Sample size requirements and model complexity: Condor, v. 120, no. 4, p. 765–786, https://doi.org/10.1650/CONDOR-18-32.1.

Sólymos, P., Matsuoka, S.M., Stralberg, D., Barker, N.K.S., and Bayne, E.M., 2018, Phylogeny and species traits predict bird detectability: Ecography, v. 41, no. 10, p. 1595–1603, https://doi.org/10.1111/ecog.03415.

Project Link

https://www.usgs.gov/centers/asc/science/boreal-partners-flight?qt-science_center_objects=0#qt-science_center_objects

Population Ecology of Waterfowl and Loons

The Population Ecology of Waterfowl and Loons project at the ASC is conducted by four staff members and includes various research directions and methods that inform our partners. In 2018, research objectives included (1) quantifying abundance and distribution of waterbird species in western and northern Alaska; (2) assessing response of waterbird species to shifts in climate, such as warmer ocean water temperatures, declines in sea ice, and earlier spring phenology; (3) assessing demographic analyses and trends for species of management concern, such as, seabirds, spectacled eiders, black brant geese, and emperor geese; (4) conducting surveys and assessments of eelgrass and seaweeds of western Alaska that are important food and ecosystem components for migratory birds; and (5) quantifying use of offshore and onshore habitats by loon species marked with satellite transmitters in Alaska and Canada.

Pair of spectacled eiders flying near the Colville River, northern Alaska, 2013. Photograph by Ryan Askren, U.S. Geological Survey.

Time frame	Budget	Project partners
FY2005–ongoing	$1,000,000	Bureau of Land Management ($100,000), U.S. Fish and Wildlife Service ($100,000), and California Department of Fish and Wildlife ($20,000).

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094

Recent Publications

Christie, K.S., Hollmén, T.E., Flint, P.L., and Douglas, D.C., 2018, Non-linear effect of sea ice—Spectacled Eider survival declines at both extremes of the ice spectrum: Ecology and Evolution, v. 8, no. 23, p. 11808–11818, https://doi.org/10.1002/ece3.4637.

Kelsey, K.C., Leffler, A.J., Beard, K.H., Choi, R.T., Schmutz, J.A., and Welker, J.M., 2018, Phenological mismatch in coastal western Alaska may increase summer season greenhouse gas uptake: Environmental Research Letters, v. 13, no. 4, p. 044032, https://doi.org/10.1088/1748-9326/aab698.

Ward, D.H., Amundson, C.L., Stehn, R.A., and Dau, C.P., 2018, Long-term trends in fall age ratios of black brant: Journal of Wildlife Management, v. 82, no. 2, p. 362–373, https://doi.org/10.1002/jwmg.21388.

Project Links

https://www.usgs.gov/centers/asc/science/waterfowl-research?qt-science_center_objects-0#qt-science_center_objects
https://www.usgs.gov/centers/asc/science/loon-research?qt-science_center_objects=0#qt-science_center_objects

Conditions of Reproductive Success for Migratory Golden Eagles in Denali National Park and Preserve, Alaska

Golden eagle in flight. Photograph by Tom Koerner, U.S. Geological Survey.

The reproduction and occupancy of golden eagles have been studied in Denali National Park and Preserve for nearly 30 years. The number of eagle breeding territories and reproduction at those territories recently has declined. Furthermore, there is evidence that the reproductive success of Denali's golden eagles is being affected by conditions outside their breeding grounds. In a new study, USGS researchers will identify how the survival and reproductive success of Denali's golden eagles are linked to non-breeding season events and environmental conditions. Scientists will radio tag eagles to identify migration routes, stop-over areas, and wintering ranges of breeding golden eagles and their offspring. They also will study the duration of migrations and conditions at stop-overs and wintering areas. Coupled with the long-term data collected on golden eagles at Denali, this study will provide information about whether survival and reproductive success are related to environmental and ecological factors outside breeding areas.

Time frame	Budget	Project partners
FY2016–19	$225,000	Alaska Department of Fish and Game, and National Park Service.

Contact

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Recent Publication

Tracey, J.A., Madden, M.C., Bloom, P.H., Katzner, T.E., and Fisher, R.N., 2018, Golden eagle (*Aquila chrysaetos*) habitat selection as a function of land use and terrain, San Diego County, California: U.S. Geological Survey Open-File Report 2018–1067, 13 p., https://doi.org/10.3133/ofr20181067.

Physical and Ecological Factors for Increase in Abundance and Distribution of Arctic Goose Populations

The Arctic Coastal Plain of northern Alaska has had a warming trend over the past 30 years, leading to reductions in sea ice and saltwater inundation of coastal habitats. Saltwater-tolerant plants are now thriving in these areas. Since the 1970s, data collected by the FWS have indicated a shift in the distribution of molting black brant geese in the Teshekpuk Lake Special Area. Methods include band recovery and ground measurements. The core objectives of the project are to quantify shifts in molting distribution and habitats being used, and to develop forecasts of future habitat quality for geese that can assist management in planning for potential development scenarios.

Black brant flying near the Colville River, northern Alaska. Photograph by Ryan Askren, U.S. Geological Survey.

Time frame	Budget	Project partner
FY2016–20	$220,000	Bureau of Land Management ($40,000).

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094

Recent Publication

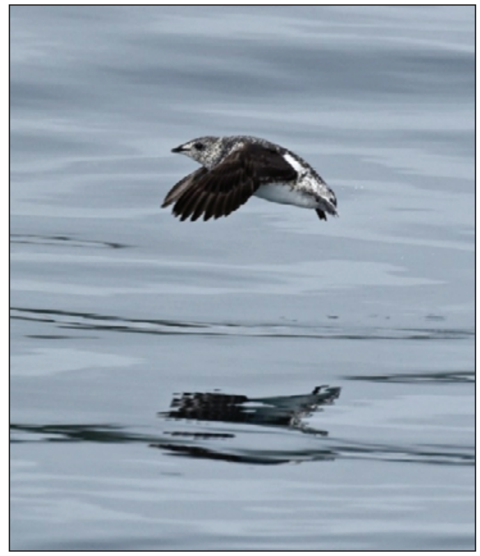
Flint, P., Whalen, M., and Pearce, J., 2014, Changing arctic ecosystems—Sea ice decline, permafrost thaw, and benefits for geese: U.S. Geological Survey Fact Sheet 2014–3088, 2 p., https://doi.org/10.3133/fs20143088.

Project Link

https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems?qt-science_center_objects=0#qt-science_center_objects

Contaminant Exposure, Bioaccumulation, and Ecological Effects in Aquatic and Terrestrial Habitats

Alaska contains a diverse suite of aquatic habitats that provide critical ecosystem services. Environmental contaminants are among the key threats to the viability of these habitats and the species they support. Although the proximity of these water bodies to contaminant sources is important, the intrinsic ecological properties of each habitat type can affect contaminant cycling and effects. The USGS FRESC Contaminant Ecology Program works across a range of aquatic habitats in the Western United States and Alaska to evaluate contaminant exposure, assess the accumulation through the food web, and quantify the biological effects in aquatic and aquatic-dependent wildlife. Furthermore, the habitat, landscape, and land-use patterns that contribute to contaminant dynamics will be measured. For example, mercury, a toxic metal, may threaten seabird species such as the Kittlitz's murrelet. The USGS measured mercury concentrations in Kittlitz's murrelet eggshells, guano, blood, and feathers from four locations in Alaska. Results of this study indicate that mercury concentrations from two Kittlitz's murrelets at Glacier Bay National Park and one at Adak Island had were greater than those associated with impaired reproduction in other bird species, and may merit further study to determine the potential threat of mercury at the population scale.



Kittlitz's murrelet flying above the water in Cook Inlet, south-central Alaska. Photograph by Sarah Schoen, U.S. Geological Survey.

Time frame	Project partners
FY2010–20	U.S. Fish and Wildlife Service, National Park Service, and Biodiversity Research Institute.

Contact

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Recent Publication

Kenney, L.A., Kaler, R.S., Kissling, M.L., Bond, A.L., and Eagles-Smith, C.A., 2018, Mercury concentrations in multiple tissues of Kittlitz's murrelets (*Brachyramphus brevirostris*): Marine Pollution Bulletin, v. 129, no. 2, p. 675–680, https://doi.org/10.1016/j.marpolbul.2017.10.055.

Population Status and Ecology of North Pacific Shorebirds

Alaska is widely recognized as a global center for breeding shorebirds, as 90 percent of the migratory species in the Western Hemisphere have breeding populations in Alaska. Research objectives are to provide information needed for management agencies, such as the current distribution and abundance of shorebird species in Alaska, the factors involved in driving population changes in Alaska and throughout the broad non-breeding distribution of these species, and an evaluation of new and emerging topics with this species group. Methods involve population genetics, satellite telemetry and other tagging, and ground surveys.

Bar-tailed godwit flock flying over the mudflats on Cape Avinof, western Alaska. Photograph by Dan Ruthrauff, U.S. Geological Survey.

Time frame	Project partners
FY2001–present	U.S. Fish and Wildlife Service, Bureau of Land Management, and Alaska Department of Fish and Game.

Contact

Dan Ruthrauff, ASC, druthrauff@usgs.gov, (907) 786–7162; and
Lee Tibbitts, ASC, ltibbitts@usgs.gov, (907) 786–7038

Recent Publications

Ely, C.R., McCaffery, B.J., and Gill, R.E., Jr., 2018, Shorebirds adjust spring arrival schedules with variable environmental conditions—Four decades of assessment on the Yukon-Kuskokwim Delta, Alaska, *in* Shuford, W.D., Gill, R.E., Jr., and Handel, C.M., eds., Trends and traditions—Avifaunal change in western North America: Western Field Ornithologists Studies of Western Birds No. 3, p. 296–311, https://www.westernfieldornithologists.org/Avifaunal_Changes.php.

Rakhimberdiev, E., Duijns, S., Karagicheva, J., Camphuysen, C.J., Dekinga, A.A., Dekker, R., Gavrilov, A., ten Horn, J., Jukema, J., Saveliev, A., Soloviev, M., Tibbitts, T.L., van Gils, J. A., Piersma, T., and Castricum, V.R.S., 2018, Fuelling conditions at staging sites can mitigate Arctic warming effects in a migratory bird: Nature Communications, v. 9, no. 1, 10 p., https://doi.org/10.1038/s41467-018-06673-5.

Savage, S.E., Tibbitts, T.L., Sesser, K.A., and Kaler, R.A.S., 2018, Inventory of lowland-breeding birds on the Alaska Peninsula: Journal of Fish and Wildlife Management, v. 9, no. 2, p. 637–658, https://doi.org/10.3996/082017-JFWM-070.

Project Link

https://www.usgs.gov/centers/asc/science/shorebird-research

Seabirds and Forage Fish Ecology Program

The DOI is mandated by the Migratory Bird Treaty Act and the Endangered Species Act to conserve and protect all seabirds. Seabirds also serve as practical indicators of change in the marine environment—natural or human induced—because they can be readily monitored at colonies and at sea. For these reasons, marine bird research is a vital part of the DOI mission in Alaska. The USGS studies the seabird population dynamics and feeding ecology of various seabird species, including threatened and endangered species to better understand why seabird populations fluctuate over time and how natural and anthropogenic factors influence population biology. The USGS characterizes the response of seabirds to changes in oceanography and marine climate, and resulting fluctuations in prey abundance, distribution, and quality. Long-term tasks that form the core of the USGS ASC's forage fish, seabird, and ecosystem studies include (1) compilation and analyses of data on the pelagic distribution of marine birds in the North Pacific relative to biological oceanography and changes in climate; (2) development of methods for censusing and monitoring trends in seabird populations on land and at sea; (3) studies of oceanography, plankton, forage fish and seabirds around major seabird colonies in Alaska; (4) focused studies of rare, threatened or endangered seabirds; and (5) measurement of the impact of human-related sources of mortality on seabirds, including subsistence harvest, oil pollution, vessel disturbance, and by-catch in fishing gear.

Common murres in a colony in Cook Inlet, south-central Alaska, 2017. Photograph by Sarah Schoen, U.S. Geological Survey.

Time frame	Project partners
FY2002–ongoing	U.S. Fish and Wildlife Service, National Park Service, Bureau of Offshore Energy Management, Exxon Valdez Oil Spill Trustee Council, Farallon Institute, and University of Washington.

Contact

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Recent Publications

Arimitsu, M.L., Hobson, K.A., Webber, D.N., Piatt, J.F., Hood, E.W., and Fellman, J.B., 2017, Tracing biogeochemical subsidies from glacier runoff into Alaska's coastal marine food webs: Global Change Biology, v. 24, no. 1, p. 387–398, https://doi.org/10.1111/gcb.13875.

Lawonn, M.J., Roby, D.D., Piatt, J.F., Pyle, W.H., and Corcoran, R.M., 2018, Breeding ecology of Kittlitz's Murrelets on Kodiak Island, Alaska: Journal of Field Ornithology, v. 89, no. 0, p. 1–15, https://onlinelibrary.wiley.com/doi/abs/10.1111/jofo.12267.

Piatt, J.F., Arimitsu, M.L., Sydeman, W.A., Thompson, S.A., Renner, H., Zador, S., Douglas, D.C., Hatch, S., Kettle, A.B., and Williams, J.C., 2018, Biogeography of pelagic food webs in the North Pacific: Fisheries Oceanography, v. 27, no. 4, p. 366–380, https://doi.org/10.1111/fog.12258.

Schoen, S.K., Piatt, J.F., Arimitsu, M.L., Heflin, B.M, Madison, E.N., Drew, G.S., Renner, M., Rojek, N.A., Douglas, D.C., and DeGange, A.R., 2018, Avian predator buffers against variability in marine habitats with flexible foraging behavior: Marine Biology, v. 165, no. 47, 14 p., https://doi.org/10.1007/s00227-018-3304-4.

Thompson, S.A., García-Reyes, M., Sydeman, W., Arimitsu, M., Renner, H., Hatch, S., and Piatt, J., 2019, Effects of ocean climate on the length and condition of forage fish in the Gulf of Alaska: Fisheries Oceanography, v. 28, no. 6, p. 658–671, https://doi.org/10.1111/fog.12443.

Von Biela, V.R., Arimitsu, M.L., Piatt, J.F., Heflin, B., Schoen, S.K., Trowbridge, J.L., and Clawson, C.M., 2019, Extreme reduction in the nutritional value of a key forage fish during the Pacific marine heatwave of 2014–2016: Marine Ecology Progress Series, v. 613, p. 171–182, https://doi.org/10.3354/meps12891.

Project Link

https://www.usgs.gov/centers/asc/science/seabirds-and-forage-fish-ecology

Fish

Fish Ecology and Conservation

Federal partners such as the FWS, U.S. Forest Service, and Bureau of Land Management often look to the USGS for assistance with statistical study design, analysis of data, monitoring design, and interpretation of research results related to aquatic systems and biota. The USGS Aquatic Landscape Ecology Research Team provides technical assistance to partners with questions related to aquatic conservation and fish ecology. Activities involve developing and applying models as well as statistical assistance. For example, researchers from USGS, Oregon State University, and the U.S. Forest Service studied coho salmon, from hatching through the first summer of life, in the Copper River Delta, Alaska, to evaluate links between coho salmon phenology and stream thermal variability. The results of this study provide insights into the interactions between environmental variability and the early life-history stages of coho salmon.

Coho salmon. Photograph by Jonny Armstrong, U.S, Geological Survey.

Time frame
FY2016–22

Contact

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Project Link

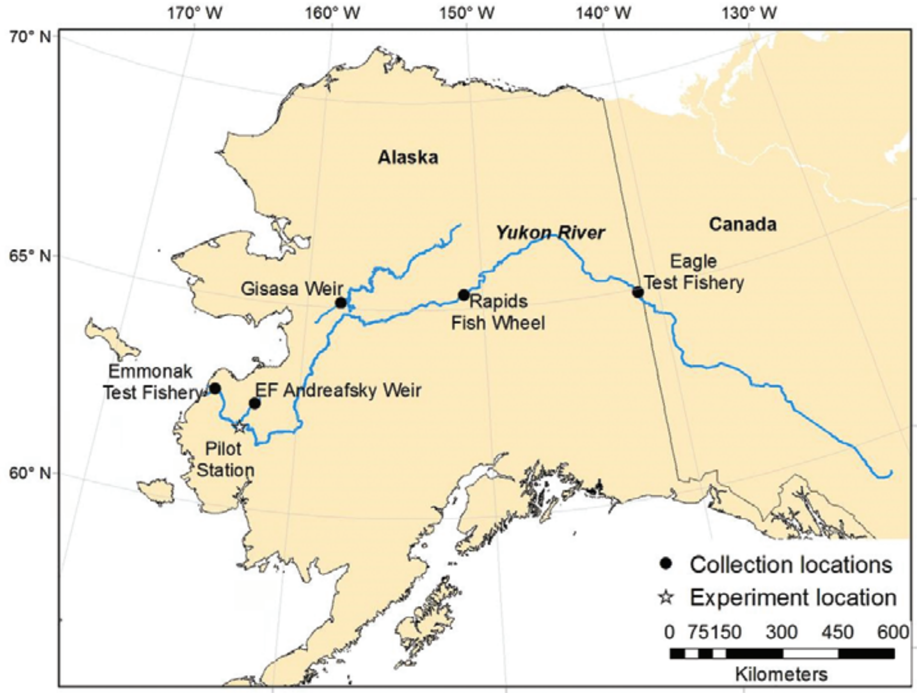
https://www.usgs.gov/center-news/phenology-young-coho-salmon-copper-river-delta-alaska

Recent Publication

Campbell, E.Y., Dunham, J.B., Reeves, G.H., and Wondzell, S.M., 2018, Phenology of hatching, emergence, and end-of-season body size in young-of-year coho salmon in thermally contrasting streams draining the Copper River Delta, Alaska: Canadian Journal of Fisheries and Aquatic Sciences, v. 76, p. 185–191, https://doi.org/10.1139/cjfas-2018-0003.

Heat Stress in Migrating Yukon River Chinook Salmon

Yukon River Chinook salmon have been in decline since the 1990s for unknown causes and the pace of decline has recently accelerated. Heat stress during spawning migration has the potential to cause significant pre-spawn mortality of adult fish. Two biomarkers will be used to assess the presence of heat stress in Yukon River Chinook salmon—(1) the concentration of a specific heat shock protein (HSP70) associated with stress, and (2) the expression (that is, transcription) of genes involved with thermal stress and physiological pathways affected by thermal stress. Fish will be collected during the spawning migration at established monitoring sites throughout the Yukon River watershed including test fisheries at Emmonak and Eagle, weirs on tributaries (East Fork Andreafsky River and Gisasa River), and a subsistence fish wheel near Tanana. A short (less than 48-hour) manipulative temperature experiment will distinguish baseline protein and gene expression levels in fish held at a cooler control temperature from fish held at temperatures associated with low (18 °C) and high (21 °C) heat stress. The potential influence of migration timing, age, and size on the presence of stress indicators also will be evaluated. The results of this study will be used to assess the likelihood of increases in freshwater adult mortality and reduced reproductive success from heat stress. If heat stress indicators are present, managers may adjust escapement goals to compensate for the likelihood of increasing re-spawn mortality rates.



Locations of Chinook salmon muscle tissue samples on Yukon River, western and interior Alaska. Map by Vanessa von Biela, U.S. Geological Survey.

Time frame	Budget	Project partner
FY2016–ongoing	$435,000	Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative.

Contact

Vanessa Von Biela, ASC, vvonbiela@usgs.gov, (907) 786–7073

Recent Publication

Burril, S.E., von Biela, V.R., Hillgruber, N., and others, 2018, Energy allocation and feeding ecology of juvenile chum salmon (*Oncorhynchus keta*) during transition from freshwater to saltwater: Polar Biology, v. 41,no. 7, p. 1447–1461, https://doi.org/10.1007/s00300-018-2297-2.

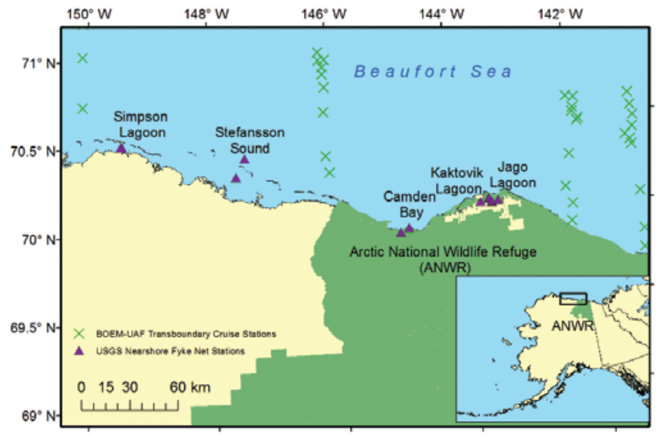
Project Link

https://www.usgs.gov/centers/asc/science/assessing-heat-stress-migrating-yukon-river-chinook-salmon?qt-science_center_objects=0#qt-science_center_objects

Nearshore Fish Surveys in the Beaufort Sea

In the Arctic, rapid changes in temperature and salinity have led to changes in locations where fish commonly occur. Recent offshore survey efforts provide an opportunity to detect these changes and to compare fish abundance between offshore and nearshore habitats to understand whether nearshore habitats are used for specific life stages (such as juvenile rearing, feeding, or reproduction). Updated information on fish community and use of nearshore habitats will provide management agencies with information for assessments and will improve understanding of current susceptibility and risks of development and production in Federal waters. For example, information from this study will support BOEM in assessing whether red-throated loons are behaviorally affected by industrial activities and in assessing if nearshore fish communities are sufficiently abundant and of adequate nutrition to enable loons to be reproductively successful.

Time frame	Budget	Project partner
FY2017–20	$780,000	Bureau of Ocean Energy Management.



Fish sample survey locations on Beaufort Sea coast, northern Alaska. Map by Vanessa von Biela, U.S. Geological Survey.

Contact

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Project Link

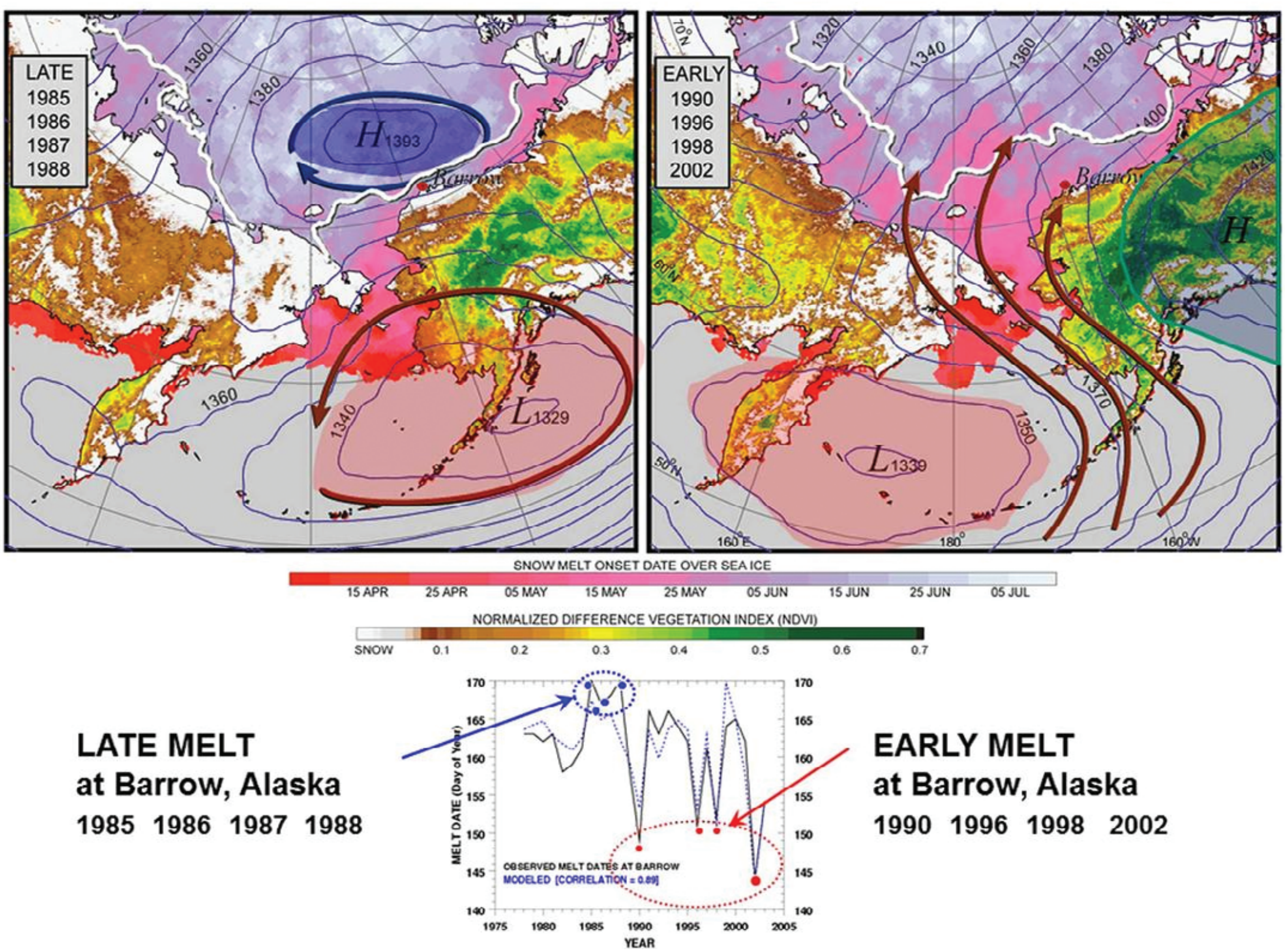
https://www.usgs.gov/energy-and-minerals/energy-resources-program/science/alaska-petroleum-systems

Habitat

Habitat Dynamics—Using Satellite Remote-Sensing in Landscape-Scale Wildlife and Ecological Process Studies

The Habitat Dynamics Project examines how short- and long-term changes in the environment affect the distribution and survival of wildlife populations. As seen in the illustrations above, at Utqiaġvik (Barrow), Alaska, years with late snowmelt (left image) are associated with a high-pressure system over the Arctic basin and low-pressure over the eastern Bering Sea, a pattern that tends to block the flow of warm southerly air into the higher latitudes. In contrast, years with early snowmelt (right image) are associated with a low-pressure system over the western Bering Sea and a high-pressure ridge over eastern Alaska that tends to facilitate the northerly flow of warm southerly air.

Understanding linkages between the physical and biological environment is critical for making informed management decisions. This project serves as a focal point of capability and expertise for integrating remote sensing, satellite telemetry, and GIS. Working collaboratively with other principal investigators, project participants apply satellite and software technologies to study spatial and temporal interactions between wildlife populations and their environment. Three primary project objectives are to develop (1) optimal structures for wildlife distribution databases with emphasis on satellite tracking data, (2) environmental thematic databases with emphasis on Arctic regions, and (3) GIS algorithms for integrated data analyses.



Atmospheric circulation patterns strongly influencing the timing of snowmelt and vegetation green-up in the Arctic.

Time frame	Project partners
FY1990s–ongoing	U.S. Fish and Wildlife Service and North Slope Borough.

Contact

David C. Douglas. ASC, ddouglas@usgs.gov, (907) 364–1576

Recent Publications

Cox, C.J., Stone, R.S., Douglas, D.C., Stanitski, D., and Gallagher, M.R., 2019, The Aleutian Low-Beaufort Sea Anticyclone—A climate index for predicting the timing of springtime melt in the Pacific Arctic cryosphere: Geophysical Research Letters, v. 46, no. 13, p. 7464–7473, https://doi.org/10.1029/2019GL083306.

Divoky, G.J., Douglas, D.C., and Stenhouse, I.J., 2016, Arctic sea ice a major determinant in Mandt's black guillemot movement and distribution during non-breeding season: Biology Letters, v. 12, no. 9, https://doi.org/10.1098/rsbl.2016.0275.

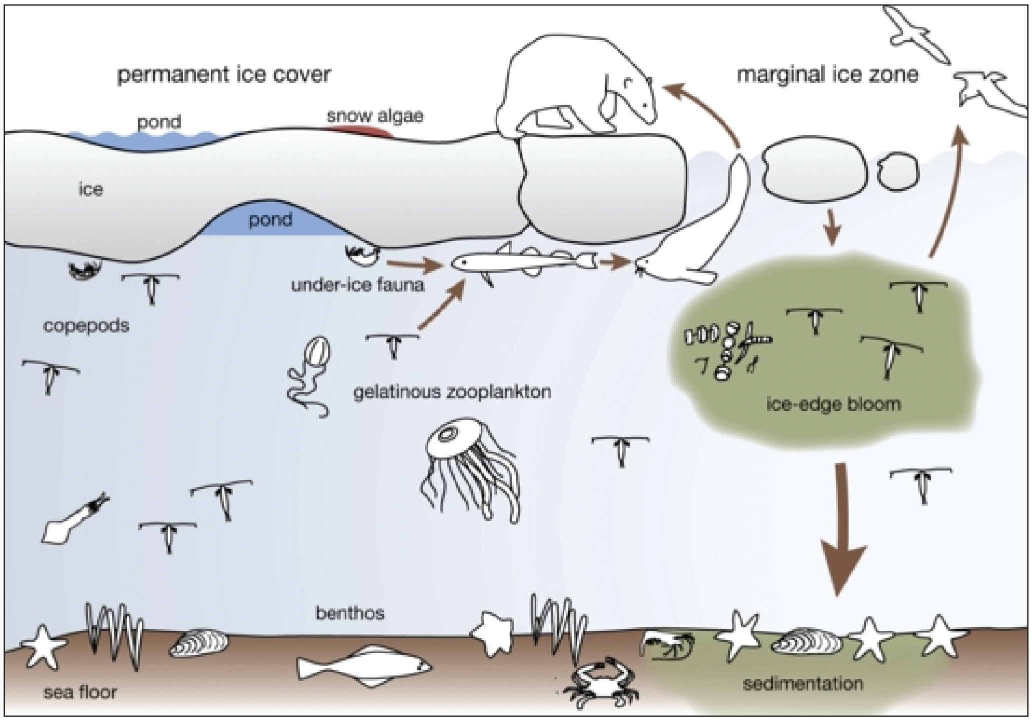
Douglas, D.C., and Atwood, T.C., 2017, Uncertainties in forecasting the response of polar bears to global climate change, *in* Butterworth, A., ed., Marine mammal welfare, volume 17: Cham, Switzerland, Springer International Publishing, p. 463–473, https://doi.org/10.1007/978-3-319-46994-2_25.

Ross, M.V., Alisaukas, R.T., Douglas, D.C., and Kellet, D.K., 2017, Decadal declines in avian herbivore reproduction—Density-dependent nutrition and phenological mismatch in the Arctic: Ecology, v.98, no. 7, p. 1869–1883, https://doi.org/10.1002/ecy.1856.

Project Link

https://www.usgs.gov/centers/asc/science/habitat-dynamics

Advancements in Quantitative Ecology



Schematic illustration of sea ice-associated Arctic food web. Sea ice is a dominant feature of the Arctic ecosystem and strongly influences the ecology of Arctic species. Source: Hugo Ahlenius, GRID-Arendal; Conservation of Arctic Flora and Fauna.

The Quantitative Ecology Project at the ASC involves research to address ecological issues of national and international importance by modeling population, community, and ecosystem dynamics; designing ecological experiments; estimating biological and ecological parameters; and testing biological and ecological hypotheses. Issues are addressed in the context of broad research programs of the ASC (often relating to trust species managed by the DOI, including polar bears, Pacific walruses, sea otters, migratory birds, and various species of Pacific salmon), and include work in marine, freshwater, and terrestrial ecosystems of Alaska and Canada. There is a strong emphasis on research that allows future status or conditions to be predicted or forecasted. The focus is on questions of immediate and ongoing concern to the DOI that either cannot be answered with existing quantitative techniques or that require exceptionally complex quantitative analyses.

Contact

Jeffery Bromaghin, ASC, jbromaghin@usgs.gov, (907) 786–7086

Time frame	Project partner
FY2009–ongoing	U.S. Fish and Wildlife Service.

Recent Publications

Bromaghin, J.F., 2017, qfasar—Quantitative fatty acid signature analysis with R.: Methods in Ecology and Evolution, v. 8, no. 9, p. 1158–1162.

Bromaghin, J.F., Budge, S.M., and Thiemann, G.W., 2017, Detect and exploit hidden structure in fatty acid signature data: Ecosphere, v. 8, no. 7, p. e01896, https://doi.org/10.1002/ecs2.1896.

Bromaghin J.F., Budge, S.M., Thiemann, G.W., and Rode, K.D., 2017, Simultaneous estimation of diet composition and calibration coefficients with fatty acid signature data: Ecology and Evolution, v., no. 7, p. 6103–6113.

Bromaghin, J.F., McDonald, T.L., Sterling, I., Derocher, A.E., Richardson, E.S., Regehr, E.V., Douglas, D.C., Durner, G.M., Atwood, T.C., and Amstrup, S.C., 2015, Polar bear population dynamics in the southern Beaufort Sea during a period of sea ice decline: Ecological Applications, v. 25, p. 634–651.

Project Link

https://www.usgs.gov/centers/asc/science/quantitative-ecology-research

Biometrics

The Biometrics Program develops quantitative methods and applies them to wildlife studies. Research is focused on problems in sampling wildlife and habitats, estimating biological and ecological parameters, testing biological and ecological hypotheses, and modeling population, community, and ecosystem dynamics. The focus is on questions of immediate and ongoing concern to the DOI and partners that either cannot be answered with existing quantitative techniques or that require exceptionally complex analytical approaches.

Time frame	Project partner
FY1994–ongoing	U.S. Fish and Wildlife Service.

Contact

Rebecca Taylor, ASC, rebeccataylor@usgs.gov, (907) 786–7004

Recent Publications

Jay, C.V., Taylor, R.L., Fischbach, A.S., Udevitz, M.S., and Beatty, W.S., 2017, Walrus haul-out and in water activity levels relative to sea ice availability in the Chukchi Sea: Journal of Mammalogy, v. 98, no. 2, p. 386–396.

Taylor, R.L., and Udevitz, M.S., 2018, Design considerations for estimating survival rates with standing age structures: Wildlife Society Bulletin, v. 42, no. 1, p. 32–39, https://doi.org/10.1002/wsb.858.

Taylor, R.L., Udevitz, M.S., Jay, C.V., Citta, J.J., Quakenbush, L.T., Lemons, P.R., and Snyder, J.A., 2017, Demography of the Pacific walrus (*Odobenus rosmarus divergens*) in a changing Arctic: Marine Mammal Science, v. 34, no. 1, p. 54–86, https://doi.org/10.1111/mms.12434.

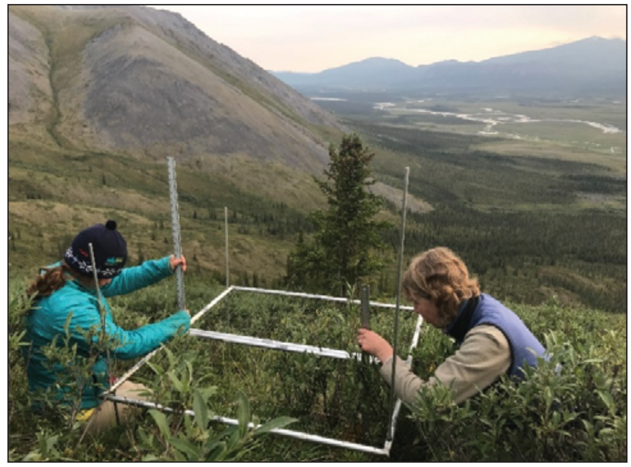
Udevitz, M.S., Jay, C.V., Taylor, R.L., Fischbach, A., Beatty, W.S., and Noren, S.R., 2017, Forecasting consequences of changing sea ice availability for Pacific walruses: Ecosphere, v, 8, no. 11, p. e02014, https://doi.org/10.1002/ecs2.2014.

Project Link

https://www.usgs.gov/centers/asc/science/biometrics-research

Detecting Vegetation Change in the Arctic National Wildlife Refuge

Environmental conditions in the Arctic are rapidly changing, leading to a shift in the composition and distribution of vegetation cover. For example, shrub cover is expanding across many areas of the Arctic. The redistribution of Arctic vegetation has large implications for wildlife and ecosystem services that are important for human well-being, including production of subsistence food, access to natural resources, and traditional cultural practices. To improve our understanding of how the Arctic landscape is shifting, the USGS is working with the FWS on a long-term vegetation monitoring study in the Arctic region of Alaska. The FWS initiated the study in response to the National Wildlife Refuge System Improvement Act of 1997, which requires the FWS to monitor the trends and status of fish, wildlife, and plants on wildlife refuge land. The objectives of the study are to monitor vegetation, soil, and environmental variables on permanent study sites within five of the ecological zones in the Arctic. Information from this study will inform land-management decisions relating to the preservation of flora and fauna, recreation, and development of natural resources in the ANWR.



Measuring of species composition and vegetation height on a permanent alpine vegetation plot near the Sheenjek River, northeastern Alaska. Photograph by U.S. Geological Survey.

Time frame	Project partner
FY2014–ongoing	U.S. Fish and Wildlife Service.

Contact

Elizabeth Powers, Alaska Regional Office, epowers@usgs.gov, (907) 786-7085

Remote Sensing Ecology Project, LandCarbon Alaska

Sampling of biomass, permafrost, vegetation species, and soil organic layer thickness in the Yukon Flats, interior Alaska. Photograph by Bruce Wylie, U.S. Geological Survey.

This effort was a contribution to a larger carbon assessment of Alaska (LandCarbon) that summarized terrestrial and aquatic carbon stocks and dynamics (see Wylie and others, 2016, in section, "Recent Publications," that follows) The effort was part of a larger team "special issue" of ecological applications synthesis papers. The objective was to do a data synthesis that improved our understanding of the main drivers of the spatiotemporal patterns of carbon in Alaska. The data synthesis was to address the potential carbon impacts related to the sensitivity of Alaska's ecosystems to change. Our methods used in-place observations, remote-sensing data, and an array of modeling techniques to assess (1) climate; (2) wetland, upland, and water extents; (3) permafrost distributions; and (4) vegetation changes driven by fire. Results suggested a future reduction of near-surface (less than 1-meter) and deep (less than 5-meter) permafrost of 4–21 percent and 33–55 percent, respectively, by the end of the 21st century. Fire extents are increasing and are expected to cause a shift from spruce to early successional deciduous forests.

Time frame	Budget	Project partners
FY2008–20	$1,000,000	U.S. Fish and Wildlife Service, Bureau of Land Management, and National Aeronautics and Space Administration Arctic-Boreal Vulnerability Experiment.

Contact

Bruce Wylie, EROS Center, wylie@usgs.gov, (605) 594–6078; and
Neal Pastick, EROS Center, njpastick@contractor.usgs.gov, (605) 594–2652

Recent Publications

Minsley, B.J., Pastick, N.J., Wylie, B.K., Brown, D.R.N., and Kass, M.A., 2017, Evidence for nonuniform permafrost degradation after fire in boreal landscapes: Journal of Geophysical Research Earth Surfaces, v. 121, p. 320–335, https://doi.org/10.1002/2015JF003781.

Pastick, N.J., Duffy, P., Genet, H., Rupp, S.T., Wylie, B.K., Johnson, K.D., Jorgenson, M.T., Bliss, N., McGuire, A.D., Jafarov, E.E., and Knight, J.F., 2017, Historical and projected trends in landscape drivers affecting carbon dynamics in Alaska: Ecological Applications, v, 77, p. 1383–1402, https://doi.org/10.1002/eap.1538.

Pastick, N.J., Jorgenson, M.T., Goetz, S.J., Jones, B.M., Wylie, B.K., Minsley, B.J, Genet, H., Knight, J.F., Swanson, D.K., and Jorgenson, J.C., 2019, Spatiotemporal remote sensing of ecosystem change and causation across Alaska: Global Change Biology, v. 25, p. 1171–1189, https://doi.org/10.1111/gcb.14279.

Pastick, N.J., Jorgenson, M.T., Wylie, B.K., Nield, S.J., Johnson, K.D., and Finley, A.O., 2015, Distribution of near-surface permafrost in Alaska—Estimates of present and future conditions: Remote Sensing of Environment, v. 168, p. 301–315, https://doi.org/10.1016/j.rse.2015.07.019.

Wylie, B.K., Pastick, N.J., Johnson, K.D., Bliss, N., and Genet, H., 2016, Soil carbon and permafrost estimates and susceptibility to climate change in Alaska, chap. 3 *of* Zhu, A., and McGuire, A.D., eds., Baseline and projected future carbon storage and greenhouse-gas fluxes in ecosystems of Alaska: U.S. Geological Survey Professional Paper 1826, p. 53–76, https://doi.org/10.3133/pp1826.

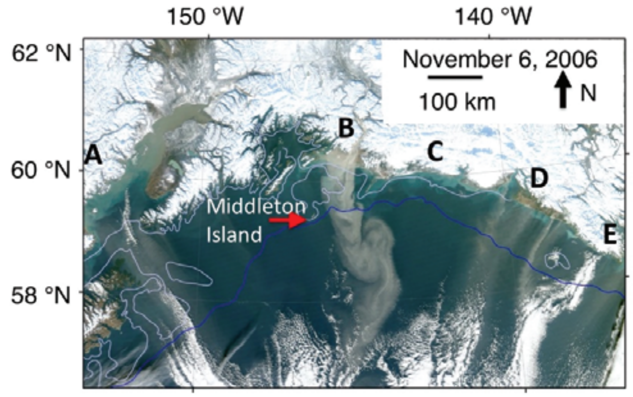
Project Link

https://www.usgs.gov/centers/eros/science/ecosystem-performance-productivity-and-sustainability?qt-science_center_objects=0#qt-science_center_objects

Nutrient and Contaminant Metal Fluxes to Alaskan Coastal Surface Waters

The supply of the essential nutrients, phosphorus (P), nitrogen (N), and iron (Fe) sets limits on various ecosystem biological processes as diverse as the burial of carbon in terrestrial wetlands and biological productivity in lakes and the ocean. This project will entail new field work sampling and analyzing dust from several remote Alaskan settings. A key objective will be to address whether Alaskan glacial flour dust, Asian dust, or both are important sources of the nutrients P, N and Fe for these terrestrial and marine ecosystems in coastal Alaska. A long-term objective is to infer whether the rates of key processes are changing, and if so, why. Methods will include time-series filtered air sampling on Middleton Island, and seasonally strategic sampling at other locations including near the mouths of the Copper and Alsek Rivers and Iliamna Lake.

Time frame	Budget	Project partners
FY2018–21	$207,000 (FY2019)	University of Washington School of Oceanography, Professors James Murray and Randelle Bundy; and National Science Foundation Chemical Oceanography ($291,000).



Airborne dust plumes emanating from riverbed sediments from glacier-bearing watersheds of coastal Alaska. Image also shows 100-meter bathymetric contour (white line) and the 500-meter contour (blue line). Lettered regions include locations where dust is (and is not) produced, including (A) Iliamna Lake; (B) Copper River; (C) a region where high coastal mountains prevent the winds that cause the dust; (D) Yakutat Bay/Alsek River region; and (E) Cross Sound west of Juneau. Source: John Crusius (U.S. Geological Survey) created image using data collected by the National Aeronautics and Space Administration Terra and Aqua satellites (http://modis.gsfc.nasa.gov/).

Contact

John Crusius, ASC, jcrusius@usgs.gov, (206) 543–6978

Recent Publications

Crusius, J., Schroth, A.W., Resing, J.A., Cullen, J., and Campbell, R.W., 2017. Seasonal and spatial variabilities in northern Gulf of Alaska surface water iron concentrations driven by shelf sediment resuspension, glacial meltwater, a Yakutat eddy, and dust: Global Biogeochemical Cycles, v. 31, p. 942–960, doi:10.1002/2016GB005493.

Schroth, A. W., Crusius, J., Gassó, S., Moy, C. M., Buck, N.J., Resing, J.A., and Campbell, R.W., 2017. Atmospheric deposition of glacial iron in the Gulf of Alaska impacted by the position of the Aleutian Low: Geophysical Research Letters, v. 44, p., 5053–5061, https://doi.org/10.1002/2017GL073565.

Project Link

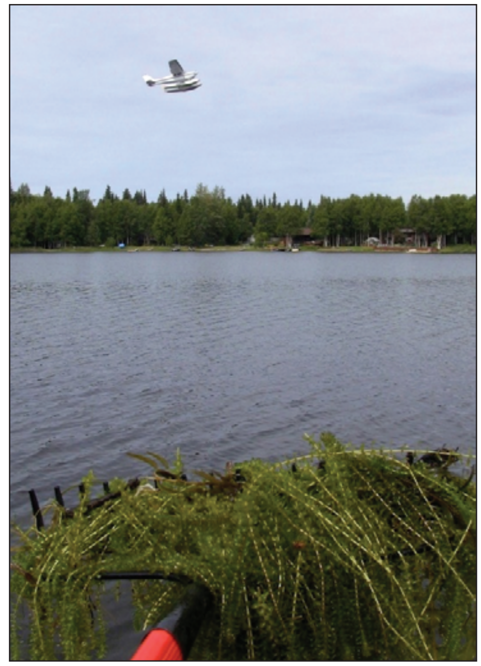
https://www.nsf.gov/awardsearch/showAward?AWD_ID=1756126&HistoricalAwards=false

Cross-Cutting Programs

U.S. Geological Survey and National Park Service Natural Resources Preservation Program

The Natural Resources Preservation Program (NRPP) is a nationwide science partnership that directs USGS capabilities toward priority research issues identified by the NPS. NPS priorities for these funds change annually and, for 2018, the focal objectives identified by the NPS Alaska Region were on topics such as invasive species and species of conservation concern that occur on NPS park lands. Final USGS ASC and Forest and Rangeland Science Center projects chosen by the NPS Alaska Region for funding in recent years included:

- Yellow-billed loon genetics and dietary distinction;
- Determining how Elodea impacts fish performance in subarctic food webs;
- Application of next-generation sequencing of environmental DNA for the detection and monitoring of rare and elusive aquatic taxa, including invasive species and species of concern, in Alaska parklands; and
- Reproductive success of migratory golden eagles in Clark National Park and Kodiak National Wildlife Refuge.



Elodea spp. on a rake in Sand Lake in Anchorage, Alaska. Photograph by Cecil F. Rich, U.S. Fish and Wildlife Service.

Time frame	Budget	Project partner
FY2018–19	$450,000	National Park Service, Alaska Region ($50,000 in-kind).

Contact

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Grant Hilderbrand, ASC, ghilderbrand@usgs.gov, (907) 786–7076; and
Todd Katzner, FRESC, tkatzner@usgs.gov, (201) 426–5232

Recent Publication

Menning, D.M., Simmons, T. and Talbot, S.L., 2018, Using redundant primer sets to detect multiple native Alaskan fish species from environmental DNA: Conservation Genetics Resources, https://doi.org/10.1007/s12686-018-1071-7.

U.S. Geological Survey and U.S. Fish and Wildlife Service Science Support and Quick Response Program

This program operates as a nationwide annual science collaboration in which USGS scientists address priority research needs identified by the FWS. FWS priorities for these funds change annually and, for 2018, the FWS Alaska Region identified a need to focus on science information delivery on topics addressing invasive species, climate change, and landscape conservation design. The final USGS ASC projects chosen by the FWS Alaska and Pacific Region for funding in 2018 were as follows:

- Managing for shorebirds on O'ahu, Hawai'i—Space-use, habitat-use and status of five species of migratory shorebirds;
- Cross-seasonal effects and disease as constraints on numbers of emperor geese;
- Population ecology of polar bears in the Chukchi Sea in response to changing sea-ice conditions;
- A collaborative approach to assess migration route and stopover sites, habitat selection, status, and trends of a FWS species of high concern, the buff-breasted sandpiper;
- Design of a photographic survey approach to estimation of population size of black brant at Izembek National Wildlife Refuge; and
- Prioritization and risk assessment of freshwater invasive species to Alaska.

Emperor geese gathered near the shoreline on Kodiak Island, Alaska. Photograph by Brian Uher-Koch, U. S. Geological Survey.

Time frame	Budget	Project partner
FY2018–19	$700,000	U.S. Fish and Wildlife Service, Alaska Region and Pacific Region.

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094; and
Grant Hilderbrand, ASC, ghilderbrand@usgs.gov, (907) 786–7076

Recent Publications

Leach, A.G., Ward, D.H., Sedinger, J. S., Riecke, T.V., Hupp, J.W., and Ritchie, R.J., 2019, Spatial distribution of band recoveries of black brant: Journal of Wildlife Management, v. 83, p. 304–311, https://doi.org/10.1002/jwmg.21595.

Regehr, E.V., Hostetter, N.J., Wilson, R.R., Rode, K.D., St. Martin, M., and Converse, S.J., 2018, Integrated population modeling provides the first empirical evidence of vital rates and abundance for polar bears in the Chukchi Sea: Scientific Reports, v. 8, article no. 16780.

Rode, K.D, Olson, J., Smith, T., Eggett, D., Douglas, D., Durner, D., Atwood, T.C., Regehr, E. V., Wilson, R.R., Smith, T., and St. Martin, M., 2018, Denning phenology and reproductive success of polar bears in a changing climate: Journal of Mammalogy, v. 99, p. 16–26.

Rode, K.D., Wilson, R.R., Douglas, D.C., Muhlenbruch, V., Atwood, T.C., Regehr, E.V., Richardson, E.S., Pilfold, N.W., Derocher, A.E., Durner, G.M., Stirling, I., Amstrup, S.C., St. Martin, M., Pagano, A.M., and Simac, K., 2018, Spring fasting behavior in a marine apex predator provides an index of ecosystem productivity: Global Change Biology, v. 24, p. 410–423.

Ware, J.V., Rode, K.D, Bromaghin, J.F., Douglas, D.C., Wilson, R.R., Regehr, E.V., Amstrup, S.C., Durner, G., Pagano, A.M., Olson, J., Robbins, C.T., and Jansen, H.T., 2017, Habitat degradation affects the summer activity of polar bears: Oecologia, v. 184, p. 87–99.

Alaska Native Science and Engineering Program Partnership

The USGS Alaska Region partners with the University of Alaska Anchorage Alaska Native Science and Engineering Program (ANSEP), a comprehensive Science, Technology, Engineering, and Math (STEM) program beginning with students in sixth grade and continuing through high school, into science and engineering undergraduate and graduate degree programs through to the Ph.D. ANSEP's objective is to effect systematic change in the hiring patterns of Alaska Natives in science and engineering by placing students on a career path to leadership. USGS partners with ANSEP through a cooperative agreement, providing $50,000 per year to support the program. Currently, USGS is in year 3 of a 3-year agreement with ANSEP, and this is the second agreement with the program. USGS also provides ANSEP students with opportunities (1) to work in a multidisciplinary science environment that examines fish, wildlife, and lands in an ecosystem context; (2) to conduct water and mineral resource assessments; (3) to acquire a better understanding of natural hazards; and (4) to use state-of-the-art tools, from the latest molecular genetics techniques to geospatial information technologies. USGS funds these student hires at a cost of $10,000 per year.

Alaska Native Science and Engineering Program student working in the U.S. Geological Survey Alaska Science Center genetics laboratory.

Time frame	Budget	Project partner
FY2006–ongoing	$60,000	Alaska Native Science and Engineering Program.

Contact

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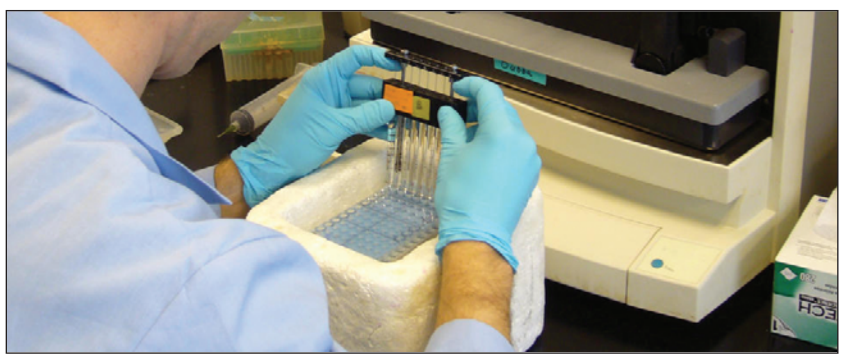
Project Link

https://www.ansep.net/

Developing and Applying Molecular Tools to Natural Resource Problems in Alaska

This project is conducted by staff members of the ASC and includes various research directions and methods that inform our partners about genetics and genomics. In 2018, research objectives included (1) genetic characterization of wolf, bears, invasive species and migratory birds for the NPS, the ADF&G and the FWS; (2) research on modeling future distributions of high-Arctic vertebrates in the tundra ecosystem; (3) population genetics on high-latitude bird species such as the three loon species, Pacific black brant, Steller's eiders, and raptors; (4) genomic assessment of Artic cod in the southern Beaufort Sea; (5), use of environmental DNA (eDNA) to survey terrestrial and marine ecosystems for native and invasive species; and (6) development of genetic markers for conducting research on species of management agency interest.



Molecular ecology laboratory procedure. Photograph by Yvette Gillies, U.S. Geological Survey.

Time frame	Budget	Project partners
FY2005–19	$700,000	U.S. Fish and Wildlife Service ($100,000), National Park Service ($50,000), Alaska Department of Fish and Game ($100,000), Bureau of Ocean Energy Management ($100,000), and California Department of Fish and Wildlife ($100,000).

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094

Project Link

https://www.usgs.gov/centers/asc/science/molecular-ecology-laboratory-alaska?qt-science_center_objects=0#qt-science_center_objects

Recent Publications

Colella, J.P., Lan, T., Schuster, S.C., Talbot, S.L., Cook, J.A., and Lindqvist, C., 2018, Whole-genome analysis of *Mustela erminea* finds that pulsed hybridization impacts evolution at high-latitudes: Communications Biology, article no. 51, https://doi.org/10.1038/s42003-018-0058-y.

Gravley, M.C., Sage, G.K., Talbot, S.L., and Carlson, M.L., 2018, Development and characterization of 12 polymorphic microsatellite loci in the sea sandwort, *Honckenya peploides*: Journal of Plant Research, v. 131, no. 5, p. 879–885, https://doi.org/10.1007/s10265-018-1036-7.

Greiman, S.E., Cook, J.A., Tkach, V., Hoberg, E.P., Menning, D.M., Hope, A.G., Sonsthagen, S.A., and Talbot. S.L., 2018, Museum metabarcoding—A novel method revealing gut helminth communities of small mammals across space and time: International Journal of Parasitology, v. 48, no. 13, p. 1061–1070, https://doi.org/10.1016/j.ijpara.2018.08.001.

Wilson, R.E., Ely, C.R., and Talbot, S.L., 2018, Flyway structure in the circumpolar greater white-fronted goose: Ecology and Evolution, v. 8, no. 16, p. 8490–8507, https://doi.org/10.1002/ece3.4345.

Wilson, R.E., Menning, D.M., Wedemeyer, K., and Talbot, S.L., 2018, A transcriptome resource for the Arctic Cod (*Boreogadus saida*): Marine Genomics, v. 41, p. 57–61, https://doi.org/10.1016/j.margen.2018.03.003.

Genomics of Wildlife

The Genomics of Wildlife project is conducted by two staff members of the ASC and includes various research directions and methods that inform our partners. In 2018, research objectives included (1) providing guidance to ASC staff on genomics laboratory protocols and data processing pipelines; (2) determining breeding area origins of harvested common eiders in the Eastern United States and Canada; (3) genomics of the rusty blackbird, a species of conservation concern; (4) genetics to assist with age structure and forage species of Pacific walrus in the Chukchi Sea; and (5) genetic analyses of endangered bird species in Hawaii.

Pacific walrus hauled out on sea ice in the Chukchi Sea, northern Alaska. Photograph by Tyrone Donnelly, U.S. Geological Survey.

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094

Time frame	Budget	Project partners
FY2005–19	$200,000	U.S. Fish and Wildlife Service ($50,000), Sea Duck Joint Venture ($50,000), and Canadian Wildlife Service ($20,000).

Project Link

https://www.usgs.gov/centers/asc/science/molecular-ecology-laboratory-alaska?qt-science_center_objects=0#qt-science_center_objects

Recent Publications

Sonsthagen, S.A., Wilson, R.E., and Underwood, J.G., 2018, Interisland genetic structure of two endangered Hawaiian waterbirds—The Hawaiian Coot and Hawaiian Gallinule: Condor, v. 120, no. 4, p. 863–873, https://doi.org/10.1650/CONDOR-18-98.1.

van Rees, C.B., Reed, J.M., Wilson, R.E., Underwood, J.G., and Sonsthagen, S.A., 2018, Small-scale genetic structure in an endangered wetland specialist: possible effects of landscape change and population recovery: Conservation Genetics, v. 19, no. 1, p. 129–142, https://doi.org/10.1007/s10592-017-1020-0.

U.S. Geological Survey Emerging Wildlife Disease

The USGS Emerging Wildlife Disease project is a funding opportunity for USGS scientists nationwide to compete for internal research funding to address diseases of high concern to the United States. This project is conducted by staff members of the ASC and historically has focused on emerging disease topics such as avian influenza, bacterial and parasitic infections in wildlife, and Avian Keratin Disorder in landbirds. In 2018, research objectives included (1) quantification of avian influenza prevalence, maintenance, and evolution in wild waterfowl sampled in the migratory bird flyways of the United States; (2) determination of parasites infecting landbirds of Alaska; (3) investigation of a candidate virus associated with Avian Keratin Disorder; and (4) testing of seabird tissues for harmful algal toxins.

Common murres in a colony in Cook Inlet, south-central Alaska, 2017. Photograph by U.S. Geological Survey.

Time frame	Budget	Project partners
FY2005–19	$250,000	U.S. Fish and Wildlife Service ($100,000), Bureau of Land Management ($20,000), U.S. Department of Agriculture, and USGS National Wildlife Health Center ($100,000).

Contact

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Project Link

https://www.usgs.gov/centers/asc/science/wildlife-disease-and-environmental-health-alaska?qt-science_center_objects=0#qt-science_center_objects

Recent Publications

Li, L., Bowman, A.S., DeLiberto, T.J., Killian, M.L., Krauss, S., Nolting, J.M., Torchetti, M.K., Ramey, A.M., Reeves, A.B., Stallknecht, D.E., Webby, R.J., and Wan, X.-F., 2018, Genetic evidence supports sporadic and independent introductions of low pathogenic H5 avian influenza A viruses from wild birds to domestic poultry in North America: Journal of Virology, 92:e00913-18, https://doi.org/10.1128/JVI.00913-18.

Ramey, A.M., DeLiberto, T.J., Berhane, Y., Swayne, D.E., and Stallknecht, D.E., 2018, Lessons learned from research and surveillance directed at highly pathogenic influenza A viruses in wild birds inhabiting North America: Virology, v. 518, p. 55–63, https://doi.org/10.1016/j.virol.2018.02.002.

Ramey, A.M., Reeves, A.B., Donnelly, T.F., Poulson, R.L., and Stallknecht, D.E., 2018, Introduction of Eurasian-origin influenza A(H8N4) virus into North America by migratory birds: Emerging Infectious Diseases, v. 24, no. 10, https://doi.org/10.3201/eid2410.180447.

Reed, J.A., Sexson, M.G., Smith, M.M., Schmutz, J.A., and Ramey, A.M., 2018, Evidence for Haemosporidian parasite infections in Spectacled Eiders (*Somateria fischeri*) sampled in Alaska, USA during the breeding season: Journal of Wildlife Diseases, v. 54, no. 4, p. 877–880, https://doi.org/10.7589/2018-01-012.

Reeves, A.B., Hall, J.S., Poulson, R.L., Donnelly, T.F., Stallknecht, D.E., and Ramey, A.M., 2018, Influenza A virus recovery, diversity, and intercontinental exchange—A multi-year assessment of wild bird sampling at Izembek National Wildlife Refuge, Alaska: PLoS One, v. 13, no. 4, e0195327, https://doi.org/10.1371/journal.pone.0195327.

Schoen, S.K., Van Hemert, C., Smith, M.M., Arimitsu, M.L., Pearce, J.M., Kaler, R., and Bodenstein. B., 2018, Harmful algal bloom toxins in Alaska seabirds: U.S. Geological Survey and U.S. Fish and Wildlife Service, bureau-approved informational handout, 2 p., https://prd-wret.s3-us-west-2.amazonaws.com/assets/palladium/production/s3fs-public/atoms/files/USGS_HAB_toxins_in_Alaska_sea_birds_September_2018.pdf.

U.S. Geological Survey Changing Arctic Ecosystems—Cross-Cutting Science Theme

The USGS Changing Arctic Ecosystems (CAE) program quantifies the current and likely future response of wildlife and habitats to physical change in the Arctic and rapidly responds to the science needs of DOI agencies and other decision makers. Research objectives of this particular CAE project in FY2019 included a data summary and analysis for (1) investigation of sea ice and marine benthic community shifts, (2) wildlife disease in a changing Arctic, (3) functional genomics of wildlife response, (4) hydro-ecological response of river ecosystems to permafrost thaw, and (5) shifts in abundance and distribution of 20 waterbird species over a 26-year time period on the Arctic Coastal Plain of northern Alaska. Many other additional CAE projects are described in subsequent pages.

Arctic fox in the summer on the northern coast of Alaska. Photograph by Ryan Askren, U.S. Geological Survey.

Time frame	Budget	Project partners
FY2015–19	$500,000	National Park Service, North Slope Borough, U.S. Department of Agriculture, University of Texas, and U.S. Fish and Wildlife Service.

Contacts

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094; and Grant Hilderbrand, ASC, ghilderbrand@usgs.gov, (907) 786–7076

Recent Publication

Van Hemert, C.R., Spivey, T.J., Uher-Koch, B.D., Atwood, T.C., Sinnett, D.R., Meixell, B.W., Hupp, J.W., Jiang, K., Adams, L.G., Gustine, D.D., Ramey, A.M., and Wan, X., 2018, Survey of Arctic Alaskan wildlife for influenza A antibodies—Limited evidence for exposure of mammals: Journal of Wildlife Diseases, v. 55, no. 2, p. 387–398, https://doi.org/10.7589/2018-05-128.

Project Link

https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems?qt-science_center_objects=0#qt-science_center_objects

Measuring and Forecasting the Response of Wildlife to Changes in Ecosystem Processes on the Arctic Coastal Plain

Research objectives of this CAE project in FY2019 included (1) greater understanding in the behavioral shifts of Arctic-nesting geese to earlier spring phenology and to the increase of the western Arctic snow goose population in northern Alaska; (2) contribution of shorebird information from northern Alaska to the Arctic Shorebird Demographic Network that quantifies response of shorebird species to Arctic change across a network of 16 northern latitude study sites in Russia, the United States, and Canada; (3) estimation of survival rates of three species of loons that breed in northern Alaska; and (4) quantification of forage quality and quantity for caribou of the Central Arctic Herd.

Caribou grazing on the tundra.

Time frame	Budget	Project partners
FY2015–ongoing	$1,000,000	Bureau of Land Management ($100,000), U.S. Fish and Wildlife Service ($100,000), and Alaska Department of Fish and Game ($100,000).

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094

Recent Publications

Barboza, P.S., Van Someren, L.L., Gustine, D.D., and Bret-Harte, M.S., 2018, The nitrogen window for arctic herbivores—Plant phenology and protein gain of migratory caribou (*Rangifer tarandus*): Ecosphere, v. 9, no. 1, e02073, https://doi.org/10.1002/ecs2.2073.

Hupp, J.W., Ward, D.H., Soto, D.X., and Hobson, K.A., 2018, Spring temperature, migration chronology, and nutrient allocation to eggs in three species of arctic-nesting geese—Implications for resilience to climate warming: Global Change Biology, v. 24, no. 11, p. 5056–5071, https://doi.org/10.1111/gcb.14418.

Johnson, H.E., Gustine, D.D., Golden, T.S., Adams, L.G., Parrett, L.S., Lenart, E.A., and Barboza, P.S., 2018, NDVI exhibits mixed success in predicting spatiotemporal variation in caribou summer forage quality and quantity: Ecosphere, v. 9, no. 10, e02461, https://doi.org/10.1002/ecs2.2461.

Oster, K.W., Barboza, P.S., Gustine, D.D., Joly, K., and Shively, 2018, R., Mineral constraints on arctic caribou (*Rangifer tarandus*)—A spatial and phenological perspective: Ecosphere, v. 9, no. 3, e02160, https://doi.org/10.1002/ecs2.2160.

Uher-Koch, B.D., Koch, J.C., Wright, K.W., and Schmutz, J.A., 2018, Comparative nest survival of three sympatric loon species breeding in the Arctic: Journal of Avian Biology, v. 49, no. 7, e01671, https://doi.org/10.1111/jav.01671.

Weiser, E.L., Lanctot, R.B., Brown, S.C., Gates, H.R., Bentzen, R.L., Bêty, J., Boldenow, M.L., English, W.B., Franks, S.E., Koloski, L., Kwon, E., Lamarre, J-F., Lank, D.B., Liebezeit, J.R., McKinnon, L., Nol, E., Rausch, J., Saalfeld, S.T., Senner, N.R., Ward, D.H., Woodard, P.F., and Sandercock, B.K., 2018, Environmental and ecological conditions at Arctic breeding sites have limited effects on true survival rates of adult shorebirds: The Auk, v. 135, no. 1, p. 29–43, https://doi.org/10.1642/AUK-17-107.1.

Weiser, E.L., Lanctot, R.B. Brown, S.C. Gates, H.R. Bentzen, R.L. Boldenow, M.L. Cunningham, J.A. Doll, A.C., Donnelly, T.F., English, W.B., Franks S.E., Grond, K., Herzog, P., Hill, B.L., Kendall, S.J., Kwon, E., Lank, D.B., Liebezeit, J.R., Rausch, J., Saalfeld, S.T., Taylor, A.R., Ward, D.H., Woodard, P.F., and Sandercock, B.K., 2018, Effects of leg flags on nest survival of four species of Arctic-breeding shorebirds: Journal of Field Ornithology, v. 89, no. 3, p. 287–297, https://doi.org/10.1111/jofo.12264.

Project Link

https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems?qt-science_center_objects=0#qt-science_enter-objects

Forecasting Effects of Climate Change on the Distribution and Abundance of Birds

Research objectives of this CAE project in FY2019 included (1) analysis and summary of landbird abundance and habitat change on the Seward Peninsula in western Alaska over a 26-year time frame, and (2) summary of a multi-year landbird productivity survey on the Seward Peninsula.

Time frame	Budget	Project partner
FY2015–19	$500,000	National Park Service ($50,000).

Whimbrel on the tundra, Seward Peninsula, Alaska. Photograph by Rachel Richardson, U.S. Geological Survey.

Contact

John Pearce, ASC, jpearce@usgs.gov, (907) 786–7094

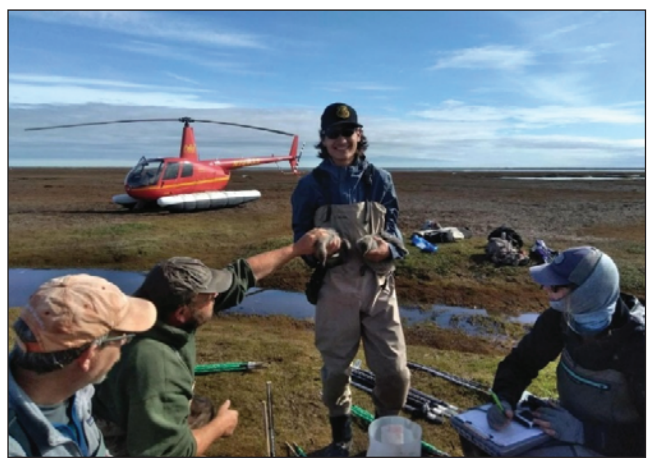
Project Link

https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems?qt-science_center_objects=0#qt-science_center_objects

Alaska Native Science and Engineering Program Outreach

Objectives of this CAE project in FY2019 included (1) support of ANSEP through summer and longer-term internships at the USGS ASC to provide science experience and training to Alaska Native students and other students, and (2) teaching and outreach to ANSEP summer middle school classes about the work of scientists at the USGS.

Time frame	Budget	Project partner
FY2015–19	$50,000	Alaska Native Science and Engineering Program.



U.S. Geological Survey intern on the Colville River Delta, northern Alaska.

Contact

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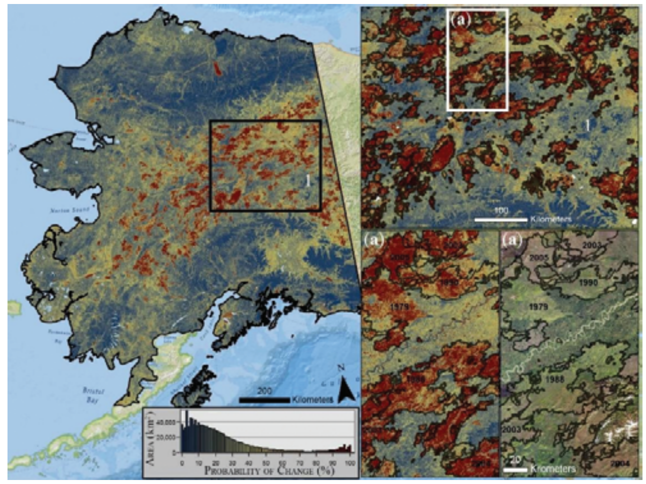
Project Link

https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems?qt-science_center_objects=0#qt-science_center_objects

Data Management, Integration, and Visualization

Objectives of this CAE project in FY2019 included (1) briefings and presentations delivered to the Waterfowl Conservation Committee (Bethel, Alaska), North Slope Borough Planning Commission (Utqiagvik, Alaska), and Alaska Tribal Conference on Environmental Management (Anchorage, Alaska); (2) publication of a report on recent (2002–2017) studies within the 1002 Area of the ANWR; (3) participation in the One Health Disease Prioritization Workshop for Alaska; and (4) data management support for CAE research projects.



Map of Alaska showing probability of change occurrence.

Time frame	Budget	Project partner
FY2015–19	$100,000	U.S. Fish and Wildlife Service ($50,000).

Contact

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Project Link

https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems?qt-science_center_objects=0#qt-science_center_objects

Recent Publications

Adams, L.G., and Gustine, D.D., 2018, Caribou forage and soil data, North Slope of Alaska, 2011–2014: U.S. Geological Survey data release, https://doi.org/10.5066/F7JQ106W.

Fischbach, A.S., and Jay, C.V., 2018, Pacific walrus seasonal distribution from USGS Tracking Data, Chukchi and Bering Seas, 1987–2015: U.S. Geological Survey data release, https://doi.org/10.5066/F7VH5N43.

Koch, J.C., 2018, Arctic Coastal Plain seasonal lake drainage, water temperature, and solute and nutrient concentrations, 2011–2014: U.S. Geological Survey data release, https://doi.org/10.5066/F7BC3XHJ.

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Hydro-Ecology of the Arctic

Research objectives of this CAE project in FY2019 included (1) continued monitoring of basins for the Hydro-Ecology of Arctic Thaw (HEAT) project, focused on the link between Arctic warming and altered hydrology, biogeochemistry, and ecology of headwater streams; (2) studying the implications of early season flooding on nesting area use by Pacific black brant geese; and (3) studying the impacts of goose population increases on pond ecosystems in northern Alaska.

Time frame	Budget
FY2015–19	$200,000

Stream winding through polygonal ground on the Arctic Coastal Plain, northern Alaska. Photograph by Josh Koch, U.S. Geological Survey.

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Project Links

https://www.usgs.gov/centers/asc/science/changing-arctic-ecosystems?qt-science_center_objects=0#qt-science_center_objects
https://www.usgs.gov/centers/asc/science/hydro-ecology-arctic-thawing-heat-hydrology?qt-science_center_objects=0#qt-science_center_objects

Recent Publications

Koch, J.C., Fondell, T.F., Laske, S.M., and Schmutz, J.A., 2018, Nutrient dynamics in partially drained arctic thaw lakes: Journal of Geophysical Research—Biogeosciences, v. 123, no. 2, p. 440–452, https://doi.org/10.1002/2017JG004187.

Koch, J.C., Jorgenson, M.T., Wickland, K.P., Kanevskiy, M., and Striegl, R.G., 2018, Ice wedge degradation and stabilization impacts water budgets and nutrient cycling in Arctic trough ponds: Journal of Geophysical Research—Biogeosciences, v. 123, no. 8, p. 2604–2616.

Acronyms

Acronym	Full name
AAR	After Action Review
ADF&G	Alaska Department of Fish and Game
AKDOT&PF	Alaska Department of Transportation and Public Facilities
ANSEP	Alaska Native Science and Engineering Program
ARDF	Alaska Resource Data File
ASC	USGS Alaska Science Center
AU	assessment units
AVO	Alaska Volcano Observatory
BCFG	billion cubic feet
BOEM	Bureau of Ocean and Energy Management
CAE	USGS Changing Arctic Ecosystems
°C	degrees Celsius
DGGS	Alaska Division of Geological and Geophysical Surveys
DOI	U.S. Department of the Interior
EarthMRI	USGS Earth Mapping Resources Initiative
EROS Center	USGS Earth Resources Observation and Science Center
FRESC	USGS Forest and Rangeland Ecosystem Science Center
FWS	U.S. Fish and Wildlife Service
FY	Fiscal Year
GIS	geographic information system
Hg	mercury
IfSAR	Interferometric Synthetic Aperture Radar
ION	Indigenous Observation Network
JIRP	Juneau Icefield Research Program
lidar	light detection and ranging
MII	marine intertidal invertebrate
MSB	Matanuska-Susitna Borough
NASA	National Aeronautics and Atmospheric Administration
NHD	National Hydrography Dataset
NHDPlus HR	National Hydrography Dataset Plus High Resolution
NOAA	National Oceanic and Atmospheric Administration
NPR-A	National Petroleum Reserve in Alaska
NPS	National Park Service
OCS	Outer Continental Shelf
QRP	Quick Response Program
SSP	Service Science Support
TPS	Total Petroleum System
USGS	U.S. Geological Survey
VSC	Volcano Science Center
WBD	Watershed Boundary Dataset
3D	three-dimensional
3DEP	3D Elevation Program
Y-K Delta	Yukon-Kuskokwim Delta

Active Research Partners

Aarhus University [Denmark]
Ahtna Native Regional Corporation
Alaska Department of Transportation and Public Facilities
Alaska Division of Geological & Geophysical Surveys
Alaska Division of Geological & Geophysical Surveys
Alaska Division of Geological and Geophysical Surveys
Alaska Geospatial Council
Alaska Hydrography Technical Working Group
Biodiversity Research Institute
Bureau of Indian Affairs
Bureau of Land Management
Bureau of Ocean and Energy Management
Canadian Wildlife Service
City of Unalakleet
Columbia University
Department of Natural Resources
Eskimo Walrus Commission
Exxon Valdez Oil Spill Trustee Council
Farallon Institute
Federal Emergency Management Agency
Full Name
Geological Survey of Canada
GEOMAR, Kiel [Germany]
Juneau Icefield Research Program
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration
National Park Service
National Resources Conservation Service
National Science Foundation
National Streamflow Information Program
National Weather Service
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US Fish and Wildlife Service
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Yukon River Inter-Tribal Watershed Council

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